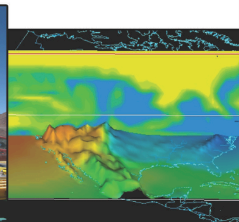
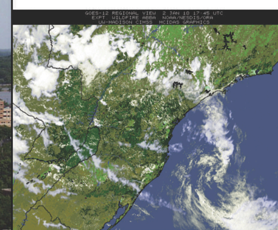
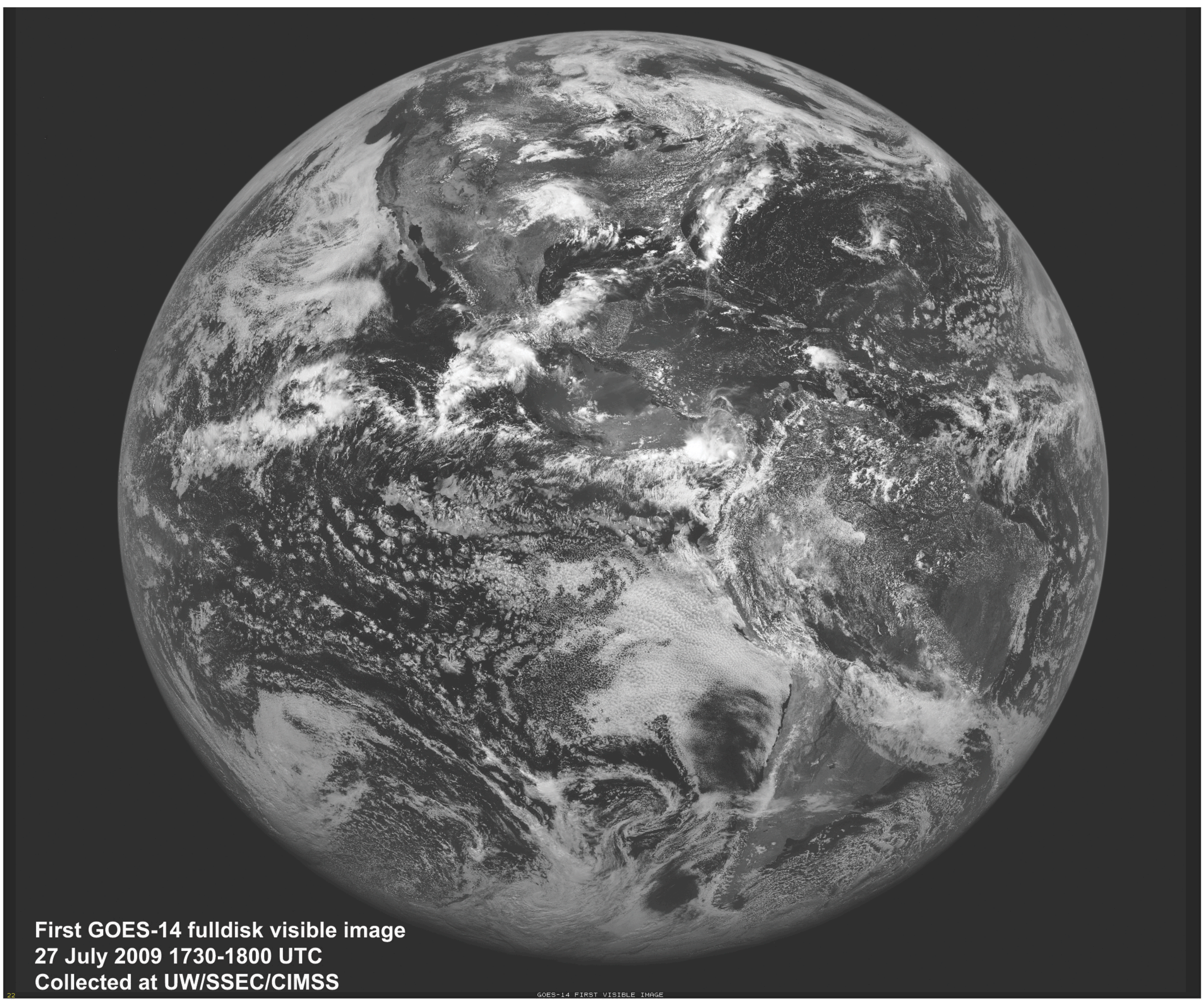
Proposal for the continuation of The Cooperative Institute for Meteorological Satellite Studies at the University of Wisconsin-Madison

CIMSS

from concepts and data to products and applications



First GOES-14 fulldisk visible image
27 July 2009 1730-1800 UTC
Collected at UW/SSEC/CIMSS

Proposal for the continuation of The Cooperative Institute for Meteorological Satellite Studies at the University of Wisconsin-Madison

Principal Investigator: Steven Ackerman

Total Proposed Cost:
$60,000,000

For the Period:
1 July 2010 to 30 June 2015

Abstract

The University of Wisconsin–Madison proposes to continue hosting a NOAA Cooperative Institute (CI) that will conduct research to support NOAA’s mission goals of “Serve Society's Needs for Weather and Water Information” and “Mission Support.” This CI will conduct work in four theme areas: (1) Satellite Meteorology Research and Applications, to support weather analysis and forecasting through participation in NESDIS product assurance and risk reduction programs and the associated transitioning of research progress into NOAA operations, (2) Satellite Sensors and Techniques, to conduct instrument trade studies and sensor performance analysis supporting NOAA’s future satellite needs as well as assisting in the long term calibration and validation of remote sensing data and derived products, (3) Environmental Models and Data Assimilation, to work with the Joint Center for Satellite Data Assimilation (JCSDA) on improving satellite data assimilation techniques in operational weather forecast models, and (4) Outreach and Education, to engage the workforce of the future in understanding and using environmental satellite observations for the benefit of an informed society.

This proposal details the activities that will build upon the established practices and procedures of the current Cooperative Institute for Meteorological Satellite Studies (CIMSS) housed within the Space Science and Engineering Center (SSEC) that already has a 30-year history of successful collaborations with NOAA, NESDIS/STAR, and the Advanced Satellite Products Branch (ASPB), collocated at UW-Madison. Additionally, through the UW Department of Atmospheric and Oceanic Sciences (AOS), CIMSS participates in a degree granting education program in atmospheric and oceanic sciences. With these strong partnerships, CIMSS has established the reputation as a center of excellence in environmental satellite remote sensing applications. This proposal seeks to continue supporting NOAA in meeting the weather and climate challenges of today and tomorrow.

Proposal for the continuation of The Cooperative Institute for Meteorological Satellite Studies at the University of Wisconsin-Madison

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Executive Summary

This proposal for the continuation of a National Oceanic and Atmospheric Administration (NOAA) Cooperative Institute (CI) at the University of Wisconsin-Madison (UW) builds upon the established successes of the current Cooperative Institute for Meteorological Satellite Studies (CIMSS). We propose to conduct research in support of NOAA's mission goals titled "Serve Society's Needs for Weather and Water Information" and "Mission Support." This work will focus on four theme areas: (1) Satellite Meteorology Research and Applications, (2) Satellite Sensors and Techniques, (3) Environmental Models and Data Assimilation, and (4) Outreach and Education. In this next phase of the CIMSS partnership with NOAA we propose to continue: 1) conducting collaborative, long-term research that involves NOAA scientists; 2) utilizing our scientific, education, and outreach expertise to support NOAA's research needs and mission; and 3) supporting student participation in NOAA-related research studies.

We have a 30-year history of successful collaborations with the National Environmental Satellite, Data, and Information Service's (NESDIS's) Center for Satellite Applications and Research (STAR) and its Advanced Satellite Products Branch (ASPB) collocated at UW. CIMSS has established and will continue to maintain an outstanding research program that remains relevant to NESDIS and NOAA, particularly in the area of satellite remote sensing. As a CI within the Space Science and Engineering Center (SSEC), we offer access to unique resources, such as SSEC's Data Center. The infrastructure supplied by SSEC/CIMSS helps the ASPB meet its objectives and supports the transition of research findings to operational environments. In addition, through the UW Department of Atmospheric and Oceanic Sciences (AOS), UW-CIMSS participates in a strong education program offering graduate and undergraduate degrees. We will continue to promote the involvement of students and postdoctoral scientists in NOAA-funded research.

UW-CIMSS works closely with NESDIS to define research projects of mutual interest. Thus, this CI proposal describes activities in broad terms, which will be specified in more detail collaboratively with STAR and ASPB upon selection for continuation. UW-CIMSS proposes activities that directly contribute to the NOAA themes for this CI:

Theme: Satellite Meteorology Research and Applications

- Develop new methods of using Geostationary Operational Environment Satellites (GOES) to support weather analysis and forecasting through participation in programs like the GOES Improved Measurements and Product Assurance Plan (GIMPAP) and GOES-R Risk Reduction;
- Transition research to NOAA operations through participation in activities such as the Product Systems Development and Implementation (PSDI) and GOES-R Algorithm Working Group (AWG);
- Develop climate datasets from geostationary and polar orbiting weather and environmental satellites;
- Develop improved methods of characterizing the atmosphere using satellite observations, in particular, continue advancement of atmospheric profiling, atmospheric motion vectors, tropical cyclone analysis, fire detection, cloud properties, and ozone retrievals;
- Produce new and advanced analysis products by integrating measurements from geostationary and polar satellites with aircraft and ground-based observations to better detect aviation weather hazards; and
- Advance synergistic algorithms for atmospheric and environmental products from multiple sensors from single platforms and multiple platforms.

Theme: Satellite Sensors and Techniques

- Conduct instrument trade studies and sensor performance analysis to support NOAA's future satellite needs;
- Contribute expertise and algorithms to the international efforts to intercalibrate the Global Observing System for geostationary and polar orbiting imagers and sounders;

- Participate in post-launch test efforts for the GOES and NPOESS (National Polar-orbiting Operational Environmental Satellite System) Preparatory Project (NPP) / Joint Polar Satellite System (JPSS) series of satellites;
- Further develop software modules (such as HYDRA and McIDAS-V (Man computer Interactive Data Assimilation System)) that enable quantitative interrogation and comparison of remote sensing data and derived products; and
- Continue to maintain and develop direct broadcast processing packages to provide the National Weather Service (NWS) with products to aid in real time forecast and fire management, air quality monitoring and to support international direct broadcast users.

Theme: Environmental Models and Data Assimilation

- Develop and improve existing data assimilation techniques;
- Improve radiance assimilation techniques through efforts to improve the community radiative transfer model (CRTM);
- Continue collaboration with NOAA to quantify and improve the information obtained from existing and future satellites; and
- Continue participation in Observing System Experiments (OSE) and Observing System Simulation Experiments (OSSE) that help guide NESDIS planning for the future and improve utilization of the present remote sensing assets.

Theme: Outreach and Education

- Continue education of students in NOAA-related fields in order to provide a suitable workforce for the future;
- Continue research training for undergraduate and graduate students through collaborations with the Department of Atmospheric and Oceanic Sciences;
- Participate in the Cooperative Research Program (CoRP) Science Symposium;
- Provide professional training on the use of satellite observations in weather forecasting through programs such as GOES-R Proving Ground, Satellite Hydrology and Meteorology Course (SHyMet) and the Virtual Institute for Satellite Integration Training (VISIT);
- Continue to work with the NWS in bringing appropriate satellite images and derived products to the forecasting offices;
- Conduct outreach to the public through participation in activities such as Science On a Sphere (SOS), radio call in shows, and the American Meteorological Society’s (AMS) WeatherFest;
- Train high school teachers on the uses of environmental satellite data through workshops, online training activities and our *Satellite Meteorology for Grades 7-12* CD and Web site;
- Continue to offer week-long remote sensing schools to the national and international communities;
- Support the Suomi Distinguished Professor position; and
- Extend education collaborations with STAR Cooperative Institutes (CIs) and NOAA’s Cooperative Remote Sensing Science and Technology Center (CREST).

The above activities, conducted in collaboration with NOAA scientists, are aimed at helping NOAA deliver weather and water information that serves society’s needs and at providing mission support. Three additional functions that UW-CIMSS performs to achieve the same ends are:

- Hosting ASPB and providing the infrastructure for them to continue their work. Beyond addressing space needs, UW provides technical support, library facilities, and Data Center access;
- Organizing and hosting NOAA-sponsored conferences, symposiums and workshops; such as the GOES-R AWG annual review meetings and GOES User’s Conference; and
- Supporting the National Climatic Data Center (NCDC) by maintaining the SSEC’s Data Center holdings, including over 30 years of GOES data, nearly a decade of non-GOES geostationary satellite data, and archiving satellite data that NOAA does not receive (e.g., GOES-10, China’s FY-2, India’s Kalpana).

Administratively, the UW-CIMSS will remain part of SSEC, an interdisciplinary research center within the UW Graduate School. This structure enables ASPB to be integrated seamlessly within CIMSS while providing substantial infrastructure to support research. The 2004 NOAA five-year review team evaluating UW-CIMSS was “favorably impressed by the solid CIMSS administration” and “the outstanding accounting system as well as exceptional staff members.” We will continue this administrative structure.

CIMSS has clear performance measures that we use to assess our capabilities and progress. Examples include the quality and quantity of publications in topical areas, the strength of outside collaborations, the efficiency and frequency of research transferred to operations, the success of graduate students supported by CIMSS research, and guidance from the Board of Directors and the Science Council. We will continue to work with NOAA/STAR to ensure that performance metrics are adapted and added in our research plan when deemed necessary.

Over the last 30 years, the existence of CIMSS has proven to be mutually beneficial to the UW and NOAA. We propose to continue providing these benefits.

1. Introduction

Accomplishments of UW-CIMSS are found throughout this proposal. Many of these achievements result from partnerships developed over many years. The following story illustrates one of these successful collaborations achieved through experienced teamwork.

On 27 June 2009 GOES-O was launched aboard a Delta IV rocket from Florida's Cape Canaveral Air Force Station. It was designated GOES-14 on 7 July 2009 when it successfully reached geostationary orbit. The first calibrated full disk visible image (see cover) was received by the SSEC Data Center at UW-Madison beginning at 17:30 UTC on 27 July 2009. After collection, SSEC transferred the image to NOAA's Office of Satellite Data Processing and Distribution (OSDPD). Shortly afterwards, the quality image appeared as part of an entry on the *CIMSS Satellite Blog* (http://cimss.ssec.wisc.edu/goes/blog/archives/3054) as well as elsewhere on the UW-CIMSS and SSEC Web sites in order to announce NOAA's success and the roles of CIMSS and SSEC in creating that success story.

On 17 August 2009 SSEC began receiving the first calibrated infrared full disk images (see Figure 1). Because NOAA had difficulty in bringing in these first infrared (IR) images, the SSEC Data Center provided them with the data.

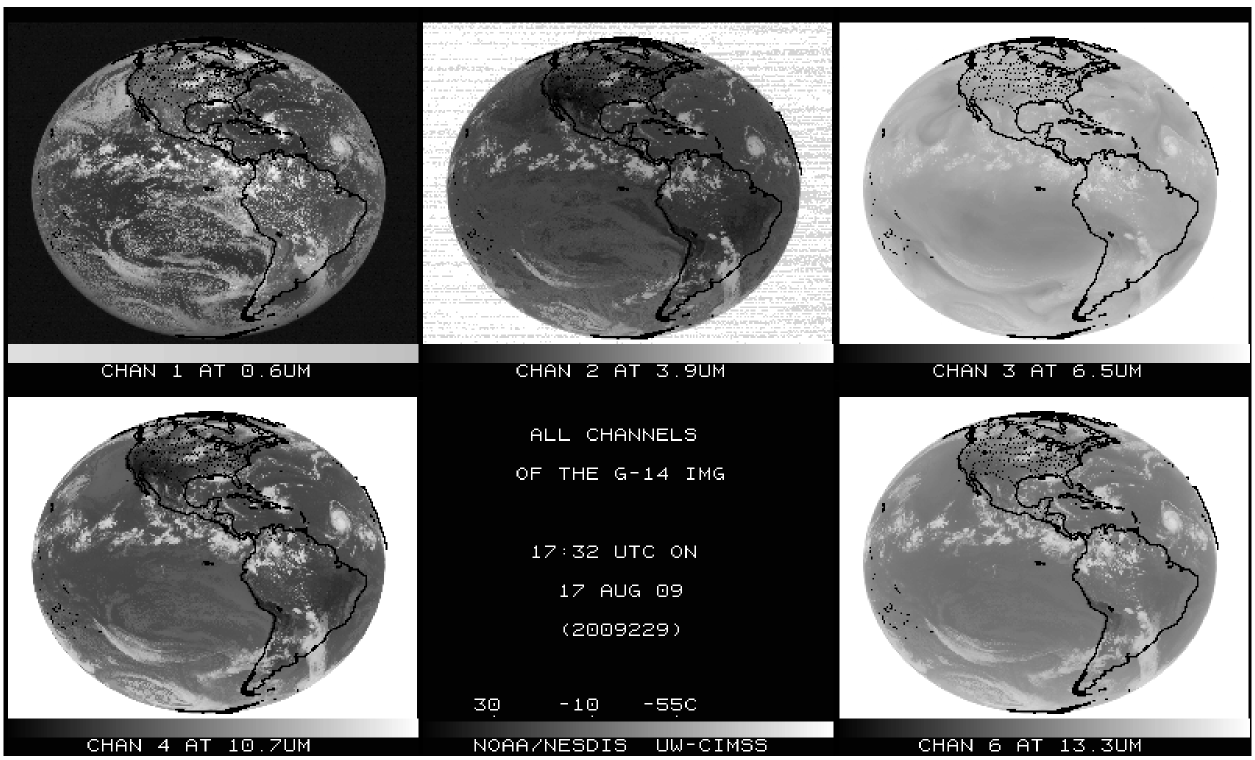

Figure 1. The first calibrated IR images (including a visible channel image) from GOES-14 received directly at SSEC by the Data Center. Direct reception at SSEC, beyond providing backup receiving capabilities for NOAA, allows NESDIS Satellite Operations Control Center (SOCC) to diagnose whether reception problems are the result of problems at NOAA SOCC or the spacecraft.

In the months that followed, UW-CIMSS scientists, working closely with the scientists from the Advanced Satellite Products Branch (ASPB) stationed at UW-CIMSS, the Cooperative Institute for Research in the Atmosphere (CIRA) and NOAA and the SSEC Data Center, participated in the post-launch science checkout and data collection (30 November 2009 to 4 January 2010). The improved image navigation and registration of GOES-14 in comparison to GOES-11 and GOES-12, was quickly demonstrated through the UW McIDAS visualization and data analysis tool. On Day 2 of the science check-out (01 December 2009), the satellite was placed into a continuous "Full Disk" scan mode, providing images of the entire hemisphere at 30 minute intervals — full disk images of the GOES-14 6.5 µm water vapor channel were soon posted on the *CIMSS Satellite Blog*. Those first images highlighted the capabilities of GOES-14. Drifting ice on the Great Lakes, volcanic plumes in Columbia and Hawaii, stratospheric intrusions into the troposphere, dust storms in Arizona, and east coast winter storms were a few of the GOES-14 science applications demonstrated by this collaborative team of university and federal researchers. The results of the post launch check-out are published in Hillger and Schmit (2009).

1.1 Background

The Cooperative Institute for Meteorological Satellite Studies (CIMSS) was established in 1980 by a Memorandum of Understanding between the University of Wisconsin-Madison (UW) and the National Oceanic and Atmospheric Administration (NOAA). The original Memorandum of Understanding (Appendix G) provides the basis for the proposed UW-CIMSS, and affirms the common interests of NOAA and the UW to conduct research on satellite observations and technology.

UW-CIMSS has worked with the Advanced Satellite Products Branch (ASPB), collocated at UW-Madison, to help NESDIS/STAR accomplish their mission of developing products from environmental satellites for short-term weather forecasting and monitoring of the earth-atmosphere system. Joint research activities include the development of algorithms to estimate cloud properties, vertical profiles of temperature and moisture, atmospheric motion, and fire characteristics; the planning and specification of future advanced satellite systems and instrumentation; and the development and application of procedures to validate the quality of measured radiances from satellite sensors. Together UW-CIMSS and ASPB perform research on the quantitative use of satellite products in numerical weather prediction systems and assist in the implementation of new techniques and products into NESDIS operations; this effort often includes real-time demonstrations of new products and/or techniques that are performed at UW-CIMSS.

As part of our research program, UW-CIMSS has had a major role in instrument design and testing as well as ground processing of satellite data into improved measurements of the Earth land, ocean, and atmosphere. UW-CIMSS has been very active in national and international field programs, testing new instrumentation, demonstrating data processing systems, and assessing the geophysical utility of the latest remote sensing measurements. Research also includes the development and testing of computer-based product analysis, data assimilation, and weather forecast techniques using existing and planned spacecraft and ground-based observations. The optimal use of satellite data in climate and global change studies has also been a vibrant part of our program. The successful transfer of many research approaches and algorithms into NOAA operations via ASPB and the resulting improvements has been a large measure of the effectiveness of UW-CIMSS. International collaborations have also been an important part of the UW-CIMSS; these collaborations have been strengthened through our visiting scientist program that has hosted sabbaticals for foreign scholars.

For education and training, UW-CIMSS has supported graduate students (currently 22) studying for their Master's and Ph.D. degrees in the Department of Atmospheric and Oceanic Sciences (AOS) as part of UW-CIMSS grants and contracts. Graduate students have worked directly with our research teams, giving the student valuable experiences for future employment in government, university, and private sectors. Undergraduate students majoring in atmospheric science or a related field have also been employed each year under UW-CIMSS grants; these students become engaged with our scientists in research activities and experience collaborative thinking and problem solving. The many students who have entered successful careers in environmental satellite remote sensing in government labs have been another measure of the successful support of NOAA by UW-CIMSS. Additionally, NOAA training programs have benefitted from the many distance learning tools, lesson modules, visualization software, and related materials provided by UW-CIMSS.

For outreach, UW-CIMSS conducts annual summer workshops for teachers and students. As part of the UW–Madison, our staff are guided by the "The Wisconsin Idea" that education should influence and improve people's lives beyond the university classroom; this idea has guided the university's mission for over 100 years. UW-CIMSS and SSEC scientists, engineers, and other technical staff have been trained in media relations so that UW-CIMSS (and NOAA) programs are explained to the public in understandable terms. Our staff have visited local schools, given public lectures, and participated in campus open-house activities.

This is a proposal for the continuation of a NOAA Cooperative Institute (CI) at the University of Wisconsin-Madison. The new CI builds upon the existing UW-CIMSS which has a 30-year history of successful collaborations with NOAA. Through its close association with the SSEC and the AOS, UW-CIMSS will continue to provide NOAA with access to a highly qualified pool of scientists, engineers, and students to further its goals and fulfill its mission to the nation.

2. Results from Prior Research

As demonstrated throughout this proposal, UW-CIMSS has made numerous innovations and outstanding contributions to the field of remote sensing. As an internationally recognized center in remote sensing science and education, UW-CIMSS has been providing fundamental contributions to NOAA's environmental satellite programs.

Research. UW-CIMSS has fostered numerous advances to the science of satellite remote sensing. Our research ranges from developing methods to measure surface and atmospheric properties from space, to calibrating and validating sensor data, to testing applications in numerical models. UW-CIMSS has worked with U.S. and international geostationary and polar-orbiting satellite systems as well as experimental instruments flown on research aircraft. Our scientists have designed and tested spacecraft instrumentation for monitoring the earth-atmosphere system and are active members on NOAA and National Aeronautics and Space Administration (NASA) science and mission teams.

The list of our "firsts" is impressive. They include the first 20-year archive of all GOES data, the first High Resolution Infrared Radiation Sounder (HIRS) cloud climatology, the first biomass burning monitoring product from GOES, the first suite of sounding products (temperature and moisture profiles, atmospheric stability) from GOES, the first sea surface temperature measurements from the GOES, the first Observing System Simulation Experiment (OSSE) for advanced geostationary sounders, and the first atmospheric motion vectors from polar orbiting satellite data. These contributions have had a positive impact on numerical model forecasts, such that today's weather forecasts are significantly better. UW-CIMSS has made numerous and broad contributions to the body of scientific knowledge, having published approximately 1,500 refereed journal papers and thousands of conference papers since 1995. A list of currently funded projects is provided in Appendix E.

Collaborative Activities with NOAA. One measure of our strong relationship with NESDIS is the more than two dozen UW-CIMSS research projects that have become operational in NOAA. Working with ASPB, our scientists have been participating in the checkout of the new GOES and Polar-orbiting Operational Environmental Satellite (POES) instruments, defining the future GOES instrument requirements, working closely to deliver software for the GOES-R Algorithm Working Group, and assessing changes in Arctic climate and global cloud cover over the past two decades using satellite observations. More than 40% of our refereed publications are co-authored with a NOAA scientist, a further testimony to the NOAA/CIMSS collaboration.

Education. UW-CIMSS mentors students both formally and informally. Our scientists have directly supervised 83 Master's and 34 Ph.D. students; undergraduate students also are involved in our research. UW-CIMSS has supported the teaching of graduate-level courses in satellite remote sensing and an undergraduate course in satellite meteorology. Our efforts to extend our educational reach beyond the state of Wisconsin have benefitted countless students and colleagues worldwide. Examples include classes taught at the Department of Applied Physics at Curtin University of Technology in Perth, Australia, a cooperation with Nanjing Information and Technology University in China, and guest teaching at CREST (the NOAA Cooperative Remote Sensing Science and Technology Center, a minority-serving institution) in New York City. UW-CIMSS has partnered with NOAA and the CIRA/RAMMB educators at Colorado State University to develop and implement online training activities through the VISIT and SHyMet programs.

International Activities. UW-CIMSS has served in a variety of leadership roles in international activities as demonstrated in letters of support (Appendix B). Examples include active participation in the International TOVS Working Group and the World Meteorological Organization's (WMO) Expert Team on Observational Data Requirements and Redesign of the Global Observing System (GOS); distributing direct broadcast processing packages for TOVS (ITPP), ATOVS (IAPP), and MODIS/AIRS (IMAPP); providing free online access to textbooks (e.g., "Applications with Meteorological Satellites" published by the WMO and distributed internationally); and serving on a number of international committees (including the Coordination Group for Meteorological Satellites and the Committee on Earth Observing Systems).

Numerous UW-CIMSS activities have supported NOAA mission goals, with exemplary contributions to serving society's needs for weather and water information, understanding climate variability, and providing critical support for NOAA's mission. The accomplishments of UW-CIMSS are provided in our annual reports (http://cimss.ssec.wisc.edu/reports/); individual programs such as GIMPAP and GOES-R are detailed in our annual reports and are available on the Web at http://cimss.ssec.wisc.edu/goes/gimpap/reports/ and http://cimss.ssec.wisc.edu/goes_r/rr/reports/ Reports from our Board of Directors and Science Council provide feedback on our accomplishments and goals, and are also routinely posted on the Web (https://groups.ssec.wisc.edu/employee-info/cimss/cimss-board-of-directors-reports).

3. Project Description

The unique research setting at UW-CIMSS, a combination of SSEC and NESDIS/STAR personnel, and the AOS students has proven to be effective in the innovative development, demonstration, and implementation of data analysis methods for operational and research remote sensing instruments. The following sections detail our technical approach to addressing the three NOAA research themes stated in the NOAA call for establishing a Cooperative Institute (CI) that focuses on satellite studies related to weather and environmental analysis. Each section includes a description of the UW-CIMSS expertise in the projects listed in the Federal Funding Opportunity (FFO) under each theme, and how our future work can support NOAA's goals in these areas.

3.1 Goals

UW-CIMSS is part of SSEC, whose scientific vision is "to strive to advance our technical excellence in the areas of:

- Observational Science (instrumentation, spacecraft system/mission design, field programs, and space flight instrument fabrication);
- Analytical Science (satellite and conventional data analysis, technique development, and modeling);
- Computational and Visualization Science (hardware and software systems for information generation, data management, and communication);
- Campus Science Support (Physics, Astronomy, Botany, Geology); and
- Education and Public Outreach (UW undergraduate and graduate programs, K–12 collaborations, science education of the general public)."

Connected to this vision are a set of goals for UW-CIMSS that support NOAA mission goals related to satellite meteorology. These goals are to:

- Advance the use of satellite data in weather forecasting;
- Support NOAA's world leadership role in advancing environmental satellite applications;
- Help NOAA effectively exploit satellite observations in response to the challenges poised by climate change; and

- Develop a workforce knowledgeable in satellite meteorology and remote sensing.

The desired outcomes for achieving these goals are for UW-CIMSS to:

- Foster collaborative research among NOAA, NASA, and the University in those aspects of atmospheric and earth system science that exploit the use of satellite technology;
- Serve as a center at which scientists and engineers working on problems of mutual interest can focus on satellite-related research in atmospheric and earth system science; and
- Stimulate the training of scientists and engineers in the disciplines involved in atmospheric and earth sciences.

These outcomes will be achieved through various proposed activities discussed throughout Section 3 of this proposal. In addition to stating proposed activities for the next five years, Section 3 demonstrates our capabilities to achieve these outcomes. This section describes some specific actions that are responsive to Section I.B of the FFO while demonstrating how our expertise and experience will aid NOAA/NESDIS in meeting it goals in satellite meteorology.

NOAA's strategic plan states an interest to partner with academic institutions to explore new concepts and applications through robust weather and water research. In support of this interest, UW-Madison proposes to continue our strong partnership with STAR and ASPB to conduct activities through UW-CIMSS that specifically supports two mission goals: (1) Serve Society's Needs for Weather and Water Information and (2) Mission Support.

Proposed research that supports NOAA's Weather and Water Mission Goal emphasizes our extensive experience in basic and applied satellite research that exploits observations from current and future instruments on national and international geostationary and polar orbiting satellites. As demonstrated in Section 3, our expertise in the retrieval of geophysical variables, such as temperature, moisture, clouds, and winds, from these weather satellites will support NOAA's Weather and Water Mission Goal. Through the GIMPAP and PSDI programs, UW-CIMSS scientists in collaboration with STAR and ASPB scientists have developed new approaches to analyzing current GOES observations and then have worked with appropriate NOAA agencies and offices to transition them from the research stage to operations. Through the GIMPAP program UW-CIMSS scientists are studying new applications for the GOES satellite constellation (e.g., convective initiation and aviation hazards) that we anticipate transferring through PSDI activities under the responsibility of the new UW-CIMSS. Our existing collaborations with NASA and NOAA have supported the JPSS (formerly NPOESS) and GOES-R programs through instrument trade studies and algorithm development. A continuation of UW-CIMSS will maintain and expand our involvement in supporting the development of new satellite analysis tools as applied to GOES-R and JPSS.

Our expertise in satellite meteorology also supports NOAA's Mission Support Goals. UW-CIMSS scientists have extensive experience and publications dealing with observations for the NASA A-Train. UW-CIMSS personnel have served on the initial science teams of MODIS, AIRS and the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) mission, providing positive teamwork activities between NOAA, NASA and an academic institution. Through this participation we have fostered collaborative activities and developed new applications that yield benefit to NOAA goals. For example, UW-CIMSS scientists, in collaboration with ASPB scientists, developed a method to derive polar winds from the MODIS measurements (e.g., Key et al., 2003). This product is used by National Centers for Environmental Prediction (NCEP), European Centre for Medium-range Weather Forecasts (ECMWF) and other NWP centers. UW-CIMSS scientists have collaborated with STAR in using AIRS observations to assess the calibration of the GOES and POES satellites (e.g., Gunshor et al., 2009). This activity is an achievement that demonstrates our commitment to assisting in the calibration, characterization and validation of the current and future satellite instruments. UW-CIMSS scientists have also made use of A-Train measurements to assess satellite derived products of relevance to NOAA. For example, we used the lidar observations from CALIPSO to assess cloud height assignments in our Atmospheric Motion Vector (AMV) algorithm (Genkova et al., 2009). UW-CIMSS scientists are also actively involved with the satellite missions discussed in NASA's decadal studies, NPP and JPSS. These activities are collaborative endeavors among NOAA, NASA, and UW-CIMSS scientists that exploit the use of satellite technologies to study the earth-atmosphere system.

The National Research Council decadal survey has recommended two NASA missions relevant to hyperspectral remote sensing: the Geosynchronous Imaging Fourier Transform Spectrometer (GIFTS) and the Climate Absolute Radiance and Refractivity Observatory (CLARREO) missions. Both of these missions evolved from and involve the expertise of the UW-CIMSS and UW-SSEC scientists and engineers. The CLARREO is in the critical formulation phases. The future of hyperspectral geostationary sounding remains one of intense international interest, with studies underway in Europe, Japan and China.

UW-CIMSS will engage collaboratively with NESDIS/STAR, international and federal agency partners and other NOAA CIs to develop new and innovative applications that can ultimately be transitioned into NOAA operations in support of weather information needs. Appendix J lists over 40 research algorithms that have been transitioned from UW-CIMSS to NOAA, NOAA Centers and other operational centers. Some of these activities were started from NOAA programs such as GIMPAP while others were leveraged through support from other agencies. These examples represent our commitment to working with NOAA to use satellite observations to improve the accuracy and capabilities of monitoring and observing weather systems. UW-CIMSS has also worked with other agencies to develop well documented science code for application to measurements from several satellite platforms. For example, algorithms have been developed for the NASA MODIS instruments that are run routinely at NASA data processing centers. We also develop and freely provide well documented software for use with NASA Direct Broadcast facilities.

Through the GOES-R Proving Ground, VISIT and SHyMet programs, UW-CIMSS has developed working relationships with various National Weather Service regional offices. We seek to expand these relationships through collaborations that lead to the development of new satellite analysis tools as requested by the NWS forecasters. Some of the satellite analysis tools and products developed at UW-CIMSS have been transitioned into the Advanced Weather Interactive Processing System (AWIPS) and some are used by the National Hurricane Center. We will continue to support the needs of these forecast offices and NOAA centers through development and research. We are currently developing stronger ties with the Storm Prediction Center (SPC), and a goal of the next five years is find means to meet those needs. Our emphasis is to provide appropriate training to interested parties seeking to make better use of satellite observations.

A team of NASA, NOAA/STAR and SSEC Data Center personnel have developed a testbed capability to conduct end-to-end studies in research support of new satellite technologies. We have the in-house capability to use the Weather Research and Forecasting (WRF) model simulations to define realistic atmospheric conditions from which we can simulate measured radiances from a satellite platform, including expected instrument noise specifications. Retrieval algorithms are then applied to these simulated radiances and compared to the original model simulation for algorithm assessment. This capability is used in collaborations with NOAA to evaluate new satellite measurement and analysis techniques. Under a new agreement, UW-CIMSS will continue to support NOAA in satellite-related research in atmospheric and earth system science studies through this end-to-end simulation capability.

In this next phase of our proposed partnership with NOAA, we will continue to conduct collaborative research with NOAA scientists; utilize our scientific, education, and outreach expertise to support NOAA's research needs and mission, and support student participation in NOAA-related research studies.

3.2 Research Themes

This section discusses UW-CIMSS's capabilities and proposed activities in the three CI research themes defined by NOAA. Each of these major subsections concludes with a summary of proposed activities that contribute to the needs of the NOAA five-year research plan as described in the FFO.

3.2.1 Satellite Meteorology Research and Application

NOAA's Weather and Water Research Area has a goal of improving the lead time of weather forecast and warning accuracy. Under certain weather scenarios, the use satellite observations can play a key role in meeting these goals. To achieve this goal requires new and innovative approaches to analyzing satellite observations; UW-CIMSS expertise is an asset to NOAA as it strives to achieve these objectives.

UW-CIMSS scientists have provided strong support to the GOES-Improved Measurements and Product Assurance Plan (GIMPAP). The aim of GIMPAP is to assure the viability of GOES products, improve current products, develop advanced products through basic and applied research, and ensure integration of the results into NESDIS and NWS operations. Many of the activities discussed below were partly developed under the GIMPAP program and ended in algorithms that were transitioned to NOAA operations through the Product Systems Development and Implementation (PSDI) program. As part of its strategic plan, NOAA seeks to transfer up to six research results into operations per year. UW-CIMSS will help NOAA meet this strategic goal through its collaborations with NESDIS/STAR and ASPB. (See Appendix J for a list of CIMSS research-to-operations accomplishments). UW-CIMSS scientists are creating, testing and validating additional algorithms that will soon be ready for implementation through PSDI. We also contribute to the GOES-R Algorithm Working Group by providing data processing algorithms and analysis tools for the Advanced Baseline Imager (ABI) instrument.

Working with NOAA, in particular STAR and ASPB, UW-CIMSS will continue to help NESDIS transfer satellite-based research into NOAA applications. In the following subsections we discuss UW-CIMSS capabilities with regard to the projects listed in the FFO and what we propose to do the next five years as a newly designated CI.

3.2.1a Estimating Global Atmospheric Characteristics

To meet its future service delivery goals in the Weather and Water area, NOAA is committed to improving the accuracy and capabilities of its monitoring and observing systems (page 38, NOAA Strategic Plan). Throughout its 30-year history, UW-CIMSS has worked closely with NESDIS to improve the capabilities of satellite remote sensing of the Earth. UW-CIMSS is nationally and internationally recognized (e.g., see letters of support in Appendix B) for its research on characterizing the global atmosphere from geostationary and polar-orbiting imagers and sounders, including temperature and humidity profiles, winds, cloud properties, aerosols, atmospheric constituents (e.g., ozone and sulfur dioxide from volcanic eruptions), and the occurrence of severe weather (e.g., tropical cyclones and thunderstorms). We propose to continue to develop improved methods of characterizing the atmosphere using satellite observations. In particular, we propose to adopt advanced computing technology to develop new methods and continue advancement of atmospheric profiling, Atmospheric Motion Vectors (AMVs), tropical cyclone analysis, cloud properties and trace gas retrievals. We propose to continue the long research collaboration between UW-CIMSS and NOAA/STAR in these research areas.

Atmospheric Motion Vectors (AMV)

The UW-CIMSS satellite-derived AMV program is a prime example of both evolutionary and revolutionary research in the field of satellite meteorology. What started as a novel concept of Verner Suomi in the late 1970s has been transformed into an important contribution to NOAA and meteorology communities across the globe. We expect further scientific advances in the AMV product from the current and future GOES and POES systems, as well as from novel approaches with other emerging sensor technologies. Improving the observation and accurate measurement of wind is paramount in advancing the nation's numerical weather prediction capabilities.

Tracking persistent cloud features in sequential geostationary satellite imagery as an estimation of the ambient wind flow was one of the original quantitative applications attempted with geostationary satellite data. A major impetus for the development of the Man computer Interactive Data Access System (McIDAS) at SSEC in the mid 1970s was to provide the capability to target and track cloud features on digital imagery. The first global demonstration of this capability occurred during the First GARP (Global

Atmospheric Research Program) Global Experiment (FGGE) in 1978-1979. Tropospheric winds were manually derived over the globe from multiple geostationary satellites.

While the utility of this new wind-tracking capability was quickly realized, the exhausting manual labor needed to produce full-disk AMV fields was a recognized limitation. To deal with this issue, UW-CIMSS began automating the algorithm in the late 1980s. Numerous refinements and advances to the technique have occurred since. For example, determination of the appropriate height assignment for a particular wind vector has been improved considerably by the use of multispectral information. The identification and tracking of "features" has been successfully expanded beyond visible and infrared window wavelengths to include water vapor imagery, helping to significantly increase coverage, both horizontally in cloud-free regions as well as vertically in middle levels of the troposphere.

The satellite-derived AMV algorithms have evolved to meet user needs by providing fast, efficient, objective, and automated tracking and quality control. The transfer of an experimental version of the automated UW-CIMSS processing algorithm to NOAA/NESDIS occurred in the early 1990s. More recently, efforts to make the algorithm more robust and with better quality control needed to meet the demands of the NOAA/NESDIS operational environment have been successful. The algorithm is now run operationally by NOAA/NESDIS to support data assimilation into NCEP and other agencies' numerical weather prediction models. UW-CIMSS has also provided the Air Force Weather Agency (AFWA) with the fully automated algorithm to support the Department of Defense (DoD) user needs.

Research on AMV algorithm improvements continues at UW-CIMSS with the exploration of cutting-edge methods and innovative applications. For example, a methodology has been developed for generating wind vectors in the polar regions using MODIS measurements from NASA's Terra and Aqua satellites (Key et al., 2003; Velden et al., 2005). The MODIS polar winds procedure is now operational at NOAA/NESDIS. Overall, many NWP studies have demonstrated a positive impact of both geostationary and polar satellite AMVs on forecasts. Today, this vibrant research program stretches from automated global wind data production and distribution to involvement in field programs and national/international collaborations. The UW-CIMSS group continues to work closely with NESDIS/STAR to share the latest research and algorithm improvements, and help transition these improvements into the NOAA/NESDIS operational production code. For example, the team will continue to develop and evaluate AMV quality indicators, essential for improving AMV data assimilation in NWP.

The UW-CIMSS automated satellite-derived winds tracking algorithm is continuously evolving. In order to advance its capabilities, new science and research ideas need to be developed and tested in collaboration with winds research collaborators at NOAA/NESDIS and elsewhere. Innovations in the UW-CIMSS automated wind derivation techniques and its applications often lead to improved wind information from GOES for operational and research use. Looking to the future, UW-CIMSS, in collaboration with STAR, is directing significant effort demonstrating and assessing the measurement capabilities of the Advanced Baseline Imager (ABI) to be launched on GOES-R (Schmit et al., 2005). The high spatial and temporal resolution of the ABI in a geosynchronous orbit will provide unprecedented observational capabilities. An ongoing and future effort of UW-CIMSS will involve the demonstration of various satellite retrieval algorithms, including atmospheric motion vectors, as well as an evaluation of the algorithm performance for different measurement error assumptions for the ABI. To support this work, the UW-CIMSS GOES-R proxy data team has produced several proxy ABI radiance datasets derived from large-scale WRF simulations (e.g., Otkin et al., 2009). These proxy datasets are very useful for demonstrating future satellite capabilities. Figure 2 shows an example of applying the proxy top-of-atmosphere radiance dataset derived from a WRF simulation of Hurricane Katrina to demonstrate the capability of deriving AMVs from the simulated ABI images. Simulations of other weather systems will continue under a new CI.

The UW-CIMSS AMV team is an integral member of the GOES-R Algorithm Working Group (AWG), and a primary focus over the next few years will be to continue preparations for operational utilization of GOES-R for AMV production. In partnership with NESDIS/STAR, UW-CIMSS will build and deliver the final AMV processing algorithm to the chosen vendor, along with the Algorithm

Theoretical Basis Document (ATBD). This effort will set the stage for a successful and expedient transition to operations immediately following the GOES-R launch.

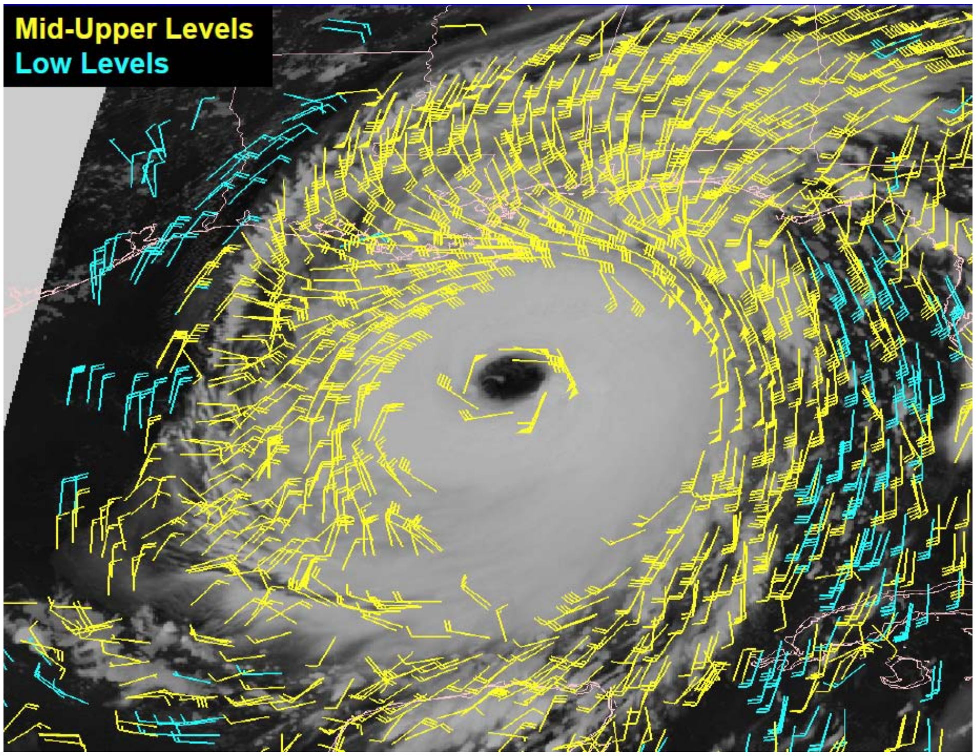

Figure 2. Atmospheric Motion Vectors retrieved from a GOES-R algorithm under development as applied to a WRF simulation of ABI radiances for a Hurricane Katrina case study. The yellow barbs are mid-level winds and the blue barbs low-level winds. The figure demonstrates the end-to-end capability of UW-CIMSS, from using the WRF to specify atmospheric conditions, to simulating a future satellite observing system, to applying a modified algorithm that demonstrates its future capabilities as validated against known model fields.

Atmospheric Profiles

Accurately extracting temperature and moisture vertical profiles from infrared and microwave sounder radiance measurements is critical for atmospheric research and forecasting applications. High quality atmospheric temperature and moisture profiles derived from geostationary and polar-orbiting satellite measurements provide valuable information for global and regional forecast models as well as for the forecasters themselves. The UW-CIMSS profiling team includes leaders in the retrieval of atmospheric temperature and moisture profiles using measured infrared radiances from satellite, aircraft, and ground-based platforms.

The long UW-CIMSS history of temperature and moisture retrievals from a geostationary satellite dates back to pioneering work during the 1970s (Smith et al., 1970; Smith et al., 1982). Collaborations with NOAA began with algorithm development for the VISSR Atmospheric Sounder (VAS) in the late 1970s. These algorithms have been continuously improved through various research projects and operate on the current series of GOES Sounders.

Algorithms have also been developed for polar orbiting satellites, including TOVS, ATOVS, MODIS, and AIRS. These polar orbiting retrieval algorithms have been distributed to a wide variety of users around the globe through the International ATOVS Processing Package (IAPP) and the International MODIS – AIRS Processing Package (IMAPP), making UW-CIMSS internationally recognized as a leader in satellite retrieval methods (see letters of support in Appendix B).

UW-CIMSS scientists continue to lead in the development of retrieval techniques for both polar and geostationary hyperspectral measurements through its field program activities with the SSEC Scanning HIS (S-HIS) aircraft instrument, the development and testing of the NASA GIFTS instrument, algorithm development and evaluation for the current AIRS and IASI advanced sounders, and demonstrating the need for hyperspectral sounders on future GOES satellites. As an example, recent work by Li and Liu (2009) demonstrated improved hurricane track forecasts from modeling runs assimilating single field of view AIRS moisture retrievals.

The GOES Sounder (onboard the current GOES series since 1994) has provided hourly temperature and moisture atmospheric profiles and associated derived products of stability, etc., over the continental United States and adjacent areas for severe storm warning and nowcasting. UW-CIMSS algorithms have been providing TOVS and later ATOVS global sounding measurements since 1978. Long-term benefits of this work have been the operational generation by NOAA/NESDIS of the GOES Sounder moisture/temperature information that is based on UW-CIMSS research algorithms, and the international use of (A)TOVS and AIRS temperature/moisture information based on UW-CIMSS algorithms. The GOES retrieval data and products are disseminated to the Numerical Weather Prediction (NWP) communities and the NOAA NWS via AWIPS. Research continues on new and improved algorithms for the current and the future generation of GOES and POES sounders.

The operational GOES Sounder clear sky products were developed at UW-CIMSS (Ma et al., 1999) and the algorithm has been improved for the legacy GOES soundings (Li et al., 2008). However, only clear observations are processed operationally. Development of products (soundings, total precipitable water, and lifted index) in cloudy regions is very important for severe storm nowcasting. UW-CIMSS scientists, in collaboration with STAR and ASPB scientists, are developing an algorithm to produce hourly single field-of-view (SFOV) cloudy soundings by combining forecast information and GOES Sounder radiances in cloudy regions (focusing on thin or low clouds). This new product is being developed under the NOAA GIMPAP program, and will soon be proposed for an algorithm transition to the operations as part of a PSDI task. Li et al. (2009) published a comparison of the GOES Sounder cloudy-sky soundings with radiosonde observations, demonstrating cloudy-sky sounding improvements over the global forecast (GFS). Since the algorithm retrieves atmospheric profile and cloud-top height (CTH) simultaneously, UW-CIMSS scientists have also validated the algorithm by comparing GOES-Sounder CTH with the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) measurements.

Atmospheric soundings from geostationary satellites provide important atmospheric stability information for severe storm warning and nowcasting. In support of weather forecasting research, UW-CIMSS derives the lifted index (LI) from the GOES-East and GOES-West Sounders each hour from a full physical retrieval algorithm (Menzel et al., 1998). The LI product is an atmospheric stability parameter that estimates the tendency of a lower troposphere parcel of air (lowest 100 hPa) to continue to rise if it were “lifted” to the middle of the atmosphere (500 hPa). The LI product is displayed as a Derived Product Image (DPI) of the LI. Figure 3 shows the time sequence of the LI imagery. In this case, the GOES sounding retrievals show earlier warning in terms of low values (negative numbers) of LI than the two model forecasts. Large instabilities smaller than -7.5 K (reds) are revealed at 16 and 17 UTC over southern Texas. The outbreak of the storm began around 18 UTC, with the LI product giving two hours of early warning compared with the model forecast. Although the GOES cloudy sounding retrievals do not reveal more large instabilities than the clear-sky retrievals during the first two hours, it does so in the later times. More importantly, the cloudy sounding retrievals significantly increase the coverage of the GOES-12 sounding product.

On the polar orbiting platforms we are in the midst of a generational transition from low vertical resolution filter-wheel radiometers (e.g., the HIRS sensor on TIROS/POES) to the new operational infrared spectrometers, IASI and CrIS, which have much greater spectral resolution. The higher vertical resolution of the hyperspectral infrared sounders (AIRS, IASI, and CrIS) provides greatly improved capabilities for observing the vertical distribution of moisture in the atmosphere and its global transport.

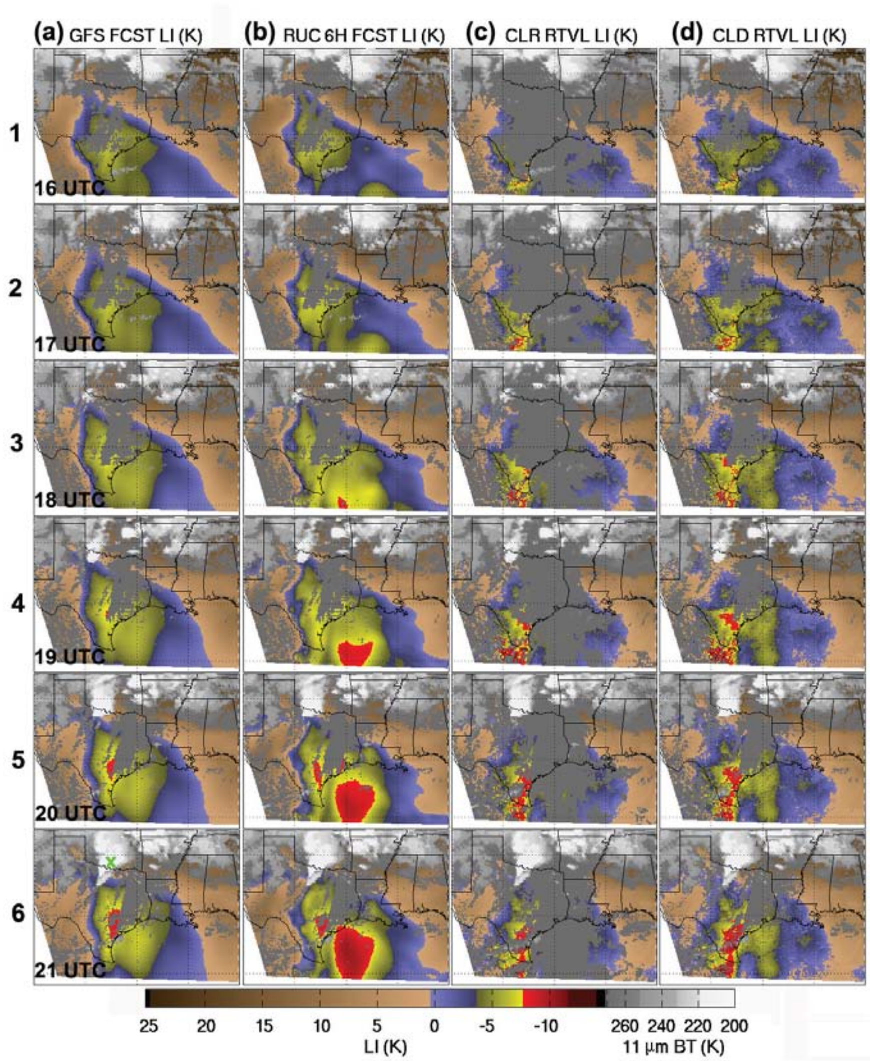

Figure 3. Time series of Lifted Index stability images generated from a global model, a regional model, and GOES soundings on 13 April 2007. From top to bottom are 1) 16 UTC, 2) 17 UTC, 3) 18 UTC, 4) 19 UTC, 5) 20 UTC and 6) 21 UTC and from the left to the right are a) the GFS forecast, b) the RUC 6-hour forecast, c) GOES-12 clear-sky retrievals and d) GOES-12 clear plus cloudy retrievals. The retrieved LI are color coded as indicated in the legend; otherwise, 11 μm Tb values (black/white) are shown, most of which are in cloudy regions with cloud optical thickness greater than 2. In this case, the GOES sounding retrievals show earlier warning at 16 UTC (-7.5 K LI) than the two model forecasts of the storm at 18 UTC. The cloudy sounding retrievals significantly increase the coverage of the GOES-12 sounding product and make the storm location more evident. UW-CIMSS has developed all of the geostationary clear sky sounding products used operationally by NESDIS; adding cloudy soundings is the next step.

For the GOES-R/S series, the Advanced Baseline Imager (ABI) will be used to provide the current GOES Sounder legacy atmospheric profile product. Given the shortcomings of ABI for sounding retrieval, it is very important to combine the high temporal ABI with hyperspectral IR data from polar-orbiting satellites for improved vertical profile soundings. Current GOES Sounder and EOS/AIRS data are being used to emulate the ABI and low earth orbit hyperspectral IR sounder in a GEO/LEO synergy study supported by GOES-R Risk Reduction. When GOES-R is launched, the ABI instrument will be used in synergy with CrIS and IASI to create combined sounding retrieval products.

In summary we propose to continue support for the GOES-R series through a synergistic use of polar orbiting hyperspectral sounding data with legacy retrieval techniques from the GOES-R ABI instrument. The polar hyperspectral retrieval algorithm work will be of direct benefit to NOAA both for the NPP/JPSS operational products and for the GOES-R synergistic products. UW-CIMSS will continue to freely distribute its sounding retrieval algorithm to the global community though the IMAPP and the forthcoming International Polar Orbit Processing Package (IPOPP).

Tropical Cyclones

Tropical cyclone (TC) research is another program for which UW-CIMSS is internationally recognized. UW-CIMSS research and development using weather satellites to study tropical cyclones began in the early 1980s (see Figure 4) with the primary focus on developing new approaches for analyzing TCs using the latest in satellite sensor technologies. The overarching goals are to increase our knowledge about these storms and to improve forecasts.

Scientists on the UW-CIMSS TC team are engaged in research to:

- Exploit satellite-based sensor technology to estimate TC intensity and structure from multispectral sources (infrared and microwave);
- Correlate satellite observations with TC behavior and trends in order to gain a better understanding of the processes affecting intensity and track changes (short term to climate scales);
- Study the dynamics of TC eyewall structures through the use of idealized and mesoscale models to further our theoretical insight into physical mechanisms leading to intensity changes;
- Optimize the impact of satellite data on NWP in TC events through collaborations with the data assimilation community; and
- Develop new satellite-based diagnostic products, fields and models to aid in TC prediction and research by working closely with forecasters and analysts, and to transition promising advances into operations.

With TC track prediction improving substantially over the last decade, intensity change forecasting has become the primary operational challenge. It is believed intensity forecasting continues to struggle because of inherent sensitivities of the TC vortex-scale behavior to the spatial and temporal subtleties of small-scale convective and stratiform cloud dynamics and microphysics, complex ocean coupling processes, and subtle interactions with resolved and unresolved aspects of the surrounding environment. In this regard, we seek to improve our overall theoretical and empirical understanding of multi-scale interactions on TC structure changes in order to help NOAA better predict rapid intensity changes.

The TC prediction challenges are often strongly coupled with accurate knowledge about the initial state. Forecasters need to have a solid estimate of the current intensity and structure at their analysis time before they can issue a confident forecast. Numerical prediction models are bound to their initialization of the TC and its environment. Since TCs are primarily located over oceans, and often away from conventional data sources, remote sensing of key geophysical parameters and variables from satellites, either directly or inferred, is frequently the only way to observe the initial conditions of the TC and its environment. Development of satellite-based techniques and algorithms to accurately estimate this initial state is a major thrust of our research program.

UW-CIMSS research includes efforts to monitor and infer TC intensity using a variety of satellite platforms. The Advanced Dvorak Technique (ADT), a continuation and advancement of the original Objective Dvorak Technique (ODT), utilizes geostationary infrared satellite imagery and cloud-top temperature patterns to deduce current TC intensity. The ODT was based upon the operational Dvorak Technique (DT), developed by NOAA scientists, but is inherently subjective. The ODT removed the subjectivity of the DT while retaining the core of the DT methodology. The ADT algorithm advanced the technique beyond the scope of the DT with such additions as automated storm center determination, regression-based intensity prediction using new satellite-retrieved parameters, and inclusion of outside information such as passive microwave (MW) imagery. The ADT is utilized at several national TC operational centers, such as the NOAA Satellite Analysis Branch (SAB), the National Hurricane Center

(NHC), the Central Pacific Hurricane Center (CPHC), and the Joint Typhoon Warning Center (JTWC). Collaborations with these centers have led to significant theoretical and functionality improvements within the ADT. The ADT has been selected to be the official NOAA TC intensity estimation routine for GOES-R and beyond, due to its ability to produce timely and accurate TC intensity estimates from geostationary satellite imagery.

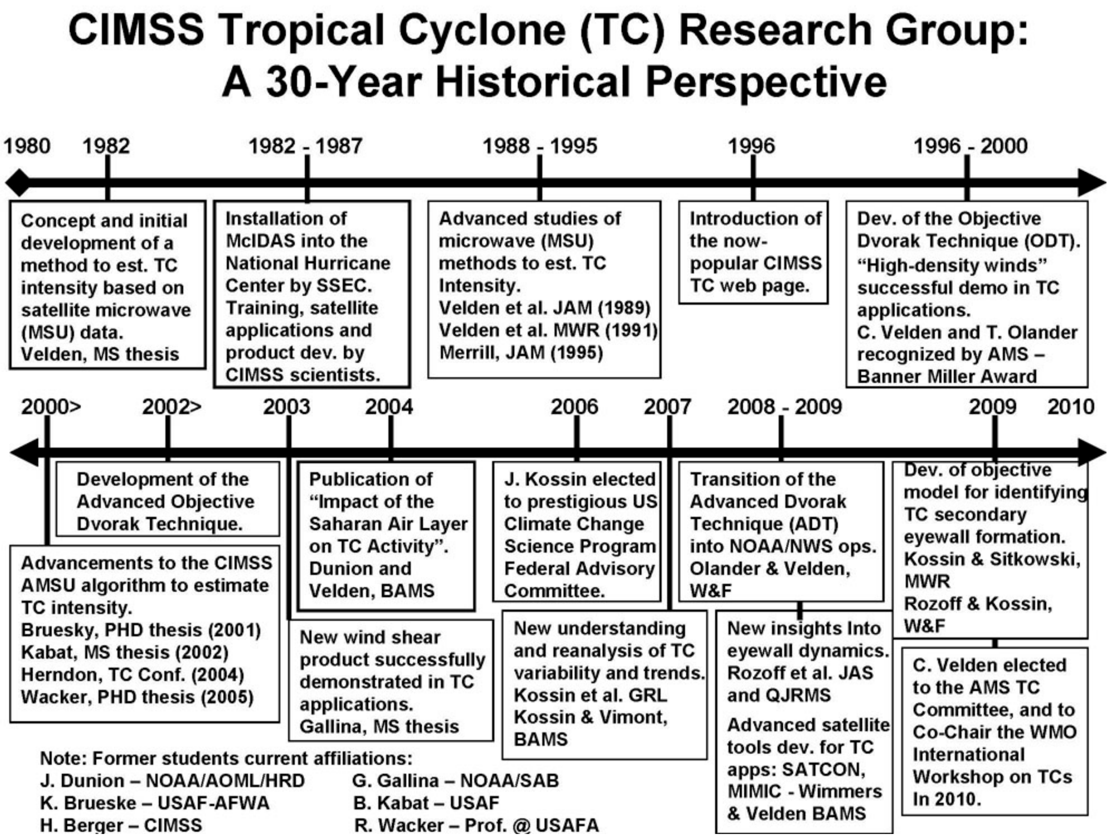

Figure 4. A 30 year perspective of the tropical cyclone research conducted at CIMSS, marking the significant events and the achieved transitions of algorithms from research to operations. UW-CIMSS has had a long standing working relationship with the Tropical Prediction Center (formerly the National Hurricane Center) wherein new approaches for analyzing TCs are shared with the operational forecasters. Examples include microwave determinations of TC intensity, visualization with McIDAS, improving the Objective Dvorak Technique with high density winds, understanding impact of the Saharan dust on TC formation, and modeling secondary eyewall formation.

Another CIMSS-developed method for determining current TC intensity utilizes polar orbiting passive microwave (MW) imagery to assess the temperature anomaly structure within the TC core and the surrounding environment. Measurement of this temperature structure using passive MW imagery can be directly related to current TC intensity; however several sources of error exist. CIMSS research has devised methods to account for and alleviate these issues, leading to accurate TC intensity estimates (e.g., Brueske and Velden, 2003). These estimates are also utilized by all of the national operational TC forecasting centers to help determine TC intensity. The one major drawback is that MW imagery from a polar orbiting satellite is not always available, with gaps between TC overpasses on the scale of one to twelve hours or more, so TC estimates from the ADT are needed during these gaps.

To emphasize the strengths and minimize any deficiencies from the various TC intensity estimation technique, a "satellite consensus" (SATCON) algorithm is being developed with collaborators at CIRA to blend information from different algorithms to produce the most accurate satellite-based TC intensity estimates available.

The UW-CIMSS TC research group, along with our national and international collaborators, will continue to develop and optimize various objective schemes incorporating data from multiple satellite platforms, such as passive microwave imagery and geostationary infrared/visible imagery, to more accurately analyze TC structure and environmental parameters necessary to improve the prediction of intensity change. As with our previous work, the knowledge gained and algorithms developed will be transitioned into NESDIS/NOAA operations upon successful demonstration. Finally, we are looking ahead to GOES-R and beyond, and will continue to adapt and improve our objective algorithms to work within that framework.

Clouds

UW-CIMSS has been active in remote sensing cloud studies since its inception in 1980. UW-CIMSS developed and incrementally improved the CO_2 slicing method (Menzel et al., 1983) which yields cloud top pressure information from satellite observations. Application of the CO_2 slicing algorithm has led to a better understanding of global cloud distributions. This research has provided a satellite climatology of cloud-top pressure from HIRS observations (Wylie et al., 2005). Analysis of this dataset quantifies the strong seasonal cycle in high clouds. UW-CIMSS scientists are now using the CO_2 slicing method on MODIS observations to continue the HIRS long-term data record.

UW-CIMSS scientists, working in collaboration with ASPB scientists in Madison, have developed a long-term climate record using AVHRR and HIRS observations. Led by ASPB scientist Dr. Heidinger, UW-CIMSS scientists are assisting in the reprocessing of the entire Advanced Very High Resolution Radiometer (AVHRR) GAC (Global Area Coverage) archive within STAR. The PATMOS-x project (e.g., Pavolonis et al., 2005; Heidinger and Pavolonis, 2009) derives atmospheric and surface climate records from NOAA's AVHRR flown on the POES spacecraft. PATMOS-x consists of twice daily fields from all of AVHRR/2 and AVHRR/3 data from 1981 to the present.

A team of UW-CIMSS scientists led by Dr. Key of ASPB is also using the AVHRR data to study climate change in the Arctic. Their analysis has indicated that cloud amount has been decreasing during the winter but increasing in spring and summer. During summer, fall, and winter, cloud forcing has tended toward increased cooling.

In addition to utilizing observations from polar orbiting satellites, UW-CIMSS has been developing cloud retrievals from GOES observations, both the Imager and Sounder (Schreiner et al., 2001). The GOES Sounder cloud product has been routinely generated on an hourly basis at UW-CIMSS for the past 15 years. This retrieval system produces cloud top pressure and effective cloud amount. The routinely produced cloud top height (CTH) at UW-CIMSS using the CO_2 slicing technique has been the pathfinder for the operational GOES Sounder cloud product that has been used in the Rapid Update Cycle (RUC) model. As improvements and modifications in the processing software have been implemented at UW-CIMSS, updates to the operational processing system have also been provided to the NESDIS Office of Satellite Data Production and Distribution (OSDPD). Cloud-top information is produced for a variety of applications, ranging from nowcasting to initializing numerical models. The operational generation of the GOES Sounder cloud information is disseminated to the NWP communities and the NOAA's NWS via AWIPS. The hourly cloud-top information from the GOES Sounder was first assimilated into the operational NCEP Eta Data Assimilation System (EDAS) in 2003. Long term studies of the diurnal behavior of cloudiness may provide insight and further understanding of cloudiness, especially for high-thin, -thick, and –opaque clouds.

Research conducted at UW-CIMSS has led to an operational satellite-derived product of high clouds that augments the Automated Surface Observing System (Menzel and Strabala, 1989). By adding a 13.3 µm ("CO_2 absorption") band to the GOES Imager suite of radiances, cloud products are now derived using the CO_2 absorption technique for determining cloud information for semi-transparent high clouds. Now, full resolution estimates of cloud top pressure and effective cloud amount can be calculated for hourly, half hourly, or even 15-minute intervals.

Satellite observations provide a means of tracking, monitoring the distribution and changes of clouds regionally and globally. UW-CIMSS has developed algorithms for detecting clouds using high spectral resolution infrared measurements (e.g., Huang et al., 2004b; Chung et al., 2000). These measurements were designed with the application of atmospheric temperature and moisture retrievals and provide increased capabilities over narrow-band radiometers. UW-CIMSS scientists have led the way in demonstrating that these observations are also useful for detecting clouds and for characterizing their optical properties. Our goal has been to apply these algorithms to current and future hyperspectral sensors on polar orbiting and geostationary satellite platforms with a view to improving our understanding of the Earth's hydrological cycle and energy budget.

UW-CIMSS, in collaboration with NASA scientists, are using MODIS observations to improve upon existing remote sensing studies of clouds. The MODIS cloud detection algorithm, cloud top pressure and cloud phase were developed at UW-CIMSS and run routinely at the NASA MODIS data center. These algorithms have been incorporated into the IMAPP and have laid the framework for cloud detection of Japanese Global Imager (GLI) and the "Medium Resolution Spectral Imager" (MERSI) onboard the Chinese new generation of polar-orbiting satellite FY-3A, launched in June 2008.

Clouds are a crucial component in all weather and climate studies. The errors associated with retrievals of cloud properties are large and over the next phase of a UW-CIMSS we will work with STAR, ASPB and our NASA collaborators in reducing these retrieval errors. In addition to improving current approaches (e.g., Holz et al., 2008; Frey et al., 2008), we will strive to assure that new satellite systems, including the ABI through participation in GOES-R, have the capability to make improved cloud observations.

Total Column Ozone

Ozone benefits life on Earth by absorbing ultraviolet (UV) light from the sun that would otherwise cause cellular damage. At the surface, however, ozone has a negative affect on human health and the rest of the biosphere. For those two reasons, monitoring ozone in the atmosphere has become an important part of environmental monitoring and remote sensing. Additionally, ozone is strongly correlated to the dynamics of the tropopause, where high total column ozone (TCO) values reflect a lower tropopause and a higher amount of potential vorticity (PV), a very useful dynamical measure, in the layer.

UW-CIMSS began development of total column ozone estimates from the GOES Sounder in the late 1990s. Satellite-based ozone detection IR retrieval methods have better spatial and temporal resolution than polar orbiting instruments such as the Total Ozone Mapping Spectrometer (TOMS), which uses backscattered UV light to measure ozone quantities. However, the geostationary IR retrieval methods tend to have lower accuracy and precision due to the impact of clouds, water vapor, and surface variations on the IR signal. Improved resolution from IR methods will enable observing of previously undetectable ozone dynamics and fine-scale features that indicate clear air turbulence.

The GOES Sounder allows real-time observation of ozone dynamics and higher-resolution structures than had been detectable via polar orbiting platforms. Development work led to a regression estimate of TCO using GOES Sounder longwave infrared bands above 4 microns. Validation studies have found that the regression methods performed very well, achieving an accuracy within 5% with a minimal bias (Li et al., 2007). The regression supplements the primary ozone absorption band (at ~9.6 microns) with other IR bands above 4 microns (Li et al., 2001), in particular the carbon dioxide absorption bands that are highly correlated to stratospheric temperature. Additional regression predictors such as latitude and time of year improve results by accounting for climatological variations.

Meteosat Second Generation's (MSG) SEVIRI instrument is another geostationary instrument capable of monitoring ozone. While lacking the carbon dioxide bands of the GOES Sounder, SEVIRI has higher resolution and much greater coverage (full disk every 15 minutes as opposed to hourly coverage of the Continental U.S. and adjacent waters). To compensate for the missing bands, a temperature profile from a numerical weather model is employed (Jin et al., 2008), allowing SEVIRI ozone estimates to perform as well as, if not better than, the GOES Sounder (Figure 5).

UW-CIMSS proposes to continue to refine the ozone regression for the current GOES Sounder as well as MSG SEVIRI and upcoming GOES-R, for which SEVIRI acts as a proxy. Improving performance over challenging land surfaces and adding processing over low clouds will provide benefits to users in the aerosol modeling community and for tracking mesoscale and smaller tropopause features that could indicate turbulence. The use of geostationary TCO as a source function for aerosol models and as an indicator of tropospheric dynamics will continue to grow as instruments improve.

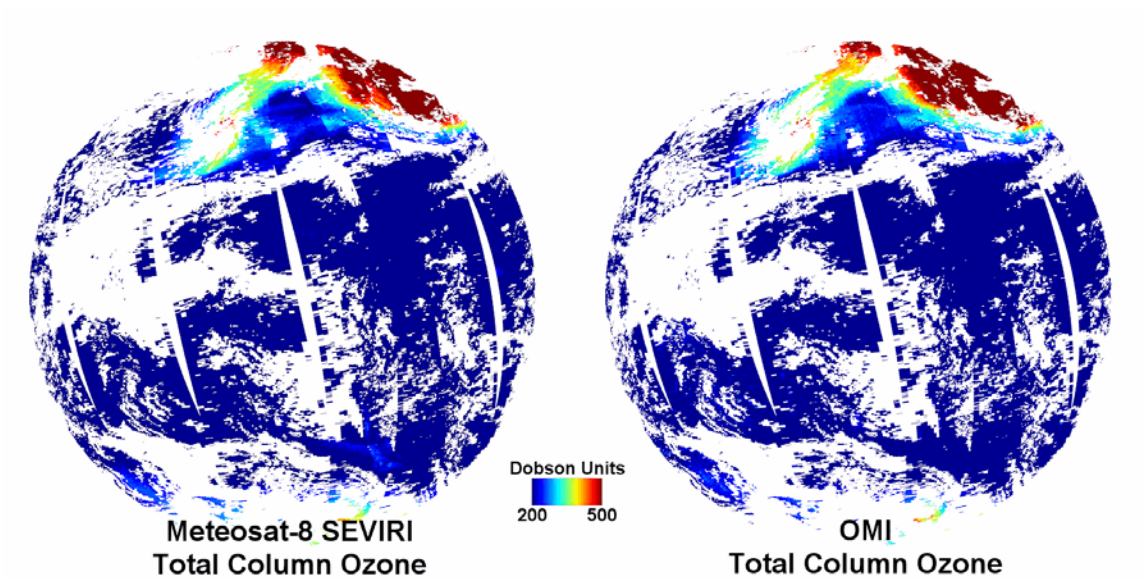

Figure 5. Spatially and temporally collocated SEVIRI and OMI TCO from 14-15 February 2006 over Europe, the Atlantic Ocean, and Africa showing the good correlation (0.94) and small bias (1.6 Dobson Units) of the two datasets. The OMI footprints were compared to the average of only the cloud-free SEVIRI ozone values within each footprint (causing missing data for completely cloudy OMI footprints). This is an example where UW-CIMSS is using Meteosat Second Generation's SEVIRI instrument to prepare for the capabilities of the future Advanced Baseline Imager as part of the GOES-R AWG.

3.2.1b Satellite Applications for Aviation

The nation's air transportation system forecasts as much as a threefold increase in demand for air capacity by 2025, demonstrating the need for focused research to mitigate weather impact on aviation. Geostationary and polar satellites provide means to improve the monitoring of current aviation weather conditions and provide value-added information for nowcasting and forecasting aviation hazards such as those caused by low ceiling/visibility, convection, turbulence, icing, volcanic ash, and wind shear. In response, NOAA, in partnership with the FAA, is conducting research to mitigate the impacts of weather on the air transportation system. UW-CIMSS will continue to work with NOAA (and leverage our NASA and FAA collaborations) to improve the detection of aviation hazards using satellite observations.

Since the UW-CIMSS five-year review in 2004, we have expanded our research in the area of satellite applications for aviation. UW-CIMSS, in collaboration with ASPB, has developed new aviation applications using satellite sounders and imagers, including:

- inference of in-flight turbulence (Feltz et al., 2009);
- detection of convective initiation, overshooting tops and enhanced-V structures related to convectively-induced turbulence (Sieglaff et al., 2010; Bedka et al., 2009);
- detection of volcanic ash location, height and mass loading (Pavolonis et al., 2006);
- objective visibility detection; and
- retrieval of the diagnostic mesoscale wind field.

UW-CIMSS is currently working within the NOAA GIMPAP program to conduct research on convective initiation and turbulence detection using the current GOES satellite series. UW-CIMSS also collaborates with NASA in their Advanced Satellite Aviation Weather Products (ASAP) program to improve the use of satellite data in detecting hazardous aviation weather. The outstanding success in this emerging research area has led to UW-CIMSS receiving several NASA awards, including:

- NASA LaRC Paul Holloway Technology Transition Award 2008;
- NASA Honors Group Achievement Award (ASAP) 2006; and
- NASA Aviation Safety and security program award for outstanding contributions to aviation weather safety research and development 21 September 2005.

UW-CIMSS is leading an effort to develop future GOES-R aviation requirement science algorithms to detect volcanic ash, SO_2, fog, turbulence, convective overshooting-tops, enhanced-V's and visibility through funding from NOAA. Figure 6 shows an example of a research project that combines aircraft measurements of turbulence with polar and geostationary satellite measurements to explore the relationship between turbulence and thunderstorm structure.

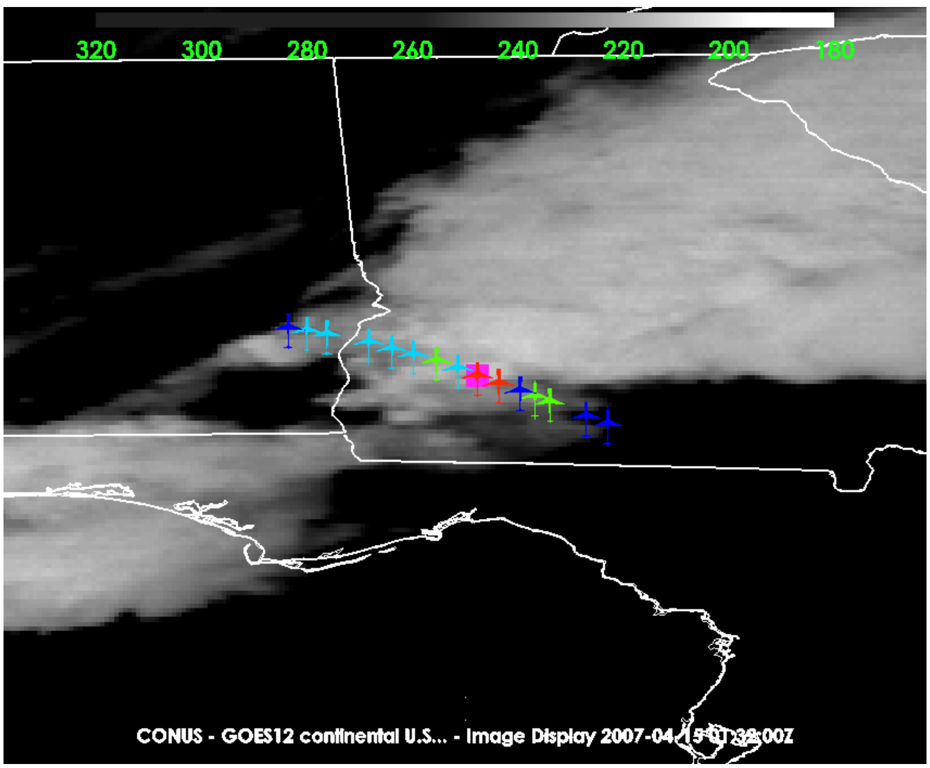

Figure 6. Overshooting Top detection from an automated algorithm applied to geostationary satellite data compared with objective Eddy Diffusion Rate (EDR) data from United flight 757. The magenta box is the OT from the automated algorithm, red airplanes are EDR severe turbulence reports, green are moderate turbulence, cyan is light turbulence, and blue is null. UW-CIMSS is leading the GOES-R AWG effort to meet aviation requirements for understanding and detecting turbulence.

As a second example or our research in aviation hazards, UW-CIMSS scientists are working to improve the prediction of the timing and location of the initial development of thunderstorms (i.e., convective initiation) using satellite observations. Convective initiation can be identified through rapid cloud-top cooling in geostationary satellite infrared imagery far in advance (30-45 minutes) of significant precipitation echoes detected by ground-based radar. Thunderstorms account for most of the air traffic delays in the United States and cost the aviation industry many millions of dollars annually in lost time, fuel, and efficiency through delayed, canceled, and rerouted flights. Therefore, knowledge of when and where convective initiation is occurring based upon satellite observations can benefit the aviation industry through improvements in safety and flight path efficiency.

We propose to continue our work with NOAA, and our other partners, to produce new and advanced analysis products by integrating measurements from geostationary and polar satellites with aircraft and ground-based observations to better detect aviation weather hazards. UW-CIMSS will continue the development and automation of identifying aviation hazards using satellite observations from imagers and sounders. This work includes a continued collaboration with the NOAA/ASPB team on volcanic ash detection, detection of turbulence generated by mountain waves, tropospheric folds and upper tropospheric turbulence associated with convection in preparation for the Joint Planning and Development Office's NextGen 4-D weather cube.

3.2.1c Detecting and Monitoring Fires and Smoke

The biomass burning monitoring team at UW-CIMSS is nationally and internationally recognized for its achievements in space-based detection of fires. For over 20 years the GOES fire monitoring program at UW-CIMSS has been a collaborative effort between STAR and UW-CIMSS personnel with support from NOAA, NASA, and the DoD. Developed at UW-CIMSS, the GOES Wildfire Automated Biomass Burning Algorithm (WF_ABBA) processing system provides fire detection and fire characteristics and has run in real-time since 2000 and operationally at NESDIS since 2002. This UW-CIMSS research program developed, implemented, and continues to enhance and maintain a global real-time geostationary fire detection and characterization monitoring system with applications to: 1) hazards monitoring, 2) emissions monitoring, 3) air quality assessment, 4) data assimilation in aerosol/trace gas models, 5) land-use and land-cover change research, 6) carbon cycle and climate change research, and 7) international policy and resource management. This work, in collaboration with ASPB, supports NOAA's objective to improve observing and understanding of fires and air quality.

Biomass burning from both wildfires and agricultural burning remains one of the largest unknown sources of emissions in the U.S. The Clean Air Act mandates that sources of aerosols and precursors to ozone formation be monitored within the U.S. Intercontinental transport of biomass burning emissions also needs to be monitored. Model data assimilation studies have shown the importance of incorporating real-time diurnal fire products in aerosol transport and air quality models to correctly diagnose and predict air pollution (Reid et al., 2009).

With the implementation of Version 6.5.006 of the WF_ABBA and subsequent transfer to NESDIS Operations, the WF_ABBA produces fire detections and characteristics in real-time for satellites in the GOES, Meteosat Second Generation, and MTSAT series. The same system, in conjunction with modern computer systems, allows for reprocessing of older GOES data back to the start of GOES-8 in 1995, as well as over the entire lifetimes of the other supported satellites. The WF_ABBA fires archive dataset extends back 15 years over the Western Hemisphere and also globally, supporting the various efforts listed above as well as providing a dataset of geostationary detected and characterized fires from a consistent algorithm, meeting requests of the international community (IGOS GOFC/GOLD, CEOS, GEO, CGMS) for a consistent, long-term global dataset.

Figure 7 shows composites of GOES-East detected fires over the southeastern Amazon Basin for the month of August from 1997 through 2008. Burning patterns change from year to year, but the spread of burning into the forest is quite clear, especially along the road at the center of the composites.

Over the next five years UW-CIMSS proposes to continue work with NOAA and international working groups and committees on the further development and implementation of the global geostationary fire monitoring system. The WF_ABBA will be adapted to satellites that can detect fires, such as MTSAT-2, INSAT-3D, the South Korean COMS, future GOES, and possibly others such as Russia's GOMS Elektro L MSU-GS. UW-CIMSS will continue to develop and implement the GOES-R ABI fire algorithm for improved fire detection and characterization. Research on better use of ancillary datasets (lightning data, surface emissivity, etc.) and additional spectral bands to reduce false alarms provides early fire identification associated with lightning strikes and improved diurnal monitoring, assessment, and sub-pixel fire characterization. Continued research at UW-CIMSS ensures a smooth transition from current GOES/MODIS to the next generation ABI/VIIRS allowing for a consistent, quality controlled, long-term geostationary fire database. This proposed work also addresses the needs of the international user community (GOFC/GOLD, CEOS, GEOSS).

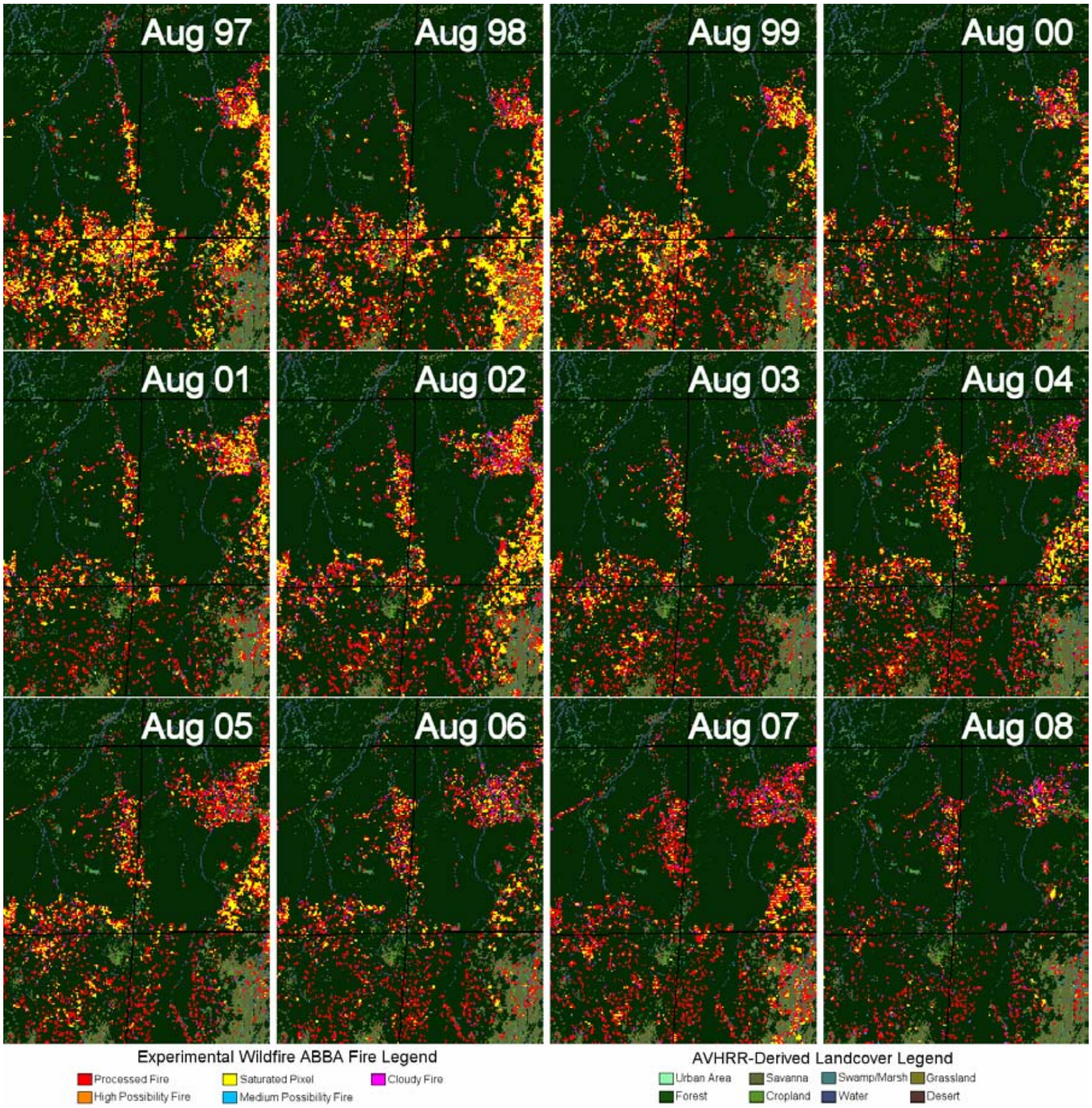

Figure 7. Composites of GOES-East detected fires with the WF ABBA over the southeastern Amazon Basin from August 1997 to August 2008. Red pixels are characterized (processed) fires and yellow represents fires that saturated the sensor. Burning patterns change from year to year, but the spread of burning into the forest is quite clear, especially along the road at the center of each panel. The WF_ABBA is being adapted for use with many of the geostationary satellites of the Global Observing System as part of the international collaboration started with CEOS (Committee of Earth Observing Satellites).

3.2.1d Estimate Sea and Lake Ice

International and domestic vessels regularly travel through the Great Lakes, which saves energy and is more fuel efficient in comparison to trains, trucks and airplanes. Despite their vast size, large sections of the Great Lakes freeze over in winter resulting in shipping hazards and interruption. Mapping and monitoring of the sea and lake ice extent, concentration, thickness, and particularly ice movement are critical to winter navigation, shore structure protection, hydropower generation, sea and lake ecology, and flooding caused by ice jams. Part of NOAA's strategic goal in transportation is to provide accurate, timely, and integrated weather information to meet air and surface transportation needs. On the sea and Great Lakes, this requires the identification of ice, monitoring of ice growth, and estimation of ice thickness and motion. Research and development of satellite remote sensing of ice are needed to meet these requirements for transportation and climate needs. UW-CIMSS has a strong collaboration with the ASPB team lead, Dr. Jeff Key. Two Ph.D. students he advised, who received their degree from AOS, currently work at UW-CIMSS as research scientists in collaboration with him to study sea and lake ice and develop methods of detecting, estimating, and tracking ice on the Great Lakes and elsewhere.

Algorithms for detecting sea and lake ice, retrievals of their concentration, thickness and motion using satellite infrared and visible observations are developed and validated at UW-CIMSS (Wang et al., 2009a, b). Applications of these algorithms to the MODIS onboard the Terra and Aqua satellites and SEVIRI onboard the Meteosat Second Generation (MSG) satellites show encouraging results for application to GOES-R.

UW-CIMSS proposes to continue to provide methods of sea and lake ice research, continuing our collaboration with NOAA/ASPB in AWG algorithm development. UW-CIMSS will continue algorithm development for GOES-R including evaluating, improving, and developing retrieval algorithms for the estimations of ice and snow properties that include ice/snow identification, ice/snow extent, ice concentration, ice thickness and age, and ice motion. Through these efforts, UW-CIMSS will help NOAA prepare for the next generation weather satellites.

3.2.1e Remote Sensing Coastal Waters and Lakes

NOAA strategic plans document a goal of facilitating a stronger understanding of coastal, Great Lakes, and weather sciences. Coastal waters are often characterized by significant concentrations of suspended sediments sourced from river outflows and from lakebed re-suspension. High concentrations of suspended matter can directly affect many water column and benthic processes such as phytoplankton productivity, growth rates of submerged aquatic vegetation, nutrient dynamics, and transportation of pollutants. Access to near real-time (e.g., direct-broadcast) and retrospective satellite observations supports Great Lakes monitoring and avoids understating changes in the Great Lakes environment.

The UW-CIMSS developed IMAPP software (Huang et al., 2004a) offers direct broadcast community members with an interest in their regional coastal environment the capability to map and study water quality and coastal management. UW-CIMSS is developing the tools for the direct broadcast community's processing package for estimating coastal suspended sediment concentrations from locally received MODIS data. It is anticipated the software will provide a significant impetus to the study of high-sediment coastal regions worldwide, with flow-on benefits to environmental managers and NOAA, thus helping to meet one of NOAA's goals for the Great Lakes.

UW-CIMSS currently provides MODIS true color 250 m resolution images to the Great Lakes Environmental Research Laboratory (GLERL). This collaboration has been positive, and we look forward to extending our work on the Great Lakes regions in collaboration with NOAA scientists and other CIs. We propose to continue developing collaborations in remote sensing of the Great Lakes, building on NASA funding to provide to the direct broadcast community a processing package for estimating coastal suspended sediment concentrations from locally received (direct broadcast) MODIS data.

3.2.1f Climate Data Records

UW-CIMSS researchers continue to develop methods to monitor cloud properties, atmospheric profiles, fires and sea/lake ice concentrations at local to global scales. Applications of these methods yield needed datasets for climate studies. UW-CIMSS scientists, working in collaboration with ASPB scientists, have developed a long-term climate record of global cloudiness using AVHRR and HIRS observations. The collaborative research of UW-CIMSS and ASPB enhances NOAA's ability to use satellite observations to advance the national climate mission, including monitoring and understanding climate variability and change. Some specific examples are noted below.

UW-CIMSS scientists have developed a HIRS cloud data record. Analysis of this dataset shows that 1) high clouds have a strong seasonal cycle, and 2) high clouds show small but statistically significant increasing trends in the tropics and Northern Hemisphere. UW-CIMSS scientists are now conducting research on how to best integrate the existing HIRS dataset with the CO_2 slicing method applied to the MODIS observations, in order to develop a robust global climate data record for high clouds.

A long-term AVHRR dataset is being used to study climate change in the Arctic. An analysis of trends shows that the Arctic has been cooling at the surface during the winter, but warming at other times of the year. The surface albedo has decreased, particularly during the autumn months. Cloud amount has been decreasing during the winter but increasing in spring and summer. During summer, fall, and winter, cloud forcing has tended toward increased cooling. This tendency implies that if seasonal cloud amounts were not changing, surface warming would be even greater than that observed.

PATMOS-x consists of twice daily fields from all of AVHRR/2 and AVHRR/3 data from 1981 to the present. In addition, monthly averaged fields are also available from single and multiple satellites. The PATMOS-x philosophy is to generate multiple data products on a grid using a common processing path. Developing cloud climatologies that are physically consistent with those from EOS and JPSS is crucial so that the 30 years of POES data contribute to the climate missions of more advanced sensors.

UW-CIMSS scientists use satellites to detect and monitor fires and smoke associated with wildfires, prescribed burns, deforestation and agricultural applications throughout the world. This effort has yielded a global, satellite-based, fire database that is used to study global fire trends.

Because of UW-CIMSS and SSEC scientific expertise and history of collecting, processing, and distributing data from diverse Earth satellite projects, SSEC has been selected to play a vital role in providing continuity with the next generation polar-orbiting satellite program, the NPOESS Preparatory Project (NPP). NASA has established the Atmosphere Product Evaluation and Algorithm Test Element (PEATE) at SSEC to enable the NPP Science Team to evaluate the operational Sensor Data Records (SDRs) and Environmental Data Records (EDRs) (both pre-launch and post-launch) from NPP for their suitability in continuing the NASA climate data record (CDR).

Knowledge of calibration accuracy of satellite radiances and derived products is absolutely necessary for climate studies. UW-CIMSS is active in calibrating sensors on geostationary and polar orbiting satellites as well as validating derived products as discussed in Section 3.2.2.

UW-CIMSS proposes to continue work with NOAA and STAR/ASPB, in developing climate data records for clouds, fire and sea/lake ice. CDRs require carefully calibrated satellite observed radiances and UW-CIMSS has and will continue to work with ASPB in monitoring the calibration of the GOES and polar orbiting NOAA satellites. UW-CIMSS will also be active in developing stronger ties with NESDIS's CI CICS as we pursue these activities.

3.2.1g Summary of Proposed Activities

In summary, we propose to continue to develop improved methods of characterizing the earth-atmosphere system using satellite observations. Successful algorithms will be transferred to NOAA operations. Many of the projects are developing algorithms for delivery to the GOES-R Algorithm Working Group. Specific examples of our proposed research plan include:

- Work with the GOES-R proxy team to develop and test new retrieval algorithms for application to the Advanced Baseline Imager;
- Continue preparations for operational utilization of GOES-R for AMV production;
- Support the GOES-R program through a synergistic use of polar orbiting hyperspectral sounding data with legacy retrieval techniques from the ABI instrument;
- Freely distribute sounding retrieval algorithms to the global community though the IMAPP and the forthcoming International Polar Orbit Processing Package (IPOPP);

- Develop and optimize various objective schemes incorporating data from multiple satellite platforms to more accurately analyze TC structure and environmental parameters necessary to improve the prediction of intensity change;
- Refine the ozone regression algorithm for the current GOES Sounder as well as MSG SEVIRI and upcoming GOES-R;
- Continue our aviation work to produce new and advanced analysis, including volcanic ash detection, detection of turbulence generated by mountain waves, tropospheric folds and upper tropospheric turbulence associated with convection;
- Work with NOAA and international working groups on further development and implementation of the global geostationary fire monitoring system, including the GOES-R ABI fire algorithm for improved fire detection and characterization;
- Enhance methods of sea and lake ice research, continuing our collaboration with ASPB in AWG algorithm development, to evaluate, improve, and provide retrieval algorithms for the estimations of ice and snow properties that include ice/snow identification, ice/snow extent, ice concentration, ice thickness and age, and ice motion;
- Develop improved methods of monitoring clouds and their properties from satellite observations, conducting studies to better characterize the errors in cloud retrievals with the ultimate goal of improving the methodologies; and
- Work with NOAA and ASPB in developing climate data records for clouds, fire and sea/lake ice. UW-CIMSS will develop stronger ties with NOAA CICS as we pursue these activities.

All of these activities will contribute directly to the NOAA 5 Year Research Plan by supporting the product research and development needs for next generation of operational satellites.

3.2.2 Satellite Sensors and Techniques

Throughout its history, UW-CIMSS has actively partnered with NOAA in planning future remote sensing requirements and defining instrument specifications. SSEC/CIMSS has conducted system and instrument trade studies by leveraging our end-to-end engineering and science capabilities. UW-CIMSS has supported NOAA in assessing new technologies, satellite measurement systems, and the associated system requirements. We have also helped to transform these requirements for data, products, and services into applicable technical requirements.

This section discusses UW-CIMSS's expertise with regard to the specific projects listed under this theme of the FFO. As indicated, these activities are largely coupled with NOAA objectives and personnel. Therefore, we do not explicitly propose specific activities but rather discuss in general terms the proposed work to be conducted in an extended CI relationship.

3.2.2a Satellite Sensor Calibration

NOAA continues to conduct research to increase the accuracy of on-orbit calibration of its satellite instruments. Extensive efforts are made to validate satellite derived products and to assure system specified requirements are met. UW-CIMSS has assisted NOAA in these pursuits.

UW-CIMSS has been active in a GEO/LEO satellite intercalibration project for more than two decades. Early efforts included comparisons of GOES-7 (VAS) to NOAA-11 (HIRS). Intercomparison of geostationary (GEO) satellite measured radiances to NOAA polar orbiting, or Low Earth Orbiting (LEO), satellite measured radiances continues. The international suite of operational geostationary imagers was recently compared to both AVHRR and HIRS (Gunshor et al., 2009). As high spectral resolution sounders in LEO, such as AIRS and IASI, have come on line, they have become the space-based calibration standards by which other infrared instruments are compared (Tobin et al., 2006, Gunshor et al., 2009).

The development of calibration/validation procedures contributes directly to improved forecasts through improved model initialization. As climate studies making use of infrared satellite measurements mature, using time-series of satellite measurements that span beyond the life of a single satellite, intercalibration will become increasingly important. As intercalibration methods are developed and longer records are kept, those researchers conducting climate studies with these instruments will benefit.

UW-CIMSS and SSEC are actively involved in field campaigns whose objectives include the validation of satellite radiances and derived products. For example, UW scientists participated in the Joint Airborne IASI Validation Experiment (JAIVEx), an international calibration/validation campaign in support of the NPOESS (now called JPSS) and Metop series of operational satellites. Although all measurements on the Metop-A and A-train satellites are of interest, the focus of JAIVEx was on the validation of radiance observations and meteorological products from the Infrared Atmospheric Sounding Interferometer, IASI, on Metop-A. UW scientists and engineers participated through the collection and analysis of the UW Scanning-HIS instrument flown onboard a high-altitude aircraft. The experiment demonstrated the high quality of both the IASI and AIRS measurements. Participation in these field programs is often enabled through a collaboration of national and international agencies, and we will seek to continue this participation in the future.

UW-CIMSS will continue to work directly, and successfully, with NOAA and ASPB to develop calibration routines for both GOES and POES satellites. We will participate in the VIIRS characterization and performance assessment effort and continue to contribute to the GSICS efforts to intercalibrate the world's geostationary infrared imagers. UW-CIMSS scientists also will participate in post-launch test efforts for the GOES series of satellites.

3.2.2b Sensor Performance Analysis

Recognizing the importance of observational systems to weather and climate applications, NOAA research seeks to insure that new observations meet the demands of both applications through close coordination of observing system requirements. In support of this NOAA goal UW-CIMSS collaborates with NESDIS and other CIs in the post-launch check-out of GOES satellites. UW-CIMSS has been involved in the post-launch science checkout of every GOES satellite, examining the quality of the Imager and Sounder instrument data and derived products. Checkout includes collection and archive of the GOES VARiable (GVAR) data, an assessment of the radiometric accuracy of the instruments, and validation of various products. During the science checkout, data are made available through the SSEC Data Center and can be viewed and analyzed in McIDAS. The Data Center archives these data as well.

Radiometric performance of the instruments is assessed in three primary ways. First, the data from the GOES Imager is collocated and compared to polar-orbiting instrument data using the UW-CIMSS GEO-LEO intercalibration methods. Second, the noise in each band is estimated from special space views. Third, quantitative products and derived imagery are generated and compared to other GOES operationally generated products.

Recent examples of UW-CIMSS participation include post launch science checkout of GOES-14 (see Hillger and Schmit, 2009) conducted 30 November 2009 to 4 January 2010. In collaboration with ASPB and CIRA/RAMMB, UW-CIMSS tasks for the GOES-14 checkout, included:

1. software modifications for various operational products, such as Clear Sky Brightness Temperature, Imager and Sounder Cloud Products and Temperature/Moisture Retrieval algorithms that were forwarded to the operational production algorithms;
2. documentation regarding radiometric and product accuracy that is part of the GOES-14 NOAA science technical report (see http://rammb.cira.colostate.edu/projects/goes-o/); and
3. examples of the data quality and comparison with other datasets are posted on the UW-CIMSS Satellite Blog: http://cimss.ssec.wisc.edu/goes/blog/archives/4094.

Figure 8 displays an example involving the GOES-13 Imager. Intercalibration tests with polar-orbiting high spectral resolution AIRS revealed that the 13.3 micrometer band on the GOES-13 Imager was off by 2.4 K (Wu et al., 2008). UW-CIMSS showed that shifting the operational spectral response function (SRF) would bring better agreement. NOAA scientists took these results to the instrument vendor, who then responded with a new SRF for that band (Figure 8). UW-CIMSS researchers also contributed to a study of Japan's geostationary imager, MTSAT-1R, which was affected by crosstalk from the water vapor band to the shortwave band resulting in 8 to 9 K errors in brightness temperatures of the shortwave band; a subsequent correction was also verified by UW-CIMSS.

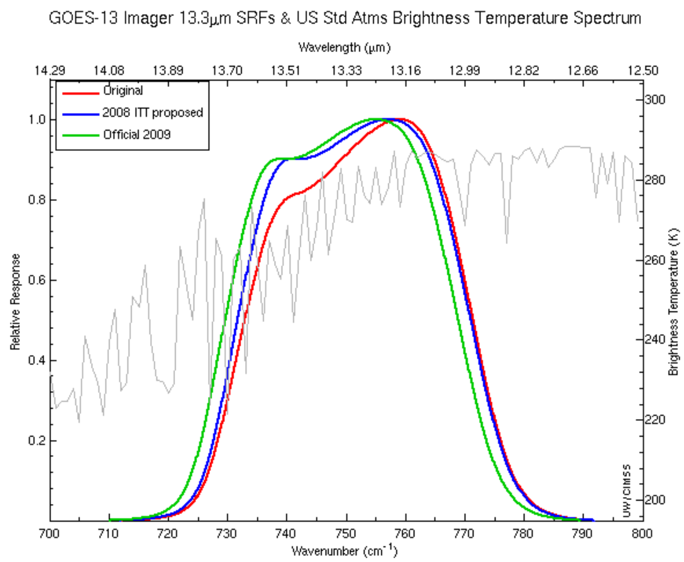

Figure 8. The GOES-13 Imager 13.3 micrometer band spectral response function (SRF) plotted against a brightness temperature spectrum calculated from the U.S. Standard Atmosphere. The original SRF (red) was replaced in 2008 by the instrument vendor pre-launch lab measurements (blue). CIMSS on-orbit inter-comparison with AIRS and IASI suggested shifting the GOES-13 band 6 SRF further (green) to longer wavelengths (shorter wavenumbers). UW-CIMSS is the first to demonstrate adjustment of GOES SRFs by inter-calibration with polar orbiting high spectral resolution IR sensors. In orbit calibration necessary for climate datasets calibration will rely on techniques such as these.

UW-CIMSS will continue supporting NOAA's efforts in sensor performance analysis. Next up, the GOES-P post launch science checkout is planned shortly after the scheduled launch in March 2010. Before being used operationally the quality of the data and products must be evaluated. UW-CIMSS is building a processing system to handle data from GOES-15 and planning to conduct analyses of radiance integrity. The steps required to complete the checkout are similar to previous post-launch checkouts. The lessons learned from post launch science checkouts of current GOES instruments will be applied to the GOES-R series of satellites. To accommodate the expanded radiance data and products provided by the GOES-R, additional calibration and algorithm checkout tests and applications will be developed and implemented.

3.2.2c Specification of Instrument Characteristics for Future Satellite Imagers and Sounders

NOAA's research plan states its commitment to "accelerating the development of new environmental observational technology and sensors, including state-of-the art observational uncertainty estimates." All of NOAA's CIs play an important role in helping NOAA meet this goal.

In past decades, UW-CIMSS has supported the spectral channel selection for the VISSR Atmospheric Sounder (VAS), the subsequent operational GOES Sounder, and the next generation GOES-R Imager (ABI) (Schmit et al., 2005). For the polar orbiting instruments UW-CIMSS has strongly advocated the addition of a water vapor absorption channel to later versions of the VIIRS. UW-CIMSS scientists have also explored the noise versus spectral resolution for the NPP CrIS instrument (for which the original design concept was developed at SSEC/CIMSS).

UW-CIMSS has conducted capability assessments for various instrument configurations. A recent example is our investigation of the capability of the GOES ABI to estimate atmospheric profiles of temperature and moisture in the absence of an accompanying sounder. UW-CIMSS tests with research analysis tools in a simulated operational framework revealed that limited soundings would be possible.

UW-CIMSS is currently conducting research on future GOES advanced imaging and sounding requirements by performing trade studies on the spectral coverage/resolution, spatial coverage and resolution, temporal resolution, and radiometric resolution. UW-CIMSS scientists have worked with STAR, ASPB and the GOES-R Program Office on the evaluation of user product requirements and transforming them into instrument technical requirements. Specifically, during the past few years UW-CIMSS scientists have accomplished the following in collaboration with STAR and ASPB:

- Selection of the ABI 16 bands (Schmit et al., 2005) and simulation of the spatial resolution, coverage, and scan strategies. For example, Figure 9 below shows the simulated lifted index (LI) product from a GOES-R scan mode (every 15 minutes for disk coverage – left panel, plus every 5 minutes for CONUS – upper right panel, plus every 30 seconds for mesoscale – lower right panel);
- Study of legacy atmospheric profile product generation with ABI in the absence of a GEO hyperspectral IR sounder;
- Trade studies used for the formulation of the Hyperspectral Environmental Suite (HES) sounding instrument, including spectral coverage, spectral resolution, signal-to-noise ratio, and ensquared energy;
- Advice on GOES-R instruments to the GOES-R Atmosphere, Ocean, Land (AOL)/Technical Advisory Panel;
- Presentations of science results at AMS annual meetings, GOES Users' Conferences, National and International Conferences, GOES Users community, Education Units and International Institutes;
- Guidance to international partners in the Global Observing System (EUMETSAT, NSMC, etc) in support of their next generation geostationary planning (see letters of support in Appendix B); and
- 37 peer-reviewed papers since 2002 under partial support of this program.

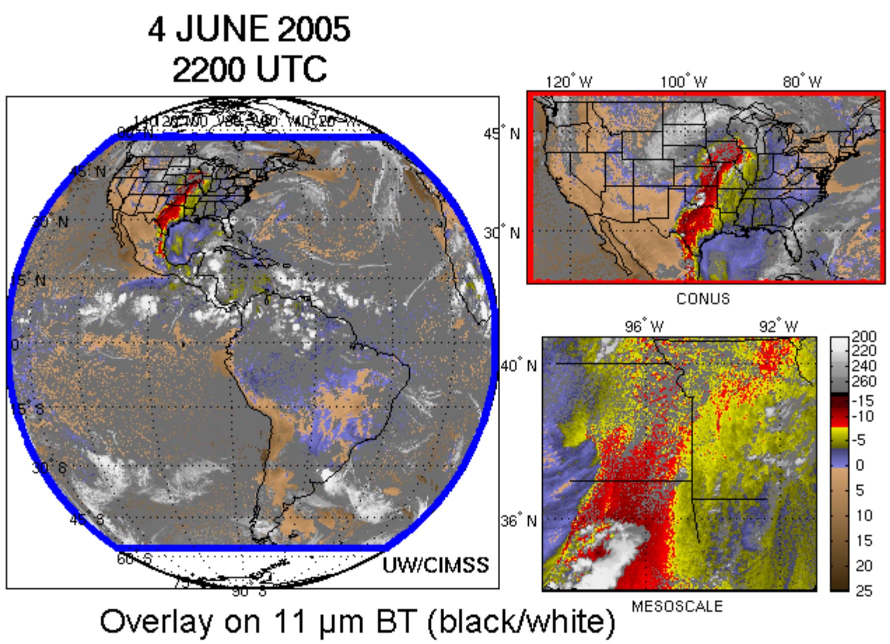

Figure 9. Simulated lifted index (LI) product from a GOES-R scan mode using 15 minutes for disk coverage (left panel), plus every 5 minutes for CONUS (upper right panel), plus every 30 seconds for mesoscale (lower right panel). This figure demonstrates the end-to-end capability of UW-CIMSS to support NOAA instrument trade studies.

SSEC/CIMSS scientists and engineers are currently active in the formulation of the NASA CLARREO Decadal Survey mission. The ability of this mission to create "benchmark observations" in the radiance domain would enable the establishment of a climate record from many sensors that is sensitive to climate change. This new climate emphasis serves to complement the technology and algorithm techniques developed by UW-CIMSS over the past 20 years for weather applications. Indeed the high level of climate benchmark requirements demanded for accurate remote sensing of temperature and water vapor in the infrared have been derived from experience with the original HIS aircraft instrument, the ground-based AERI program, and subsequently with the CrIS, IASI, and future CLARREO sensors. The unique role of UW-CIMSS/SSEC in the area of hyperspectral remote sensing is blending weather and climate research activities to provide the tools and technologies needed for NOAA to provide the information needed for decision making on policy in this rapidly changing world. Hyperspectral information content plays a critical role in the study of short time scale phenomenon such as convective precursors to severe storms and hurricane intensification as well as decadal change in temperature, water vapor, and clouds.

UW-CIMSS will continue to provide science support on future GOES and POES instrument requirements and study the impact of instrument specifications on derived products that NOAA requires. We will investigate the impact of any ABI instrument specification changes or modifications on various GOES products, identifying algorithm or processing modifications that may be used to mitigate sensor impacts on product requirements including processing system, time latency, accuracy, precision, and other measures. UW-CIMSS will continue to work with SSEC, NOAA, and NASA on the preparation for a future advanced sounder for geostationary orbit, working to define the instrument characteristics that meet user requirements and to prepare for data applications in high impact weather nowcasting, nearcasting and forecasting. UW-CIMSS will continue to contribute similar guidance and support to the POES instruments (formerly NPOESS and now JPSS).

3.2.2d Multi-Sensor Data Fusion

NOAA/STAR, in collaboration with its CIs, seeks to develop multi-platform and multi-sensor products that improve the accuracy of its research and operational products. Reliable methodologies are being studied for combining measurements from multiple sensors from single or multiple platforms; they include sensor data collocation, data fusion, improved product generation, and evaluation.

UW-CIMSS has demonstrated the value of multi-sensor products. As noted in Section 3.2.2b, we have combined multiple sensors from multiple platforms to conduct calibration activities. In addition, UW-CIMSS scientists have conducted science studies using multi-sensor approaches. Temperature, moisture and clouds have been studied with a combination of AVHRR and HIRS (e.g., Frey et al., 1996), AVHRR and ERBE (e.g., Inoue and Ackerman, 2002), and MODIS and AIRS (e.g., Li et al., 2004; Li et al., 2005a, b). Efforts are being made to combine polar orbiter sounder measurements with more timely GOES Imager measurements to accurately describe atmospheric conditions. The goal is to maintain the quality of atmospheric temperature and moisture profiles during the GOES-R era in the absence of a geo-sounder. UW-CIMSS work in this area is laying the groundwork for future GOES sounding products.

UW-CIMSS will continue to advance the synergistic algorithm for quality atmospheric and environmental products from multiple sensors and from single and multiple platforms. Our focus will be on the combination of GOES-R ABI and hyperspectral IR sounder from polar-orbiting satellites for better atmospheric vertical temperature and moisture profiles. ABI provides very limited profile information with high spatial and temporal resolution, but when combined with forecast information, ABI is able to continue the legacy atmospheric profile products of the current GOES Sounder. With hyperspectral IR sounder data from polar-orbiting satellites included, the GOES-R legacy atmospheric profiles can be improved.

3.2.2e Satellite Product Validation with Field Observations

One of NOAA's Weather and Water Program Objectives is to reduce the uncertainty associated with weather and water decision tools and assessments, including uncertainties associated with satellite observations. Meeting this objective requires field observations to validate satellite derived products.

UW-CIMSS has participated in numerous field campaigns to validate satellite derived products (See Appendix K for a list of experiments). Observations from aircraft and ground-based measurements systems have been used to assess the performance of satellite algorithms in retrieving given physical parameters (e.g., Schmit et al., 2002; Hawkinson et al., 2005). Many of these validation exercises leverage collaborative activities with NASA, DoE and NSF.

An example of our validation work is the evaluation of the airborne Water Vapor Sensing System (WVSS) by UW-CIMSS. In the late 1990s, the North American Observing System (NAOS) study group performed an evaluation of the value of automated aircraft reports relative to and as a supplement for rawinsonde observations. The results of that study clearly identified the need to add moisture data to the temperature and wind reports already included in the aircraft data; this need was later formalized into an official National Weather Service (NWS) data requirement. In an early attempt to fill this data gap in the 400km and 12-hr spacing of the U.S. rawinsonde network, the first generation Water Vapor Sensing System (WVSS-I) has been operating aboard roughly 30 UPS aircraft for more than five years. To improve accuracy and reduce maintenance/operations costs noted in the WVSS-I tests, a second generation WVSS-II has been developed and undergone successful initial testing. UW-CIMSS participated in both experiments, collaborating with the NWS in designing assessment and implementation strategies for the WVSS-II. Petersen et al. (2009) evaluated other existing continuous moisture datasets to provide a basis for determining the optimal time and distance spacing between observations thus better utilizing the WVSS-II measurements. Figure 10 shows the accuracy assessments accomplished through intercomparison of the WVSS-II with other accepted ‘standard’ observations. Our work in assessing the WVSS-II measurements will continue with future deployments of the AERIbago mobile lab to provide validation observations at selected airports.

UW-CIMSS will continue its involvement with NASA, NSF and DOE field programs, which help NOAA by validating satellite (GOES, NOAA, EOS, GOES-R, NPP, and JPSS), aircraft (SHIS, WVSS-II), and ground based (AERI, MWR, radiosonde) products.

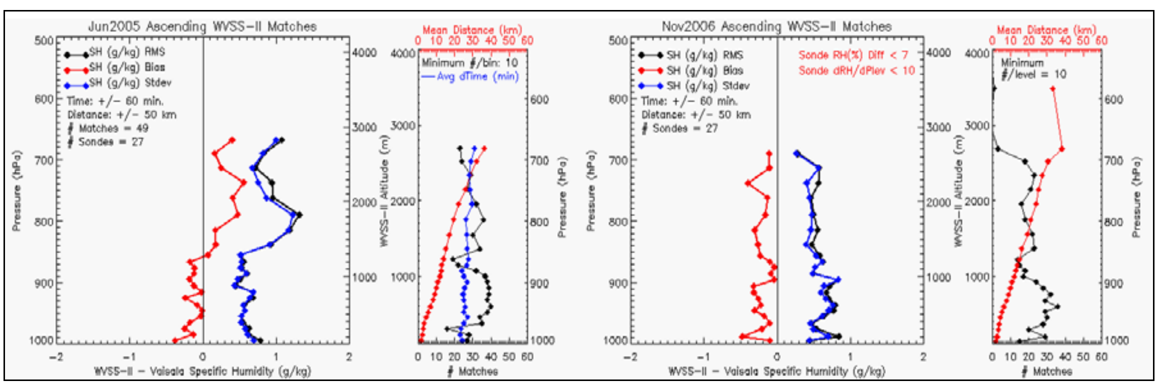

Figure 10. Intercomparisons of WVSS-II ascent and rawinsonde moisture profiles (mixing ratio, g/kg) from spring 2005 (left) and fall 2006 (right) showing results of initial engineering improvements. Although results for these quality-controlled data fall within WMO standards, additional modifications were needed to reduce system failures and to provide quality data in aircraft descent. UW-CIMSS joined the NWS in efforts to validate the WVSS measurements and to determine optimal sampling strategies; this is an important component of the future observing system of moisture, complementing radiosonde and satellite measurements.

3.2.2f Summary of Proposed Activities

As a continuing cooperative institute, UW-CIMSS proposes to evaluate new ideas and techniques to support NOAA in its transition of technologies and applied research into an operational framework. In providing this support UW-CIMSS will:

- Continue to support NOAA in conducting system and instrument trade studies. By leveraging UW-CIMSS end-to-end capabilities (discussed in Section 3.4), we can help smooth the transition of research analysis tools to operational application;
- Continue to support NOAA in assessing new technologies and satellite measurements systems and defining system requirements;
- Support NOAA in transitioning technologies and research into an operational framework by helping to evaluate new ideas and techniques;
- Continue to work directly, and successfully, with NOAA and ASPB to develop calibration routines for both GOES and POES satellites. We will participate in the VIIRS and CrIS characterization and performance assessment effort and continue to contribute to the GSICS efforts to intercalibrate the world's geostationary infrared imagers;
- Support NOAA's efforts in sensor performance analysis, including the forthcoming GOES-P post launch science checkout. The lessons learned from post launch science checkouts of current GOES instruments will be applied to the GOES-R series of satellites;
- Provide science support on future GOES and POES instrument requirements and study the impact of instrument specifications on derived NOAA required products;
- Investigate the impact of any ABI instrument specification changes or modifications on various GOES products, identifying algorithm or processing modifications that may be used to mitigate sensor impacts on product requirements including processing system, time latency, accuracy, precision, and other measures;
- Work with SSEC, NOAA, and NASA on the preparation for a future advanced sounder for geostationary orbit, working to define the instrument characteristics that meet user requirements and to prepare for data applications in high impact weather nowcasting and forecasting;
- Provide guidance and support to the JPSS (formerly NPOESS) Imager and Sounder instruments;
- Advance the development of synergistic algorithm for quality atmospheric and environmental products from multiple sensors from single platform and multiple platforms. Our focus will be on the combination of GOES-R Advanced Baseline Imager (ABI) and hyperspectral IR Sounder from polar-orbiting satellites for better atmospheric vertical temperature and moisture profiles; and
- Continue involvement with NASA, NSF and DOE field programs that support satellite calibration and validation.

3.2.3 Environmental Models and Data Assimilation

Satellite observations have become the primary source of information for Numerical Weather Prediction (NWP) models and are a major contributor to forecast improvements over the last two decades. However, due to the large volume of satellite data and limitation in computing resources available to operational centers, assimilation techniques necessarily must attempt to compress the data with minimal information lost. Compression techniques include thinning (both spatially and spectrally, especially for hyperspectral observations), principal component analyses, and physical profile retrievals. To date, thinning of radiances assimilated directly has been the preferred method and yields the best results; however, the availability of high spectral resolution data from multiple satellites suggests other approaches must be re-visited. UW-CIMSS is working with NOAA and the JCSDA in developing techniques to assimilate the information from remote sensing sounders and imagers into NWP systems. These studies help to ensure that the large investment in advanced instrumentation will continue to bring rapid forecast improvements. The approach to realizing improved forecasts is for model impact studies to guide the utilization of current remote sensing assets and to suggest high priorities for future remote sensing improvements.

Areas in which UW-CIMSS scientists are working to support NOAA in the theme of environmental modeling and data assimilation are presented below.

3.2.3a Nowcasting

Objective short-range forecasts, 0-9 hours into the future, are especially important for warning the public about hazardous weather events. UW-CIMSS and NOAA are using satellite-derived temperature, moisture and wind fields in nowcast and nearcast models to provide more accurate short-term forecasts. Despite the advances in many aspects of NWP that have taken place over the past decades, determining the location and timing of convective development in the near future continues to present a major problem to operational weather forecasters. Tools are needed both to identify where significant convection is initiating and to isolate the environments where hazardous convection can, or cannot form 0-9 hours in advance. Toward this end, UW-CIMSS has developed nowcasting (0-1 hour prediction) systems to detect and monitor areas of convective initiation based on the growth rate and vertical extent of transient convective clouds. UW-CIMSS has also developed a nearcasting (1-9 hour) tool that uses satellite-based Derived Product Images (DPI) to identify environments in which convection is, or is not likely to develop to hazardous levels by predicting the growth of convective and static instability. This work is helping to ensure the optimal use of satellite data in nowcasts/nearcasts of severe weather. It is also helping to meet the stated NWS goals of providing early detection and improving Probability of Detection as well as reducing False Alarms of severe convective storms. Relationships have been established by UW-CIMSS with several NWS Weather Forecast Offices (WFOs), the National Severe Storms Laboratory (NSSL) and the NCEP Storm Prediction Center (SPC) for evaluating and critiquing the new objective nowcasting products.

UW-CIMSS research has demonstrated that these new objective prediction tools enable forecasters both to significantly improve their use of current and future satellite data over the continental U.S and to alleviate the deficiencies in very-short-range forecasts of hazardous convection (see Figure 11). The convective initiation nowcasting system has been successfully demonstrated in the U.S. and Europe and is consistent with the FAA modernization plans. The nearcasting system is being tested in the U.S. and has, as a surrogate for GOES-R ABI, demonstrated substantial skill using MSG SEVIRI data in Europe.

We propose to continue and expand this nowcasting/nearcasting work with local WFOs and with the NCEP Service Centers. Our nowcasting and nearcasting algorithms continue to be evaluated by operational forecasters and their feedback will be integrated in further improvements. Our goal is to have strong nowcast/nearcast tools in use at WFOs and NCEP Service Centers by the time that GOES-R is deployed.

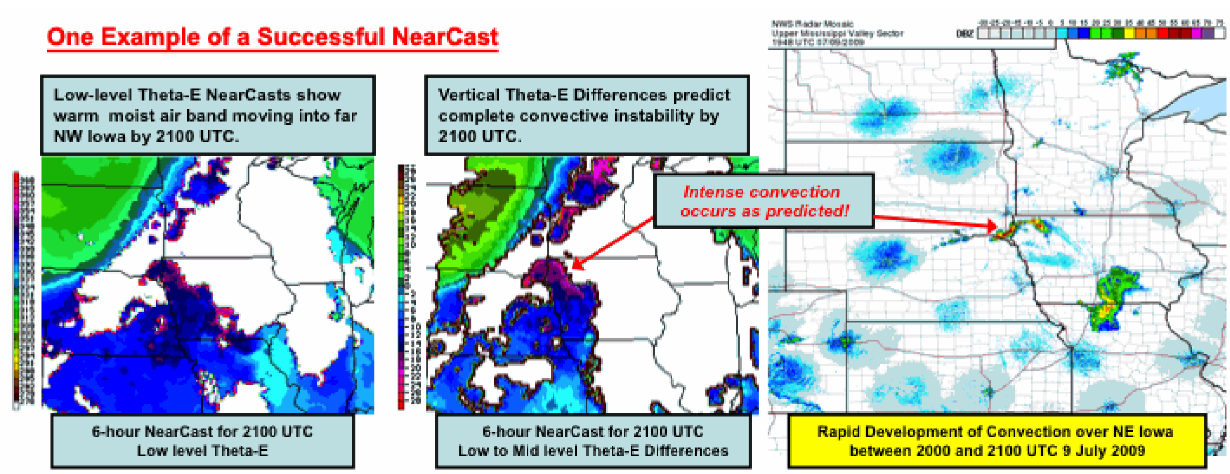

Figure 11. 6-hour nearcast of the timing and location of rapidly forming isolated convection in northwestern Iowa on 9 July 2009. NWP products indicated largest threat in west-central Iowa, south of the nearcast and the subsequently observed convection. UW-CIMSS research has been demonstrating these new objective prediction tools that enable forecasters to improve very-short-range forecasts of hazardous convection.

3.2.3b Assimilation of Satellite Derived Atmospheric Composition Products in Atmospheric Chemistry Models

UW-CIMSS is collaborating with NOAA to advance data assimilation and the transfer of new research and technology into operations through parallel testbed studies. Recommendations from recent NOAA Air Quality (AQ) workshops have helped to define where this research should be focused. Current satellite composition data needs to be exploited and preparations need to be made for future multi-platform composition data. The impact of space-based measurements relative to enhanced regional profile and surface networks needs to be systematically evaluated.

UW-CIMSS and Dr. B. Pierce, a scientist with ASPB, are actively involved in AQ research in collaboration with NOAA/STAR and NASA scientists. Part of this effort has involved development and use of the Regional Air Quality Modeling System (RAQMS), which is a multi-scale (global-to-regional) unified (troposphere-stratosphere) chemical forecasting/assimilation system (Pierce et al., 2007). It is designed to address the emerging needs within the AQ forecasting/assessment community by prototyping assimilation of satellite-based constituent measurements. RAQMS currently assimilates satellite observations of 3-dimensional distributions of ozone, carbon monoxide, column total ozone and aerosol optical depth (AOD).

Working with ASPB, UW-CIMSS scientists are advancing NOAA's development of AQ modeling and assimilation techniques. This work is intended to help ensure the optimal use of the large volume of AQ measurements available from satellites, now and in the near future.

UW-CIMSS proposes to build on its success of working with Dr. Pierce in developing the RAQMS and work with NOAA, NASA and other Cooperative Institutes to improve Air Quality data assimilation methods, modeling techniques and forecasts.

3.2.3c Development of Satellite Data Assimilation Methods

Advanced data assimilation techniques are required to improve the quality of analyses and model initialization, and to maximize the value of existing and new observational datasets. The JCSDA was developed by NOAA to accelerate and improve the quantitative use of research and operational satellite data in weather, ocean, climate, and other environmental analysis and prediction systems. UW-CIMSS has played a strong role in the JCSDA since its inception. A recent focus of UW-CIMSS data assimilation studies has been on the newer, more voluminous satellite datasets, including satellite sounding systems from polar orbiting platforms. When possible, direct assimilation of satellite radiances has been preferred by most NWP centers. UW-CIMSS scientists have had a major role in improving the radiance assimilation techniques used in NCEP's operational forecast system in several ways, including:

- improving the community radiative transfer model (CRTM) for both infrared and microwave radiances (Heidinger et al., 2006);
- improving the knowledge of surface emissivity for land, ice and ocean waters; and
- developing techniques used to assimilate infrared hyperspectral radiances.

UW-CIMSS scientists have also worked with NOAA/NESDIS and NOAA/NWS/NCEP personnel to develop and transition new satellite products into the NCEP operational data assimilation systems. Examples include the MODIS polar atmospheric motion vectors (AMV), the GOES Sounder precipitable water vapor product, the Navy's WindSAT product from CORIOLIS, and the EUMETSAT/NESDIS Advanced Scatterometer (ASCAT) surface wind product from Metop.

UW-CIMSS scientists in Madison and stationed at NCEP/EMC have been working with the AIRS Science Team, NCEP and NESDIS personnel and others in developing techniques to assimilate the AIRS and IASI infrared (IR) water vapor channels into NCEP's Global Data Assimilation System/Global Forecast System (GDAS/GFS). Recent focus has been on improving the assimilation techniques of the hyperspectral (AIRS and IASI) water vapor channels. The channels which include strong water vapor absorption spectral lines, have a narrow spectral response, and are sensitive to moisture in the stratosphere as well as the troposphere are being examined. By closer screening of the observations, adjusting the model background error and adjusting the water vapor channels' assimilation weights, the IASI and AIRS water vapor channels can be used by the analysis and lead to better moisture field forecasts (Jung et al., 2009).

Although infrared and microwave radiances play a critical role in the quality of the NOAA/NCEP forecast models, there is still considerable room for improvement in their assimilation. UW-CIMSS scientists will continue to: 1) work with the JCSDA and NCEP to develop and improve assimilation techniques of water vapor and other trace gases, and 2) continue our important role in the development of radiative transfer models and surface emissivity products currently used by NWP.

Advanced data assimilation systems employing the Ensemble Kalman filter (EnKF) are becoming more widely used within the research community. An EnKF system does not require the development of adjoint or tangent linear models and contains flow-dependent background error covariances, which makes it an attractive option for assimilating cloud-affected satellite observations at high spatial and temporal resolutions. Regional-scale Observing System Simulation Experiments (OSSEs) are currently being performed to examine how the assimilation of both clear and cloudy-sky ABI infrared radiances impacts the accuracy of atmospheric analyses and affects the skill of short-range numerical model forecasts. Preliminary results from an ongoing study are encouraging and indicate that cloudy 8.5 μm radiances have a large positive impact on the cloud field, particularly in the upper troposphere. Substantial effort will be required to better understand the impact of cloudy observations on the analysis and to more easily extract the greatest information content possible. Improvements to cloudy forward radiative transfer modeling and the treatment of cloudy processes in NWP models is also necessary, as are techniques to reduce the data volume and correct for biases in the observations.

UW-CIMSS proposes to continue collaboration with NOAA, the JCSDA and the JCSDA partners to quantify and improve the information obtained from existing and future satellites. The development of new assimilation techniques and improvements to existing techniques will continue at UW-CIMSS with the intended benefit of increasing and improving the information used by assimilation systems in order to improve understanding of the atmosphere and our ability to monitor changes and forecast weather events.

3.2.3d Impact Studies and Observing System Simulation Experiments

Impact studies or Observing System Experiments (OSEs) and Observing System Simulation Experiments (OSSEs) are intended to affect the design decisions regarding maintaining current systems and preparing for future observing systems. OSEs are used for testing existing observing systems by using data denial or data inclusion experiments. OSSEs are used to test proposed observing systems by simulating observations from an NWP model. These observations are then assimilated in a manner similar to the data inclusion experiments. Impacts from both the OSEs and OSSEs are measured by their improvements to weather analyses and forecasts.

UW-CIMSS measured the individual impact of in-situ rawinsonde (RAOB) data and remotely sensed GOES and POES data routinely used in NCEP's Eta Data Assimilation/Forecast System (EDAS). In 15-day periods during Fall 2001, Winter 2001/2002, Spring 2002 and Summer 2002, UW-CIMSS ran a 32-km version of the EDAS four times at both 0000 UTC and 1200 UTC. Differences between the experimental and control runs were accumulated over the 15-day periods and analyzed to demonstrate the 24- and 48-hr forecast impact of these data types in the EDAS. The results of this seminal OSE are summarized in Figure 12 (Zapotocny et al., 2005). The results show the positive impact of both GEO and LEO data on the forecasts; the largest impact was from GEO winds and LEO temperature and moisture. UW-CIMSS personnel have more recently conducted similar OSEs using NCEP's Global Forecast System (GFS) and are reported in Zapotocny et al. (2007) and Jung et al. (2008).

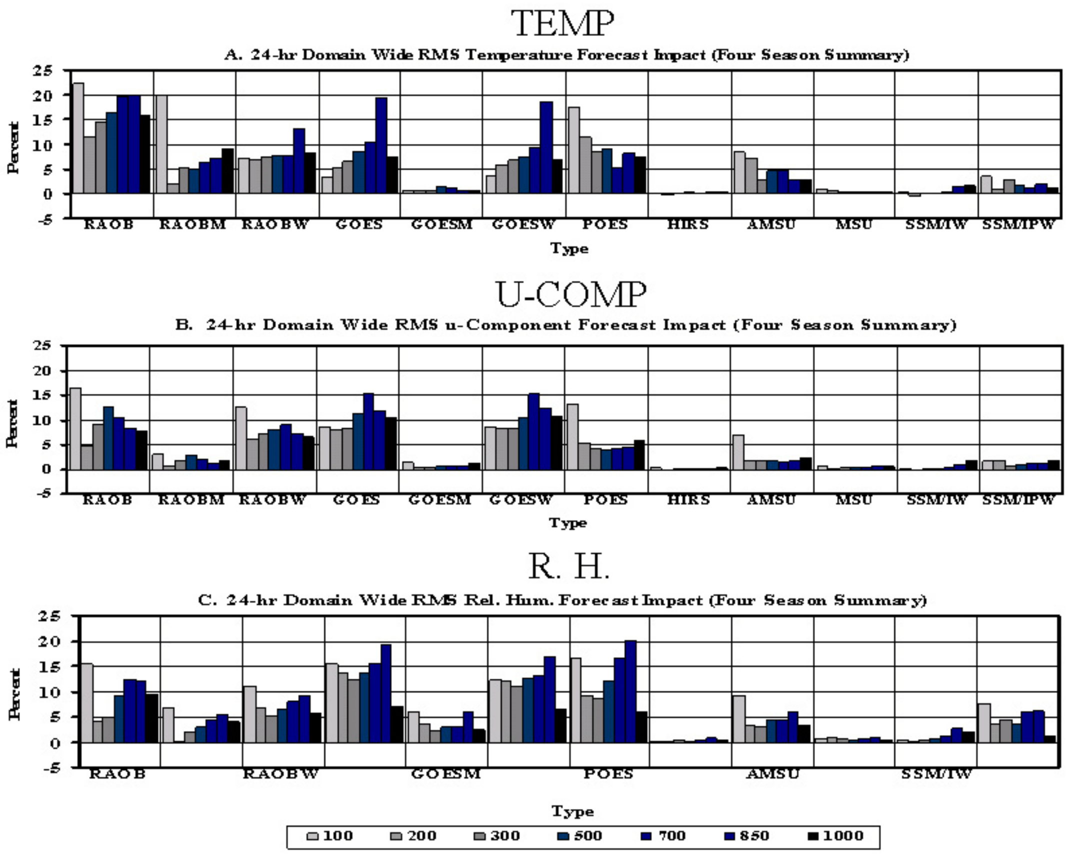

Figure 12. Four season summary of time averaged forecast impact (%) results for three standard meteorological fields (temperature, wind, and moisture profiles from 1000 to 100 hPa) after 24-hrs of Eta model integration without RAOB (temp and wind), RAOBM (temp only), RAOBW (wind only), GOES (temp and wind), GOESM (temp), GOESW (wind), POES (HIRS, AMSU, and MSU), HIRS, AMSU, MSU, SSMIW (low level winds), SSMIPW (total precipitable water). The time period examined utilizes a regional model EDAS with 32 km resolution for both the assimilation and forecast. UW-CIMSS conducted this OSE demonstrating that all components of the Global Observing System (geostationary satellites, polar orbiting satellites, and radiosondes) contribute positively to the regional forecasts.

Another recent OSE was a two-season experiment to study the impacts of assimilating the Advanced SCATterometer (ASCAT) surface winds product. The assimilation system and forecast model are a recent version of the NCEP Global Data Assimilation/Global Forecast System (GDAS/GFS) at the current operational resolution. The impacts of assimilating the ASCAT surface wind products were assessed during two seasons by comparing the forecasts through 168 hours of control simulations utilizing all the data types assimilated into the operational GDAS with the experimental simulations using this new surface wind product.

Results for a summer season suggest that assimilation of ASCAT data has a neutral to small positive impact as shown by the day 5 anomaly correlation bar chart in Bi et al., 2009. Current studies propose to evaluate the quality control procedures and thinning routine (superobs) used for WindSat for potential improvements. We plan to investigate using a modest thinning routine at various resolutions compared to the present superob routine. The thinning routine will enable us to evaluate the observations with respect to the model background and potentially improve the quality control procedures as was done with the ASCAT.

OSSEs are conducted to aid in the design of future observing system instruments. However, results depend on a combined measure of the information content of a component of the observing system and the model skill in utilizing that information in assimilation and forecast; if there is no impact, it could be either lack of new information or under-developed skill in the model for assimilating new information. Noting the difficulty of performing realistic OSSEs, it is essential that such experiments are open to careful review by the wider scientific community. Nonetheless, the benefit of well run OSSEs is optimized resource allocation for maintaining and evolving the satellite component of the observing system. UW-CIMSS has contributed both OSEs and OSSEs for NESDIS to help in their decision making regarding the U.S. Satellite Observing Systems.

UW-CIMSS performed the first and only OSSE regarding the utility of geostationary high spectral resolution measurements. Value of various measurements was assessed from information content theory. There was indication of significant information content in radiance measurements from a geostationary high spectral resolution interferometer (GEO-I); investigations suggested that geostationary high spectral resolution soundings were close to providing radiosonde-like information in moist atmospheres available for temperature and moisture profiling every hour every 50 km in clear skies. Using the Rapid Update Cycle as the vehicle for this OSSE, it was determined that geostationary radiometer sounders (GEO-R) provide moisture information at and above 700 hPa beyond that available from radiosondes, aircraft reports, and profilers, but not below. On the other hand, a geostationary interferometer (GEO-I) could provide twice as much temperature and moisture information as the GEO-R, and GEO-I could resolve boundary layer moisture (below 700 hPa) in clear skies. Polar orbiting high spectral resolution IR sounders did not equal GEO-I for moisture performance; hourly high spectral observations were found to make obvious improvements to regional model performance (Aune et al., 2000).

Placing a hyperspectral IR sounder in geostationary orbit will lead to substantial improvements in monitoring the mesoscale environment for severe weather forecasting and other applications. UW-CIMSS scientists have conducted studies on the application of a geostationary advanced IR sounder for severe storm warning (Schmit et al., 2009). A convective initiation event from the IHOP (International H2O Project) field experiment was used as an example to demonstrate the potential utility of a Hyperspectral Environmental Suite (HES)-like instrument for severe storm nowcasting applications. Data from an advanced IR sounder would provide detailed stability information (e.g., Lifted Index) with high temporal resolution useful for determining favorable locations for convective initiation. Atmospheric data from a high-resolution WRF model was used to generate simulated HES and ABI stability products. Comparison of these products shows that the ABI (or the current GOES Sounder) provides limited stability information before the storm development due to the limited spectral IR information for temperature and moisture profiling. The high spatial and temporal geostationary advanced IR sounder, however, can provide critical information about the destabilization much earlier than the current GOES Sounder, ABI, and the radar (Figure 13).

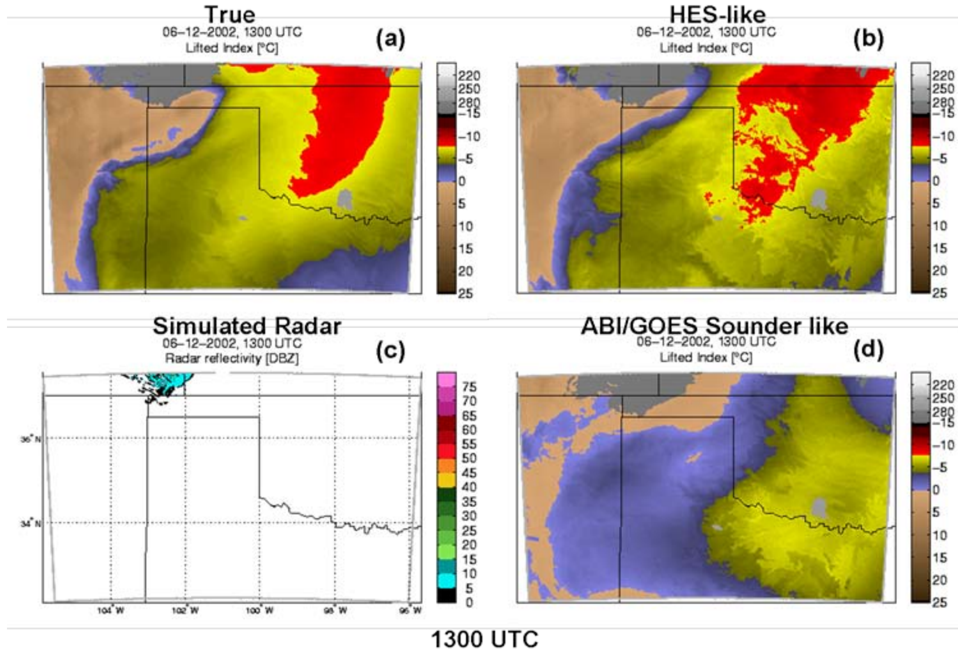

Figure 13. The clear sky LI (color regions) from (a) true fields (simulated with a model), (b) Hyperspectral Environmental Suite (HES) simulated data, (d) ABI/GOES Sounder simulated data, and (c) radar reflectivity at 1300 UTC on 12 June 2002. The black/white regions in the LI plot are the cloud top temperatures from WRF model output, while the red regions show the extremely unstable areas. HES is showing the atmospheric destabilization well in advance of the other systems; ABI starts to show it four hours later and the radar starts to indicate the precipitation band eight hours later. This figure demonstrates that the HES-like instrument provides important information about extreme destabilization several hours earlier than ABI, the current GOES Sounder, and radar.

3.2.3e Developing Simulated Datasets for GOES-R Algorithm Development and Testing

Simulated data are also critical to the design and pre-launch scientific studies needed to assure the success of future satellite instruments. UW-CIMSS has made substantial use of NWP model simulations and computing infrastructure and software tools developed at UW-CIMSS to generate model-derived proxy radiance datasets for use in GOES-R research and measurement demonstration activities. The principal effort involves generating highly realistic proxy ABI radiance datasets and providing support to users of these datasets. The proxy radiance datasets have been extensively utilized during the past several years to demonstrate the advanced measurement capabilities of future satellite sensors (e.g., Otkin et al., 2007). Such datasets are an attractive alternative to those derived from existing air- and ground-based instruments since they can more easily be configured to represent the appropriate spatial, temporal, and spectral resolutions of the advanced sensor. Substantial effort has been directed toward demonstrating the measurement capabilities of the ABI sensor to be launched onboard GOES-R (see section 3.4.1).

Since clouds directly impact weather conditions, it is critical that NWP models realistically simulate their properties and structural evolution in order to achieve a more accurate forecast. Accurately simulating clouds is also important for algorithm development and assessment. The scarcity of conventional observations with fine temporal and spatial resolution makes it difficult to properly validate the accuracy of cloud-resolving (< 5-10 km resolution) model simulations; thus it is necessary to utilize high-resolution satellite observations. Satellite radiances and derived cloud products, such as cloud top pressure, cloud optical thickness, and cloud fraction are routinely available from a variety of sensors. Although the accuracy of many satellite-derived cloud datasets is too low to provide an absolute measure of the observed cloud properties, such datasets are valuable for evaluating the realism of simulated cloud fields. For instance, Otkin and Greenwald (2008) used MODIS cloud data to determine which cloud microphysical and planetary boundary layer schemes in the WRF model produced the most realistic cloud properties within a large extratropical cyclone. The best parameterization schemes identified in this study were subsequently employed in each of the simulations used to derive proxy ABI radiance datasets (see section 3.4.1). Recent studies by Otkin et al. (2009) and Greenwald et al. (2010) have compared WRF model output from these simulations to SEVIRI and CloudSat observations. Overall, the results revealed that the combined NWP-forward modeling framework employed at UW-CIMSS is able to produce highly realistic proxy radiance datasets.

UW-CIMSS proposes to continue with additional model simulations to support the creation of GOES-proxy datasets. One example is a realistic dust and aerosol properties simulation in order to support the evolving needs of the GOES-R project.

3.2.3f Summary of Proposed Activities

The UW-CIMSS data assimilation and modeling teams will continue to work with NOAA and other agencies and CIs to achieve optimal use of satellite based measurements. Specifically, we propose to:

- Continue and expand the nowcasting and nearcasting algorithm development and testing in order to provide WFOs and NCEP Service Centers with a robust set of associated tools before GOES-R is deployed;
- Build on the success in developing the RAQMS in collaboration with ASPB and work with NOAA and other CIs to improve air quality data assimilation methods, modeling techniques and forecasts;
- Continue collaboration with NOAA, the JCSDA and the JCSDA partners to quantify and improve the information obtained from existing and future satellites;
- Participate in OSEs and OSSEs to help guide NESDIS planning for the future and improve utilization of the present remote sensing assets from satellites; and
- Create additional model simulations for GOES proxy datasets. Examples include a realistic treatment of clouds, dust and aerosol properties in the simulations in order to support the evolving needs of the GOES-R project.

3.3 Education and Outreach

NOAA’s *2009-2029 Education Strategic Plan* focuses on “strengthening the environmental literacy of the American public and supporting the development of a future workforce in science, technology, engineering, mathematics (STEM) and other disciplines which support NOAA’s mission.” UW-CIMSS education goals are aligned with this NOAA strategic plan.

Education and outreach are a key element of the UW-CIMSS mission. UW-CIMSS personnel collaborate with NOAA educators and other education partners to develop, test, implement, and disseminate quality educational programs and materials suitable for a variety of ages. The education and outreach activities summarized below indicate the breadth of our work. NOAA is involved in nearly all of these activities. UW-CIMSS proposes to continue formal education, informal education and professional training activities that complement NOAA’s education and outreach mission. These efforts include:

- Supporting graduate students in NOAA-related fields of remote sensing;
- Supporting undergraduate students, engaging them in senior thesis remote sensing;
- Conducting outreach to the public through our SOS (Science on a Sphere) programs, a radio call-in show and AMS WeatherFest;
- Training high school teachers through workshops and online training activities;
- Engaging promising high school students through workshops on careers in atmospheric science;
- Remaining active in GOES-R Proving Ground, SHyMet, and VISIT programs to support the training of the many users of satellite data;
- Maintaining and evolving an informative and interesting CIMSS Web site (see http://cimss.ssec.wisc.edu/);

- Developing Internet-based training activities and web-based education material on satellite meteorology; and
- Continuing our international outreach programs.

In short, UW-CIMSS is following the strategy of investing in the future by connecting with tomorrow's leaders. These activities will be coordinated with the NOAA Office of Education. UW-CIMSS existing infrastructure enables NOAA to engage UW-CIMSS in activities that positively impact the NOAA Education Strategic Plan.

3.3.1 Higher Education

NOAA has established its CIs at locations with proven and longstanding academic excellence. Partnerships with universities provide NOAA with a vehicle for leveraging the talent, resources, and professional connections residing within the research and education community. The UW-Madison is constantly ranked in the top five universities receiving federal research funding. The strong relationship of UW-CIMSS with the Department of Atmospheric and Oceanic Sciences (AOS), an academic department within the College of Letters and Sciences, supports undergraduate and graduate education. SSEC, the parent organization of CIMSS, is an interdisciplinary research center within the UW–Madison Graduate School and provides a powerful infrastructure that supports student learning with an outstanding library, a data center, environmental sensing instrumentation, and technical and administrative support.

3.3.1a Graduate Education

One measure of education success is the number of graduate students who conduct research projects and write theses with UW-CIMSS scientists as mentors. Since 1980, CIMSS has mentored 83 M.S. and 34 Ph.D. graduate students, many of these through collaborative research efforts and financial support with NOAA. UW-CIMSS is currently supporting 22 AOS graduate students on research projects that range from new remote sensing techniques to data assimilation. Students are directly engaged in our research projects and their research contributes to the success of individual UW-CIMSS grants and contracts. Graduate students in UW-CIMSS have an academic advisor in AOS and a science advisor in UW-CIMSS or ASPB. Graduate students work directly with UW-CIMSS and ASPB research teams, giving the student valuable experience for the future. Appendix C provides a list of current CIMSS graduate students and Appendix I provides a historical list of the graduate students who have worked on CIMSS projects.

UW-CIMSS has a goal of supporting a skilled workforce that helps to meet NOAA needs. During the next five years, we will continue to foster collaborative research activities between UW-CIMSS and other STAR cooperative institutes (Cooperative Institute for Research in the Atmosphere – CIRA, Cooperative Institute for Climate Studies – CICS, Cooperative Institute for Oceanographic Satellite Studies – CIOSS) and centers (Cooperative Remote Sensing Science and Technology Center – CREST). Through continued collaboration with CoRP and its institutes, UW-CIMSS will be better situated to continue performing the research needed to support STAR's science and education missions.

A mechanism to strengthen CI collaborations is through the STAR-CoRP Symposium that is held annually. This symposium, with rotating theme and location, provides an opportunity for the NESDIS CIs and Center to share their research and education activities, and in particular to showcase the work of students, post-docs, and early career scientists. UW-CIMSS will remain active in this symposium, sending students and early career scientists to participate. To extend collaborations, UW-CIMSS will support visits to the other STAR Cooperative Institutes for follow-up research exchanges after this symposium.

UW-CIMSS will continue its positive collaborations with CREST, a multidisciplinary center led by the City College of the City University of New York (CUNY). CIMSS has a formal collaboration through a Memorandum of Understanding (MOU) with two CREST members, CUNY and Hampton University. We will continue to collaborate on research and education activities through this MOU. Specifically, we will continue to host students from both organizations, providing resources during their stay, and encourage visits by our students to these institutes. We have also collaborated on the teaching of courses, and will continue this endeavor. We will work to expand our research collaborations with these organizations, focusing on remote sensing research that includes participation of our students. Research collaborations between our institute's students and scientists include air quality studies, lidar studies of the atmosphere and water quality of coastal regions (including the Great Lakes).

3.3.1b The Suomi Distinguished Professor

As part of the CI agreement, UW-Madison will continue a chair for the Suomi Distinguished Professorship. This chair is designed to attract distinguished professionals who have experience in the disciplines of remote sensing, weather and climate, and the environment. The Suomi Professor, which need not be held by tenured faculty, carries out research, teaching, and public service in the socially relevant environmental and climate sciences in the spirit of the inquisitive approach of Verner Suomi.

The Suomi Distinguished Professor holds a joint appointment in SSEC and AOS. The Suomi Professor is selected by a committee of senior personnel from both AOS and SSEC. The position is held for up to five years (although a limited number of annual extensions are possible in appropriate circumstances). It is the intent that this position also support NOAA/NESDIS in their mission of environmental remote sensing. The Suomi Distinguished Professor will be expected to serve on NOAA committees when asked, advise NOAA when asked, mentor students within the NESDIS CIs, and deliver an annual lecture at a forum to be determined each year (e.g., at the annual CI symposium or the AOS colloquium).

3.3.1c Undergraduate Education

Participating in a research program is a valuable experience for an undergraduate student; it stimulates curiosity and develops a passion for discovery. UW-CIMSS normally employs two-four undergraduate students each year who are majoring in atmospheric science or a related field and have expressed interest in pursuing advanced degrees. By providing research experiences for undergraduates, UW-CIMSS plays a valuable role in integrating research and education at UW–Madison. Participation in a UW-CIMSS research project helps to prepare the undergraduate to conduct future independent research and to experience collaborative thinking while engaged with other scientists. The exceptional work of students has been recognized through awards; two recent examples include:

- Ms. Annelise Lenz was the recipient of the American Meteorology Society's 2009 Father James B. Macelwane Award for outstanding research; and
- Mr. Jordan Gerth received the National Weather Associations Meteorological Satellite Applications Award in 2007.

In addition, students support the outreach activities that UW-CIMSS conducts in the summer months.

Each year UW-CIMSS awards 2-5 Verner E. Suomi Scholarships to incoming freshman. Any graduating high school senior who plans to study the physical sciences on a campus within the University of Wisconsin system (especially meteorology, earth science, oceanography, physics, astronomy, science or math education, environmental science and engineering) is eligible. Each award consists of $1,000. If a student attends UW-Madison, UW-CIMSS often hires him/her during the summer or through their undergraduate career to participate and contribute to NOAA-related research projects.

3.3.1d International Summer Schools and Workshops

CIMSS hosts and supports visiting scientists from around the world and has strong ties with research and operational centers in China, Australia, and Europe. We have maintained scientist exchange programs with many research partners (Figure 14). CIMSS and NOAA fostered the creation and growth of the International TOVS Working Group (ITWG) after the inception of the NOAA series of operational polar orbiting satellites in 1978.

Since September 2001, UW-CIMSS scientists have been teaching "International Summer Schools on Applications with the Newest Multi-spectral Meteorological Satellites" in various cities in Europe. To date there have been ten schools (venues and dates are Sasso di Castalda, Italy, 2009; Istanbul, Turkey, 2008; Monteponi, Sardinia, 2008; Benevento, Italy, 2007; Ostuni, Italy, 2006; Krakow, Poland, 2006; Bertinoro Italy, 2004; Maratea, Italy, 2003; Roma, Italy, 2002; Bologna, Italy, 2001). The ten-day courses offer an in depth explanation of methods and techniques used to extract information from environmental satellite data, with emphasis on the latest measuring technologies. Workshops consist of lectures, laboratory sessions, group lab projects, homework and tests. Classroom size is usually between 20-30 students. The students have come from many countries including Assam, Bahamas, Bulgaria, Burkina Faso, Cameroon, China, Czech Republic, Ecuador, Egypt, Estonia, Ethiopia, Hungary, Iran, Iraq, Italy, Jordan, Kenya, Latvia, Libya, Lithuania, Mauritania, Palestine, Poland, Romania, Senegal, Slovakia, Sudan, Syria, Togo, Tunisia, Turkey, Ukraine, and Vietnam. Local hosts and EUMETSAT offer support for the schools as well as travel and per diem of many of the students.

While not directly funded by NOAA, these schools are of direct benefit as they help a larger community to utilize the remote sensing assets of the Global Observing System. In addition, the schools represent a large step in establishing a dialogue between scientists in a diverse collection of countries; it is a goal that communications and collaborations started during the course will be sustained. UW-CIMSS continues to receive invitations to offer one or two schools every year.

3.3.2 K-12 Education

Effective K-12 science education is essential to our nation's future. To advance science literacy and to provide students with the capability for study and stewardship of our planet, it has been our privilege and responsibility at UW-CIMSS to share weather and climate expertise with K-12 teachers and students for over two decades. These activities range from conducting workshops on the UW-Madison campus to distributing cutting-edge software that enables web-based education worldwide. Example K-12 related activities are listed below:

- CIMSS has hosted week-long science camps annually for high school students since 1991. Participating students experience science education, research, and modern technology firsthand. They spend a week at the UW–Madison working with data and computers in various education activities that furthers their interest in careers in the physical sciences.
- CIMSS has hosted week-long teacher workshops since 2002.
- CIMSS has started a three-year program with the Madison Metropolitan School District (MMSD) to prepare science teachers to be climate literacy ambassadors in their schools and communities. Every MMSD middle and high school science teacher who wants to participate will have the opportunity to do so; we expect 200 teachers will progress through the program.
- CIMSS has developed and maintains a Web page and CD titled "Satellite Meteorology for Grades 7-12." Hundreds of these CDs are distributed annually at workshops and education symposia.
- CIMSS has developed web-based educational tools and curricula that facilitate the use of satellite observations in K-12 Earth science education. Examples of these tools and courses can be seen at http://cimss.ssec.wisc.edu/education/.
- CIMSS has conducted workshops locally and nationally in collaboration with NOAA and other partners.

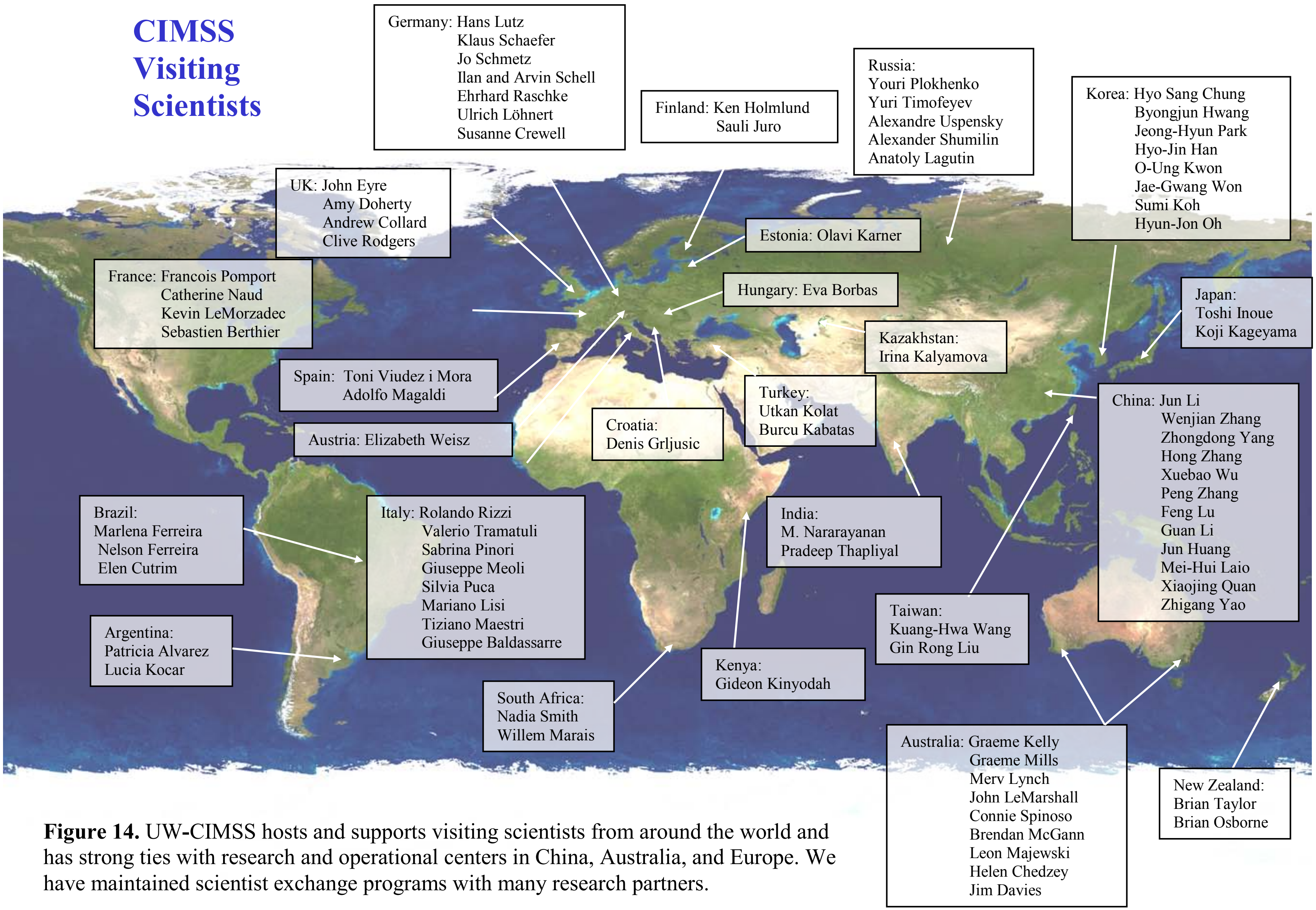

Figure 14. UW-CIMSS hosts and supports visiting scientists from around the world and has strong ties with research and operational centers in China, Australia, and Europe. We have maintained scientist exchange programs with many research partners.

3.3.3 Public Outreach

UW-CIMSS supports the NOAA goal to facilitate a stronger understanding of ocean, coastal, Great Lakes, weather, and climate sciences, and to empower the American public with the ability to use this knowledge to improve their safety, protect property, increase economic vitality, and enhance the stewardship of our planet.

UW–Madison has a long history in public outreach, embodied in what is known as "The Wisconsin Idea" where the University of Wisconsin brings its resources to the public; the idea seeks to make "the beneficent influence of the University available to every home in the State." We seek to expand the concepts in The Wisconsin Idea to the nation. Some of the many UW-CIMSS outreach activities are included below:

- UW-CIMSS staff visit local schools, give public lectures, and participate in campus open-house activities. CIMSS and SSEC scientists, engineers, and other technical people are trained in media relations so that our work is explained to the public in terms they will understand and people without a science background become intrigued with our work and with science in general.
- UW-CIMSS hosts an interesting and robust Web site where many of our research and education programs provide individual pages explaining their goals and purpose for both the professional and citizen communities (see http://cimss.ssec.wisc.edu/).
- NOAA's Office of Education awarded a joint Hampton University (HU) and UW–Madison team a grant to develop and implement educational applications on NOAA's Science on a Sphere (SOS). The SOS visualization technology was installed at Nauticus, The National Maritime Center (TNMC), in Norfolk. UW-CIMSS continues to supply data for display on the Nauticus sphere.
- UW-CIMSS is collaborating with the Science Museum of Minnesota (SMM) to develop and install a kiosk at CIMSS/SSEC about our satellite research. The UW-CIMSS kiosk displays will also be available through the kiosks in the SMM.
- UW-CIMSS is hosting an exhibit in the Dane County Airport in January-June 2011 on satellite images of Wisconsin.
- For the past decade, the UW-CIMSS Director has appeared on a monthly live call-in radio show about weather and climate that is web-cast live. NOAA is frequently mentioned in answers to caller questions.
- UW-CIMSS scientists contribute to *The Whyfiles*, a web-based repository of articles that explain the science behind the news while discussing current research activities.
- To provide the public with information about the accomplishments of the "Father of Weather Satellites," SSEC is creating the Verner E. Suomi Museum, which will prominently feature NOAA and the applications of its environmental satellites.

In all of these outreach activities, UW-CIMSS describes its relationship to NOAA and the value of NOAA to the nation.

3.3.4 Professional Training

The GOES Users Group Subcommittee on Training, Education, and Outreach has recommended training and education resources be developed to recruit, expand and maintain a skilled workforce. UW-CIMSS fully supports this action by developing and delivering an array of valuable training resources that will prepare future operational meteorologists to effectively utilize satellite data in the GOES-R era.

UW-CIMSS provides distance learning tools, lesson modules, and related materials to the National Weather Service (NWS) through the Virtual Institute for Satellite Integration Training (VISIT) program to facilitate the integrated use of satellite data and products in the forecast process. UW-CIMSS has created sample lessons in such diverse areas as Enhanced-V signatures, satellite-derived winds, new satellite characteristics and capabilities, TROWALs, Water Vapor Imagery, and Mesoscale Convective

Vortices; we continue to share this material with NWS forecasters and others. To date more than 13,000 people have viewed the VISIT materials, while dozens of presentations are made each month.

CIMSS developed the VISITview collaboration and teletraining software toolkit that delivers the VISIT lessons. VISITview is now the backbone of NWS training (not only for satellite-related materials, but for other aspects of the forecast process as well), and has been embraced by the WMO for use with their Virtual Lab. The software is freely available. A spin-off of the VISITview software is the Animations applet (AniS), which is being used by hundreds of sites worldwide to show animations of weather related data. The NWS is using this software to present many of their web-based weather animations.

UW-CIMSS also provides data products over the Web for public use. The very popular and educational UW-CIMSS Tropical Cyclone (TC) Web page was the first TC page to come online in 1994, and continues to support real time and post analysis users (both operational and research) worldwide (http://cimss.ssec.wisc.edu/tropic2/). Recently, we opened our online archive of specialized TC imagery and satellite-derived products that is already widely accessed by researchers.

3.3.5 Summary of Proposed Education and Outreach Activities

Under a new CI agreement with NOAA, UW-CIMSS proposes to embed our education and outreach activities within the larger context of NOAA's education and outreach goals. We will:

- Continue formal education, informal education and professional training activities that complement NOAA's education and outreach mission;
- Continue to be active participants in the STAR-CoRP Symposium;
- Continue a chair for the Suomi Distinguished Professorship in AOS;
- Attract and nurture diverse students;
- Continue joint education activities with STAR's CREST;
- Provide opportunities in education and research related to NOAA needs;
- Foster learning experiences in interdisciplinary and intradisciplinary teams;
- Embed our education activities within the larger context of NOAA's goals;
- Offer one or two remote sensing schools to the international community every year;
- Refine and improve educational activities that facilitate the use of satellite observations in K-12 Earth science education;
- Continue our active outreach program, building upon a diversity of past successes;
- Expand the number of distance learning modules that are aimed at helping to prepare tomorrow's forecasters for the next generation of meteorological satellites. Specifically, the popular "MODIS Products in AWIPS" VISIT lesson will be used as a starting point. In addition, AWIPS Weather Event Simulator (WES) cases will be created that will enable NWS staff to utilize satellite imagery in a "delayed playback" case study mode (see Figure 15);
- Continue the *CIMSS Satellite Blog* (http://cimss.ssec.wisc.edu/goes/blog), a valuable "just-in-time" training resource that highlights examples of new satellite products for a variety of current weather events;
- Host informational and educational Web site and continue to distribute data products on tropical cyclones and other topics through the UW-CIMSS Web site;
- Develop new and innovative methods of online training in support of professional development of weather forecasters and K-12 teachers;
- Work to leverage connections with the NWS and NESDIS to assure that the UW-CIMSS AWIPS remains current to the operational standard, that CIMSS imagery and products for AWIPS stay compatible with the software and germane to forecast operations, and useful experimental data remains available to NWS field offices in a timely and reliable manner;
- Remain proactive in delineating the datasets that are useful and necessary for NWS operations in the future, and in assuring that these data are available via AWIPS so that forecasters have "day

one" readiness for maximum usage. This need arises from the new space-based resources resulting from the Joint Polar Satellite System (JPSS; formally NPOESS), and GOES-R deployments will lead to an order of magnitude expansion in available data; and

- Support, through collaboration with AOS and SSEC, the Suomi Distinguished Professor position.

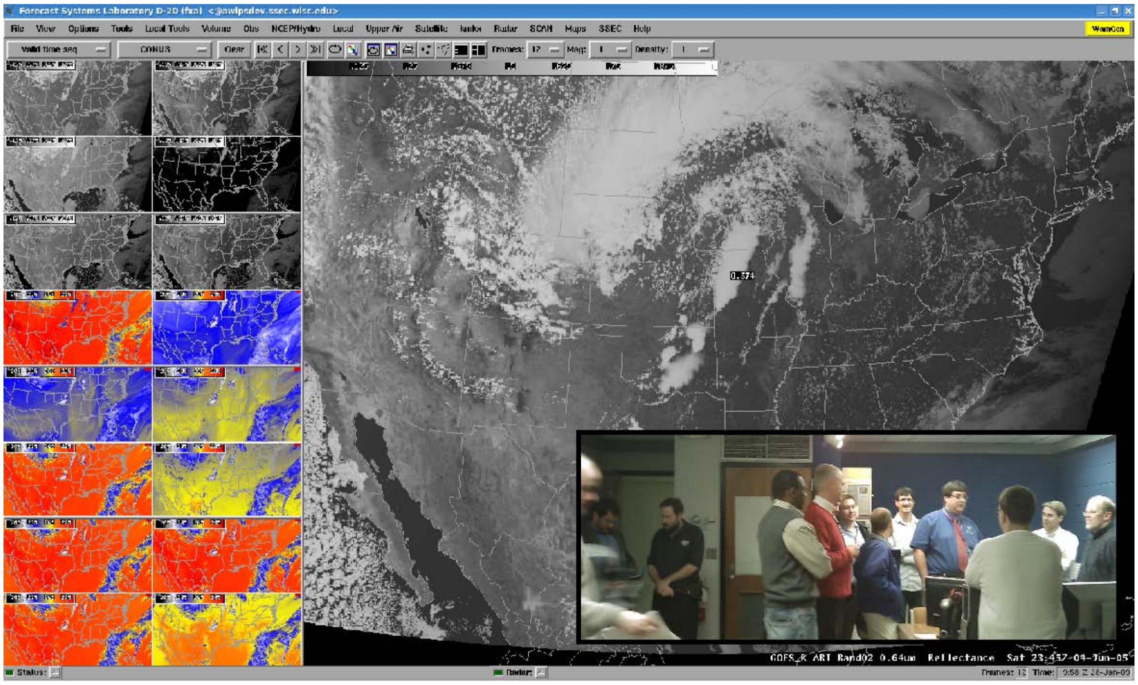

Figure 15. UW-CIMSS and ASPB research and development staff (lower right) hosting visitors from the NWS Sullivan (MKX) Forecast Office at their meeting in Madison, WI on 27 Jan 2009, congregating around an AWIPS workstation located at CIMSS. The imagery of all the GOES-R ABI spectral bands shown in the AWIPS environment have been simulated from a high resolution model analysis of a case study from 04 June 2005. These demonstrations of ABI imagery are part of the GOES-R AWG pre-launch preparations.

3.4 Unique Capabilities

CIMSS possesses all of the unique capabilities specified by NOAA in the FFO for this re-competition. These capabilities are demonstrated in discussions throughout Section 3.2. Here we provide further evidence of these capabilities and other capabilities with examples to demonstrate the benefit to NOAA.

3.4.1 End-to-end Data Processing Demonstration

End-to-end data processing demonstrations are critical to determining requirement specifications of the next generation of weather satellites and the transition of products from a research to an operational environment. CIMSS has demonstrated its end-to-end data processing capabilities through support of the GOES-R Risk Reduction program, the GOES-R AWG, and the GOES-R Proving Ground. As a first step in this process, CIMSS uses the Weather Research and Forecasting (WRF) model to create an atmospheric analysis dataset covering a large geographic domain with high spatial resolution (e.g., Otkin et al., 2007). In the next step, a sophisticated forward radiative transfer model is used to convert the model simulated temperature, moisture, and cloud fields into top of atmosphere (TOA) radiances for each spectral band on a given sensor. The simulated radiances are then remapped from the model grid points to a projection appropriate for the satellite sensor. This step produces a realistic "proxy" dataset that contains the correct spatial resolution at all satellite zenith angles. Next, expected noise characteristics are added to the simulated measurements. In the final step, algorithms are applied to the simulated data and the retrieved parameters are validated for known model conditions.

CIMSS has directed substantial efforts toward demonstrating the measurement capabilities of the GOES-R ABI sensor using its end-to-end data processing facilities. Proxy radiance datasets have been created for a wide range of atmospheric conditions using data from high-resolution WRF model simulations. Several large-scale simulations requiring extensive memory resources were performed at the National Center for Supercomputing Applications and at the Pittsburgh Supercomputing Center. Local computing resources were employed for smaller simulations and to generate the proxy visible and infrared radiance datasets. Various groups have used these datasets to demonstrate and evaluate ABI retrieval algorithms, such as those for atmospheric motion vectors, water vapor and temperature soundings, and cloud properties, under different measurement error assumptions. The proxy radiance datasets have also been used to improve our understanding of the physical processes underlying mountain wave turbulence signals observed in current water vapor imagery and to evaluate the accuracy of the WRF model simulations.

CIMSS proposes to continue to develop and utilize these datasets to help inform the broader research and operational community about the ABI sensor's advanced weather monitoring and measurement capabilities. Additional model simulations including realistic dust and aerosol properties may also be performed in order to support the evolving needs of the GOES-R project.

3.4.2 Scientific Analysis of Satellite Products for Weather and Environmental Analysis

Letters of support (see Appendix B) clearly document the community awareness of the scientific capabilities of CIMSS. Another source demonstrating CIMSS expertise in this area is the *CIMSS Satellite Blog*. This blog routinely demonstrates how satellite observations and their derived products are applied to analyzing the environment and the weather. Hits on the blog typically number several thousands per day, from countries all over the world. The blog also provides up-to-date status of current weather satellites, such as demonstrating the capabilities of the GOES-14 during its Science Test. Blog topics have included the improved navigation and registration of GOES-14, 'vog' (volcanic smog), ice motion, snow, stratospheric intrusion vortices, blowing dust, rapid scan imagery, lake effect snow, fires, standing waves, special full disk Earth images, and volcanoes. More information on the GOES-14 cases can be found as part of the *CIMSS Satellite Blog* at: http://cimss.ssec.wisc.edu/goes/blog/archives/category/goes-14.

The continuation of UW-CIMSS will assure that our expertise continues to contribute to the analysis and understanding of satellite data applications to weather and environmental conditions. We propose to continue the *CIMSS Satellite Blog* and to develop new, effective means of communicating these analyses.

3.4.3 Evolutionary and Revolutionary Algorithm Development

CIMSS has defined and evolved algorithms that convert satellite radiances to geophysical parameters throughout its history. Scientists at CIMSS have led the historic efforts to derive early methods to retrieve temperature and moisture profiles, to track atmospheric motion vectors, to retrieve cloud properties, and to detect fires from satellite measurements. An example is the CIMSS role in detecting fires from geostationary satellites. The efforts began in 1987 with Elaine Prins, a graduate student working with Dr. William Smith (former director of CIMSS) and Dr. Paul Menzel, formally of NOAA. She received her M.S. in 1989 on "Geostationary satellite detection of biomass burning in South America." Upon completing her formal education studies, she worked in the private sector on air quality for one year before returning to CIMSS to work on biomass burning issues. Eventually she headed the CIMSS research effort using geostationary satellite observations to detect and monitor biomass burnings. In 1990 the NASA carbon cycle program funded CIMSS to begin what became a premier biomass burning program. In 1996 Ms. Prins was hired by NOAA and became part of the ASPB. In 1998 she was awarded the U.S. Department of Commerce/NOAA Administrator's Award for developing the first automated technique for detecting fires using geostationary satellite data, which had been proven to be a valuable tool in the detection and monitoring of fires in the Western Hemisphere. In 1999 she received the NOAA

Bronze Medal Award for developing and providing remotely sensed fire products via the WorldWide Web; these products were used by the Brazilian and U.S. governments to monitor and manage wildfires in South America. In 2002, the research algorithm she had been developing for more than 10 years was incorporated into NOAA operations. Now a UW-CIMSS scientist, she is actively involved in developing new ways of retrieving global fire characteristics using measurements from a suite of geostationary satellites in the Global Observing System.

This example is not unique. Similar examples can be found in the development of algorithms for atmospheric profile retrievals, cloud properties, tropical cyclone monitoring, and atmospheric motion vectors. A common feature in these examples is how funding by other agencies (often NASA) initiates innovative research that subsequently reaches an advanced stage, whereupon collaborations with ASPB lead to operational algorithms that are transitioned to NOAA. A more recent example is the UW-CIMSS work in the area of aviation hazards. Initial funding was provided by NASA, and these research results are now being integrated into current GOES and GOES-R AWG activities.

CIMSS proposes to continue innovating and evolving methods of retrieving information from satellite radiances.

3.4.4 Geostationary and Polar-orbiting Satellite Expertise

The previous sections provide many examples of CIMSS expertise in satellite remote sensing and its application to understanding the atmosphere and the land and ocean surface. Currently, CIMSS is developing and delivering 33 of the 57 algorithms required by the GOES-R AWG. CIMSS scientists also work closely with ASPB scientists in retrieving the state of the atmosphere from polar orbiting satellites.

This expertise is recognized internationally, as the support letters in Appendix B testify. As noted by R. Saunders (Head of the Satellite Imagery Applications Group of the U.K. MetOffice), “CIMSS has remained a leading centre for satellite meteorology over the last 30 years and is able to continue to provide world leading science in many areas of satellite meteorology.” P. Bauer (Head of the Satellite Section Research Department of ECMWF) states “the exploitation of this data for NWP would not be possible without the basic research invested at CIMSS, without the swift transition of research products into operations and the supporting service along the product’s lifetime provided by CIMSS.”

CIMSS will continue to maintain and share this expertise through collaboration with NOAA, NASA and our international partners in satellite remote sensing.

3.4.5 Field Campaigns for the Validation of Satellite Products

Appendix K lists the various field campaigns where CIMSS and SSEC scientists have participated in small and large ways. SSEC designed and fabricated two high spectral resolution aircraft instruments, the HIS and Scanning HIS, that have flown in many field experiments to validate space based instruments such as AIRS and IASI and demonstrate the capabilities from geostationary hyperspectral measurements. SSEC also operates a mobile weather laboratory, the ‘AERIbago', which is a Winnebago outfitted with meteorological instruments. The AERIbago carries the Atmospheric Emitted Radiance Interferometer (AERI), which provides highly accurate upward looking infrared radiance measurements of the lower troposphere which can be used to calculate boundary layer thermodynamic profiles. The SSEC High Spectral Resolution Lidar (HSRL) provides unique observations of clouds and aerosols. A fourth component of SSEC measurement systems includes a rooftop lab (the meteorological instruments on our building rooftop), built through project funding and UW-Madison investment. Scientists and students make use of these ground-based, rooftop-based and aircraft observations in a variety of research programs, often to validate satellite products.

Students have participated in the validation of satellite derived products as part of their research degree work. Any AOS student that is using or developing new satellite products needs to validate the measurement to demonstrate its accuracy. For example, the M.S. thesis of J. Hawkins employed observations from the DOE ARM site's active sensors to assess the cloud height retrievals from the GOES observations. Other examples include using aircraft turbulence measurements to validate satellite signatures of weather hazards to aviation and using the profiling capabilities of the AERIbago to validate temperature and moisture profiles from satellites.

Validation of satellite derived products is critical in transitioning research algorithms to operations. Much of our current validation activities leverage CIMSS participation in field campaigns funded by agencies other than NOAA. SSEC has an engineering staff that collaborates with CIMSS scientists in the development of instruments and their operation during the field programs. CIMSS and SSEC are committed to maintaining these collaborations and will continue to seek opportunities to validate our satellite products.

3.4.6 Strong Publication Record

CIMSS scientists have a strong publication record as demonstrated in Ackerman et al. (2009). This BAMS paper notes that CIMSS has published more than 400 articles in refereed journals between 1995 and 2007 and more than 1000 publications in conference proceedings. The peer-reviewed publication per PI per year in 1995 was less than 2 and has grown to 3.4 in 2007. This paper also explains how CIMSS is addressing its mission goals through its publications, providing a methodology that can be adapted by others wishing to do a programmatic evaluation. A Web site devoted to CIMSS Publications can be found at: http://library.ssec.wisc.edu/resources/cimss/. Maintaining a strong publication record is necessary for a research center within a strong university system.

3.4.7 Software Design for Data Acquisition and Analysis

CIMSS is a research organization that strives to provide knowledge, assistance, products (in the sense of measurements and derived information content), and training. Often, the long-term objective of our research projects is to transition new developments to an operational environment, when appropriate and practical. Thus, in the process of developing research code, CIMSS scientists are continually guided to structure that code so that transition to an operational framework is feasible and effective.

Beginning in 1984, CIMSS scientists developed the International TOVS Processing Package (ITPP), designed to retrieve atmospheric temperature and moisture profiles, total ozone and other parameters in both clear and cloudy atmospheres from TOVS radiance measurements from direct broadcast on the NOAA polar orbiting operational satellites. These algorithms were upgraded with the deployment of the ATOV instruments, and the IAPP was provided to the international user community. Upon evidence for the need for this type of direct broadcast software to be freely and openly available, CIMSS and SSEC scientists received NASA support to develop and freely distribute the International MODIS/AIRS Processing Package (IMAPP) which allows ground stations capable of receiving EOS direct broadcast to create imagery and other derived products (see Figure 16). These processing packages have enabled users to apply real-time applications to their local region ranging from monitoring of severe weather, wild fires, pollution, flood and other environmental events. For example, a letter of support (see Appendix B) from Dr. P Frost, from the Council for Scientific and Industrial Research in South Africa, states “Products such as IMAPP have enabled the CSIR to successfully operate two MODIS direct broadcast systems, which in turn enabled the development of the Advanced Fire Information System (AFIS), which provides daily fire information to more than 500 fire managers across Southern Africa.”

SSEC and CIMSS increasingly find themselves in a position where software is seen as reusable knowledge, and requires appropriate documentation and training in its use. CIMSS will continue to work with the SSEC software engineering staff who provide software design and development and maintenance of algorithm libraries, agreeing on interfaces, requirements, and schedule for releasing new libraries.

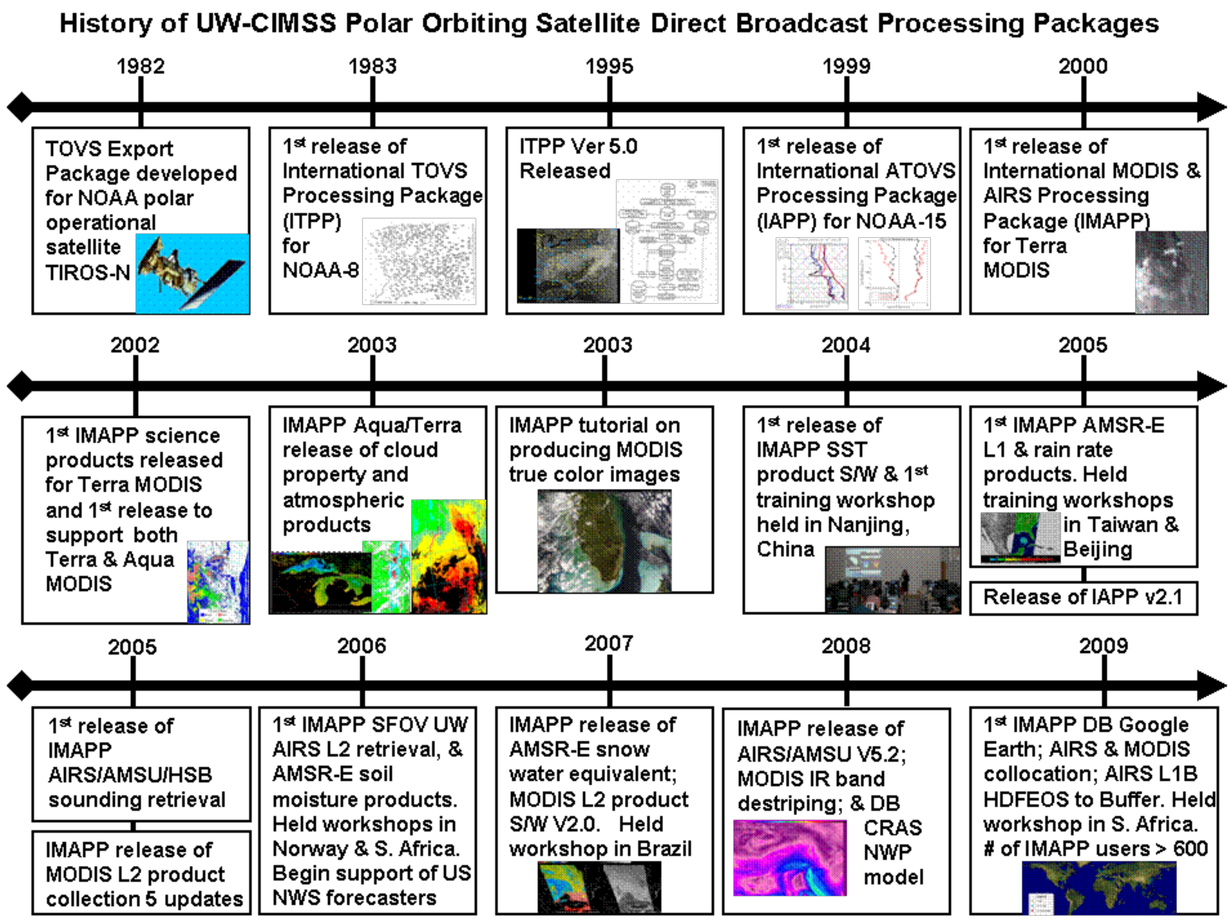

Figure 16. History of UW-CIMSS Polar Orbiting Satellite Direct Broadcast Processing Packages. UW-CIMSS scientists developed the International TOVS Processing Package (ITPP), designed to retrieve atmospheric temperature and moisture profiles, total ozone and other parameters in both clear and cloudy atmospheres from TOVS radiance measurements from direct broadcast on the NOAA polar orbiting operational satellites. These algorithms were upgraded with the deployment of the ATOV instruments and the IAPP was provided to the international user community. UW-CIMSS, with NASA support, also developed and are freely distributing a similar International MODIS/AIRS Processing Package (IMAPP). These processing packages have enabled users to apply real-time applications to their local region ranging from monitoring of severe weather, wild fires, pollution, flood and other environmental events.

3.4.8 Data Handling Capabilities: Processing, Reformatting, Storage, and Distribution

CIMSS makes extensive use of the SSEC Data Center. The value of the SSEC Data Center to CIMSS and NOAA was explicitly highlighted in the CIMSS independent review in 2004: "… it is essential to preserve the data archive center of CIMSS which has long been a beacon of the program. While the Data Center is considered a broader facility of SSEC and run in part on a cost recovery basis, it is an integral and valuable component of the infrastructure of CIMSS and an essential element of almost all research done at CIMSS…"

The Data Center has over 1000 TB of disk space holding over 30 years of GOES data, and nearly a decade of non-GOES geostationary satellite data. The Data Center has four L-Band Antennas, one of which can automatically track high inclination geostationary satellites. The four antennas give SSEC the ability to ingest and archive all four GOES satellites currently sending data simultaneously. SSEC has two C-Band Antennas and will soon have a third to act as a back up. There is also an X-Band antenna for receiving EOS data, which provides near-realtime data to NWS sites across the country. A more complete description of the SSEC Data Center is found in Appendix M.

Besides the data reception, archiving and serving data, additional Data Center activities include:

- Ingesting over 235 GB of data per day, and archiving over 150 GB per day;
- Providing data and maintaining the Unidata Local Data Manager (LDM) real-time broadcast to over 150 universities and colleges;
- Generating and maintaining real-time data products for the SSEC and CIMSS Web sites;
- Assisting NOAA and SOCC with initial post-launch instrument and bit stream checkout with periodic check-ups during the instrument lifetime;
- Providing satellite data to NOAA for data they do not receive (e.g., GOES-10, China's FY-2, India's Kalpana) and acting as a data backup to their system;
- Processing user data requests and product generation for real-time and archived data;
- Providing help desk support to users of the SSEC Desktop Ingestor (SDI);
- Testing software changes for the SDI-104 and providing information for the user's manual; and
- Acting as a focal point for satellite information.

Recent interactions with several NOAA offices include the following:

- Providing NESDIS/STAR with 5+ years of full resolution Meteosat 8 and 9 data via online archive;
- Providing NESDIS/STAR with GOES-13 data until NOAA's Environmental Satellite Processing Center (ESPC) system was operational;
- Providing NOAA/ESPC with first visible and infrared full disk images from GOES-14 when ESPC had a failure on their system;
- Working with NOAA/ESPC on specifying modifications to the GVAR to handle navigation parameters that were no longer stored in the Block0 portion of the signal;
- Providing NOAA/ESPC with real-time data from the Chinese FY2C and FY2D geostationary satellites;
- Re-navigating and supplying NOAA/ESPC with near real-time re-navigated Kalpana (India) geostationary satellite data;
- Ingesting, processing and relaying EOS direct broadcast data for NWS AWIPS systems;
- Ingesting, processing and relaying NOAA POES polar products for NWS AWIPS systems;
- Providing NOAA/ESPC data ingest backup for MTSAT and GOES:
    - 21.6 GB   Aug 2009
    - 1.5 GB   Sept 2009
    - 13 GB   Oct 1 – Oct 11 2009
- Providing general data access to NOAA/ESPC (includes GOES, MSG, MTSAT, FY2, NOAAport, and Kalapna):
    - 678 GB   July 2009
    - 1.2 TB   Aug 2009
    - 1.0 TB   Sep 2009
    - 390 GB   Oct 1 – Oct 11 2009
- Providing NOAA/ESPC with GOES-13 archive data to troubleshoot a noise issue (no other sites had this data).

3.4.9 Data Compression Research

With the advances in contemporary sensor technologies with higher spectral and/or spatial resolutions, more capable satellite instruments are being developed for Earth remote sensing. These technologies result in a significant increase in data volume and present a challenge to satellites with limited access to a growing congested radio frequency spectrum. Data compression techniques provide data reduction for effective downlink and rebroadcast as well as economic archiving. Data communication techniques facilitate robust information transfer over limited-bandwidth and often noisy channels. Under NOAA's funding during the period of 2003-2008, CIMSS had made significant contributions to data compression research for NOAA's future hyperspectral sounders. These works included the development of the error-resilient wavelet-based reversible variable-length coding software for NOAA GOES-R data compression and the development of the GIFTS data compression software Predictive Partitioned Vector Quantization (PPVQ) which was made available to NOAA and NASA Langley to provide a low-cost, effective and efficient compression solution for GIFTS compression and rebroadcast. Our NOAA co-leads, Roger Heymann (Office of Systems Development) and Tim Schmit (STAR) received the 2006 NOAA Bronze medal with the citation “for reducing costs and increasing satellite earth science global data distribution and archiving through world-leading R&D in data compression.”

In 2008 CIMSS extended data compression expertise and technique from ground processing and rebroadcast to onboard compression. We developed a high-speed universal minimum-redundancy lossless entropy coding FPGA chip with 5.5 times throughput improvement over the CCSDS Rice coding chip for onboard data compression. In 2009 we further developed a high-performance 3D lossless compression FPGA chip which featured a significantly higher compression ratio than JPEG-LS, JPEG-2000 and CCSDS IDC for hyperspectral and ultraspectral data.

3.4.10 Software Design for Data Analysis, Operational Implementation, and Visualization

CIMSS scientists have a long history of developing data analysis and visualization software tools to assist them in their research. For over 30 years McIDAS (Man-computer Interactive Data Access System) has been a cornerstone for imaging and analyzing satellite data, comparing numerous data types within a single display, and evaluating satellite derived products. Many of the satellite products delivered to NOAA/OSDPD are displayed on NOAA McIDAS systems; even the AWIPS GINI format for GOES imagery is created on NOAA’s McIDAS systems. The McIDAS software has gone through several stages of evolution, and is currently undergoing a completely new development in Java to provide 4-dimensional visualization and powerful new data analysis tools for multi- and hyperspectral satellite data. Figure 17 reviews the legacy of McIDAS from 1968 to date.

Data analysis is at the heart of CIMSS research. Flexible and capable analysis and visualization tools provide scientists with the ability to view data and evaluate products not only from different perspectives, but to include a variety of data from other sources. These tools provide capabilities essential to our science and our research objectives. CIMSS scientists benefit greatly from the McIDAS software tools developed within SSEC/CIMSS, and work together to develop the next generation McIDAS. An example of CIMSS scientists working with McIDAS-V developers is shown in Figure 18. Using results from the EOS/AIRS single field of view temperature/moisture retrieval algorithm developed at CIMSS, the scientist has differenced the 3-dimensional precipitable water vapor retrieval field from the ECMWF analysis of precipitable water vapor at the nearest time. The analysis power of McIDAS-V is demonstrated in the figure as the transect showing the moisture differences can be moved anywhere within the three-dimensional domain, and a probe can provide single gridpoint readout.

Access to satellite data continues to be challenging. New sensors and platforms present new formats, navigation, and calibration. CIMSS activities involve groups of researchers from around the globe. Without standards and conventions for data formats, we tend to spend an inordinate amount of time simply writing scripts or computer code to translate data from one form to another. CIMSS scientists are working with NOAA, Unidata and others to define standards for satellite data file formats, especially as it concerns future instruments.

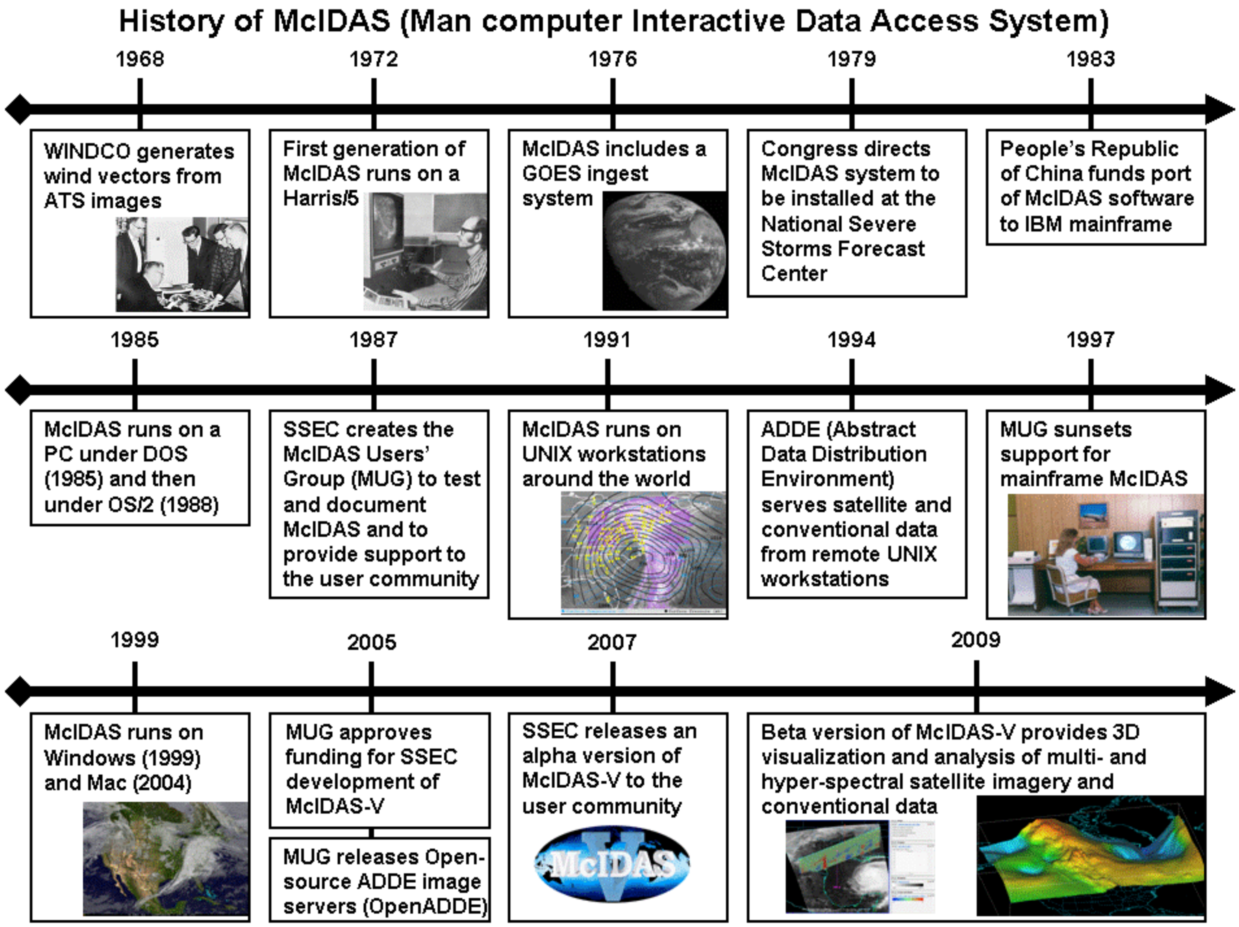

Figure 17. Forty-year history of McIDAS milestones in supporting environmental satellite research and operations. UW-CIMSS has been developing McIDAS software to provide NOAA and the remote sensing user community with visualization and analyses tools; most recently 4-dimensional visualization and hyper spectral infrared data analyses have been added.

The McIDAS-V development team proposes to continue working closely with GOES-R scientists developing operational algorithms for ABI and will begin work with the GLI teams. Emerging ideas in the GOES-R Risk Reduction program will also be strongly supported. As new ideas are brought forth for applying GOES-R measurements in synergy with other measurement systems, McIDAS-V is well positioned to provide the analysis and evaluation tools as well as the advanced visualization to support scientist needs. The McIDAS-V development team also proposes to continue supporting the NPP/JPSS projects, especially in development of tools to extract information from the hyperspectral sounder CrIS observations. Finally, the McIDAS-V development team will continue to bring numerous other research and operational data, both national and international, into its domain for use by researchers and operational users.

The primary goal of data analysis and visualization activities is to provide scientific users with the tools and information they need to perform their jobs, as well as making their work easier to understand. McIDAS-V provides a versatile, powerful, and freely available tool for our weather satellite user community. Allowing scientists working with NOAA environmental satellite date to develop techniques, evaluate their results, and share them through a shared toolkit will provide scientific and financial benefits for years to come.

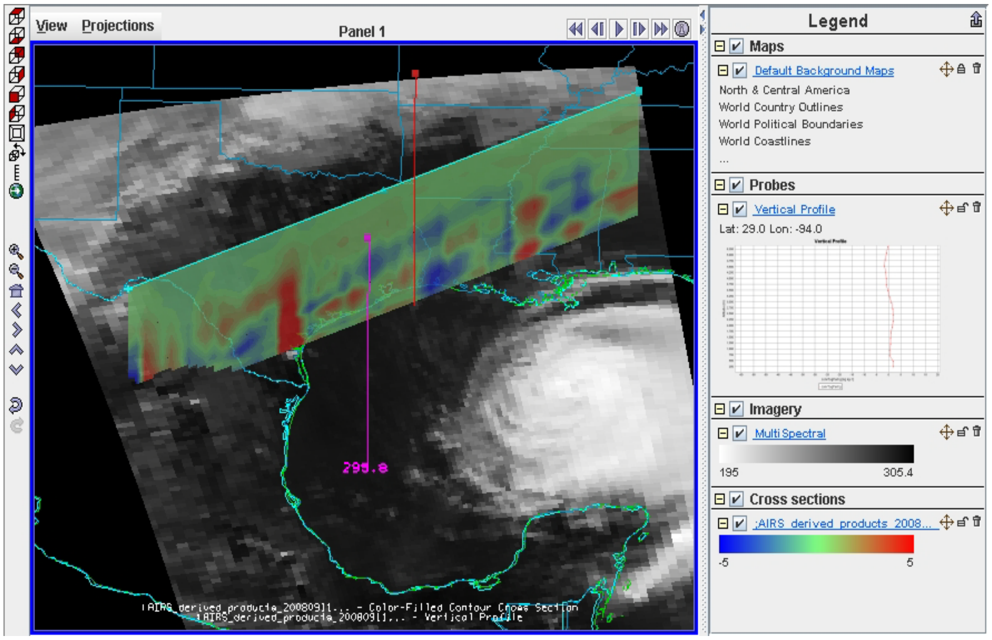

Figure 18. AIRS window channel image (grey-scale) and 2D moveable transect showing ECMWF-AIRS water-vapor retrieval (color-scale). Values from the transect are re-sampled from the 3D difference field and auto-updated as the transect is dragged in space, demonstrating the powerful interactive and data integration capabilities of McIDAS-V. UW-CIMSS scientists have been working with McIDAS-V developers to incorporate new ways of viewing new remote sensing data; after beta testing with in-house and selected outside collaborators these improvements are distributed to the McIDAS Users Group and beyond.

3.4.11 Collocation and Collaboration with NOAA ASPB

Since its inception, UW-CIMSS has hosted a NOAA research team in Madison. The group's original focus was to develop geostationary and polar orbiting temperature and moisture retrievals from the VAS and TOVS sounding instruments. Over the years, the diversity and research strength of the ASPB team has grown, as has the breadth of UW-CIMSS research. The UW-CIMSS/ASPB collaborations on numerous projects have significantly furthered the breadth of NOAA science, provided important products to NOAA operations, and demonstrated the positive outcomes from government and university scientists working together. Today ASPB's seven members stationed in Madison have a broad research excellence, as evidenced by Table 1 below. UW-CIMSS PIs and support staff work with ASPB scientists on many projects related to this expertise.

Table 1. ASPB Team members and their research collaborations with CIMSS staff

Jeffrey Key, Branch Chief	Polar satellite observations, Arctic climate change, Sea and Lake Ice, PDSI
Timothy Schmit	Geostationary Sounder and Imager Applications, GIMPAP, PSDI, GOES-R AWG and Proving Ground
Andrew Heidinger	Cloud properties, cloud climatology
Michael Pavolonis	Cloud properties, Aviation hazards, including volcanic ash detection
Gary S. Wade	GOES Sounder derived products, weather analysis and forecasting, GOES-R Proving Ground, Public outreach
Robert Aune	Data assimilation, numerical modeling
R. Bradley Pierce	Aerosols, Ozone, air quality modeling

UW-Madison will support the continued collocation of and collaboration with the ASPB team. Combining the strengths of university and federal government researchers advances the transfer of scientific findings, tools and products to the operational users.

3.4.12 Collocation with an Atmospheric Sciences Academic Department that has a Strong Remote Sensing Program and Offers Graduate Degrees

CIMSS has a strong partnership with the AOS, an academic department within the College of Letters and Sciences and consists of 15 faculty, 6 adjunct faculty and approximately 65 graduate students and 40 undergraduate majors. The unique research setting at CIMSS, a combination of SSEC and ASPB personnel, and AOS students and faculty has proven to be effective in the development, demonstration, and implementation of data processing and analysis techniques for research and operational remote sensing applications. CIMSS is housed in the same building as the SSEC and AOS. The department is committed to an excellent educational program and has approved ASPB scientists serving as adjunct faculty. Research by the faculty covers a broad range of topics relating to the atmosphere and oceans. The department is particularly strong in the area of climate dynamics, weather systems, and satellite remote sensing. AOS faculty serve as academic advisors to graduate students supported by CIMSS PI grants. AOS faculty also have grants through CIMSS and collaborate with CIMSS PIs. Example collaborations include:

- **Ralf Bennartz**: Serves on the CIMSS Science Council and collaborates on JCSDA research on the CRTM for microwave and shortwave radiation. Also collaborates with CIMSS scientists using microwave observations from space;
- **Jonathan Martin**: Collaborations on research of frontal systems and on public outreach projects. Serves on the CIMSS Science Council;
- **Galen McKinley**: Expert in CO_2 cycle is collaborating on issues of Lake Superior and climate literacy-funded projects from NSF and NASA;
- **Michael Morgan**: Collaborates with CIMSS scientists and students on data assimilation through the JCSDA office;
- **Grant Petty**: Collaborates on microwave observations from satellite platforms;
- **Greg Tripoli**: Collaborates on satellite data assimilation on the mesoscale as well as satellite observations of thunderstorms and hurricanes to assess model performance;
- **David Turner**: Multiple collaborations with scientists and graduate students on remote sensing from satellite and ground-based platforms;
- **Dan Vimont**: Collaborates on statistical analysis of hurricane observations from satellites; and
- **Pao Wang**: Collaborations on the modeling of thunderstorms and cirrus, and how to validate model output using satellite observations.

3.4.13 Training Programs, Graduate and Undergraduate Student Support and Mentorship, and Visiting Scientists from the U.S. and Abroad

In addition to collaborations with AOS to support graduate and undergraduate education, CIMSS collaborates with CREST in providing training opportunities for students and post-doctoral studies. CIMSS has hosted graduate students from CREST, providing training activities primarily in our research analysis tools. Two students formerly associated with the CREST consortium now work at CIMSS.

CIMSS hosts visiting scientists from all over the world (24 different countries), as depicted in Figure 14. As noted in Section 3.3, CIMSS researchers organize and conduct international workshops on remote sensing. The success of these is indicated by a letter of support from P. Frost of the Merake Institute in South Africa (Appendix B), who comments on the “Two extremely” successful training courses in “Pretoria during 2006 and Cape Town in 2009 [which] provided more than 80 local scientists with a wealth of knowledge. Through dedication and hard work the CIMSS team have contributed significantly to the development of remote sensing application in South Africa.”

3.4.14 International Collaborations with Satellite Agencies in Efforts to Shape the Global Space-based Observing System

Appendix B has several letters of support from leaders of satellite agencies in other countries. As **Dr. J. Schmetz** (Head of the Meteorology Division at the European Organization for the Exploitation of Meteorological Satellites; EUMETSAT) notes “CIMSS was and is a key part of what I would call a *world-centre of gravity for satellite meteorology.*” **Dr. Wenjian Zhang**, the Director of the WMO (World Meteorological Organization) Observing and Information Systems Department, former Deputy Administrator of China Meteorological Administration (CMA), notes “The great success of CIMSS also has had profound and positive impact on the WMO Space Program through their achievements in scientific publications and hardware and software development in the field of satellite meteorology.” Quoting **Dr. Chen**, Director of the Meteorological Satellite Center, Central Weather Bureau, Taiwan; “It is highly foreseeable that we will continue to increase our understanding of earth environment through the advance remote sensing techniques develop by CIMSS.”

CIMSS scientists serve on the mission planning teams of EUMETSAT for their future polar orbiting and geostationary sensors (Dr. Paul Menzel has served on the Post EPS Mission Requirements Team and is currently serving on the MTG-IRS Mission Planning Team; Dr. Paolo Antonelli is presently providing scientific support to the MTG-IRS science team). CIMSS scientists also serve on CEOS (Dr. Paul Menzel participated in the CEOS Ad Hoc Team on Satellite Data Utilization in 2003 and later chaired the atmospheres team of the SIT drafting the CEOS response to the GCOS Implementation Plan in 2006) and CGMS (Drs. Allen Huang and Paul Menzel have contributed reports in response to various action items from the CGMS over the years) various committees when called upon to do so. The growth of GEOSS depends on building close ties with our international partners.

3.4.15 Summary of Proposed Activities

UW-CIMSS proposes to sustain and further develop these unique capabilities that make many of the CI benefits to NOAA possible. These unique capabilities provide opportunities for UW-CIMSS to:

- Continue to develop and utilize end to end datasets to help inform the research and operational community about the GOES-R ABI sensor’s advanced weather monitoring and measurement capabilities;
- Continue the *CIMSS Satellite Blog* and to develop new, effective means of communicating these analyzes;
- Continue innovating and evolving methods of retrieving information from satellite radiances;
- Maintain and share expertise in satellite remote sensing through collaboration with NOAA, NASA and our international partners;
- Seek opportunities through field campaigns to validate our satellite products, involving students where possible;
- Maintain a strong publication record;
- Continue to operate the SSEC Data Center as an essential resource to CIMSS and NOAA scientists;
- Evolve our data analysis and visualization tools (e.g., McIDAS-V) to allow scientists working with NOAA environmental satellite date to develop techniques, evaluate their results, and share them across the community;
- Continue our collocation and collaboration with the collocated ASPB team in the coming decade, working together to combine the strengths of university and federal government researchers for the benefit of society;
- Advance our collaborations with university, federal and international partners; and
- Engage undergraduate and graduate students in our research to train them for careers in remote sensing.

3.5 Business Plan

"Let the scientists do science." This philosophy embraced by both CIMSS and the Space Science and Engineering Center (SSEC) ensures a successful partnership resulting in maximum benefit to the scientists in CIMSS and to NOAA. SSEC provides a service-focused infrastructure, consisting of top quality business professionals, dedicated to achieving this philosophical goal. This section reviews that service and its relationship with the UW-Madison and NOAA.

3.5.1 Organizational Structure

3.5.1a CIMSS Organizational Structure

CIMSS resides within SSEC at the University of Wisconsin-Madison (UW). SSEC is part of the Graduate School, which oversees graduation education and a large sector of the campus research enterprise. Current CIMSS activities (i.e., funding) comprise approximately 40% of SSEC projects.

CIMSS Director

The CIMSS Director, Steven A. Ackerman is a scientist Principal Investigator and Faculty member in the Department of Atmospheric and Oceanic Sciences (AOS) which shares the 15 story Atmospheric, Oceanic and Space Sciences building with SSEC/CIMSS. The CIMSS Director has an appointment within AOS as required by the Memorandum of Understanding between UW-Madison and NOAA.

CIMSS Board and Council (Executive Council and Council of Fellows)

CIMSS is advised by a Board of Directors (akin to the Executive Council defined in the CI handbook) and a Science Advisory Council (e.g., the Council of Fellows in the CI handbook) (Appendix H identifies the current Board and Science Council membership). The Board of Directors meets formally once a year to review the policies, research themes, and priorities of CIMSS, including budget and scientific activities. The Board is also responsible for approving the appointment of members to the Science Advisory Council. The Science Advisory Council advises the CIMSS Director in establishing the broad scientific content of CIMSS programs, promoting cooperation among CIMSS, NOAA, NASA and other agencies, maintaining high scientific and professional standards, and preparing reports of CIMSS activities. The Science Council also meets formally, nominally once a year.

CIMSS Staffing Structure

SSEC/CIMSS Executive Director, Thomas Achtor, oversees the day-to-day operations of CIMSS and provides management and coordination for the CIMSS research grants/contracts. As SSEC Executive Director for Science, Mr. Achtor provides CIMSS with important representation at the highest departmental administrative level.

The cornerstone of CIMSS research are the Principal Investigators (PIs). CIMSS has a philosophy that encourages its staff to develop proposal ideas. Proposal ideas, written by individuals and small teams, are discussed and reviewed with the CIMSS Director. All CIMSS proposals undergo a thorough review process, overseen by the SSEC/CIMSS Executive Director. The CIMSS Director holds frequent PI meetings where discussions are held on important topics, including upcoming meetings, key deadlines for product delivery, and responding to agency announcements of opportunity. PI meetings are also a forum for sharing recent research results.

Finally, CIMSS staff (over 130 individuals, including students) provide much of the expertise that goes into its research activities. Most staff members work on multiple research projects, allowing the staff to expand their knowledge and skills. This arrangement provides management a versatile core of talent with the ability to move where and when needed. The close relationship between CIMSS management, the PIs and the staff gives CIMSS great flexibility to meet its research goals. A complete listing of CIMSS PIs, supporting scientists, visitors and others is provided in Appendix C.

3.5.2 CIMSS/SSEC Operations within the University of Wisconsin Madison

SSEC is a major multi-disciplinary research center on the UW-Madison campus. Due to SSEC's size and interdisciplinary nature of research, the university fiscally supports a strong departmental administrative infrastructure unique to SSEC and different from the rest of campus, enabling SSEC's "scientists to just do science."

Dr. Henry E. Revercomb is the SSEC Director and an active PI in science and engineering programs. Supporting Dr. Revercomb are three Executive Directors, Thomas Achtor in Science, Fred Best in Technology and John Roberts in Administration. This team works closely with CIMSS Director, Steven Ackerman to define policy, establish goals and ensure sound research.

Short descriptions of key SSEC and UW-Madison support infrastructure are included below.

3.5.2a SSEC Administrative support

The SSEC administrative support team includes 15 full-time staff and several students providing services such as human resources, proposal processing, grant and contract management, accounting, financial programming, purchasing, travel, meeting logistics, and facilities management. A summary of key SSEC administrative support follows:

Human Resources and Payroll

The SSEC Office of Human Resources works directly with the CIMSS Directors and with the UW-Madison Office of Academic Personnel to create position openings, conduct application reviews, process employment adjustments and payroll, support medical leave, and address other employee issues. The SSEC HR office maintains employee records and ensures that annual employee review materials are collected.

Every employee of SSEC/CIMSS is assigned a work supervisor, who reports through the staffing chart to one of the Directors or Executive Directors. SSEC has developed a professional development plan that includes annual reviews (at a minimum) with work supervisors and/or Directors. SSEC also has a mentoring program for new employees to make sure that they understand the policies in the SSEC Employee Handbook and they learn how to use the resources in the building and the campus. In addition, SSEC has an equity and diversity committee which works with staff members and with the Directors to address recommendations made by staff. A chair of this SSEC committee participates in a similar group within the UW Graduate School.

Grant/Contract Management, Accounting, and Financial Programming

SSEC employs five full-time accounting and financial programming experts. SSEC has developed its own accounting system that integrates directly into the campus-wide financial system to provide customizable, specific, and enhanced reporting capability for their projects. The SSEC system gives CIMSS and SSEC Directors detailed cost information on programs and projects as well as a global view of the entire CIMSS program. Principal Investigators and Program Managers receive monthly emailed reports and have online access to years of accounting data, including project spending, labor, travel, and purchases. Additionally, these experts proactively examine financial data and award terms and conditions on a monthly basis to assist with routine project management to ensure that PI obligations are being met. The 2004 NOAA five-year review team evaluating UW-CIMSS noted "the outstanding (SSEC) accounting system as well as exceptional staff members."

Purchasing

SSEC employs a full-time delegated purchasing agent who is trained to make purchases in accordance with university, state and federal purchasing requirements. When CIMSS projects require purchases or bids from vendors, the purchasing agent reviews the requirement(s) with the PI and the appropriate director(s), gathers the necessary information and undertakes the necessary purchasing actions.

Travel

SSEC maintains a travel office that assists CIMSS staff in making travel arrangements and in reviewing and filing their travel reimbursement statements. The office also keeps up to date with university, state and federal travel regulations to ensure compliance.

Meetings and Facilities

Over the past five years, SSEC/CIMSS administrative staff has planned more than 40 professional meetings for many groups varying in size and purpose. Taking into account the goals and needs of the group and the available funding, this support team coordinates appropriate venues in-house, on campus, or off-site.

Additionally, SSEC is committed to providing facilities support for CIMSS, including the planning and execution of refurbishing projects on various floors and rooms occupied by CIMSS. One such example is a recent remodeling effort to create a dedicated high-tech briefing room. This space, complete with several flat screen displays and other audio/video features includes seating for a small group (~24); the CAVE (CIMSS Audio–Visual Environment) has already proven very useful for the researchers to discuss and showcase their work.

3.5.2b UW-Madison Provided Support

UW-Madison provides additional support to SSEC/CIMSS via the Graduate School Dean's Office, the Research and Sponsored Programs Office (RSP), and other campus administrative offices.

The Graduate School Dean's office serves a supervisory role over SSEC, ensuring that SSEC is in compliance with UW, State of Wisconsin, and federal regulations. They provide further assistance by serving as an intermediary and voice for SSEC with the rest of campus, for example by addressing proposed policy updates that would impact SSEC's research and by supporting the UW fiscal contributions to SSEC's strong administrative infrastructure.

RSP is responsible for the final review, negotiation and submission of all CIMSS grant and contract applications and for the negotiation of agreements. RSP staff provides financial and other administrative assistance by preparing financial reports, submitting invoices, and processing payments. Additionally, they provide valuable training on UW-Madison and Sponsor's policies/procedures for administrators and investigators.

Beyond RSP, several other administrative offices on campus contribute to the overall benefit of CIMSS. One such example includes Property Control. They provide equipment information and financial data as required by University Administration for annual financial reporting, identify custodianship and holder of title to University equipment, maintain records required for calculating Federal overhead equipment use charges, provide control for proper use and disposition of University assets, ensure adequate insurance coverage and loss settlement, and provide required interim and final property reports for Federal and non-federal grants and contracts.

Compliance with University, State, and Federal Laws

Each year, UW-Madison is audited by the Legislative Audit Bureau for the State of Wisconsin for compliance with Office of Management and Budget (OMB) Circular A-133. The audit is posted online and copies of the audit are forwarded to the Federal clearinghouse as required. The most recent A-133 Audit results can be found at: http://www.legis.state.wi.us/lab/reports/09-5full.pdf

To ensure compliance with OMB Circular A-21, RSP provides extensive training to department administrators and PIs identifying the basis whereupon charges are consistently treated, necessary, reasonable, allocable, permissible, and allowable against federal projects. The Cost Studies section of RSP is responsible for planning and developing facilities and administrative cost rates for the UW-Madison. The rate proposal is prepared using cost allocation and distribution methods as set forth in OMB Circular A-21 and other Federal Cost Principles. RSP personnel actively participate in rate negotiations with federal representatives and announce the agreed upon rates to faculty and appropriate campus representatives.

Additionally, UW-Madison complies with State of Wisconsin law, OMB Circular A-110, Federal Demonstration Partnership (FDP) terms, and agency specific terms as applicable.

3.5.2c Proposal Development, Review and Processing

As aforementioned, CIMSS encourages and provides support to its staff to develop proposal ideas. Proposal ideas are discussed with the CIMSS Director and/or the SSEC/CIMSS Executive Director for Science (ED-S) as well as NESDIS scientists. The ED-S works with the PI and an SSEC budget specialist to address staffing, computing, and budgetary issues during the development stage. All CIMSS proposals receive a final scientific review by the CIMSS Director and/or the ED-S. The name of the CIMSS Director appears on the cover page of all CIMSS proposals, acknowledging the support of CIMSS for that particular proposal initiative.

CIMSS proposals are also reviewed and processed by SSEC administration. An SSEC budget specialist completes all required federal and university forms. An electronic proposal record is created on UW's proposal routing system WISPER, and a UW proposal number is assigned. The PI and the SSEC Executive Director for Administration (ED-A) receive an email request to sign/approve the WISPER record.

After both the PI and the SSEC ED-A sign the proposal online, the package is sent electronically to the UW-Madison Graduate School. The Graduate School approves all SSEC proposals prior to submission. They review the budget and other documents, and then forward it to RSP, where it is reviewed and signed by the authorized official. The package is then submitted from RSP to NOAA through Grants.gov. Figure 19 shows the proposal movement from inception to delivery to NOAA.

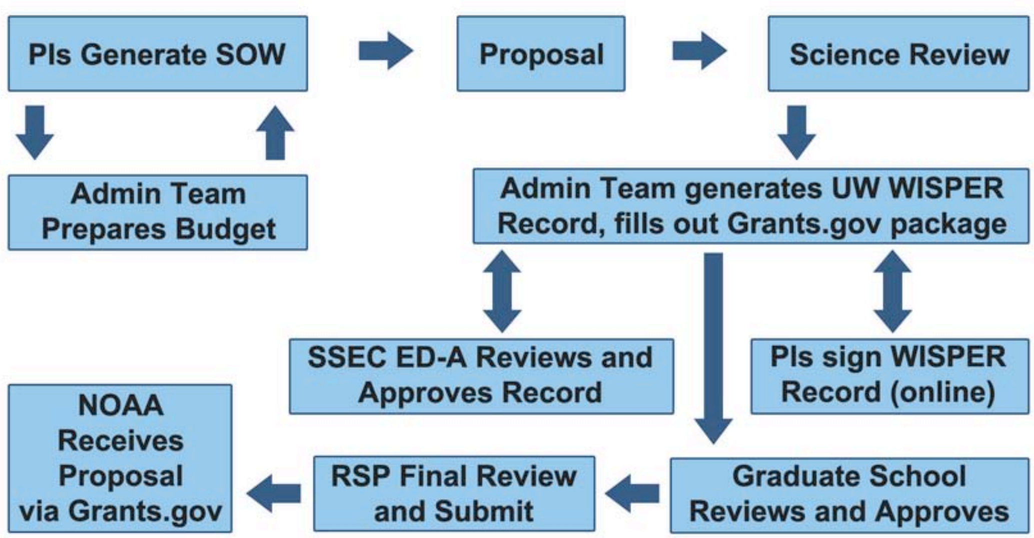

Figure 19. Flow chart of the movement of a UW-CIMSS proposal from PI through SSEC administration and the UW-Madison system to NOAA. Federal guidelines are checked at several administrative levels within UW-CIMSS. Online processing has helped to speed up the process, as has good communication with the NOAA Grants office.

UW-Madison – NOAA Interaction on Proposal Awards

The next phase of the proposal process involves the NOAA/NESDIS/STAR administrative office receiving the proposal through Grants.gov, reviewing it for compliance, and preparing it for delivery to the NOAA Grants Management Division (GMD). The SSEC/CIMSS administrative team has excellent communication with NESDIS/STAR administrators in the preparation/compliance process. When the NESDIS/STAR officer assures all requirements are met, the proposal is sent to GMD for review and approval. If approved for funding, RSP then reviews the award documents and negotiates any concerns or legal issues with NOAA. Once an agreement is met, NOAA then makes official notice of award to the PI. RSP accepts the award on behalf of the Board of Regents of the University of Wisconsin System, assigns a UW-Madison project number to it, and informs SSEC. SSEC then sets up an account for the award in its own accounting system.

SSEC Management and Oversight of Funded Programs

Once a grant award is officially entered into the UW-Madison system, SSEC administration works with the CIMSS PI to set up the administrative account for the project. For large programs, a Program Manager (PM) may be assigned to work with the PI and to be a point of contact for SSEC administration. An SSEC project number (or numbers if there is more than one specific task) is created and the budget is allocated to specific categories (e.g., labor, travel, publications). After the program begins, SSEC collects financial data and sends the PI / PM monthly financial statements. These statements include all labor charges to the project, as well as other itemized charges. The PI / PM is required to review these charges and notify SSEC administration if anything is not understood or out of order. For larger projects, monthly program reviews are held with SSEC, the ED-S and the PI / PM. Any areas of concern are conveyed to the PI and the CIMSS Director, with a statement of actions to be taken. The ED-S works with SSEC administration to ensure that quarterly, semi-annual or annual technical reports are submitted. The SSEC ED-A ensures that billing information is submitted to RSP and conveyed to NOAA. In addition, all this information is available on a restricted/secure area of the SSEC Web site. PI / PMs can access current and all historical labor and other financial information for their projects online. Many of the reports delivered are in Excel spreadsheets so PI / PMs can easily move the information into personalized financial databases. SSEC employs two administrative programmers to create online accounting and other resources for PIs. They are also available to help design and create advanced financial information for individual programs.

At the end of each month, all program spending is billed to the UW account number via the SSEC accounting system. The UW-Madison bills NOAA for actual spending on a monthly basis. RSP prepares semi-annual financial reports and submits them to NOAA. As mentioned above, the CIMSS PI and ED-S are responsible for the periodic technical reports that are submitted to NOAA.

3.5.3 Additional SSEC Areas of Key Infrastructure Support

The strong fiscal support SSEC/CIMSS receives from UW-Madison enables it to provide excellent facilities and technical expertise for its scientists and its programs. The following sections provide a summary of UW-Madison investment in SSEC capabilities.

3.5.3a Technical Computing

The SSEC Technical Computing support team includes six full-time staff and several part-time students providing consultation and implementation on system design, networking infrastructure, and full support for Unix and PC computing. Specific support activities include:

Computer Support: Provide in-depth computer support, including purchasing assistance, system configuration and setup, repair, application installs, and support for scientific and high performance computing systems.

System Design and Planning: Consult with project staff on system design for project needs.

Computing Infrastructure: Plan, implement and support computing infrastructure for SSEC. Special emphasis is placed on technologies to support collaboration between science groups. Computing infrastructure includes both the network infrastructure and services such as email, backups, printing, Web serving, FTP serving, revision control systems, DNS servers, and collaboration servers. SSEC works closely with the UW-Madison Division of Information Technology to provide network infrastructure. The most recent upgrade provides gigabit networking for any location in the building.

Computing Policy: Help develop SSEC computing policy and assist in compliance. Work as the liaison between SSEC and other organizations, including the UW, State of Wisconsin, NOAA, and NASA. Develop and maintain computing policies that allow SSEC to work effectively with outside agencies while maintaining a primary focus as an educational research center.

Recent examples include:

- Working with SSEC Quality Assurance on technical planning and specific recommendations for ITAR compliance, including participating in training sessions for staff on ITAR compliance;
- Assisting NOAA Advanced Satellite Products Branch Chief with NOAA International Laptop Travel Procedures compliance; and
- Developing and implementing SSEC specific policies for Atmosphere PEATE computing systems; this work required developing policy based on Department of Commerce regulations in collaboration with NASA GSFC contacts.

3.5.3b Data Center, including Data Acquisition Facilities

The SSEC Data Center was established to create and maintain the facilities, human expertise and technology necessary to provide SSEC/CIMSS scientists and their collaborators with access to and archive of the highest quality geophysical data in a timely fashion (often in near real-time). Data Center receiving, archiving and serving activities include:

- Ingesting over 235GB of data per day, and archiving over 150GB per day;
- Providing data and maintaining the Unidata Local Data Manager (LDM) real-time broadcast to over 150 universities and colleges;
- Generating and maintaining real-time data products for the SSEC Web site;
- Assisting NOAA and SOCC with initial post-launch instrument and bit stream checkout with periodic check-ups during the instrument lifetime;
- Providing satellite data to NOAA for data they do not receive (e.g., GOES-10, China's FY-2, India's Kalpana) and acting as a data backup to their system;
- Processing user data requests and product generation for real-time and archived data;
- Providing help desk support to users of the SSEC Desktop Ingestor (SDI);
- Testing software changes for the SDI-104 and providing information for the user's manual; and
- Acting as a focal point for satellite information.

The SSEC Data Center has four L-Band antennas, one of which can automatically track high inclination geostationary satellites. The four antennas give SSEC the ability to ingest and archive all four GOES satellites currently sending data simultaneously. SSEC also has two C-Band Antennas and will soon have a third to act as a back up. The facility also has an X-Band antenna for receiving NASA/EOS Direct Broadcast data.

Finally, the Data Center staff has extensive experience ingesting, distributing, and archiving satellite data.

3.5.3c Library

SSEC maintains an atmospheric science library as part of the UW–Madison library system. A full-time librarian is assisted by two part-time assistants. The Schwerdtfeger Library was dedicated in 1983 to support the research activities of SSEC, CIMSS, ASPB, and the instructional programs of the Department of Atmospheric and Oceanic Sciences. The Library collects and preserves unique material and provides access to earth and space science research resources. The Schwerdtfeger Library's Web site has been developed with the research interests of CIMSS and SSEC scientists in mind.

Library staff use state of the art tools, available from standard sources as well as developed in-house to efficiently meet current and anticipated client research needs. Services include, but are not limited to: extensive reference, research and technical services; teaching; access to print and electronic collections;

participation in local and international information networks, interlibrary loan and digital resource construction (see Appendix N for more information about SSEC's library).

3.5.3d Web Team / Media

The SSEC Web Team helps support the goals and activities of CIMSS and its scientists by assisting in creating and maintaining Web sites. The Web is a critical means for disseminating our research and results to others in the scientific community, as well as the general public. In addition to taking responsibility for the parent CIMSS Web site, the team also works with research groups to create Web pages highlighting specific research projects. This effort includes providing technical, design and usability expertise. The Web team also helps ensure that CIMSS Web sites follow relevant university, state and federal regulations (i.e., Section 508 accessibility standards), as well as industry standards (i.e., W3C guidelines).

CIMSS Web sites also play a key role in our commitment to education and outreach (EPO). For example, CIMSS researchers have developed Web-based resources and tools for professional development (e.g., VISITview), as well as for K-12 teachers (e.g., Satellite Meteorology for Grades 7-12 and Satellite Applications for Geoscience Education). These Web-based programs have continued to grow in size and scope over the years.

3.5.3e Quality Assurance

SSEC/CIMSS has developed an advanced quality and safety program for center-wide use. All SSEC processes are designed to be scalable to meet the needs of the varying types of projects and to be compliant with ISO 9001 standards. The Quality Assurance and Safety personnel have developed a standardized set of processes for all SSEC/CIMSS projects, allowing managers and staff to work on different projects without having to learn or develop new procedures. They have also developed QA resources such as the Quality Web site, and the Groups project Web site and project document repository.

SSEC employs two full-time staff members who are responsible for creating, updating and maintaining quality system processes and documentation, evaluating project and staff safety, and training staff in areas of quality processes and safety.

SSEC is currently developing a set of project management initiatives intended to improve upon SSEC's excellent track record of project management (see Table 2). These initiatives along with SSEC's current quality, cost accounting and administrative processes will improve end-to-end management of SSEC/CIMSS projects.

Table 2. SSEC Project Management Initiatives

Initiative	**Purpose**
Management Information System	Generate proposals for large/complex projects. Create project baseline documentation (work breakdown structures, budgets, schedules).
Project Planning Initiative	Ensure project baseline documentation is available for all projects.
Deliverables Management System	Review award documentation, and identify and track project deliverables and reports.
Project Management Training	Ensure SSEC/CIMSS project managers are managing, monitoring and submitting reports per funding agency needs and SSEC processes.

3.5.3f Engineering

SSEC has a long and successful history of working collaboratively with a diverse group of researchers in different disciplines to help define, design, implement, test, and document cutting-edge hardware and software projects. SSEC maintains a strong instrument development capability that involves the disciplines of electrical, mechanical, thermal, optical, electro-optical, software, and systems engineering, as well as program management and quality assurance. Teaming with a broad range of scientific researchers, SSEC has developed both small and large research instruments for applications in space and throughout the world, including several instruments focused on observing planet Earth with state of the art measurement capabilities.

SSEC is a world leader in developing high spectral resolution infrared spectrometers, including the ground-based AERI (Atmospheric Emitted Radiance Interferometer), aircraft-based Scanning-HIS (High-resolution Interferometer Sounder), and space-based instruments GIFTS (Geosynchronous Infrared Fourier Transform Spectrometer). SSEC is also a leader in developing high resolution Lidar instruments for atmospheric research, both ground-based and aircraft-based.

3.6 Performance Measures

Indicators of a successful research center include the number of publications in refereed journals, the success rate for submitted proposals, the number of graduating graduate students, awards of recognition, international scientist exchange programs, conference presentations and software distribution. CIMSS closely tracks of all these activities as noted in the examples below:

- At a research university the number and quality of publications are credible evidence of the value of a research group. Access to electronic databases permits publication analysis of an institute's publication record with special regard to the organization's mission. CIMSS has recently published an article in BAMS on its publication record (Ackerman et al., 2009). This paper examined the mission success of CIMSS by using bibliometric methods that include quantitative, descriptive, and citation analyses.
- Over 40% of CIMSS publications include a NOAA co-author. We strive to continue that record of publication.
- CIMSS keeps track of its research algorithms that have been transferred to NOAA and other agencies with operational responsibilities. A list is given in Appendix J. CIMSS scientists are currently delivering code to the GOES-R Algorithm Working Group. We will continue to monitor and report the timeliness of these deliveries.
- CIMSS scientists and students have received several recognition awards. These awards are listed in Appendix L. In addition, CIMSS scientists have collaborated with ASPB and NOAA scientists who have received NOAA's gold, silver and bronze medals. As CIMSS scientists cannot receive the NOAA award, a mirror award was established at the University of Wisconsin-Madison.
- CIMSS tracks the graduation rate of graduate students that conducted research with CIMSS scientists. A history of graduate students is listed in Appendix I. We continue to track these graduation rates and which students go to work with NOAA.
- Performance reporting has been done through the CI annual report, containing synopses of all research projects attached to the CI (including Task II and other-agency activities that map to NOAA themes) and their relevance to NOAA mission goals. We also report on success stories from NOAA operations for CI-relevant transitions.
- CIMSS holds regular meetings of its Board of Directors receiving feedback from them and the CIMSS Science Council. Members are listed in Appendix H. Recent reports are available on the CIMSS Web site (https://groups.ssec.wisc.edu/employee-info/cimss/cimss-board-of-directors-reports)

We will continue to work with NOAA on refining and detailing performance metrics that are relevant to NOAA. Pending the acceptance of this proposal, we will work with NOAA/STAR to ensure that any new performance metrics are adopted in our research plan.

3.7 Cost Sharing Plan

While the following is not "documented cost sharing," the services outlined below are of direct benefit to the federal government. The UW-Madison invests heavily in CIMSS to support its partnership with NOAA. This financial support brings significant additional capability and flexibility to the CIMSS Director and the CIMSS research teams.

In the discussion below, where possible, dollar amounts are provided for CIMSS support services based on the most recent State of Wisconsin fiscal year (SFY) costs (1 July 2008 to 30 June 2009). This support has been and continues to be an ongoing contribution throughout the 29 years of CIMSS partnership with NOAA. The most recent fiscal year data provides accurate examples of the broad support that UW-Madison provides to the CIMSS program. The total UW-Madison contribution for SFY2009 is estimated to be $1,947,000 and is explained in greater detail below:

1. **Physical space for ASPB.** Through the MOU with NOAA, the UW-Madison has agreed to provide physical space for NOAA/ASPB scientists, including office facilities, computing and other university services (e.g., access to facilities). The total square footage of ASPB occupied office space (7 persons) is approximately 995 square feet not including the use of conference rooms, labs, and other facilities.
2. **Salary Support for CIMSS Director and Executive Director.** A portion of the CIMSS Director and the SSEC/CIMSS Executive Director salary and fringe benefits is provided by the university. In SFY2009 this salary support amounted to $127,000.
3. **Salary support for the CIMSS program.** A portion of the CIMSS University Services Associate and the CIMSS Webmaster salary is provided by the university. In SFY2009 this salary support amounted to $29,000.
4. **SSEC Administrative staff support.** As described in the Business Plan (section 3.4), the University has enabled SSEC to provide broad administrative support for their research programs. CIMSS is a direct beneficiary of this support. The estimated UW-Madison contribution to CIMSS for these services is $1,178,000.
5. **Technical Computing (TC)** is an expanding service for SSEC/CIMSS. UW-Madison provides funding for SSEC technical computing support (the largest Internet volume user on campus) from infrastructure (e.g., wiring, switches, routers) to individual CIMSS scientist support (e.g., office connectivity, workstation and personal computing). The value to CIMSS of this support in SFY2009 was approximately $308,000.
6. **SSEC Data Center** plays a key role in most CIMSS science programs, providing scientists and collaborators with global satellite and other data in near real time to support research and development. The Data Center works closely with NOAA/NESDIS/OSDPD, /OSO and /NCDC to support GOES ground station, product creation and archiving activities. Several times a year the SSEC Data Center provides data back-up support to OSDPD when data is lost. The cost of Data Center operations is large; some support funding is obtained by selling data to outside users. However, there is still a large UW-Madison contribution to the Data Center. In SFY2009 this contribution is estimated to be $96,000.
7. **The Schwerdtfeger Library** at SSEC/CIMSS is part of the campus library system. The library's primary purpose is to serve as a resource for CIMSS scientists and AOS students. The UW-Madison provides funds to support the SSEC Library activities. In SFY2009 this cost was $84,000.
8. **Quality Assurance and Program Management.** The UW-Madison provides support for SSEC to employ experts in Quality Control and Employee Training. This group has developed specific quality and safety procedures for SSEC/CIMSS including several documents (e.g., workplace emergencies). This team is also developing management training materials specific to SSEC/CIMSS project needs. The value to CIMSS of this support in SFY2009 was approximately $68,000.

9. **SSEC Rooftop Instrument Site and Mobile Laboratory.** SSEC has obtained funds to develop an instrument validation site on the roof of its 15-story building. A UW-Madison grant funded the purchase and installation of high quality basic meteorological measurements (temperature, moisture, wind, pressure, solar radiation.) NSF has funded the purchase and installation of remote sensing instruments. To bring all this information to scientists and other users, UW-Madison has funded the development of a data collection, management and Web-based delivery system for this instrument site.
   Also available to CIMSS projects is the SSEC Mobile Laboratory. The Dept. of Energy funded the purchase of a Winnebago vehicle as a mobile data collection facility. The mobile laboratory has deployed in numerous field programs where NOAA has either led or actively participated. The UW-Madison provides funds to support the recurring maintenance and upgrade costs for this mobile laboratory.
   While the annual financial maintenance cost for these facilities is relatively minimal, it is of great benefit to the projects at SSEC to have this equipment available. The ongoing support for the Rooftop Instrument Group and Mobile Laboratory has an annual value of approximately $8,000.
10. **Start-up Funds for new ideas and projects:** The UW-Madison has provided support for new ideas that have a strong likelihood of leading to new proposals. These funds have supported several projects of significant benefit to both CIMSS and NOAA. SFY09 approximate reinvestment of these programs totaled approximately $49,000. A brief summary of several examples follows.
    a. **High spectral resolution IR interferometry:** The UW-Madison has provided important support to the continuing efforts to build, operate, and demonstrate the important capabilities of hyperspectral infrared sounders. While significant program funding has supported this work, gaps in funding were bridged by UW-Madison. SSEC's work in this area has been of great benefit to NOAA instrument design planning.
    b. **Blackbody calibration facility:** SSEC has created a calibration laboratory in its lower level. Accurate calibration of measurements is a key issue for NOAA's environmental satellite program. SSEC's work in this area has proven to be of direct and significant benefit to the forthcoming CrIS sounder on NPP/JPSS. Improved performance from the measurements leads to more accurate products from the CIMSS development teams.
    c. **Data compression:** The very high data rates from advanced instrumentation require data compression. SSEC/CIMSS has received funding in this area, but again the UW-Madison has provided crucial support when there have been funding gaps.
    d. **Visualization tools:** When a new generation of data analysis and visualization tools were needed to work with the next generation of environmental satellite data, the UW-Madison funded a design study and proof of concept to develop the goals and requirements for the project. That funding has led to current NOAA and IPO support for building the open source, freely available McIDAS-V software.
11. **Support of Visiting Scientists.** The UW-Madison has provided partial support to foreign scientists visiting CIMSS for extended stays to help defray their living expenses; salaries and transit costs are usually borne by the home institution. To date, CIMSS has hosted more than 80 scientists for extended stays (see Figure 14 in Section 3.3.1d). In addition UW-Madison supports CIMSS scientists to visit foreign laboratories for extended stays fostering stronger collaborations (example institutes include the Australian Bureau of Meteorology in Melbourne, Curtin University of Technology in Perth, EUMETSAT Met Division, the Chinese National Satellite Meteorological Center). These extended visits at home and away from CIMSS have cemented our strong international collaborations; UW-Madison has helped to make these exchanges possible.

In summary, this section enumerates the many areas of **strong support the UW-Madison has provided to strengthen the partnership with NOAA in this Cooperative Institute.** NOAA benefits tremendously from the support the UW-Madison provides to NOAA/ASPB and SSEC/CIMSS. This financial commitment furthers the goals of both NOAA and CIMSS, supporting their science teams to provide the government with innovation and creativity in the research to operations process. This commitment from the UW-Madison further enhances NOAA's operational capability by linking with a strong university partner that can provide numerous programs and facilities that benefit NOAA in many ways.

In addition to the substantial University support detailed above, we will also cost share one percent of the CIMSS Director's time for the full period of the award.

3.8 CIMSS Milestones

Back in 1966, the PI of the spin-scan imaging camera system on the first U.S. geostationary weather satellite, Verner E. Suomi, made the simple, yet profound statement about the images: "the clouds moved, not the earth." Dr. Suomi was instrumental in working with NOAA (called NESS in those days) to establish and advance the U.S. geostationary weather satellite program. Suomi went on to play a major role in the design of atmospheric sounders and turned his concept of digital analysis and visualization computer systems into McIDAS. In the late 1970s Dr. Suomi worked with the NOAA Director, David Johnson, (see 2002 bullet below on the David Johnson award) to help create one of NOAA's earliest Cooperative Institutes. CIMSS has continued the tradition of science innovation and excellence demonstrated by Dr. Suomi. This proposal has provided numerous examples of science contributions from CIMSS scientists to our understanding of the earth / atmosphere system and their impact on people's lives. Studying the earth from space has truly given our generation a global perspective of weather and climate. What follows is a sampling of significant CIMSS milestones over the past 10+ years, demonstrating that the "Suomi tradition" lives on at Wisconsin.

1998 Developed sounding applications with GOES Sounder and published BAMS article
1998 Developed a training module (Cooperative Program for Operational Meteorology, Education, and Training (COMET) CD) on GOES Sounder use
1999 Investigated diurnal SST variations with GOES and published Bulletin of American Meteorological Society (BAMS) paper in 1999
1999 Transferred 20-year GOES archive to NCDC
1999 Chaired WMO Expert Team on Evolution of the GOS (until Dec 2005)
1999 Started annual Suomi Scholarship Awards to freshmen entering the UW System who are interested in careers in the physical sciences
2000 Published and distributed through the WMO "Notes on Applications with Meteorological Satellites"; this textbook is used in classrooms and in training and research programs internationally
2000 Developed polar atmospheric motion vectors derived from Moderate Resolution Imaging Spectroradiometer (MODIS) water vapor measurements
2000 Conducted first Observing System Simulation Experiment (OSSE) to test the impact of simulated high-spectral resolution IR measurements from a geostationary interferometer
2000 Released International ATOVS Processing Package (IAPP) to international ATOVS users' community
2001 Taught first CIMSS Remote Sensing School in Bologna, Italy in September; this effort was followed by nine more schools in subsequent years
2001 Analyses of Scanning HIS data confirms hyperspectral depiction of vertical moisture profile
2001 Tropical Cyclone Web site receives record number of hits during hurricane season
2001 Real-time assimilation of the GOES WF_ABBA fire product in the Naval Research Laboratory Navy Aerosol Analysis and Prediction System (NAAPS) begins
2001 Developed VISITview collaboration and teletraining software toolkit that delivers the VISIT lessons; this toolkit is now the backbone of NWS training

2002 Conducted and published results of study on impact of GEO, LEO and Raob measurements in a regional forecast model
2002 Dr. Jun Li receives the David Johnson Award
2002 Hosted week long summer school for high school teachers and students; annual event continues through decade
2002 GOES WF_ABBA made operational at NOAA/NESDIS as part of the Hazards Mapping System, routine updates continue through decade
2003 First demonstration of "altitude-resolved" winds from hyperspectral soundings
2003 European Centre for Medium-range Weather Forecasts (ECMWF) uses CIMSS MODIS derived polar winds in operations
2003 ABBA charts the burning in Amazonia for the past decade
2003 Nominated for Pixie Award for contributions to *The Whyfiles*, a Web-based repository of articles that explain the science behind the news about scientific topics
2004 Demonstrated positive impact of polar winds in Numerical Weather Prediction (NWP) forecasts working with the National Centers for Environmental Prediction (NCEP), ECMWF, and other NWP centers
2004 International MODIS and AIRS Processing Package first distributed to the international Terra and Aqua direct broadcast user community
2004 WF_ABBA fire products assimilated into the operational CATT BRAMS (Coupled Aerosol and Tracer Transport to the Brazilian developments on the Regional Atmospheric Modeling System) model at INPE/CPTEC (Instituto Nacional de Pesquisas Espaciais/Centro de Previsão de Tempo e Estudos Climáticos)
2004 Created "Satellite Meteorology for Grades 7-12" course available on CDs and online
2004 Began collaborations with the National Center for Atmospheric Research (NCAR), Massachusetts Institute of Technology (MIT), and the Federal Aviation Administration (FAA) to transition satellite-based aviation weather software for turbulence and convective initiation
2005 Developed HYDRA, freeware that has become a critical part of training and research programs internationally
2005 MODIS winds used operationally at NCEP
2005 Clear Sky Brightness Temperature (CSBT) algorithm for GOES Imagers transferred to NOAA/NESDIS operations
2005 Performed trade-off studies for GOES-R ABI spectral channel selection; 16 bands are defined and simulated with MODIS, SEVIRI, and AIRS
2005 CIMSS insolation products from GOES used to calculate evapotranspiration estimates over Wisconsin and Minnesota; product is used heavily by potato growers and also by others who grow irrigated crops
2006 Participated in Meteosat Third Generation Mission Planning Team and provided geo-sounder trade off study support
2006 Contributed atmospheres input for Committee on Earth Observation Satellites (CEOS) response to Global Climate Observing System (GCOS) Implementation Plan
2006 CIMSS Satellite Blog was established to serve as an online library of interesting and educational weather phenomena to be used for a variety of satellite training activities
2006 Began annual participation at AMS WeatherFest featuring weather and climate applets
2007 Performed trade-off studies for GEO advanced IR sounder definition
2007 Published polar ice cover charted with Advanced Very High Resolution Radiometer (AVHRR) data since 1980s
2007 Multi-year South American GOES WF_ABBA archive delivered to LBA-DIS
2007 Made the Geosynchronous Imaging Fourier Transform Spectrometer (GIFTS) data compression software available to NOAA and NASA Langley
2007 Conducted GEOSS Americas/Caribbean Remote Sensing Tier 1 Workshop on Transforming Data into Products in Brazil

2007 CIMSS hyperspectral IR sounding retrieval (CHISR) algorithm developed for full spatial resolution sounding product from AIRS and IASI
2007 Aviation AWG is created to develop and satisfy turbulence, convective overshooting-top/enhanced-V, fog/low cloud, volcanic ash, SO_2, and visibility requirements for GOES-R
2008 McIDAS-V introduced for beta testing
2008 Introduced MODIS data and products to National Weather Service (NWS) forecast offices via the Advanced Weather Interactive Processing System (AWIPS)
2008 Transitioned Automated Dvorak Technique (ADT) to NOAA/NWS operations
2008 Transitioned objective convective overshooting-top algorithm to NCAR for testing in Graphical Turbulence Guidance product used operationally at NOAA/AWC
2008 Developed a high-speed universal minimum-redundancy lossless entropy coding FPGA chip with 5.5 times throughput improvement over the CCSDS Rice coding chip for onboard data compression
2009 Delivered next generation global geostationary WF_ABBA (GOES, Meteosat, MTSAT-1R; version 6.5.006) to NOAA/NESDIS Operations
2009 10 years of half-hourly WF_ABBA fire products available online at the FLAMBE Web site (http://www.nrlmry.navy.mil/flambe/index.html)
2009 Added air quality analyses to real time nowcasts
2009 Began transitioning 33 GOES-R AWG algorithms to NOAA GOES-R Program Office for operational use with ABI sensor
2009 Developed a high-performance 3D lossless compression FPGA chip for multispectral and ultraspectral data
2009 Demonstrated a GPU-based high-performance IASI radiative transfer model with 1523times speedup over the traditional CPU-based counterpart. Compute time for one day's amount of 1,296,000 IASI spectra was reduced from 15 days to 15 minutes. Started to develop the GPU-based RTTOV for the UK Met Office/ECMWF
2009 Celebrated 50 years since the first satellite meteorological experiment developed at UW
2009 Hosted the GOES Users Conference

3.9 Proposal Summary

This proposal seeks to continue supporting NOAA/NESDIS/STAR in meeting current and future challenges in satellite meteorology. The work described above builds upon the established practices and procedures of the current Cooperative Institute for Meteorological Satellite Studies (CIMSS) housed within the Space Science and Engineering Center that has a history of successful collaborations with NOAA, NESDIS/STAR, and the Advanced Satellite Products Branch (ASPB) collocated at UW-Madison. We will conduct, in collaboration with on- and off-site NOAA colleagues, research in four theme areas: (1) Satellite Meteorology Research and Applications to support weather analysis and forecasting through participation in NESDIS product assurance and risk reduction programs and the associated transitioning of research progress into NOAA operations, (2) Satellite Sensors and Techniques to conduct instrument trade studies and sensor performance analysis supporting NOAA's future satellite needs as well as assisting in the calibration and validation of remote sensing data and derived products, (3) Environmental Models and Data Assimilation to improve satellite data assimilation techniques in operational weather forecast models, and (4) Outreach and Education to engage the current and future workforce in understanding and using environmental satellite observations for the benefit of an informed society. For 30 years UW-CIMSS has proven its excellence, service, and benefit to NOAA as a Cooperative Institute, a partnership we are eager and prepared to continue.

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Appendices

Appendix A: Acronyms

ABBA	Automated Biomass Burning Algorithm
ABI	Advanced Baseline Imager
ADT	Advance Dvorak Technique
AERI	Atmospheric Emitted Radiance Interferometer
AFWA	Air Force Weather Agencey
AFWEX	Atmospheric Radiation Measurement First ISCCP Regional field Experiment Water Vapor Experiment
AIRS	Atmospheric InfraRed Sounder
AMS	American Meteorological Society
AMSU	Advanced Microwave Sounder Unit
AMV	Atmospheric Motion Vectors
AniS	AnimationS applet
AO	Announcement of Opportunity
AOD	Aerosol Optical Depth
AODT	Advanced Objective Dvorak Technique
AOL	Atmosphere, Ocean, Land
AOS	Department of Atmospheric and Oceanic Sciences
APP	AVHRR Polar Pathfinder
AQ	Air Quality
AQF	Air Quality Forecasts
ARM	Atmospheric Radiation Measurement
ASADA	Automated Smoke/Aerosol Detection Algorithm
ASAP	Advanced Satellite Aviation weather Products
ASCAT	Advanced Scatterometer
ASOS	Automated Surface Observing Station
ASPB	Advanced Satellite Products Branch
ASTER	Advanced Spaceborne Thermal Emission and Reflection radiometer
ATBD	Algorithm Theoretical Basis Document
ATOVS	Advanced TIROS Operational Vertical Sounder
ATReC	Atlantic Thorpex Respond Campaign
AVHRR	Advanced Very High Resolution Radiometer
AWG	Algorithm Working Group
AWC	Aviation Weather Center
AWIPS	Advanced Weather Interactive Processing System
AWRP	Aviation Weather Research Program
BAMS	Bulletin of the American Meteorological Society
BAR	Bias-Adjusted Reordering
BRN	Bulk Richardson Number
BUFR	Binary Universal Form for the Representation
CA	Cooperative Agreement
CALIPSO	Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations
CAPE	Convective Available Potential Energy
CART	Cloud and Radiation Testbed
CATT BRAMS	Coupled Aerosol and Tracer Transport/Brazilian Regional Atmospheric Modeling System
CAVE	CIMSS Audio-Visual Environment
CCSDS	Consultative Committee for Space Data Systems
CD	Compact Disc
CDR	Climate Data Record
CEOS	Committee for Earth Observation Satellites
CGMS	Coordination Group for Meteorological Satellites
CI	Cooperative Institute
CICS	Cooperative Institute for Climate Studies (University of Maryland and North Carolina State)
CIMSS	Cooperative Institute for Meteorological Satellite Studies

CIRA	Cooperative Institute for Research in the Atmosphere (Colorado State University)
CIOSS	Cooperative Institute for Oceanographic Satellite Studies (Oregon State University)
CLARREO	Climate Absolute Radiance and Refractivity Observatory
CLAVR	Clouds from AVHRR
CMC	Canadian Meteorological Centre
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COMET	Cooperative Program for Operational Meteorology Education and Training
COMS	Communication, Ocean, Meteorological Satellite (Korea)
CONUS	CONtinental (or CONterminus) United States
CORIOLIS	US Air Force/Navy meteorological science satellite
CoRP	Cooperative Research Program (STAR)
COS	Community of Science
CPHC	Central Pacific Hurricane Center
CPL	Cloud Physics Lidar
CPTEC	Center for Weather Forecasting and Climate Studies (Brazil)
CREST	Cooperative Remote Sensing Science and Technology Center (consortium of 8 universities)
CrIS	Cross-track Infrared Sounder
CRTM	Community Radiative Transfer Model
CSBT	Clear-Sky Brightness Temperature
CTH	Cloud Top Height
CUNY	City University of New York
CWB	Central Weather Bureau (Taiwan)
DAAC	Distributed Active Archive Center
DB	Direct Broadcast
DC	Detector Controller
DNS	Domain Name System
DOD	Department of Defense
DOE	Department of Energy
DPI	Derived Product Imagery
DT	Dvorak Technique
DURIP	Defense University Research Instrumentation Program
DWD	Deutscher Wetterdienst
ECMWF	European Centre for Medium-Range Weather Forecasts
EDAS	Eta Data Assimilation System
ED	Department of Education
ED-A	Executive Director – Administration (SSEC)
ED-S	Executive Director – Science (SSEC)
EDR	Eddy Diffusion Rate
EDR	Environmental Data Record
EMC	Environmental Modeling Center
EnKF	Ensemble Kalman Filter
EOS	Earth Observing System
EPA	Environmental Protection Agency
EPO	Education and Public Outreach
ER-2	Earth Resources (airplane), #2
ERBE	Earth radiation budget experiment
ESPC	Environmental Satellite Processing Center
FAA	Federal Aviation Administration
FDP	Federal Demonstration Partnership
FFO	Funds from Operations
FFY	Federal Fiscal Year
FGGE	First GARP Global Experiment
FIRE	First ISCCP Regional Field Experiment
FLAMBE	Fire Locating and Monitoring of Burning Emissions
FNMOC	U.S. Navy Fleet Numerical Meteorology and Oceanography Center

FOV	Field Of View
FPDT	Forecast Products Development Team
FPGA	Field-Programmable Gate Array
FTP	File Transfer Protocol
FTS	Fourier Transform Spectrometers
FY	Fiscal Year
GAC	Global Area Coverage
GARP	Global Atmospheric Research Program
GB	Gigabyte
GCM	General Circulation Model
GCOS	Global Climate Observing System
GDAS	Global Data Assimilation System
GEO	Geostationary
GEO-I	Geostationary Interferometer
GEO-R	Geostationary Radiometer sounders
GEOSS	Global Earth Observation System of Systems
GFS	Global Forecast
GIF	Graphics Interchange Format
GIFTS	Geosynchronous Imaging Fourier Transform Spectrometer
GIMPAP	GOES Improved Measurements and Product Assurance Plan
GINI	GOES Ingest and NOAAPORT Interface
GLERL	Great Lakes Environmental Research Laboratory
GLI	Japanese Global Imager
GMAO	Global Modeling and Assimilation Office
GMD	Grants Management Division (NOAA)
GMS	Geostationary Meteorological Satellite
GOCART	Global Ozone Chemistry Aerosol Radiation Transport
GOES	Geostationary Operational Environmental Satellite
GOFC/GOLD	Global Observation of Forest Cover / Global Observation of Landcover Dynamics
GOMS	Geostationary Operational Meteorological Satellite (Russia)
GOS	Global Observing System
GPS	Global Positioning System
GS	Graduate School
GSFC	Goddard Space Flight Center
GSICS	Global Space-based Inter-Calibration System
GVAR	GOES VARiable data
GWINDEX-III	Global Wind Experiment
HDF	Hierarchical Data Format
HES	Hyperspectral Environmental Suite
HIRS	High-resolution Infrared Radiation Sounder
HIS	High-spectral resolution Interferometer Sounder
HSR	High Spectral Resolution
HSRL	High Spectral Resolution Lidar
HU	Hampton University
HYDRA	Hyper-spectral Data Research Application
IAPP	International ATOVS Processing Package
IASI	Infrared Atmospheric Sounding Interferometer
IDEA	Infusing satellite Data into Environmental Applications
IDV	Integrated Data Viewer
IGOS	Integrated Global Observing Strategy
IHOP	International H_2O Project
IMAPP	International MODIS/AIRS Processing Package
IMG	Interferometric Monitor for Greenhouse gases
INPE	Instituto de Pesquisas Espaciais
INR	Image Navigation and Registration
INSAT	Indian National Satellite

IPO	Integrated Program Office
IPOPP	International Polar Orbiter Processing Package
IR	InfraRed
ISCCP	International Satellite Cloud Climatology Project
ISO	International Organization for Standardization
ITAR	International Traffic in Arms Regulation
ITPP	International TOVS Processing Package
ITS	Interferometer Thermal Sounder
ITWG	International TOVS Working Group
JAIVEx	Joint Airborne IASI Validation Experiment
JCSDA	Joint Center for Satellite Data Assimilation
JPDO	Joint Planning and Development Office
JMA	Japan Meteorological Agency
JPL	Jet Propulsion Laboratory
JPSS	Joint Polar Satellite System
JTWC	Joint Typhoon Warning Center
K	Kelvin
Km	Kilometer
LBA-DIS	Large-Scale Atmosphere-Biosphere Experiment in Amazonia
LDM	Local Data Manager
LEO	Low Earth Orbit
LI	Lifted Index
LSU	Louisiana State University
M.S.	Master of Science
MAS	MODIS Airborne Simulator
MBCC	Midnight Blackbody Calibration Correction
McIDAS	Man computer Interactive Data Access System
MCR	Measurement Concept Review
MCST	MODIS Calibration Science Team
MERSI	Medium Resolution Spectral Imager
Meteosat	METEOrological SATellite
METOP	Series of polar orbiting meteorological satellites (EUMETSAT)
MIT	Massachusetts Institute of Technology
MIXCRA	Mixed-Phase Cloud Property Retrieval Algorithm
MLEV	Minimum Local Emissivity Variance
MMSD	Madison Metropolitan School District
MODIS	MODerate-resolution Imaging Spectroradiometer
MOU	Memorandum of Understanding
MSPS	Modern Sensor Processing System
MSG	Meteosat Second Generation
MSU	Microwave Sounding Unit
MTSAT-1R	Japan’s geostationary imager
MURI	Multidisciplinary University Research Initiative
MW	Microwave
MWR	Microwave Radiometer
NAAPS	Navy Aerosol Analysis and Prediction System
NAOS	North American Observing System
NASA	National Aeronautics and Space Administration
NAST	NPOESS Airborne Sounder Testbed
NCAR	National Center for Atmospheric Research
NCDC	National Climatic Data Center
NCEP	National Centers for Environmental Prediction
NESDIS	National Environmental Satellite, Data and Information Services
NHC	National Hurricane Center
NIST	National Institute for Standards and Technology
NOAA	National Oceanic and Atmospheric Administration

NPN	NOAA Profiler Network
NPOESS	National Polar Orbiter Environmental Satellite System
NPP	NPOESS Preparatory Project
NSF	National Science Foundation
NSMC	National Satellite Meteorology Center (China)
NSSL	National Severe Storms Laboratory
NWP	Numerical Weather Prediction
NWS	National Weather Service
NWSFO	NWS Forecast Office
ODT	Objective Dvorak Technique
OFCCP	Office of Federal Contract Compliance Programs
OMB	Office of Management and Budget
OMI	Ozone Monitoring Instrument (Aura)
ORA	Office of Research & Applications
OSD	Office of Systems Development
OSDPD	Office of Satellite Data Processing and Distribution
OSE	Observing System Experiments
OSSE	Office of Space Science Education
OT	Overshooting top
PACJET	Pacific Landfalling Jets Experiment
PALMS	Precision Agricultural-Landscape Modeling System
PATMOS-x	Pathfinder Atmosphere
PDT	Product Development Teams
PEATE	Product Evaluation and Algorithm Test Elements
Ph.D.	Doctor of Philosophy
PI	Principal Investigator
PM	Program Manager
POES	Polar Orbiting Environmental Satellite
PPVQ	Predictive Partitioned Vector Quantization
PSDI	Product Systems Development and Implementation
PV	Potential Vorticity
RAMMB	Regional and Mesoscale Meteorology Branch (CIRA)
RAMS	Regional Atmospheric Modeling System
RAOB	RAdiosonde OBservation
RAQMS	Regional Air Quality Modeling System
RSP	Research and Sponsored Programs
RT	Radiative Transfer
RUC	Rapid Update Cycle
SAB	Satellite Analysis Branch (OSDPD)
SAFARI	Southern African Regional Science Initiative
SAL	Saharan Air Layer
SATCON	Satellite Consensus
SCAR-B	Scientific Committee for Antarctic Research
SCSB	Satellite Climate Studies Branch (CICS)
SDI	SSEC Desktop Ingestor
SDR	Sensor Data Record
SEVIRI	Spinning Enhanced Visible and InfraRed Imager
SFOV	Single Field of View
SFY	State Fiscal Year
SGP	Southern Great Plains
SHARP	Summer High School Apprenticeship Research Program
SHEBA	Surface Heat Budget of the Arctic Ocean
S-HIS	Scanning High resolution Interferometer Sounder
SHyMet	Satellite Hydrology and Meteorology
SMM	Science Museum of Minnesota
SO_2	Sulfur dioxide

SOCC	Satellite Operations Control Center
SOI	Successive Order of Interaction
SOS	Science on a Sphere
SOW	Statement of Work
SPC	Storm Prediction Center
SRF	Spectral Response Function
SSEC	Space Science and Engineering Center
SSM/I	Special Sensor Microwave/Imager
SST	Sea Surface Temperature
STAR	Satellite Applications and Research
STEM	Science, Technology, Engineering, Mathematics
TAP	Technical Advisory Panel
TB	Terabytes
TC	Tropical Cyclones
TCO	Total Column Ozone
THORPEX	The Observing system Research and Prediction Experiment
TIROS	Television InfraRed Observation Satellite
TNMC	The National Maritime Center
TOA	Top of Atmosphere
TOMS	Total Ozone Mapping Spectrometer
TOVS	TIROS Operational Vertical Sounder
T-PARC	THORPEX Pacific Asian Regional Campaign
TPC	Tropical Prediction Center
TPW	Total Precipitable Water
TRMM	Tropical Rainfall Measuring Mission
TROWAL	TROugh of Warm air ALoft
TXR	Thermal-Infrared Transfer Radiometer
UAH	University of Alabama–Huntsville
UPS	United Parcel Service
USDA	U.S. Department of Agriculture
UTC	Universal Coordinated Time or Universal Time Coordinated
UV	UltraViolet
UW	University of Wisconsin
VAS	VISSR Atmospheric Sounder
VIIRS	Visible/Infrared Imager and Radiometer Suite
Vis5D	Visualization of Five-Dimensional data
VisAD	Visualization for Algorithm Development
VISIT	Virtual Institute for Satellite Integration Training
VISSR	Visible and Infrared Spin-Scan Radiometer
WES	Weather Event Simulator
WF_ABBA	Wildfire Automated Biomass Burning Algorithm
WINCE	WINter Cloud Experiment
WISC-T2000	Wisconsin Snow Ice-Terra 2000
WFO	Weather Forecast Office (NWS)
WMO	World Meteorological Organization
WRF	Weather Research and Forecasting model
WVIOP	Water Vapor Intensive Observing Period
WVSS	Water Vapor Sensing System

Appendix B: Letters of Support

CICS: Phil Arkin

CIRA: Graeme Stephens

CREST: Reza Khanbilvardi

CWB (Taiwan): Chia-Rong Chen

ECMWF: Peter Bauer

EUMETSAT: Johannes Schmetz

IMAA (Italy): Vincenzo Cuomo

NCEP: Louis Uccellini

NHC: Bill Read

NWS Milwaukee-Sullivan Office (MKX): Jeff Craven

UK Met Office: John Eyre

UK Met Office: Roger Saunders

WMO: Wenjian Zhang

UNIVERSITY OF MARYLAND
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January 19, 2010

Prof. Steven A Ackerman
Director, CIMSS
University of Wisconsin-Madison
1225 West Dayton St
Madison WI 53706

Dear Prof. Ackerman:

I am writing this letter to support your proposal to continue leading the Cooperative Institute for Meteorological Satellite Studies (CIMSS). Since CIMSS was first established as a NOAA Cooperative Institute in 1980 it has successfully conducted research in the general area of satellite meteorology and applications with a wide variety of national and international partners, including CICS. Your personal leadership over the past decade has contributed greatly to CIMSS strong role in support of NOAA's satellite-based research and the transition of research results to various operational agencies. CIMSS is known world-wide for its strength in the development of visualization and analysis tools, your meteorological satellite data center and associated end-to-end data processing capabilities, and your ability to evolve observing systems from the drawing board to space.

The CICS emphasis on the use of satellite observations and climate modeling to support NOAA's climate services should dovetail nicely with your proposed extension of CIMSS and I am confident that strong collaborative research efforts between our Institutes, particularly on the development of long term satellite data sets, will result. We look forward to working with your researchers over the next decade.

Sincerely,

Phillip A. Arkin
Executive Director, Cooperative Institute for Climate and Satellites (CICS)

CC: Dr. Otis Brown, Director, CICS-NC

Colorado State University
Knowledge to Go Places

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FAX: (970) 491-8449
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To whom it concerns,

I write this letter in my capacity as Director of the NOAA cooperative institute (CI) at CSU (CIRA) to offer the support of the CIMSS proposal in the strongest possible way. In my view CIMSS has been one of the major success stories of the NOAA CI program and are the poster child of the NESDIS CI's. The contributions of CIMSS to the NOAA mission are second to none and the institute has been exemplary in the successful way they have been able to transfer their research to important operational applications. CIMSS also offers NOAA other important benefits such as in the connecting of NOAA's interests to both a strong academic program of the University and the cutting edge activities of the Space Science and Engineering Center (SSEC).

I also want to comment about collaboration between CIMSS and CIRA. CIRA and CIMSS have a long history together, not only in shared projects, and in exchange of key research staff and students but both institutes in many ways have even deeper ties. The current director of CIMSS is a former student of the Atmospheric Science Department at CSU and the founding Director of CIRA was a former student of the sister Department at Wisconsin. Our relationship thus runs deep and our collaborations reflect this sense of family as both CIs continue to flourish in partnership. We are looking forward to building yet stronger collaborations in the future as together we serve the emerging NOAA interests and address the key needs of the nation.

Sincerely

Dr. Graeme Stephens
University Distinguished Professor
CIRA Director

National Oceanic and Atmospheric Administration
Cooperative Remote Sensing Science and Technology Center

NOAA CREST

February 19, 2010

Dr. Steven Ackerman
Director
Cooperative Institute for Meteorological Satellite Studies (CIMSS)
University of Wisconsin-Madison
1225 W. Dayton St.
Madison, WI 53706

Dear Dr. Ackerman:

This letter is to express the support of NOAA-Cooperative Remote Sensing Science and Technology (CREST) Center, at the City College of the City University of New York for CIMSS.

It is worth mentioning the long existing collaboration between CREST and CIMSS including Students Summer Exchange Program since 2006. Through this exchange program, each summer, several students gain hands-on experience on software like McIDAS, IDL etc., besides interacting with CIMSS scientists on their doctoral research projects in areas that include application of LIDAR techniques to study aerosols and other air constituents, and Real-time Air Quality Modeling System (RAQMS). Earlier in 2005, CREST partner at Hampton University had a collaborative three-year Environmental Literacy Grant on "Educational Applications of the National Maritime Center Science on a Sphere".

In the near future, with the CIMSS's new cooperative agreement, CREST and all its academic members anticipate enhancing our partnership and collaboration in the following areas of research; education and outreach:

(1) **Air Quality Proving Ground and Aerosol-Cloud Interaction Studies** will be conducted in collaboration with Brad Pierce; Tim Schmit, and Bryan Baum as CIMSS collaborators. The intent of the AQPG is to take known air quality events which have been substantiated by CREST Lidar Network (CLN) measurements; generate synthetic GOES-R AOD retrievals for these cases, and using NESDIS GOES-R ABI proxy data simulation; create realistic synthetic GOES-R retrievals for air quality parameters (AOD, particle type, smoke/dust indices, etc.);

(2) **Develop 30-year Northern Hemisphere Lake Ice Phenology Data Records using NOAA AVHRR.** CREST proposes to complement this effort by developing a 30-year Northern Hemisphere Lake Ice Phenology Data Records from NOAA AVHRR. Current products by Wang et al. at CIMSS place a particular emphasis on sea ice especially in the Arctic Sea. We suggest adding the inland water bodies too and investigate the phenology of lake ice at these locations

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(3) **Estimate Snow and Ice Characteristics with GOES-R ABI**. This study is a continuation of an earlier effort conducted in the framework of the GOES-R project/Cryosphere group led by Jeff Key at CIMSS. A new technique has been proposed by Temimi et al. (2010) to detect sea ice and estimate its concentration using data from the MSG SEVIRI sensor. This technique is in line with what has been proposed by Wang et al. at CIMSS.

(4) **Soil Moisture Estimation using Satellite Data (GOES-R)** in collaboration with Bob Rabin, CIMSS/NOAA-NSSL, the ultimate objective of this work is the development of a final product making use of observations in the visible/IR and microwave bands to regularly generate global soil moisture maps.

(5) **Dynamic Projections of GOES Moisture Products**. The stability near casts produced by CIMSS is currently tested on the statistical occurrence and intensity of storms. A more detailed analysis would determine whether cloud cells that initially look the same would develop differently according to the environmental conditions captured by the nearcast stability products. This would involve the use of tracking algorithms.

(6) **Development of Non-Traditional Red/NIR Algorithms for Improved Retrievals of Complex Coastal Water Properties for different locations**. The CREST group has specialized in non-traditional red/NIR algorithms for improved retrievals of complex coastal water properties. As part of this work it has studied chlorophyll fluorescence as a function of bio-optical parameters in coastal waters both through extensive simulations and field studies. The CREST group would like to use its expertise to apply to other water bodies like Great Lakes etc.

(7) **GOES-R Education and Public Outreach.** One example would be the use of the CIMMS Satellite Meteorology CD in the CREST weather camp. The activities booklet and demonstrations on the CD would be tested during outreach activities by both CREST and CIMMS. The CD and activity booklet together would form a powerful combination for teacher use.

(8) **Virtual Institute for Satellite Integration Training (VISIT) Participation.** As an extension to the ongoing Education, training and outreach activities at CREST, and enhance the existing collaboration with CIMSS, we propose on creating VISIT distance learning modules for the students and the community, with the goals to provide satellite imagery interpretation materials that can be used in education and environmental literacy.

(9) **Developing Training Materials for McIDAS Users and Programmers; and Museum Exhibits to Describe NOAA's Environmental Satellite Program.** In partnership with the existing McIDAS training facility at CIMSS, CREST would develop and evaluate the McIDAS training and evaluation course material for the users and programmers. Integration of CIMSS Science of Sphere (SOS) output materials to CREST SOS for Education and Public Outreach in NYC Metro Region including High School, Junior Colleges.

I am certain that many of our CREST scientists would be interested in venturing into this joint partnership and we look forward to sharing our research; education and outreach experiences with CIMSS research members in the years to come.

Sincerely,

Reza Khanbilvardi, Ph.D., P.E.
Director,
and NOAA Chair Professor of Civil Engineering

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14 January 2010

Letter of support for CIMSS

Best Steve

The Council for Scientific and Industrial Research (CSIR) in South Africa have been privileged to work with the CIMSS group for the last number of years. Products such as IMAPP have enabled the CSIR to successfully operate two MODIS direct broadcast system, which in turn enabled the development of the Advanced Fire Information System (AFIS), which provides daily fire information to more than 500 fire managers across Southern Africa. During 2007, Willem Marais from the CSIR Meraka Institute also had the opportunity to spend a month with the CIMSS group where he received expert training. Willem has become an invaluable resource to the CSIR and received an award in 2009 in the category, *Excellence by an Individual* for the work he started at CIMSS. Two extremely successful CIMSS MODIS training courses in Pretoria during 2006, and Cape Town in 2009 provided more than 80 local scientists with a wealth of knowledge. Through dedication and hard work the CIMSS team have contributed significantly to the development of remote sensing applications in South Africa. The CSIR is looking forward to continuing this relationship well in to the future as colleagues and friends.

Regards

Philip Frost

Central Weather Bureau

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Republic of China
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E-mail:crchen@msc.cwb.gov.tw

February 3, 2010

Cooperative Institute for Meteorological Satellite Studies
1225 W. Dayton Street
Madison, WI 53706
USA

To whom it may concern:

This letter is to acknowledge the contribution made by the CIMSS. The Central Weather Bureau (CWB) of Taiwan has been greatly benefited from the free codes (like IAPP ,IMAPP and others) released by the CIMSS, such that we can process MODIS and AIRS data for various weather monitoring and applications.

CIMSS has proved herself as a leader in the satellite data processing and educational software design. It is highly foreseeable that we will continue to increase our understanding of earth environment through the advanced remote sensing techniques developed by CIMSS.

Sincerely yours,

Chia-Rong Chen

Chia-Rong Chen
Director
Meteorological Satellite Center
Central Weather Bureau, Taiwan

For the record +44 118 9499080

Date: 04 February 2010

Dear Madam/Sir

The purpose of this letter is to support the renewal of the status of the Cooperative Institute for Meteorological Satellite Studies (CIMSS) as a Cooperative Institute of the National Oceanic and Atmospheric Administration.

ECMWF is the leading global and operational numerical weather prediction (NWP) centre in the world and, as other NWP centre, relies heavily on institutes like CIMSS to produce operational datasets to be assimilated in analyses, to develop advanced and new products that enhance the information extracted from the global satellite observing system and to provide the scientific expertise that supports the optimal utilization of remote sensing data for NWP.

ECMWF is currently using two different product types that have been developed and distributed by CIMSS, namely Atmospheric Motion Vectors (AMV) derived from polar orbiting imagers such as AVHRR and MODIS, and Clear-Sky Radiances (CSR) obtained from geostationary (GOES) imagers. CIMSS has performed most of the AMV product development including the reprocessing of long time series of past data that is essential for reanalyses. In close collaboration with ECMWF, CIMSS has further performed dedicated scientific studies by applying AMV processing algorithms to simulated radiance data aiming at a better understanding of AMV product uncertainties. Currently, CSR data from GOES-12 is received from CIMSS and assimilated in the operational ECMWF model. At all times, CIMSS provided extensive support with new products, for example, through the dissemination of test data parallel to the operational service allowing a seamless transition between old and new products.

The exploitation of this data for NWP would not be possible without the basic research invested at CIMSS, without the swift transition of research products into operations and the supporting service along the product's lifetime provided by CIMSS. In view of the fundamental role that CIMSS occupies in global NWP, it is of greatest importance that CIMSS receives the utmost support from NOAA established by its status as a Cooperating Institute.

Yours sincerely,

Dr. Peter Bauer
Head of Satellite Section
Research Department

ECMWF, Shinfield Park, Reading, RG2 9AX, England
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EUMETSAT
Monitoring weather and climate from space
Surveiller le temps et le climat depuis l'espace

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Prof. Steven A. Ackerman
Director, CIMSS
University of Wisconsin-Madison
1225 West Dayton St.
Madison WI 53706
USA

Your reference Votre référence	Your letter dated Votre lettre du	Our reference Notre référence	Darmstadt
		EUM/MET/LET/10/0032	29 January 2010

Subject: Letter of Support to CIMSS

I have been asked to provide a letter of support to NOAA concerning the continuation of the Cooperative Institute for Meteorological Satellite Studies (CIMSS) at the University of Wisconsin in Madison. I follow this request with pleasure. CIMSS delivers excellent scientific and practical work and provides outstanding worldwide leadership in many fields of satellite meteorology. In the following I will substantiate this observation.

First let me briefly introduce myself. I am Head of Meteorological Division at European Organization for the Exploitation of Meteorological Satellites (EUMETSAT). EUMETSAT is the European Organization operating and utilizing operational meteorological satellites. My division develops meteorological satellite applications in collaboration with the user community and with industry during the procurement of satellite ground systems. We also play the pivotal role in the definition of scientific and technical aspects for the development of future satellite programs of EUMETSAT. EUMETSAT has long-standing cooperation with NOAA/NESDIS and with CIMSS. On the EUMETSAT side this cooperation is to a large extent carried by the scientists in my Meteorological Division.

CIMSS was established as a NOAA Cooperative Institute in 1980 and has successfully conducted research in the general area of satellite meteorology and applications. An important aspect is that the work has very often been conducted with national and international partners. This implies that the internal CIMSS progress always takes into account the external progress which makes CIMSS a very competitive institution.

CIMSS has unique ability to evolve observing systems from the drawing board to space. Specifically CIMSS was and is instrumental in the planning and development of new satellite

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EUMETSAT

technology. CIMSS has also played an eminent role in a successful transition of newly developed research into operations. Clearly NOAA/NESDIS operations and other US government agencies have very much benefitted from that unique capability. The examples are numerous and let me just to drop a few examples that come to my mind: They range from the development of NOAA satellite applications, over the development of AQUA and TERRA (both NASA satellites) applications to the outstanding provision of good satellite wind data to the Navy for improved hurricane track forecasts.

Furthermore CIMSS has pioneered the development of visualization and analysis tools for satellite meteorology, CIMSS has a good data center and provide end-to-end data processing capabilities, which is most frequently used.

CIMSS was and is a key part of what I would call 'a world-centre of gravity for satellite meteorology'. CIMSS provides, in close cooperation with the Space Science and Engineering Center and the University, a center of expertise for all aspects of satellite meteorology. This includes the acquisition and discussion of user requirements, the development of new instrument concepts, the development of the science to exploit instruments, the development of operational applications of satellite measurements and the communication of the capabilities to the user community. CIMSS is unique and has proven it its capabilities and shown its leadership over decades. In the future I see CIMSS as a uniquely versatile institute addressing all important areas of satellite meteorology. CIMSS is an asset that US government institutions, such as NOAA and NASA, will increasingly consult in order to address a more rapid convergence on views, requirements and concepts, and the pertinent way toward realisation. This is also true for the international community. Speaking for EUMETSAT I would like to acknowledge the broad expertise of CIMSS and their willingness to share the expertise in a truly scientific manner. This is clearly mutually beneficial and accelerates scientific and operational progress.

I strongly recommend to continue CIMSS in its current format as a leading center for satellite meteorology supporting future work in the US and also world-wide.

Sincerely,

Dr. Johannes Schmetz
Head of Meteorological Division

Consiglio Nazionale delle Ricerche

Istituto di Metodologie per l'Analisi Ambientale

IMAA - CNR - IMAA	
Tit: Cl: F:	
N. 0000318	09/02/2010

Prof. Steve Ackerman
Director CIMSS
University of Wisconsin-Madison
1225 W. Dayton St.
Madison, WI 53706

cc. Prof. Paul Menzel

The Italian National Research Council (CNR) is a public organization of great relevance in the field of scientific and technological research whose original institution goes back to 1923. In the framework of the reorganisation process of CNR, the Institute of Methodologies for Environmental Analysis (IMAA) was officially established in 2002 as a result of the union of three existing institutes: The Institute of Advanced Methodologies for Environmental Analysis (IMAAA); the Institute of Clay Research (IRA); and the Institute of Horticultural and Industrial Culture (IOCI). IMAA is located in the CNR Research Area of Potenza (Basilicata Region).

Since its constitution, the research activities of Institute of Methodologies for Environmental Analysis have been devoted to the development and integration of satellite, airborne, and in-situ "*Earth Observation*" to study environmental and geophysical processes. The scientific activity of IMAA is focused on the study of environmental problems, covering a wide spectrum of research areas: Earth Observations by using both remote sensing and in-situ techniques to characterise atmosphere, hydrosphere, lithosphere and biosphere and their interactions, to develop meteo-climatic applications and risk prediction, prevention and mitigation; chemical-physical characterisation of soil and subsoil; monitoring anthropogenic pressure and management of agricultural and natural resources; development of advanced techniques (in-situ and remote sensing) for environmental monitoring and integration of chemical-physical, biological and geological methodologies; and integrated methodologies for Environmental Planning. These activities are supported by several laboratories and instrumental facilities.

IMAA is characterized by a large involvement in national and international research projects (European Commission, ESA, EUMETSAT, MIUR, Civil Protection Department, etc.), and national and international cooperation (NASA, NASDA, CIMSS, University of Maryland, CNRS, Planck Institut für Meteorologie, University of Naples, University of Basilicata, University of Bologna, ISAC-CNR etc.), a high scientific productivity and a concrete support and technological transfer to end users. IMAA research activity is responsive to, and develops links with, academics, central and local government, and the industrial community and promotes high level educational programs (i.e., PhD) in cooperation with national and foreign Universities. IMAA is characterised by a large involvement participation in national and international research programmes, considerable inclination to self-funding (in the past two years, IMAA has signed contracts for more than 6 M€), high scientific productivity and steady support and technological transfer to end users. IMAA counts on a staff of 65 permanent and 56 external members who are physicists, geologists, mathematicians, engineers and technicians.

Since 1992 the IMAA/CNR institute has collaborated with the Cooperative Institute for Meteorological Satellite Studies (CIMSS) through research projects and the visiting scientist program. CIMSS has been proved to be a leading research institute on satellites environmental monitoring, with specific emphasis on the analysis and prediction of weather and climate. It has served as an international centre for research on the interpretation and use of operational and experimental satellite observations and remote sensing data acquired from aircraft and the from the ground. These data have been applied to a wide variety of atmospheric and oceanographic studies and evaluated for their potential operational utility.

CIMSS plays a major role in transferring knowledge on new technology into operational practice. It is involved in a variety of educational projects. Their international role is further strengthened through its visiting scientist program that hosts sabbaticals for several foreign scholars each year.

CIMSS scientists have been travelling to Italy and other international research centers and universities in order to help foster a new generation of researchers and graduate students in the theoretical and operational aspects of satellite remote sensing. A series of lectures on remote sensing have been offered in Italy at Bologna (Sep 2001), Rome (Jun 2002), Maratea (May 2003), Bertinoro (Aug 2004), Ostuni (Jun 2006), Sasso di Castalda (Jul 2009) by Drs Paul Menzel and Paolo Antonelli. The courses offered included materials on (a) radiation and the radiative transfer equation; (b) remote sensing of the Earth surface and its atmosphere; (c) instrument considerations; (d) algorithms for detecting and estimating moisture, precipitation, and clouds properties; and (e) current and future capabilities of the global observing system. Fifty hours of classroom work was split between lectures and laboratory exercises that emphasized investigation of high spatial resolution visible and infrared data from the Moderate resolution Imaging Spectroradiometer, and Meteosat Second Generation, and high spectral resolution infrared data from the Advanced InfraRed Sounder and the Infrared Atmospheric Sounding Interferometer.

CIMSS is very active in national and international field programs, testing new instrumentation, data processing systems and assessing the geophysical utility of measurements. It plays a major role in instrument design and testing, and related software development, for improved space-based measurements of the earth's atmosphere. CIMSS has contributed a wealth software packages (IAPP, IMAPP, McIDAS, etc.) to the international scientific community in an effort to assist others in their work and research. CIMSS satellite imagery and software products have been used by professional meteorologists, teachers and students worldwide, including at IMAA from many years.

Therefore, it is hoped that the collaboration between the IMAA and the CIMSS can continue profitably in the coming years.

IMAA/CNR Director
Prof. Vincenzo Cuomo

Consiglio Nazionale delle Ricerche
- IMAA -

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL WEATHER SERVICE
National Centers for Environmental Prediction
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FEB 18 2010

Dr. Steven Ackerman
The Cooperative Institute for Meteorological Satellite Studies
University of Wisconsin – Madison
Madison, WI 53706

Dear Steven:

The purpose of this letter is to express support for the renewal of the Cooperative Institute for Meteorological Satellite Studies (CIMSS) at the University of Wisconsin-Madison. The contributions CIMSS has made in developing products for NESDIS has been valuable to the national Weather Service and specifically to the National Centers for Environmental Prediction. They have played a critical role in the development of various satellite products, including geostationary and polar atmospheric motion vectors and geostationary radiance products used by the National Hurricane Centers (Miami, FL) and the Storm Prediction Center (Norman, OK). Furthermore, CIMSS provided extensive support in effecting the transition of these research products into NESDIS and NCEP operations.

CIMSS scientists have also been active in the Joint Center for Satellite Data Assimilation development of NCEP's radiance assimilation through improvements to the Community Radiative Transfer Model and assimilation techniques of several sensors including Atmospheric Infrared Sounder (AIRS), the Infrared Atmospheric Sounding Interferometer (IASI) and polar wind vectors derived from MODIS imagery sensors.

I expect that NCEP will continue its relationship with CIMSS through NOAA's Cooperative Institute program and direct interaction with our service and modeling centers.

Sincerely,

Louis W. Uccellini
Director

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL WEATHER SERVICE
National Hurricane Center
11691 SW 17 Street
Miami, FL 33165-2149

February 12, 2010

Dear Madam/Sir

The NOAA National Hurricane Center (NHC) benefits greatly from institutes like the Cooperative Institute for Meteorological Satellite Studies (CIMSS) at the University of Wisconsin-Madison that develop new and advanced products which enhance the information extracted from the satellite observing system. The collaborating researchers at CIMSS also provide the scientific expertise that supports the optimal utilization of remote sensing data for hurricane analysis and prediction.

NHC currently uses many of the satellite-derived products that have been developed and distributed by CIMSS. Over the many years of collaboration, CIMSS has provided extensive support with new products, for example, through the dissemination of experimental advanced algorithms through their web page, and also through Joint Hurricane Testbed activities. The operational use of these products at NHC would not be possible without the basic research invested at CIMSS, without the swift transition of research products into operations, and the supporting service along the product's lifetime provided by CIMSS personnel.

In view of the important supporting role that CIMSS plays in regards to NHC activities, we recommend that CIMSS receives the utmost support from NOAA established by its status as a Cooperating Institute. The NHC urges NOAA to support the renewal of CIMSS as a Cooperative Institute of the National Oceanic and Atmospheric Administration.

Sincerely,

Bill Read
Director, National Hurricane Center

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Weather Service - WFO Milwaukee/Sullivan
N3533 Hardscrabble Rd.
Dousman, WI 53118

January 26, 2010

MEMORANDUM FOR: Dr. Steven Ackerman, Director
Cooperative Institute of Meteorological Satellite Studies
University of Wisconsin-Madison
1225 W. Dayton
Madison, Wisconsin 53706

THRU: Stephen L. Brueske
Meteorologist In Charge

FROM: Jeffrey P. Craven
Science and Operations Officer

SUBJECT: Support for CIMSS

During my four years at the NWS Milwaukee/Sullivan, I have observed and participated in the beneficial collaboration between UW-CIMSS and Weather Forecast Office (WFO) Milwaukee/Sullivan.

Numerous meetings between the UW-CIMSS research/development community and our forecast staff resulted in the creation of over two dozen cutting edge satellite and numerical prediction products. These products are routinely distributed to our Advanced Weather Interactive Processing System (AWIPS) workstations for operational use by forecasters. In addition to development, the CIMSS researchers provided our forecasters face to face training and helpful background documentation on these new products. This information allowed our staff to quickly incorporate these new products into their forecast process.

CIMSS and WFO Milwaukee/Sullivan plan to conduct a GOES R Proving Ground testbed at WFO Milwaukee/Sullivan during May through August 2010. During this time developers and forecasters will sit side by side and jointly evaluate new convective initiation and nearcasting products.
These formal critiques will enhance existing products and lay the foundation for innovative new products to harness the vast potential of satellite systems for hazardous weather forecasting.

Our operations have benefited from this valuable relationship. We look forward to additional tools, techniques, and collaboration with CIMSS on future projects.

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Email: john.eyre@metoffice.gov.uk

Professor Steven A. Ackerman
Director, CIMSS
University of Wisconsin-Madison
1225 West Dayton St.
Madison, Wisconsin 53706
USA

18 January 2010

Ref: **CIMSS**

Dear Steve,

I am very pleased to write in support of CIMSS being renewed by NOAA as a Cooperative Institute.

I have worked closely with CIMSS scientists on many topics since the 1980s, including in my capacities as Head of the Satellite Section at ECMWF (1990-95) and as Head of Satellite Applications at the UK Met Office (1995 - present). I have also been involved in activities of WMO and EUMETSAT to which CIMSS has been an active participant.

CIMSS is widely recognised as a world-leading centre for satellite meteorology – in research and development, and in education. It has also made important contributions to international efforts to improve and to coordinate the Global Observing System (GOS). CIMSS has undertaken pioneering work concerning the geostationary and polar-orbiting satellite systems of the USA and of international agencies, through advances in the following areas: improved exploitation of currently available satellite data, preparations for the data expected from new satellite missions, and studies in support of the definition and realisation of future satellite instruments.

Of the many areas in which CIMSS has been active, I can personally attest to the importance of their recent work in the following areas:

- The CIMSS cloud climatology derived from the HIRS data sets is probably the best existing record of the climatology of cirrus cloud.

- CIMSS pioneering contributions to the development of atmospheric motion vectors derived from polar satellite imagery at high latitudes have been crucial; these new products have enhanced the skill of numerical weather prediction (NWP) at several operational centres.

- CIMSS research on hyperspectral infra-red sounders borne by aircrafts and satellites over many years has been important in establishing these instruments as a major component of the GOS. CIMSS has been a leading contributor to the establishment of the science base for exploiting data from the AIRS and IASI instruments.

- CIMSS contributions to EUMETSAT studies of advanced infra-red sounders on geostationary satellites were key to current plans for the Infra-Red Sounder on Meteosat Third Generation (MTG-IRS).

- CIMSS has provided one of the current co-chairs (and three of his predecessors) of the International TOVS Working Group (ITWG), which continues to be the leading international forum for discussion of research on and application of passive satellite sounder data. CIMSS has supported the important activities of ITWG in many ways.

- CIMSS members have contributed to activities of the WMO Commission for Basic Systems, most notably its Expert Team on the Evolution of the Global Observing System and its predecessor groups, and to the implementation of the recommendations from these activities within international space agencies through the Coordination Group for Meteorological Satellites (CGMS).

I very much hope that the important role that CIMSS plays in these and related areas can be supported into the future.

Yours sincerely,

John Eyre

Dr J R Eyre
Head of Satellite Applications

Met Office FitzRoy Road Exeter EX1 3PB United Kingdom
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Professor Steven A. Ackerman
Director, CIMSS
University of Wisconsin-Madison
1225 West Dayton St.
Madison, Wisconsin 53706
USA

23 January 2010

Ref: **CIMSS contract renewal**

Dear Steve,

It is a pleasure to support CIMSS in its bid for renewing the contract for the Cooperative Institute at the University of Wisconsin-Madison.

I have a good on-going active collaboration with many CIMSS scientists in several areas of research and have worked with CIMSS for the past 30 years. I have always been impressed by the satellite reception facilities and computer tools for manipulating the satellite data developed at CIMSS. Another very positive outcome is the number of students being trained in satellite meteorology which CIMSS helps to promote. I am aware many become experts in US Government Institutions. Our Met Office group has benefited from at least one student recently. There have been several areas of direct liaison between myself and CIMSS which I outline below.

1. I worked closely with Tom Achtor when we were both co-chairs of the International TOVS Working Group, ITWG, visiting CIMSS several times over the last 10 years for preparation meetings. The support for the ITWG from CIMSS has been invaluable both in terms of hosting the web site, providing secretarial support for the meetings and production of the proceedings. The current success of the ITWG is partly due to this support.

2. I have a collaborative project, funded by the EUMETSAT NWP SAF, with Eva Borbas at CIMSS on providing a better land surface emissivity dataset for radiative transfer models. This is proving useful for enabling more satellite data to be assimilated in NWP models over land.

3. I am just setting up another NWP SAF funded project with Allen Huang on using new computer technology for running fast radiative transfer models. Placing these contracts is a recognition of the expertise at CIMSS which is useful for assimilation of satellite data in NWP models.

4. A few years ago we hosted a scientist, Howard Berger, from CIMSS at the Met Office for several years who worked effectively in my group on improving the use of AMVs in NWP models. We still collaborate closely with Chris Velden on all aspects of AMVs and their exploitation but in particular how to improve aspects of the GOES AMVs.

5. We have recently implemented the McIDAS software at the Met Office to enhance our research tools for satellite imagery.

6. I am familiar with many other CIMSS scientists and their work (e.g. on hyperspectral sounders) and we meet at conferences on a regular basis and renew contact.

CIMSS has remained a leading centre for satellite meteorology over the last 30 years and is able to continue to provide world leading science in many areas of satellite meteorology. I trust that the important role that CIMSS plays in these areas can be supported by NOAA well into the future.

Yours sincerely,

Roger Saunders

Dr RW Saunders
Head of Satellite Imagery Applications Group

World Meteorological Organization
Organisation météorologique mondiale

Secrétariat
7 *bis*, avenue de la Paix – Case postale 2300 – CH 1211 Genève 2 – Suisse
Tél.: +41 (0) 22 730 81 11 – Fax: +41 (0) 22 730 81 81
wmo@wmo.int – www.wmo.int

TEMPS • CLIMAT • EAU
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Our ref.: 11511-10/OBS/SAT/CISM

Ms Mary E. Kicza
Assistant Administrator
National Environmental Satellite, Data and Information Service (NESDIS)
National Oceanic and Atmospheric Administration
1335 East-West Highway, SSMC1, 8th Floor
SILVER SPRING, MD 20910
USA

GENEVA, 9 February 2010

Subject: University of Wisconsin-Madison competition for Cooperative Institute for Satellite Meteorology

Dear Ms Kicza,

It is my great pleasure to write this letter to support University of Wisconsin-Madison for the NOAA Cooperative Institute for Satellite Meteorology.

I am currently the Director of the Observing and Information Systems Department of the World Meteorological Organization (WMO), former Deputy Administrator of the China Meteorological Administration (CMA), former Director General of the Department of Observations and Telecommunication of CMA, and former Director General of the National Satellite Meteorological Center (NSMC) of China.

In the past decade, the Cooperative Institute for Meteorological Satellite Studies (CIMSS) at the University of Wisconsin has been well recognized in the international community for innovative and outstanding contributions to the satellite remote sensing and applications. CIMSS has developed cutting-edge methodologies, processing software, and visualization packages to enhance the application of global environmental satellite observations. The International TOVS Processing Package (ITPP), International ATOVS Processing Package (IAPP), International MODIS/AIRS Processing Package (IMAPP), and the Man computer Interactive Data Access System (McIDAS) developed by CIMSS have been widely used by WMO Members, WMO partner organizations and many international users for real time use of satellite data for weather forecasts. CIMSS is a world class leading institute in remote sensing science, training young scientists, and helping with international coordination of the global observing system. CIMSS is the leader on the development of advanced methodologies for extracting key products such as atmospheric temperature, moisture, cloud properties, atmospheric motion vectors, and hurricane intensity from both polar-orbiting and geostationary weather satellites. Those methodologies have been used by many operational centers. CIMSS is also a leading center for training the new generation of remote sensing scientists and leaders; after finishing Ph.Ds, training, or visiting scientist programs at CIMSS, many of those young scientists have later become key leaders and played critical roles in international academic institutes, operational organizations and universities.

The great success of CIMSS also has had profound and positive impact on the WMO Space Program through their achievements in scientific publications and hardware and software development in the field of satellite meteorology. In more than the past ten years, CIMSS senior scientists and experts made remarkable contributions to the World Meteorological Organization (WMO) Expert Team on Observational Data Requirements and Redesign of the Global Observing System (GOS) with Dr Paul Menzel, the former science director of CIMSS as the Chairman of the Expert Team. Moreover, CIMSS also contributed greatly to the leadership and development of The International TOVS Working Group (ITWG), a sub-group of the Radiation Commission of the International Association of Meteorology and Atmospheric Sciences (IAMAS) with the CIMSS staff as the co-chairs of the ITWG, in the past Dr Paul Menzel, former science director of CIMSS, Mr Thomas Achtor, the former senior research program manager of CIMSS, and currently Dr Allen Huang, the distinguished scientist of CIMSS. ITWG continues to organize International TOVS Study Conferences (ITSCs) which have met every 18-24 months since 1983. Through this forum, operational and research users of TIROS Operational Vertical Sounder (TOVS) data from the NOAA series of polar orbiting satellites and other satellite atmospheric sounding data have exchanged information on methods for extracting information from these data on atmospheric temperature and moisture fields and on the impact of these data in numerical weather prediction and in climate studies. They have also prepared recommendations to guide the directions of future research and to influence relevant programs of WMO and other agencies (NASA, NESDIS, EUMETSAT, NSMC).

There is no doubt to me that the University of Wisconsin based CIMSS will continue to play key roles in using the global observation system, and contribute to serving human society's needs for weather and environmental information, understanding global changes, and providing critical support for international weather, climate and environment community.

Yours sincerely,

W. Zhang

(W. Zhang)
Director
Observing and Information Systems Department

Appendix C: UW-CIMSS Personnel Summary

(137 Associates) February 2010

CIMSS ADMINISTRATION AND TECHNICAL SUPPORT (4):	Steve Ackerman	Director
	Tom Achtor	Executive Director
	Maria Vasys	University Services Associate
	Leanne Avila	Editor/Webmaster

UNIVERSITY PRINCIPAL INVESTIGATORS: (22)

(Steve Ackerman	Professor, AOS	Clouds / Aerosols)
(Tom Achtor	Exec. Director	McIDAS-V)
Bryan Baum	Associate Scientist	Cloud Microphysics
Ralf Bennartz	Professor, AOS	Microwave / Radiative Transfer
Wayne Feltz	Assistant Scientist	Aviation Weather
Tom Greenwald	Associate Scientist	Microwave / Data Assimilation
Liam Gumley	Instrument Innovator	Direct Broadcast and Data Analysis
Bob Holz	Assistant Scientist	JPSS / Lidar
Allen Huang	Distinguished Scientist	Retrieval Science / Hyperspectral
Bormin Huang	Assistant Scientist	Data Compression / Retrieval Science
Bob Knuteson	Associate Scientist	Hyperspectral Instruments / Data Analysis
Matthew Lazarra	Assistant Scientist	Antarctic Research
Jun Li	Senior Scientist	Retrieval Science / Hyperspectral
Paul Menzel	Senior Scientist	Clouds and Climate / Instrumentation
Ralph Petersen	Senior Scientist	NWP / Nowcasting
Grant Petty	Professor, AOS	Microwave / Rainfall
Elaine Prins	Contracting Scientist	Biomass Burning / Aerosols
Hank Revercomb	Senior Scientist	Hyperspectral Instruments/Data Analysis
Dave Santek	Assistant Scientist	Polar Winds / Data Assimilation
Chris Schmidt	Senior Researcher	Biomass Burning
Bill Smith Sr.	Senior Scientist	Hyperspectral Instruments/Data Analysis
Dave Tobin	Associate Scientist	Radiative Transfer
Dave Turner	Professor, AOS	AERI instrument and science
Chris Velden	Senior Scientist	Satellite Winds / Tropical Cyclones

NOAA SCIENTISTS: (9)	Jeff Key	ASPB Team Leader
	Robert Aune	ASPB
	Andrew Heidinger	ASPB
	Mike Pavolonis	ASPB
	Brad Pierce	ASPB
	Tim Schmit	ASPB
	Gary Wade	ASPB
	Jim Kossin	NCDC
	Robert Rabin	NSSL

UNIVERSITY SCIENTIFIC AND PROGRAMMING STAFF (59)	Paolo Antonelli	Researcher
	Scott Bachmeier	Researcher
	Kaba Bah	Assistant Researcher
	Eva Borbas	Assistant Scientist
	Lori Borg	Assistant Researcher

UNIVERSITY SCIENTIFIC AND PROGRAMMING STAFF (continued)

Jason Brunner	Associate Researcher
Corey Calvert	Associate Researcher
Lee Cronce	Assistant Researcher
Geoff Cureton	Asst. Instrument Innovator
Jim Davies	Assistant Researcher
Ralph Dedecker	Asst. Instrument Innovator
George Diak	Emeritus Scientist
Dan DeSlover	Researcher
Rich Dworak	Assistant Researcher
Joleen Feltz	Assistant Researcher
Bruce Flynn	Instrument Technician
Michael Foster	Assistant Researcher
Richard Frey	Researcher
Ray Garcia	Instrument Innovator
Mat Gunshor	Associate Researcher
Dan Hartung	Research Intern
Pat Heck	Researcher
Jay Hoffman	Assistant Researcher
Ben Howell	Emeritus Scientist
Tommy Jasmin	Sr. Systems Programmer
Xin Jin	Assistant Researcher
Yong-Keun Lee	Assistant Researcher
Allen Lenzen	Sr. Instrumentation Tech
Jinlong Li	Associate Researcher
Scott Lindstrom	Sr. Instrumentation Tech
Yinghui Liu	Assistant Researcher
Graeme Martin	Instrument Technician
Szu-Chia Moeller	Assistant Researcher
Chris Moeller	Researcher
Christine Molling	Associate Researcher
Margaret Mooney	Sr. Outreach Specialist
Leslie Moy	Researcher
Fred Nagle	Researcher
Jim Nelson	Researcher
Tim Olander	Researcher
Erik Olson	Associate Researcher
Jason Otkin	Associate Researcher
Andrew Parker	Assistant Researcher
Youri Plokhenko	Researcher
Greg Quinn	Instrument Technician
Tom Rink	Sr. Instrumentation Tech
Chris Rozoff	Assistant Researcher
Todd Schaack	Researcher
Eva Schiffer	Instrument Technician
Tony Schreiner	Researcher
Justin Sieglaff	Assistant Researcher
Dave Stettner	Associate Researcher
Kathy Strabala	Researcher
William Straka	Assistant Researcher
Xuanji Wang	Associate Researcher

	Steve Wanzong	Associate Researcher
	Elisabeth Weisz	Associate Researcher
	Tom Whittaker	Researcher
	Hong Zhang	Researcher
POST DOCTORS: (4)	Zhenglong Li	Research Associate
	Colleen Mouw	Research Associate
	Min Oo	Research Associate
	Andi Walther	Research Associate
STAFF AT OTHER SITES: (4)	Howard Berger	Iowa/Associate Researcher
	Derrick Herndon	AFWA/Research Specialist
	Jim Jung	NCEP/Assistant Scientist
	Tony Wimmers	U.Calgary/Associate Researcher
VISITING SCIENTISTS (8)	Giuseppe Baldassarre	Italy
	Burcu Kabatas	Turkey
	Jarno Mielikainen	Finland
	Johannes Nielsen	Denmark
	HyunJong Oh	Korea
	Xiaojing Quan	China
	Nadia Smith	South Africa
	Zhigang Yao	China
CONTRACTING COLLABORATORS (2)		
	Sebastian Berthier	France
	Elaine Prins	Grass Valley, CA

GRADUATE STUDENTS: (22)

Student	Degree	Science Advisor	Academic Advisor
Jordan Gerth	M.S.	Ackerman	Ackerman
Na-Young Kim	Ph.D.	Bennartz	Bennartz
Utkan Kolat	M.S.	Menzel	Ackerman
Ralph Kuehn	Ph.D.	Ackerman	Ackerman
Mark Kulie	Ph.D.	Bennartz	Bennartz
Agnes Lim	Ph.D.	A. Huang	Ackerman
Chian-Yi Liu	Ph.D.	Jun Li	Ackerman
Brent Maddux	Ph.D.	Ackerman	Ackerman
Aronne Merrelli	M.S.	Turner	Ackerman
Sarah Monette	M.S.	W. Feltz	Ackerman
Kathryn Mozer	M.S.	Heidinger	Ackerman
Chan-Hwang Park	Ph.D.	Bennartz	Bennartz
Michael Pavolonis	Ph.D.	Heidinger	Ackerman
John Rausch	M.S.	Bennartz	Bennartz
Ilya Razenkov	M.S.	Eloranta	Ackerman
John Sears	M.S.	Velden	Ackerman
Matthew Sitkowski	Ph.D.	Kossin	Ackerman
Mark Smalley	Ph.D.	Holz	Ackerman
William Smith, Jr.	Ph.D.	Ackerman	Ackerman
Kenneth Vinson	M.S.	Ackerman	Ackerman

Erin Wagner	Ph.D.	Turner	Ackerman
Tim Wagner	Ph.D.	Turner	Ackerman

UNDERGRADUATE STUDENT EMPLOYEES (3)	Megan Evansen Daniel Pasowitz Luke Schiferl

Appendix D: Curriculum Vitae

Steven A. Ackerman, Principle Investigator
Curriculum Vitae
Current and Pending Support

Curricula Vitae for Co-Investigators (alphabetically):

Thomas Achtor

Ralf Bennartz

Wayne Feltz

Allen Huang

Jun Li

Paul Menzel

David Turner

Chris Velden

Prof. Steven A. Ackerman

Department of Atmospheric and Oceanic Sciences
University of Wisconsin-Madison
1225 West Dayton Street
Madison, WI 53706
608-263-3647 stevea@ssec.wisc.edu

Employment

1999-Present	Director, Cooperative Institute for Meteorological Satellite Studies
1992-Present	Professor, Department of Atmospheric and Oceanic Sciences University of Wisconsin-Madison
1989-1992	Assistant Scientist Cooperative Institute for Meteorological Satellite Studies
1987-1989	Associate Researcher Cooperative Institute for Meteorological Satellite Studies
1985-1987	Graduate Research Assistant (Ph.D) Colorado State University
1979-1985	Research Associate Colorado State University
1976-1979	Graduate Research Assistant (M.S.) Colorado State University

Academic Education

1985-1987	Colorado State University Ph.D. - Atmospheric Science Advisor: Dr. Stephen K. Cox Dissertation: "Radiative Characteristics of a Dust Laden Atmosphere"
1976-1979	Colorado State University M.S. - Atmospheric Science Advisor: Dr. Stephen K. Cox Thesis: "GATE Phase III Mean Synoptic-Scale Radiative Convergence Profiles"
1972-1976	State University of New York - Oneonta B.S. – Physics; Minor: Mathematics Graduated Cum Laude

Recent Awards

- June 2009: Statue University of New York at Oneonta: Distinguished Alumnus Award
- Jan 2009:American Meteorological Society's Teaching Excellence Award
- 2005: Dorothy Howard Prize for Folklore and Education for the website and project Wisconsin Weather Stories, Folklore and Education Section of the American Folklore Society
- Summer 2004: UW-Madison Vilas Research Associate
- Spring 2003: Winner of the Society of Academic Author's Talby prize to "recognize excellence in visuals in textbooks and other learning materials."
- Summer 2003: NASA Group Achievement Award for Outstanding Teamwork on the Earth Observing System (EOS), Aqua Mission Team
- April 1999: Chancellor's Award for Distinguished Teaching

Books and Popular Science Articles

Pryor, A., D. Kemtz, R. Olson, and S. Ackerman, 2009: Here at Home: Learning Local Culture Pedagogy through a Cultural Tour. In A View From Practice: Folklife Resources and K-12 Schooling, published by Utah State University Press - Edited by S. Swidler and P Bowman. In Press

Ackerman, S. A., 2008: Weather from Space, Extreme Weather, Astronomy magazine Kalmbach Publishing Co.

Ackerman, S. A., 2007: Developing Positive Team Collaborations. BAMS, 627-629.

Ackerman, S.A. and J.A. Knox, 2002: Meteorology: Understanding the atmosphere. Pacific Grove, CA: Brooks/Cole-Thomson Learning. xxiii, 486p. (2nd edition published in 2006)

Ackerman, S.A. and R. Pincus, 2003: "Radiation in the Atmosphere: Observations and Applications," In Handbook of Weather, Climate and Water, edited by Thomas D. Potter and Bradley R. Colman. Hoboken, NJ: John Wiley and Sons, Inc.

Pincus, R. and S.A. Ackerman, 2003: "Radiation in the Atmosphere: Foundations," In Handbook of Weather, Climate and Water, edited by Thomas D. Potter and Bradley R. Colman. Hoboken, NJ: John Wiley and Sons, Inc.

Recent Publications in Refereed Journals

Maddux, B. C., S. A. Ackerman, S. E. Platnick, 2009: Viewing Geometry Dependencies in MODIS Cloud Products Submitted to JTEC.

Crone, W. C., S. L. Dunwoody, R. K. Rediske, S.A. Ackerman, G.M. Zenner Petersen, and R. Yaros, 2010: Informal Science Education: A Practicum for Graduate Students. Submitted to International Journal of Science Education.

Liu, Y., S. A. Ackerman, B. C. Maddux, J. R. Key and R. A. Frey, 2010: Errors in Cloud Detection Over the Arctic and Implications for Observing Feedback Mechanisms, Accepted for publication in the Jour Climate.

Schmit, T. J., L. Jun, S. A. Ackerman and J. J. Gurka, 2009: High-Spectral and High-spectral Temporal Resolution Infrared Measurements from Geostationary Orbit. JTECH, 26, 2273-2292

Cheetam, J., Ackerman, S. A., C. Christoph and, 2009: Podcasting: a Stepping Stone to Pedagogical Innovation. Educause Quarterly; the on-line article can be found at http://engage.doit.wisc.edu/edu_podcasting/.

Sieglaff, J. M., T. J. Schmit, W. P. Menzel and S. A. Ackerman, 2009: Inferring Convective Weather Characteristics with Geostationary High-spectral Resolution IR Window Measurements: A Look into the Future, JTECH, DOI:10.1175/2009JTECHA1210.1, pp 1527-1541.

Ackerman, S. A., J. Phillips, D. Bull and T. Achtor, 2009: Using a Publication Analysis to Explore Mission Success. Bull. Amer. Met. Soc. 90, 1313-1320.

Feltz, W. F., K. M. Bedka, J. A. Otkin, T. Greenwald, and S. A. Ackerman, 2009: Understanding Satellite-Observed Mountain Wave Signatures Using High-Resolution Numerical Model Data. Wea. Forecasting. 24, 76-86.

Crone, W. C., R. K. Rediske, S. A. Ackerman, S. L. Dunwoody, 2009: Engaging Science and Engineering Graduate Students with Informal Science Education. American Society for Engineering Education. Extended abstracts of 116th Annual conference and Exposition, June 13-17, Austin, TX.

Liu, C-Y, J. Li, E. Weisz,. T. J. Schmit, S. A. Ackerman, and H-L Huang, 2008: Synergistic use of AIRS and MODIS radiance measurements for atmospheric profiling. GRL, 35, L21802, doi:10.1029/2008GL035859.

Wagner, T. J., W. F. Feltz, and S. A. Ackerman, 2008: The Temporal Evolution of Convective Indices in Storm-Producing Environments, Wea. Forecasting. 23, 786- 794.

Holz, R.E. S. A. Ackerman, F.W. Nagle, R. Frey, R.E. Kuehn, S. Dutcher, M. A. Vaughan and B. Baum., 2008: Global MODIS Cloud Detection and Height Evaluation Using CALIOP. J. Geophys. Res., doi:10.1029/2008JD009837.

Ackerman, S. A., A. J. Schreiner, T. J. Schmit, H. M. Woolf, J. Li, and M. Pavolonis, 2008 Using the GOES Sounder to Monitor Upper-level SO_2 from Volcanic Eruptions. Jour. Geophys. Res. 113, 2008, Doi:10.1029/2007JD009622.

Frey, R. A., S. A. Ackerman, Y. Liu, K. I. Strabala, H. Zhang, J. Key and X. Wang, 2008: Cloud Detection with MODIS, Part I: Recent Improvements in the MODIS Cloud Mask, JTECH 25, 1057-1072.

Ackerman, S. A., R. E. Holz, R. Frey, E. W. Eloranta, B. Maddux, and M. McGill, 2008: Cloud Detection with MODIS: Part II Validation, JTECH.25, 1073-1086

Li, Z, J. Li, W. P. Menzel, T. J. Schmit, J. P. Nelson III, J. Daniels and S. A. Ackerman, 2008 GOES sounding improvement and applications to severe storm nowcasting, GRL, 35, L03806, doi:10.1029/2007GL032797

Brunner, J. C., S. A. Ackerman, A. S. Bachmeier, and R. M. Rabin, 2007: A Quantitative Analysis of the Enhanced-V Feature in Relation to Severe Weather. Wea. Forecasting, 22, No. 4, 853–872.

Schreiner, A. J., S. A. Ackerman, B. A. Baum, A. K. Heidinger, 2007: A Multi-Spectral Technique for Detecting Low Level Cloudiness Near Sunrise. JTECH, 24, 10, 1800-1810.

Li, Z., J. Li, W. P. Menzel, T. J. Schmit, and S. A. Ackerman, 2007: Comparison between current and future environmental satellite imagers on cloud classification using MODIS. Remote Sensing of Environment. 108, 311-326.

STATEMENT OF CURRENT SUPPORT
PI - Steven A. Ackerman

Supporting Agency	Project Title	Award	Period	*Committed	Location
NOAA	COOPERATIVE INSTITUTE FOR METEOROLOGICAL SATELLITE STUDIES (CIMSS)	$32,582,166	1/1/06-6/30/11	5.8	UW-Madison
NASA	Comparison of A-Train Cloud Retrievals and Multi-Instrument Algorithm Studies	$513,924	8/15/07-8/14/10	1.7	UW-Madison
NOAA	Towards a Consensus AVHRR Reflectance Calibration	$209,999	8/1/07-7/31/10	0	UW-Madison
NASA	Analysis of Long-Term Fire Dynamics and Impacts In The Amazon Using Integrated Multi-Source Fire Observations	$225,031	4/1/06-3/31/09	0	UW-Madison
NASA	Algoirthm Maintenance and Validation of MODIS Cloud Mask, Cloud Top-Pressure, Cloud Phase and Atmosperic Sounding Algorithms	$1,050,000	1/15/08-1/14/11	5.3	UW-Madison
NOAA	CIMSS Studies to Support NCDC Climate Data Stewardship Objectives	$230,434	3/1/08-1/31/10	0.7	UW-Madison
NSF	Climate Change Awareness for all Educators	$30,000	9/1/08-2/28/10	0.2	UW-Madison
NASA	Suomi-Simpson Graduate Fellowship FY10-12	$50,000	7/7/09-7/6/12	0	UW-Madison
NASA	Climate Literacy Ambassadors	$436,718	2/1/10-1/31/13	2.2	UW-Madison
NASA	Develop Climate Change Applet for Web-Based Learning	$14,991	10/1/09-2/28/10	0	UW-Madison
NASA	Evaluation of CloudSat Liquid Water Content Products using AMSR-E and MODIS Cloud Products and Supporting the 2009 CALIPSO and CloudSat Workshop	$72,819	5/1/09-2/28/10	0	UW-Madison

STATEMENT OF PENDING SUPPORT
PI - Steven A. Ackerman

Supporting Agency	Project Title	Award	Period	*Committed	Location
NASA	Planetary Boundary Layer Height Studies with CALIOP	$697,956	6/1/10-5/31/13	6.0	UW-Madison
NASA	Students and Teachers Using Data from Investigations in Earth Systems Studies	$151,406	1/6/10-1/5/13	2.8	UW-Madison

*Represents Person Months for the Period Covered.
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Feb-10

Thomas Harold Achtor

Space Science and Engineering Center
University of Wisconsin-Madison
1225 West Dayton Street
Madison, WI USA 53706
608-263-4206
tom.achtor@ssec.wisc.edu

Education:
M. S., University of Wisconsin-Madison, 1981; Major: Atmospheric Science, Thesis Title, "The Role of the Upper Tropospheric Jet Streak, 850 mb Winds and Static Stability in Springtime Colorado Cyclogenesis"

B.A., University of Wisconsin-Milwaukee, 1971 Major: History, Minor: Anthropology

Professional Experience:
1999 to present: Executive Director-Science, Space Science and Engineering Center (SSEC) and Cooperative Institute for Meteorological Satellite Studies (CIMSS), University of Wisconsin-Madison (UW-Madison)

1995-present: Associate Director for Research, Wisconsin Space Grant Consortium

2002-2007: Co-chairman (elected) of the International TOVS Working Group (ITWG), International Radiation Commission (IRC)

1984-1999: Senior Research Program Manager, Cooperative Institute for Meteorological Satellite Studies (CIMSS), Space Science and Engineering Center (SSEC), University of Wisconsin-Madison (UW-Madison)

1981 to 1984: Research Specialist, SSEC/CIMSS/UW-Madison

1979-1981: Research Associate/Teaching Assistant, UW-Madison Dept. of Meteorology

Current Proposal Support:
Principal Investigator:
SSEC Support to the Unidata Program
90,000 per year
Unidata Project Office, Boulder, CO

Task Leader/Co-Investigator:
McIDAS-V Development for GOES-R AWG and Risk Reduction
$300,000 per year
NOAA/NESDIS

Task Leader/Co-Investigator:
McIDAS-V Development for NPP/NPOESS
$100,000 per year
Integrated Programs Office (IPO)

Co-Investigator:
Support for CIMSS Base Activities
PI: S. Ackerman, Co-I: T. Achtor
NOAA, 1 year, $280,000

Lecturing/Teaching Activities:
Beijing, China, 1991: Two week course sponsored by United Nations in remote sensing and satellite meteorology to Pacific rim operational forecasters.

Dhaka, Bangladesh, 1988: Follow up course instructing South Asia meteorologists in remote sensing and satellite meteorology.

Dhaka, Bangladesh, 1985: USAID program instructing Bangladeshi meteorologists in remote sensing and satellite meteorology.

Field Experiment Participation:
IHOP: Oklahoma, May 2002
ACARS Water Vapor Validation: September 1999
Pre-STORM, Seneca, KS, February 1993
TOGA COARE: March 1992
AERI Marine Experiment: Monterey, CA: November 1990
FIRE/SPECTRE, Coffeyville, KS, October 1985

Awards and Organizations:
NASA Group Achievement Award, The Agro-Climatic Environmental Monitoring Project, 1985

Professional Organizations:
American Meteorological Society
American Geophysical Union,

Ralf Bennartz Short CV

Present Appointment

June 2007 – current: Associate Professor at the Department of Atmospheric and Oceanic Sciences, University of Wisconsin - Madison.

Previous Appointments

- September 2002 – May 2007: Assistant Professor at the Department of Atmospheric and Oceanic Sciences, University of Wisconsin - Madison.
- January 2001 – August 2002: Assistant Professor at the Department of Physics and Astronomy, University of Kansas. Associate Scientist at Free University of Berlin, Institute for Space Sciences.
- June 1997 – December 2000: Research Scientist at the Institute for Space Sciences, Free University of Berlin, Germany.

University education

- May 1997. Ph.D. at the Free University of Berlin, Institute for Space Sciences. Subject: *Retrieval of rain, cloud, and humidity parameters from passive microwave data in coastal regions.* Supervisor: Prof. Dr. J. Fischer.
- April 1994. Diploma (equiv. M.S. degree) in Meteorology obtained at the University of Hamburg/Max-Planck-Institute für Meteorologie, Hamburg, Germany. Subject: *A simulation study on cloud/radiation interaction in stratocumulus clouds.* Supervisor: Prof. Dr. H. Graßl, Dr. A. Chlond.
- 1988-1990: Undergraduate studies in Atmospheric Sciences, University of Cologne, Germany.

Awards/Fellowships

- June 2008 – 2009: Visiting Faculty at MIT's Research Laboratory for Electronics.
- July 1998 – February 1999: DAAD ('German Academic Research Foundation') Research Fellowship at Purdue University, West-Lafayette, Indiana with Prof. Dr. Petty. Work on three-dimensional radiative transfer modeling.
- November 2000 – December 2000: European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) Visiting Scientist fellowship at the U.K. Met Office. Work on passive microwave remote sensing.
- September 1999 – December 1999: European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) Visiting Scientist fellowship at the Swedish Meteorological and Hydrological Institute (SMHI), Norrköping. Work on remote sensing of precipitation.

Student Mentorship - Graduate students

Amato Evan	(started fall 2007)	: PhD, co-advised with D. Vimont, finished April 2009
John Rausch	(started fall 2006)	: MS, finished May 2009
Lori Borg	(started fall 2003)	: MS, finished in Aug. 2006
Wei Zhou	(started fall 2005)	: non-thesis MS, finished Dec. 2007
Mark Kulie	(started fall 2004)	: PhD, passed preliminary examination Dec. 2006
Park Chang	(started fall 2006)	: PhD
John Rausch	(started fall 2006)	: PhD started August 2009

Student Mentorship – Postdoctoral Fellows and Research Scientists

M. Foster	(2008-present)	: Postdoctoral research associate
J. Vidot	(2005-2007)	: Postdoctoral research associate

C. O'Dell	(2004-2006)	: Postdoctoral research associate
J. Huang	(2002-2003)	: Postdoctoral research associate
M.-J. Kim	(2005)	: Postdoctoral research associate
R. Lindstrot	(2005-2006)	: Research scientist
M. Stengel	(2005-2006)	: Research scientist

Synergistic Activities

- Editor of the Journal of Applied Meteorology and Climatology (JAMC). 2006 – present.
- Co-chair and organizer of the 'Second International Workshop on Space-based Snowfall Measurements', March 31 – April 4, 2008, Steamboat Ski Village, CO.
- Member of various international scientific working groups and science teams, including the International Tyros Operational Vertical Sounder (TOVS) Working Group (ITWG), International Precipitation Working Group (IPWG), , member of MODIS sciences team.

Peer-reviewed publications (2009 only)

Bennartz, R. Ph. Lorenz, and D. Jacob, 2009: Validation of the regional coupled climate model BALTIMOS using passive microwave satellite data. Theoretical and Applied Climatology. DOI 10.1007/s00704-009-0178-x.

Boesche, E., P. Stamnes, and R. Bennartz, 2009: Aerosol Influence on Top-of-Atmosphere Polarization and Intensity in Near-Infrared Gaseous Absorption Bands. J. of Quantitative Spectroscopy and Radiative Transfer, 110, 3, 223-239.

Evan, A. T., D. J. Vimont, A. K. Heidinger, J. P. Kossin, R. Bennartz, 2009: The role of aerosols in the evolution of tropical North Atlantic Ocean temperature anomalies. Science, doi:10.1126/science.1167404.

Foster, M. J.; Ackerman, S. A.; Bennartz, R.; Heidinger, A. K.; Maddux, B. C. and Rossow, W. B. 2009: State of the Climate in 2008. Global cloudiness. Bulletin of the American Meteorological Society, Volume 90, Issue 8, 2007, S29-S30

Kulie, M. and R. Bennartz, 2009: Utilizing space-borne radars to retrieve dry snowfall from a global and regional perspective. J. Applied. Meteorology and Climatology. 48,12,2564-2580.

Lauer, A., Y. Wang, V. T. J. Phillips, C. S. McNaughton, R. Bennartz, and A. D. Clarke, 2009: Simulating marine boundary layer clouds over the eastern Pacific in a regional climate model with double-moment cloud microphysics, J. Geophys. Res., 114, D21205, doi:10.1029/2009JD012201.

Makkonen, R., Asmi, A., Korhonen, H., Kokkola, H., Järvenoja, S., Räisänen, P., Lehtinen, K. E. J., Laaksonen, A., Kerminen, V.-M., Järvinen, H., Lohmann, U., Bennartz, R., Feichter, J., and Kulmala, M., 2009: Sensitivity of aerosol concentrations and cloud properties to nucleation and secondary organic distribution in ECHAM5-HAM global circulation model, Atmos. Chem. Phys., 9, 1747-1766.

Qian, Y., D. Gong, J. Fan, L. R. Leung, R. Bennartz, D. Chen, and W. Wang, 2009: Heavy pollution suppresses light rain in China: Observations and modelling. J. Geophys. Research, doi:10.1029/2008JD011575.

Stengel, M., P. Unden, M. Lindskog, P. Dahlgren, N. Gustafsson, and R. Bennartz, 2009: 4D-Var assimilation of SEVIRI infrared radiances into the limited-area numerical weather prediction model HIRLAM. Quaterly Journal of the Royal Meteorological Society,135,645,2100-2109.

Storelvmo, T., U. Lohmann, and R. Bennartz, 2009: What governs the spread in shortwave forcings in the transient IPCC AR4 models?, *Geophys. Res. Lett.*, *36*, L01806, doi:10.1029/2008GL036069.

Vidot, J., R. Bennartz, C. W. O'Dell, R. Preusker, R. Lindstrot, and A. Heidinger, 2009: CO_2 retrieval over clouds from OCO: Model and error analysis. Journal of Atmospheric and Oceanic Technology, 26, 1090-1104.

Walther, A., M. Schroeder, J. Fischer, and R. Bennartz, 2009: Comparison of Precipitation in BALTIMOS and Radar Observations. Theoretical and Applied Climatology. DOI: 10.1007/s00704-009-0174-1.

Wood, R., M. Koehler, R. Bennartz, and C. W. O'Dell, 2009: The diurnal cycle of divergence over the global oceans. Quarterly Journal of the Royal Meteorological Society. Part B, Vol. 135, 1484-1493.

Wayne F. Feltz

Assistant Scientist
Cooperative Institute for Meteorological Satellite Studies
Space Science and Engineering Center
University of Wisconsin-Madison
1225 West Dayton Street
Madison, WI 53706

Phone: (608) 265-6583
E-mail: wayne.feltz@ssec.wisc.edu

Curriculum Vitae
January 2010

RESEARCH INTERESTS

- Using satellite observations to improve nowcasting/forecasting of aviation weather hazards such as turbulence, convection, winds, and volcanic ash
- Remote sensing of thermodynamic state using hyperspectral infrared radiances
- Validation of remotely sensed atmospheric state variables
- Understand impact of future satellite observations through simulation

ACADEMIC EDUCATION

- B.S., Earth Science, Mathematics, Northland College, Ashland, WI, May 1991
- M.S., Atmospheric Science, University of Wisconsin-Madison, May 2004

PROFESSIONAL EXPERIENCE

- Graduate Research Assistant, University of Wisconsin, Madison, WI, 1991-1994
- Space Science and Engineering Center, University of Wisconsin, Madison, WI, 1994-present
- GOES-R Aviation Algorithm Working Group Co-Chair

HONORS AND AWARDS

- *AMS Journal of Atmospheric and Oceanic Technology Editor 2009-present*
- *Academic Staff Executive Committee 2009-present*
- *AMS Committee on Radio Frequency Allocations 2009 -present*
- *Co-Chair AMS Satellite Conference, Phoenix, Arizona 2009*
- *Member of AMS Satellite Committee 2006-present*
- *NASA LaRC Paul Holloway Technology Transition Award 2008*
- *American Meteorological Society NPOESS Satellite Conference Invited Speaker 2008*
- *NASA Honors Group Achievement Award (ASAP) 2006*
- *NASA Earth Sciences Application Team Group Award 2005*
- *NASA Aviation Safety and Security Program Award 2005*
- *University of Wisconsin Committee on Academic Staff Issues Representative 2003-2009*
- *University of Wisconsin-Madison Lettau Award for "Thesis of the Year" April 1995*

PUBLICATIONS

Mr. Feltz has authored or coauthored over 30 peer reviewed scientific publications and are available at http://www.ssec.wisc.edu/~waynef including:

Feltz, W. F., W.L. Smith, R.O. Knuteson, H.E. Revercomb, H.M. Woolf, and H.B. Howell, 1998: Meteorological applications of temperature and water vapor retrievals from the ground-based atmospheric emitted radiance interferometer (AERI). *J. Appl. Meteor.,* **37**, 857-875.

Feltz, W. F. and J. R. Mecikalski, 2002: Monitoring High Temporal Resolution Convective Stability Indices Using the Ground-based Atmospheric Emitted Radiance Interferometer (AERI) During the 3 May 1999 Oklahoma/Kansas Tornado Outbreak. *Wea. Forecasting,* **17**, 445-455.

Feltz, W. F., D. Posselt, J. Mecikalski, G. S. Wade, and T. J. Schmit, 2003: Rapid Boundary Layer Water Vapor Transitions. *Bull. Amer. Meteor. Soc.*, **84**, 29-30.

Feltz, W. F., H. B. Howell, R. O. Knuteson, H. M. Woolf, and H E. Revercomb, 2003: Near Continuous Profiling of Temperature, Moisture, and Atmospheric Stability using the Atmospheric Emitted Radiance Interferometer (AERI). . *J. Appl. Meteor.,* **42**, 584-597.

Feltz, W. F., D.D. Turner, H.B. Howell, W.L. Smith, R.O. Knuteson, H.M. Woolf, R. Mahon, and T. Halter, 2005: Retrieving temperature and moisture profiles from AERI radiance observations: AERIPROF value added product technical description. DOE ARM Technical Report, TR-066, Available from http://www.arm.gov/publications/tech_reports/arm-tr-066.pdf

Feltz, W. F., K. M. Bedka, J. Otkin, and S. A. Ackerman, 2009: Understanding Satellite-Observed Mountain Wave Turbulence Signatures Using High-Resolution Numerical Model Data. Accepted for publication to J. of *Wea And Forecasting, **24**, No. 1.*

CURRENT RESEARCH

- **Principal Investigator:** “Advanced Satellite Aviation-weather Product (ASAP)” Program, funded by NASA LaRC, (2003 -), http://cimss.ssec.wisc.edu/asap/
- **Principal Investigator and Co-Chair:** GOES-R Aviation Algorithm Working Group funded by NOAA, (2007 -), http://cimss.ssec.wisc.edu/goes_r/awg/
- **Principal Investigator:** Aviation GIMPAP, funded by NOAA (2007 -)
- **Principal Investigator:** GOES-R Proving Ground, funded by NOAA (2009-)
- **Principal Investigator: Decision Support Systems:** Global Atmospheric Turbulence Decision Support System for Aviation, NASA (2008 -)
- **Principal Investigator:** Ground Systems funded by NOAA (2008 -)
- **Co-Investigator:** NOAA WVSS-II Validation funded by NOAA, (2005 -)
- **Co-Investigator:** GOES-R Proving Ground funded by NOAA (2008 -)
- **Program Manager:** Overall SSEC/CIMSS GOES-R AWG activities (2007 -)
- **More information at: http://www.ssec.wisc.edu/~waynef/**

FIELD EXPERIMENT PARTICIPATION

⇒ Participant in STORM-FEST experiment, Coffeeville, KS, 1992
⇒ Participant in Point Mugu Refractivity Experiment, Pt Mugu, CA, 1993
⇒ Participant in OTIS, Oceanic Temperature Interferometric Survey, Gulf of Mexico, January 1995
⇒ Participant in CAMEX 2, 3, Convection and Atmospheric Moisture Experiment, Wallops Island, Andros Island, September, 1995, September, 1998
⇒ Participant in numerous SGP CART field campaigns, Southern Great Plains Cloud And Radiation Testbed for Atmospheric Radiation Measurement (ARM) program, Lamont, Oklahoma1995-2000
⇒ Participant in WINCE Experiment, Madison, WI 1997
⇒ Participant in WINTEX Experiment, Madison, WI, 1999
⇒ Participant in WVSS Water Vapor Sensing System Validation Experiment, 1999
⇒ Participant in IHOP International H2O Experiment, Oklahoma Panhandle, 2002
⇒ Co-I participant in WVSS-II Water Vapor Sensing System Validation Experiment, Louisville, KY, 2005, 2006
⇒ PI participant in TAVE TAMDAR Validation Experiment, Memphis, TN, 2005
⇒ Participant in GIFTS EDU checkout experiment, Logan, UT, 2006
⇒ Water Vapor Sensing System – II Validation Participation 2009-2010

CURRENT STUDENTS (SCIENTIFIC ADVISOR)

- Sarah Monette – M.S.; Remotely sensed satellite turbulence signatures 2009 - present

FORMER STUDENT (SCIENTIFIC ADVISOR)

- Nathan Uhlenbrock – M.S.; Remotely sensed satellite turbulence signatures 2004-2006
- Mike Richards – M.S.; Determination of volcanic ash plume altitude using infrared satellite data 2004-2006
- Timothy Wagner – M.S.; AERI thermodynamic profiling applications 2004-2008

Curriculum Vitae *Hung-Lung Allen Huang, Ph. D.*

Name: Hung-Lung Allen Huang
Updated: February 2010
Office address:
Cooperative Institute for Meteorological Satellite Studies (CIMSS)
Space Science and Engineering Center (SSEC)
University of Wisconsin-Madison (UW-Madison)
1225 West Dayton Street
Madison, Wisconsin 53706
Ph: 608-263-5283
E-mail: allenh@ssec.wisc.edu
Web Page: http://www.ssec.wisc.edu/~allenh/

Experience/Expertise:

Dr. Hung-Lung Huang, also known as **Allen Huang,** is a **distinguished scientist** of the **University of Wisconsin-Madison** and a **fellow** of International Society for Optical Engineering (**SPIE**). A **Member** of Space Studies Board Committee on Earth Studies, **The National Academies** and **Adjunct professor** of many universities**.** Dr Huang received his M.S. and Ph.D. degrees from the Meteorology Department of the University of Wisconsin, Madison in 1986 and 1989, respectively.

Since 1989, Dr. Huang has been with the Cooperative Institute for Meteorological Satellite Studies (CIMSS) of University of Wisconsin-Madison as a research scientist, conducting remote sensing research in the areas of atmospheric sounding retrieval, information content analysis, satellite and aircraft high-spectral resolution sounding instrument data processing, data compression, instrument design and performance analysis, cloud-clearing, cloud property characterization, synergistic imaging, and sounding data processing and algorithm development. He also advises and supports both national and international M.S. and Ph.D. students and visiting scientists.

Current Positions, Academic, committee, and Board Appointments:

- **Committee member** of Space Studies Board Committee on Earth Studies, The National Academies – Since February 2008.
- **Fellow** of International Society for Optical Engineering (SPIE) – Since December 2007
- **Distinguished scientist** of UW-Madison – since 1 September 2006
- **Permanent Principal Investigator** (PI) of University of Wisconsin-Madison – since December 2007
- **Executive Committee member** of SPIE Optical Engineering + Applications 2008 Executive Committee
- **Science council member** of CIMSS - since 2002
- **Council member** of the Space Science and Engineering Center (SSEC) –since 2003
- Principal investigator of NASA funded International MODIS/AIRS Processing Package (IMAPP) project – since 1999
- Principal investigator of NOAA IPO International Polar Orbiter Processing

Package (IPOPP) – since 2005
- Program manager and lead scientist of algorithm development for NOAA GOES-R risk Reduction project – since 2003
- Principal investigator of NOAA GOES-R Algorithm Working Group program
- **Adjunct Member of the Graduate Faculty** at Texas A&M University, USA – since May 2007
- **Adjunct professor** of Lanzhou University, China – since May 2007
- **Adjunct professor** of Nanjing University of Information Science and Technology, China – since 2002
- **US director** of China-America Cooperative Remote Sensing Center, Nanjing, University of Information Science and Technology – since 2002
- **Guest chief scientist** of National Satellite Meteorological Center (NSMC) of China Meteorology Administration (CMA) – since 2004
- **Member of International Radiation Commission** (IRC) for the 2005 to 2008 term
- **Committee member** of Physical Sciences/Engineering Area Review Committee (ARC), University of Wisconsin-Madison for 2007 to 1010 term.
- **Chair and editor** of the SPIE Atmospheric and Environmental Remote Sensing Data Processing and Utilization annual conference and proceedings – since 2003
- **General chair** of Hyperspectral Imaging and Sounding of the Environment topical conference of Optical Society of America – 2004-2007
- **Co-chair** of International TOVS Working Group (ITWG) - since 2006
- **President** of Weather Or Knot, a scientific remote sensing consulting Wisconsin partnership company – since 1997
- **Managing member and principal scientist** of Hyper Sensing, LLC, a federal small business scientific consulting limited liability company – since 2002
- **Science member and consultant** for Northrop Grumman Space Technology's NPOESS project – 2001-2007
- **Technical Advisory Committee member** of NOAA GOES-R Risk reduction project – 2006-2008
- **Advisor of Technical Advisory Committee** of NOAA GOES-R Algorithm Working Group – since 2009

Memberships:
International Society for Optical Engineering (SPIE)
American Meteorological Society (AMS)
Optical Society of America (OSA)
International Radiation Commission (IRC)

Peer-Reviewed Publications (57):
http://www.ssec.wisc.edu/~allenh/publications.html

Other Publications/Gray Literature (223):
http://www.ssec.wisc.edu/~allenh/publications.html

Curriculum Vitae – Jun Li

Jun Li, Senior Scientist, CIMSS/SSEC/UW-Madison, 1225 West Dayton Street, Madison, WI 53706. Tel: (608) 262-3755; Fax: (608) 262-5974; E-mail: Jun.Li@ssec.wisc.edu; http://www.ssec.wisc.edu/~jli

Education:

Ph.D. in Atmospheric Science, Institute of Atmospheric Physics, Chinese Academy of Sciences, 1996. M.S. in Meteorology, Institute of Atmospheric Physics, Chinese Academy of Sciences, 1990. B.S. in Mathematics, Peking University, 1987.

Professional experience

Dr. Li has done significant research on advanced infrared (IR) sounder and imager data processing, especially on the synergistic use of high spatial resolution imager (MODIS) and high spectral resolution sounder (AIRS) data for extracting atmospheric and cloud parameters. He also developed algorithms and software for International ATOVS Processing Package (IAPP), operational MODIS total ozone and precipitable water products (MOD07/MYD07), and the GOES Sounder product generation. Dr. Jun Li also has many years of experience on hyperspectral algorithm development for instruments such as NASTI, AIRS, IASI and CrIS. Dr. Li also has very good experience on advanced imaging and sounding instrument trade studies for future GOES and the application of advanced satellite sounding measurements on high impact weather forecasting and nowcasting. He has authored and co-authored more than 70 papers in peer-reviewed journals.

2008 – Present, Senior Scientist, CIMSS, University of Wisconsin-Madison
2002 – 2008, Associate Scientist, CIMSS, University of Wisconsin-Madison
2000 – 2002, Assistant Scientist, CIMSS, University of Wisconsin-Madison
1997 – 2000, Associate Researcher, CIMSS, University of Wisconsin-Madison
1996 – 1997, Associate Researcher; Institute of Atmospheric Physics, Beijing, China
1993 – 1995, Visiting Scientist, CIMSS, University of Wisconsin-Madison.
1990 – 1993, Assistant Researcher, Institute of Atmospheric Physics, Beijing, China

Honors and Awards

(1) 2009 University of Wisconsin-Madison's NOAA-CIMSS Collaborative Award for developing NOAA's Strategic Satellite Plan to balance requirements, observation capabilities, and resources.
(2) 2007 Certificate of Appreciation by JPL/NASA in grateful recognition of contributions to the success of the AIRS project.
(3) 2003 Certificate of Recognition by NASA for the creative development of technically significant software which has been accepted and approved by NASA, entitled "Moderate Resolution Imaging Spectroradiometer (MODIS) Production Software – Atmospheric Profiles."
(4) 2002 U.S. National Space Club and National Oceanic and Atmospheric Administration's David Johnson award for his exceptional and unique contributions to the development of sounding retrieval algorithms for the nation's civil operational geostationary and polar-orbiting environmental satellites and leadership in defining the high-spectral resolution sounders for the next generation of satellites.
(5) 2000 International TOVS Study Conference (ITSC)'s first prize for poster "Further Development of International ATOVS Processing Package (IAPP)."
(6) 1997 Institute of Atmospheric Physics' Xue Du Feng Zheng Excellent Ph.D. Dissertation Award for his Ph.D. dissertation titled "Infrared remote sensing of atmosphere and its inverse problem studies".
(7) 1996 Beijing Meteorological Society's Excellent Academic Thesis Award for his paper "Simultaneous nonlinear retrieval of atmospheric temperature and absorbing constituent profiles

from satellite infrared sounder radiances" published in Advances in Atmospheric Sciences in 1994.
(8) 1996 China's Zhao Jiu Zhang Outstanding Young Scientist Award for his outstanding research on atmospheric infrared remote sensing.

Publications: Jun Li has authored/coauthored over 70 peer-reviewed scientific publications and some are available at http://www.ssec.wisc.edu/~jli, listed are selected recent publications within last three years.

Li, J., H. Liu, 2009: Improved Hurricane Track and Intensity Forecast Using Single Field-of-View Advanced IR Sounding Measurements, Geophysical Research Letters, 36, L11813, doi:10.1029/2009GL038285.
Schmit, T. J., **J. Li**, S. A. Ackerman, and J. J. Gurka, 2009: High spectral and temporal resolution infrared measurements from geostationary orbit, *Journal of Atmospheric and Oceanic Technology*, 26, 2273 - 2292.
Li, Z., **J. Li**, W. P. Menzel, et al., 2009: Forecasting and nowcasting improvement in cloudy regions with high temporal GOES Sounder infrared radiance measurements, *Journal of Geophysical Research*. - Atmospheres, 114, D09216, doi:10.1029/2008JD010596.
Jin, X., **J. Li**, T. J. Schmit, et al. 2008: Retrieving clear-sky atmospheric parameters from SEVIRI and ABI infrared radiances, J. Geophys. Res., 113, D15310, doi:10.1029/2008JD010040.
Li, J., and J. Li, 2008: Derivation of global hyperspectral resolution surface emissivity spectra from advanced infrared sounder radiance measurements, Geophys. Res. Lett., 35, L15807, doi:10.1029/2008GL034559.
Liu, C., **J. Li**, E. Weisz, et al., 2008: Synergistic Use of AIRS and MODIS Radiance Measurements for Atmospheric Profiling, Geophysical Research Letters, 35, L21802, doi:10.1029/2008GL035859.
Schmit, T. J., **J. Li**, J. J. Gurka, et al., 2008: The GOES-R ABI and the continuation of GOES-N class sounder products, J. of Appl. Meteorol. and Cli., 47, 2696 – 2711.
Li, Z., **J. Li**, W. P. Menzel, et al., 2008: GOES sounding improvement and applications to severe storm nowcasting, Geophys. Res. Lett., 35, L03806, doi:10.1029/2007GL032797.
Jin, X., **J. Li**, C. C. Schmidt, T. J. Schmit, and Jinlong Li, 2008: Retrieval of Total Column Ozone from Imagers onboard Geostationary Satellites, IEEE Transactions on Geoscience and Remote Sensing, 46, 479 - 488.
Li, J., Jinlong Li, Elisabeth Weize, and D. K. Zhou, 2007: Physical retrieval of surface emissivity spectrum from hyperspectral infrared radiances, Geophysical Research Letters. 34, L16812, doi:10.1029/2007GL030543.
Weisz, E., **J. Li**, Jinlong Li, et al., 2007: Cloudy sounding and cloud-top height retrieval from AIRS alone single field-of-view radiance measurements, Geophysical Research Letters, 34, L12802, doi:10.1029/2007GL030219.
Li, Jinlong, **J. Li**, Christopher Schmidt, James Nelson III, and Timothy Schmit, 2007: High Temporal Resolution GOES Sounder Single Field of View Ozone Improvements, Geophysical Research Letters, 34, L01804, doi:10.1029/2006GL028172.
Wang, F., **J. Li**, T. J. Schmit, and S. A. Ackerman, 2007: Trade studies of hyperspectral infrared sounder on geostationary satellite, Applied Optics, 46, 200 - 209.
Li, J., P. Zhang, T. J. Schmit, J. Schmetz, and W. P. Menzel, 2007: Quantitative monitoring of a Saharan dust event with SEVIRI on Meteosat-8, International Journal of Remote Sensing, 28, 2181 – 2186.
Li, Z., **J. Li**, T. J. Schmit, W. P. Menzel, 2007: Comparison between current and future environmental satellite imagers on cloud classification using MODIS, Remote Sensing of Environment, 108, 311 – 326.

WOLFGANG PAUL MENZEL

Education:

Ph.D	1974	University of Wisconsin - Madison (Theoretical Solid State Physics)
M.S	1968	University of Wisconsin - Madison
B.S.	1967	University of Maryland - College Park (with high honors, Omicron Delta Kappa, Phi Beta Kappa)

Experience:

* 2007 – present Verner Suomi Distinguished Professor at UW and Senior Scientist in SSEC

As Professor in Atmospheric and Oceanic Sciences and Senior Scientist in SSEC, I pursue research interests and teach classes in remote sensing of atmospheric temperature and moisture profiles, ozone, carbon dioxide, cloud properties, and surface properties.

* 1999 – 2007 Chief Scientist in NESDIS

As the Chief Scientist out of the Office of Research and Applications, I was responsible for providing guidance on science issues and initiating major science programs for the AA of NESDIS.

* 1999 – 2005 International Expert Team Chairman

As the chairman of the World Meteorological Organization Expert Team on Observational Data Requirements and Redesign of the Global Observing System, I lead 12 international experts in (a) reviewing observing system experiments indicating the relative contribution from various components, (b) recommending steps for the evolution of the surface and space-based components of the GOS and (c) reporting on how well the GOS is meeting user requirements in various applications areas and how the GOS performance can be improved.

* 1997 – 2000 Science Director of Cooperative Institute

As the Science Director of the Cooperative Institute for Meteorological Satellite Studies, I was responsible for the day to day scientific direction of the activities of the CIMSS personnel. This involved coordinating university research principal investigator proposals in response to government funding opportunities, assuring science progress on grants and contracts, fostering peer review publications, and evaluating individual performance. At that time, CIMSS housed about 70 personnel and required about $4 to 5M annual budget.

* 1989 - present Principal Investigator

As a member of the MODIS (Moderate resolution Imaging Spectrometer) science team, I am responsible for developing algorithms for the cloud mask, cloud properties, and atmospheric profiles. Early work included design, test, and application of the MODIS Airborne Simulator, a passive infrared radiometer flown on ER2 aircraft used to study cloud radiative properties (emissivity, height, temperature, phase) at 50 meter resolution. After launch of the EOS Terra and Aqua Platforms, the MAS experience was transferred to processing the MODIS 1 km resolution data routinely and studying the global cloud and moisture trends. To date the cloud top properties algorithm has been adjusted to account for calibration changes and cloud validation with CALIPSO. A continuous record of MODIS and HIRS (High resolution Infrared Sounder) cloud properties from 1978 onward is being established.

* 1986 - 2007 Adjunct Professor

Currently at the University of Wisconsin, I continue to teach graduate level courses in satellite remote sensing of the earth-atmosphere system covering atmospheric processes (emphasizing radiative transfer) and satellite applications. A textbook has been written. As adjunct professor in the Atmospheric and Oceanic Sciences Department, I have been advisor to over forty Masters and PhD students.

* 1983 – 1999 Team Leader

As Leader of the Advanced Satellite Products Team in the Office of Research and Applications of NOAA/NESDIS, I was responsible for developing, testing and evaluating procedures that show potential for derivation of new satellite products. This focused on transferring advances in the research laboratory to the operational weather forecast arena.

Selected Honors:

Haydn Williams Fellow at Curtin University, Perth, Australia in 1990
Transactions Prize Paper Award from the Geoscience and Remote Sensing Society in 1992
ARAD Trainer of the Year in 1997
Department of Commerce Bronze Medal in 1999 & 2001, Silver Medal in 1993, 1994, & 2007
American Meteorological Society Special Award in 1997, Fellow in 2007
EUMETSAT Special Award in 2007 for exemplary leadership in international collaborations

Selected Publications (from 105 peer review publications and 231 conference papers since 1974):

Joiner, J., A. P. Vasilkov, P. K. Bhartia, G. Wind, S. Platnick, and W. P. Menzel, 2010: Detection of multi-layer and vertically-extended clouds using A-train sensors, Atmos. Meas. Tech., **3**, 233-247.

Menzel, W. P. and Phillips, J. M., 2009: Satellite meteorology: How it all started, 50 years ago. Bull. Amer. Meteor. Soc., **90**, Issue 10, 1435-36.

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Menzel, W. P., R. A. Frey, H. Zhang, D. P. Wylie., C. C. Moeller, R. A. Holz, B. Maddux, B. A. Baum, K. I. Strabala, and L. E. Gumley, 2008: MODIS global cloud-top pressure and amount estimation: algorithm description and results. Jour of App Meteor and Clim., 47, 1175-1198.

Plokhenko, Y., W. P. Menzel, H. E. Revercomb, E. E. Borbas, P. Antonelli, E. Weisz, 2008: Analysis of multi spectral fields of satellite IR measurements: Using statistics of second spatial differential of spectral fields for measurement characterization. International Journal of Remote Sensing, **29**, 2105-2125, doi:10.1080/01431160701268988.

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Wylie, D. P., D. L. Jackson, W. P. Menzel, and J. J. Bates, 2005: Global Cloud Cover Trends Inferred from Two decades of HIRS Observations. Journal of Climate, **18**, 3021–3031.

Zapotocny, T. H., W. P. Menzel, J. A. Jung, and J. P. Nelson III, 2005: Four season impact study of rawinsonde, GOES and POES data in the Eta Data Assimilation System. Parts I and II: Wea. Forecasting, **20**, 161-177.

Menzel, W. P., 2000: Cloud tracking with satellite imagery: From the pioneering work of Ted Fujita to the present. Bull. Amer. Meteor. Soc., 82, 33 – 47.

Menzel, W. P., F. C. Holt, T. J. Schmit, R. M. Aune, A. J. Schreiner, G. S. Wade, G. P. Ellrod, and D. G. Gray, 1998: GOES-8/9 soundings in weather forecasting and nowcasting. Bull. Amer. Meteor. Soc., **79**, 2059-2077.

Menzel, W. P., W. L. Smith, and T. R. Stewart, 1983: Improved Cloud Motion Wind Vector and Altitude Assignment Using VAS. J. Appl. Met., Vol. 22, No. 3, 377-384.

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(a) Professional Preparation

University of Wisconsin, Madison, WI Atmospheric Sciences, Ph.D., 2003
  Thesis: *Microphysical Properties of Single and Mixed-Phase Arctic Clouds Derived From Ground-Based AERI Observations*
Eastern Washington University, Cheney, WA Mathematics, M.S., 1994
  Thesis: *Diagnosing Coronary Artery Disease with a Backpropagation Neural Network*
Eastern Washington University, Cheney, WA Mathematics, B.A., 1992

(b) Appointments

Aug 2009 – current:	Assistant Professor, Atmospheric and Oceanic Sciences Department, UW-Madison
Aug 2005 – Jul 2009:	Research Scientist, Space Science and Engineering Center, UW-Madison
Jun 2007 – Jul 2007:	Guest Professor, Institute for Geophysics and Meteorology, Univ. Cologne
Jul 2003 – Aug 2005:	Senior Research Scientist II, Climate Physics Group, Pacific Northwest National Laboratory (PNNL)
Sep 2000 – Jun 2003:	Research Assistant, University of Wisconsin – Madison
Sep 1998 – Aug 2000:	Senior Research Scientist I, Climate Physics Group, PNNL
Jul 1994 – Aug 1998:	Research Scientist, Information Sciences and Engineering Group, PNNL
Sep 1992 – Jun 1994:	Instructor, Mathematics Dept., Eastern Washington University

(c) Professional Activities

- Principal Investigator, DOE Atmospheric Radiation Measurement (ARM) Program, 2005 – present
- Chair, ARM Climate Research Facility Science Board, 2009 – present
- Chair, ARM Radiative Processes Working Group, 2007 – present
- Member, ARM Science and Infrastructure Steering Committee (SISC), 2007 – present
- ARM Raman Lidar Instrument Mentor, 2003 – present
- ARM AERI Instrument Mentor, 2006 – present
- Member, USGCRP Water Cycle Science Steering Group, 2006 – present
- Member, NSF Committee for the NCAR Facilities Assessment of Solar Measurements, 2006 – 2007
- Member, International Scientific Steering Committee for the Convective and Orographic Precipitation Study (COPS), 2006 – present
- General Chair, OSA Hyperspectral Imaging and Sounding of the Environment Topical Meeting, 2005
- Member, American Meteorological Society (AMS)
- Member, American Geophysical Union
- Member, AMS Committee on Laser Atmospheric Studies (CLAS), 2003 - 2006
- Associate Editor, AMS Journal of Atmospheric and Oceanic Technology, 2006 – present
- Developed a high-spectral-resolution radiative transfer model that includes scattering (LBLDIS), used by at least 25 users in 17 different institutions
- Field Campaign Leadership
  - Co-I, ARM Water Vapor Experiments (WVIOPs) in 1997, 1999, 2000
  - Co-I, ARM Mixed-Phase Arctic Cloud Experiment (M-PACE), 2004
  - Co-I, ARM Aerosol Lidar Validation Experiment (ALIVE), 2005
  - PI, PNNL Lexington-A Campaign to Investigate Solar Scattering and Emission in 3-5 μm band, 2005
  - PI, ARM Radiative Heating in Underexplored Bands Campaign (RHUBC-I), Feb-Mar 2007
  - Co-I, ARM Convective and Orographic Precipitation Study (COPS), Apr-Dec 2007
  - Co-I, ARM Indirect and Semi-Direct Aerosol Campaign (ISDAC), Apr 2008
  - Co-I, ARM Routine AVP CLOWD Optical Radiative Observations (RACORO), Jan-Jun 2009
  - PI, ARM Radiative Heating in Underexplored Bands Campaign (RHUBC-II), Aug-Oct 2009

(d) Selected Peer-Reviewed Publications

Delamere, J.S., S.A. Clough, D.D. Turner, E.J. Mlawer, V. Payne, and R. Gamache, 2009: A far-infrared radiative closure study in the Arctic: Application to water vapor. *J. Geophys. Res.*, submitted.

Turner, D.D., and E.J. Mlawer, 2009: Radiative heating in underexplored bands campaigns (RHUBC). *Bull. Amer. Meteor. Soc*., submitted.

Cimini, N., F. Nasir, E.R. Westwater, V.H. Payne, D.D. Turner, E.J. Mlawer, M.L. Exner, and M. Cadeddu, 2009: Comparison of ground-based millimeter-wave observations in the Arctic winter. *IEEE Trans. Geosci. Remote Sens.*, 47, 3098-3106, doi:10.1109/TGRS.2009.2020743.

Turner, D.D., U. Loehnert, M. Cadeddu, S. Crewell, and A. Vogelmann, 2009: Modifications to the water vapor continuum in the microwave suggested by ground-based 150 GHz observations. *IEEE Trans. Geosci. Remote Sens.*, 47, 3326-3337, doi:10.1109/TGRS.2009.202262.

Cadeddu, M.P., D.D. Turner, and J.C. Liljegren, 2009: A neural network for real-time retrievals of low amounts of PWV and LWP in the Arctic from millimeter-wave ground-based observations. *IEEE Trans. Geosci. Remote Sens.*, 47, 1887-1900, doi:10.1109/TGRS2009.2013205.

Löhnert, U., D.D. Turner, and S. Crewell, 2009: Ground-based temperature and humidity profiling using spectral infrared and microwave observations: Part 1. Retrieval performance in clear sky conditions. *J. Appl. Meteor. Clim.*, 48, 1017-1032, doi:10.1175/2008JAMC2060.1.

Cady-Pereira, K.E., M.W. Shephard, D.D. Turner, E.J. Mlawer, S.A. Clough, and T.J. Wagner, 2008: Improved daytime column-integrated precipitable water vapor from Vaisala radiosonde humidity sensors. *J. Atmos. Oceanic Technol.*, 25, 873-883, doi:10.1175/2007JTECHA1027.1.

Turner, D.D., S.A. Clough, J.C. Liljegren, E.E. Clothiaux, K. Cady-Pereira, and K.L. Gaustad, 2007: Retrieving liquid water path and precipitable water vapor from Atmospheric Radiation Measurement (ARM) microwave radiometers. *IEEE Trans. Geosci. Remote Sens.*, 45, 3680-3690, doi:10.1109/TGRS.2007.903703.

Turner, D.D., 2007: Improved ground-based liquid water path retrievals using a combined infrared and microwave approach. *J. Geophys. Res.*, 112, D15204, doi:10.1029/2007JD008530.

Tobin, D.C., P. Antonelli, H.E. Revercomb, S. Dutcher, D.D. Turner, J.K. Taylor, R.O. Knuteson, and K. Vinson, 2007: Hyperspectral data noise characterization using principle component analysis: Application to the Atmospheric Infrared Sounder. *J. Atmos. Remote Sens.*, 1, 013515, doi:10.1117/1.2757707.

Turner, D.D., R.O. Knuteson, H.E. Revercomb, C. Lo, and R.G. Dedecker, 2006: Noise reduction of Atmospheric Emitted Radiance Interferometer (AERI) observations using principal component analysis. *J. Atmos. Oceanic Technol.*, 23, 1223-1238.

Turner, D.D., D.C. Tobin, S.A. Clough, P.D. Brown, R.G. Ellingson, E.J. Mlawer, R.O. Knuteson, H.E. Revercomb, T.R. Shippert, and W.L. Smith, 2004: The QME AERI LBLRTM: A closure experiment for downwelling high spectral resolution infrared radiance. *J. Atmos. Sci.*, 61, 2657-2675.

Kratz, D.P., M.G. Mlynczak, C.J. Mertins, H. Brindley, L.L. Gordley, J. Martin-Torres, F.M. Miskolczi, and D.D. Turner, 2004: An inter-comparison of far-infrared line-by-line radiative transfer models. *J. Quant. Spect. Radiative Trans.*, 90, 323-341, doi:10.1016/j.jqsrt.2004.04.006.

Turner, D.D., S.A. Ackerman, B.A. Baum, H.E. Revercomb, and P. Yang, 2003: Cloud phase determination using ground-based AERI observations at SHEBA. *J. Appl. Meteor.*, 42, 701-715.

Revercomb, H.E., D.D. Turner, D.C. Tobin, R.O. Knuteson, W.F. Feltz, J. Barnard, J. Bosenberg, S. Clough, D. Cook, R. Ferrare, J. Goldsmith, S. Gutman, R. Halthore, B. Lesht, J. Liljegren, H. Linne, J. Michalsky, V. Morris, W. Porch, S. Richardson, B. Schmid, M. Splitt, T. Vanhove, E. Westwater, and D. Whiteman, 2003: The Atmospheric Radiation Measurement Program's water vapor intensive observation periods: overview, initial accomplishments, and future challenges. *Bull. Amer. Meteor. Soc.*, 84, 217-236.

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Abbreviated Curriculum Vitae
Christopher Velden

Current Position: University of Wisconsin – Space Science and Engineering Center Physical Sciences: Senior Scientist and Principal Investigator.

Chief Investigator for internationally-recognized UW-SSEC/CIMSS Tropical Cyclones Group and Satellite Winds Group

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M.S. - Dept. of Meteorology, Univ. of Wisconsin-Madison.
Topic: Tropical Cyclone Warm Core Evolution: NOAA Satellite Microwave Views. June, 1982.

B.S. - Univ. of Wisconsin-Stevens Point. Majors: Natural Sci., Geography (minor - physics). June, 1979.

Awards: AMS Fellow, 2008
OFCM Hagemeyer Award, 2003
AMS Banner Miller Award, 2001
AMS Special Award, 1998

Book Chapters:

C.S. Velden, J. Simpson, W. T. Liu, J. Hawkins, K. Brueske, and R. Anthes: *Chapter 11: The Burgeoning Role of Weather Satellites,* Hurricane! Coping with Disaster, American Geophysical Union Publication, Robert Simpson, Editor, 2003, 360 pp.

E. A. Ritchie, J. Simpson, W. T. Liu, J. Halverson, **C.S. Velden**, K. Brueske, and H. Pierce: *Chapter 12: Present Day Satellite Technology for Hurricane Research – A Closer Look at Formation and Intensification,* Hurricane! Coping with Disaster, American Geophysical Union Publication, Robert Simpson, Editor, 2003, 360 pp.

C.S. Velden: *Satellite Observations of Tropical Cyclones*, Global Perspectives on Tropical Cyclones: From Science to Mitigation**,** WMO New World Scientific Series on *Earth System Science,* C.P. Chang, Editor, in preparation.

Major Refereed Publications (last 3 years)

Velden, C.S and K. Bedka, 2009: Identifying the Uncertainty in Determining Satellite-Derived Atmospheric Motion Vector Height Assignments. To appear in J. Appl. Meteor.

Wimmers, A., and **C.S. Velden**, 2007: MIMIC: A new approach to visualizing satellite microwave imagery of tropical cyclones. Bull. Amer. Meteor. Soc., 88, 1187-1196.

Olander, T., and **C.S. Velden,** 2007: The Advanced Dvorak Technique (ADT) – Continued development of an objective scheme to estimate tropical cyclone intensity using geostationary infrared satellite imager. Wea. Forecasting, 22, 287-298.

Kossin, J. P., J. A. Knaff, H. I. Berger, D. C. Herndon, T. A. Cram, **C. S. Velden**, R. J. Murnane, and J. D. Hawkins, 2007: Estimating hurricane wind structure in the absence of aircraft reconnaissance. Wea. Forecasting, 22, 89-101.

Velden, C.S. et al., 2006: The Dvorak tropical cyclone intensity estimation technique: A satellite-based method that has endured for over 30 years. Bull. Amer. Meteor. Soc., 85, 353-385.

Evan, A., J. Dunion, J. Foley, A. Heidinger and **C.S. Velden,** 2006**:** New evidence for a relationship between Atlantic tropical cyclone activity and African dust outbreaks. *Geophys. Res. Lett.*, 33, L19813, doi: 10.1029/2006GL026408.

Velden, C.S. et al., 2005: Recent Innovations in Deriving Winds from Meteorological Satellites. Bull. Amer. Meteor. Soc., 86, 205-223.

Scientific Conference Papers since 1985 - ~200

Major Field and Professional Experience

Co-Chair (elected) 7th WMO International Workshop on Tropical Cyclones (2010)
Co-Chair, 2008 AMS Annual Meeting
Chair, AMS Committee on Satellite Meteorology (2004-2007)
THORPEX International Science Team (2002-Present)
National Academy of Sciences NPOESS/GOES-R Study for NOAA/NASA (2007-2008)
National Academy of Sciences Decadal Study for NASA (2005-2007)
National Academy of Sciences TRMM/GPM Study for NASA/NOAA (2002-2004)
National Academy of Sciences CONNTRO Committee (2000-2003)
Bulletin of the AMS Journal Subject Editor (2002-Present)
Co-Chair, WMO International Satellite Winds Working Group (1995-2008)
US Weather Research Project Science Steering Committee charter member (1996-1999)
Member AMS Committee on Satellite Meteorology (1997-2003)
Member AMS Committee on Tropical Meteorology and Tropical Cyclones (1990-1993)
Participant (PI or Co-I) in ~10 major atmospheric field programs since 1986
Visiting Scientist at the Australian Bureau of Meteorology (1987-1988)

Appendix E: Project List

Project Name	PI/PM	Agency
AVHRR Calibration	Straka	NOAA
Climate Data Stewardship	Ackerman	NOAA
HIRS Cloud Measurements	Menzel	NOAA
Thunder Tracker	Whittaker	NOAA
Secondary Eyewall	Rozoff	NOAA
CIMSS Base	Achtor	NOAA
GIMPAP Series	Ackerman	NOAA
IPO Heidinger & Key	Ackerman	NOAA
PSDI	Ackerman	NOAA
Ground Systems	Ackerman	NOAA
Data Assimilation Studies	Jung	NOAA
WV Field Experiment	Peterson	NOAA
VISIT	Bachmeier	NOAA
SHYMET	Bachmeier	NOAA
WindSat	Achtor	NOAA
GOES-R Support	Menzel	NOAA
Radiance Assimilation	Bernartz	NOAA
Hurricane Reanalysis	Kossin	NOAA
Calipso Cloud Heights	Holz	NOAA
International Polar Year Satellite Products	Wang, XJ	NOAA
STAR Cal/Val	Tobin	NOAA
MODIS Cloud Properties	Straka	NOAA
High Impact Weather	Li, Jun	NOAA
McIDAS Training	Achtor	NOAA
Snow & Ice CDRs	Wang, Xuanji	NOAA
GOES-R Risk Reduction	Ackerman	NOAA
GOES-R Proving Ground	Feltz, W	NOAA
GOES-R Algorithm Working Group	Huang, A	NOAA
IPO	Menzel	NOAA
IPOPP	Huang, A	NOAA
CrIS Validation	Tobin	NOAA
Ice Cloud Validation	Baum	NOAA
Cloud Validation	Holz	NOAA

Project Name	PI/PM	Agency
Climate Literacy Ambassadors	Mooney	NASA
CALIPSO-Ackerman	Holz	NASA
JPL Cloudsat/Calipso	Ackerman	NASA
Suomi-Simpson Fellowship FY10	Ackerman	NASA
MODIS Cloud Mask	Ackerman	NASA
NASA Climate Applet	Whittaker	NASA
Multi-Instrument Data Analysis	Holz	NASA
Cloud Products	Heck	NASA
NASA Aviation Weather	Feltz, W	NASA
Historical AVHRR Winds	Santek	NASA
Ice Cloud Bulk Optical Models	Baum	NASA
NPP Cloud Product Evaluation	Baum	NASA
NASA Marshall Collaboration	Huang, A	NASA
IMAPP	Strabala	NASA
Imager & Sounder Cloud Climatology	Menzel	NASA
NPP/PEATE	Gumley	NASA
NPP-VIIRS Science Team FY10	Moeller	NASA
Ice Tool	Whittaker	NASA
CIMSS Student Workshop	Mooney	NASA
Stratiform Boundary Layer Clouds	Bennartz	NASA
Pacific Tropical Cyclones	Velden	DOD
TC Intensity Forecasts	Velden	DOD
Naval Research Satellite Applications	Velden	DOD
NAVY Fires Research	Schmidt, C	DOD
Cloud modeling	Turner	DOE
ICECAPS	Turner	DOE
Radiative Heating in Unexplored Bands	Turner	DOE
DOE-Turner	Turner	DOE
ARM RL Aerosol Cloud Interaction	Turner	DOE
Raman Lidar Support	Turner	DOE
Aerosol-Cloud Microphysics	Bennartz	DOE
Climate Change Awareness	Ackerman	NSF
ARRA Atlantic TC Genesis	Velden	NSF
NSF Tropical Cyclones	Velden	NSF
Satellite-based Global Turbulence	Feltz, W	NCAR
LBA Fire/Satellite Comparison	Schmidt, C	University
Soils Funding	Molling	University
Agriculture Research	Molling	University
3D Globe for Outreach	Kohrs	University
Taiwan - CWB Winds	Huang, A	International
VISIT View - EUMETSAT	Whittaker	International
Radiative Transfer - EUMETSAT	Borbas	International
East China Air Quality	Huang, A	International

Appendix F: Collaborations

CIMSS Scientist	Collaborating Scientist(s)	Institute	Project Title
Kathy Strabala	Crystal Schaaf	Boston University	Preparing a MODIS Bidirectional Reflectance Distribution Function (BRDF) version for direct broadcast
Rich Frey	Thomas Kopp	Integrated Program Office	VIIRS Calibration/Validation Lead
Bormin Huang	Jarno Mielikainen	Kuopio University, Finland	Development of the GPU-based high-performance RTTOV radiative transfer model
Bormin Huang	Shih-Chieh Wei	Tamkang University, Taiwan	Satellite Data Compression
Tom Whittaker	Volker Gaertner, HansPeter Roesli	EUMETSAT	McIDAS-V Enhancements for EUMETSAT
Tom Whittaker	Volker Gaertner	EUMETSAT	VISITview modifications
Tom Whittaker	Bob Rabin	NSSL	ThunderTracker
Tom Whittaker	Jennifer Collins	University of South Florida	Applet for Hurricane Development
Tom Whittaker	Lin Chambers	NASA	Climate Change Applet for Web-Based Learning Activities
Tom Whittaker	Don Murray, et. al.	Unidata	McIDAS-V and Integrated Data Viewer development
Tom Whittaker	Bernadette Connell	CIRA	VISITview updates
Tom Whittaker	Claudia Gorski, et. al.	AMS	Planning for 2011 annual AMS meeting for IIPS conference
Tom Whittaker	Linda Miller	Unidata	Unidata Users Committee activities
Tom Whittaker	Galen McKinley	UW-Madison AOS	Climate Applet
Jun Li	Miguel A. Martinez	EUMETSAT SAFNWC, Madrid, Spain	Clear sky nowcasting product from next generation geostationary satellite measurements
Jun Li	Chaohua Dong	National Satellite Meteorological Center, Beijing, China	Cloud mask algorithm development for high spatial resolution imagers
Jun Li	Daniel Zhou	NASA Langley Research Center	Global hyperspectral IR emissivity product from AIRS and IASI
Jun Li	Hui Liu	NCAR	Improving hurricane forecast with full spatial resolution advanced IR soundings

CIMSS Scientist	Collaborating Scientist(s)	Institute	Project Title
Eva Borbas	Roger Saunders Ben Ruston	Met Office, UK Naval Research Lab	Provision of RTTOV interface for land surface infrared emissivity
Eva Borbas	Paul vanDelst, Ronald Vogal	JCSDA	Implement HSR emissivity dataset
Pat Heck	Patrick Minnis	NASA Langley Research Center	Scientific support for derivation of cloud properties from satellite data
Jim Jung	John LeMarshall Lars Peter Riishojgaard	Bureau of Meteorology, Australia NASA Goddard Space Flight Ctr	Hyperspectral Water Vapor Radiance Assimilation
Jim Jung	Nancy Baker, Li Bi	Naval Research Lab	ASCAT surface winds assimilation
Todd Schaack	Murali Natarajan	NASA Langley	Implementation of Halogen Chemistry in the Real-time Air Quality Model (RAQMS)
Todd Schaack	Mariusz Pagowski	CIRA	WRF/Chem Ozone and Aerosol Data Assimilation Studies using the GSI assimilation system
Chris Moeller	Jack Xiong, et. al.	NASA MCST	MODIS calibration
Chris Moeller	Hassan Oudrari, et. al.	NASA NICST	VIIRS prelaunch performance characterization
Chris Moeller	Jeff Myers	NASA ARC	NASA Ames Research Center on E-MAS instrument development.
Dave Santek	Michele Rienecker, Ron Gelaro	NASA GMAO	Generation and Initial Evaluation of a 27-Year Satellite-Derived Wind Data Set for the Polar Regions
Dave Santek	Li Bi	UCAR/Naval Research Lab	Assimilating and evaluating sea surface winds from ASCAT in the NCEP GDAS/GFS
Dave Santek	Don Murray, Tom Yoksas	Unidata Program Center	Unidata software development

CIMSS Scientist	Collaborating Scientist(s)	Institute	Project Title
Mat Gunshor	Monica Coakley	MIT Lincoln Labs	GRAFIIR
	Susanna Petro	NASA	
	Jaime Daniels, Julie McNeil, Mitch Goldberg, Tim Schmit	NOAA	
Mat Gunshor	Johannes Schmetz, Tim Hewison, Marianne Koenig	EUMETSAT	Satellite Calibration Activities
	Yoshihiko Tahara, Hiromi Owada	JMA	
	Fred Wu, Fangfang Yu, Robert Iacovazzi, Changyong Cao, Andy Heidinger, Mitch Goldberg	NOAA	
	Jerome Lafeuille	WMO	
Mat Gunshor	Don Hillger	NOAA/NESDIS/RAMMB	GOES checkouts
	Tim Schmit, Gary Wade	NOAA/NESDIS/ASPB	
Ralf Bennartz	K. Hamilton, A. Lauer, et al.	University of Hawaii	Advanced cloud microphysics for climate modeling
Ralf Bennartz	J. Schmetz, P. Watts, M. Koenig, et al.	EUMETSAT	Retrievals of cloud microphysical parameters from SEVIRI and MODIS
Ralf Bennartz, Tom Greenwald	F. Weng, P. van Delst, et al.	NOAA/NESDIS STAR, JCSDA	Radiative transfer modeling for satellite data assimilation
Ralf Bennartz	A. Heidinger	NOAA/NESDIS STAR	Evaluation of PATMOS data for climate research purposes

CIMSS Scientist	Collaborating Scientist(s)	Institute	Project Title
Bryan Baum	Ping Yang Andrew Heymsfield	Texas A&M University National Center for Atmospheric Research	Refinement of ice cloud bulk optical models: From microphysical measurements to global retrievals using multiple satellite instruments
Dave Tobin, Bob Knuteson	Larrabee Strow	University of Maryland Baltimore County	Infrared Radiative Transfer and High Spectral Resolution Infrared Sounders
Dave Tobin	Stephen Tjemkes	EUMETSAT	MTG IRS studies
Dave Tobin	David Turner	UW-Madison AOS	Far Infrared Radiation and Water Vapor studies
Dave Tobin	Tim Hewison Fred Wu	EUMETSAT NOAA NESDIS	GSICS studies
Dave Tobin	Dan Mooney Joe Predina Farhang Sabet	MIT ITT NGST	CrIS studies
Dave Tobin	Denis Blumstein	CNES	IASI studies
Dave Tobin	Jim Anderson, John Dykema Dave Young	Harvard University NASA Langley	CLARREO
Dave Tobin	Carmine Serio	University of Basilicata, Potenza, Italy	RHUBC (Radiative Heating in Underexplored Bands Campaign)
Chris Rozoff	Wesley Terwey David S. Nolan Fuqing Zhang	University of South Alabama University of Miami Penn State University	Dynamics of horizontally and vertically sheared convection and applications to tropical cyclones
Chris Rozoff	Jonathan Vigh Mark DeMaria, John Knaff John Kaplan	NCAR NOAA/NESDIS, Fort Collins, CO NOAA/Hurricane Research Division, Miami, FL	GOES-RRR hurricane rapid intensity index development

CIMSS Scientist	Collaborating Scientist(s)	Institute	Project Title
Chris Rozoff	David Lorenz	UW-Madison Center for Climatic Research	Dynamics of secondary eyewall formation and eyewall replacement cycles
Scott Lindstrom	Dan Bikos, Jeff Braun, Mark DeMaria, Bernie Connell	CIRA	VISIT and SHyMet training activities
	Tony Mostek, Brian Motta	NOAA	
	Patrick Dills	COMET	
Justin Sieglaff	Peter Webley	University of Alaska - Fairbanks	Volcanic Ash Detection and Physical Property Retrievals
	David Schneider	USGS/Alaska Volcano Observatory/University of Alaska - Anchorage	
	William Rose	Michigan Technological University	
	Tony Hall	National Weather Service/Alaska Aviation Weather Unit	
Wayne Feltz	Robert Sharman, John Williams	NCAR/UCAR	NASA ROSES: Decision Support Systems: Global Atmospheric Turbulence Decision Support System for Aviation
Wayne Feltz	Valliappa Lakshmanan	CIMMS/University of Oklahoma	NOAA GOES Convective Initiation
Wayne Feltz	John Murray	NASA Langley Research Center	NASA ASAP/ROSES
Wayne Feltz	Doreen Neil	NASA Langley Research Center	NASA AERi
Wayne Feltz	Bill Smith Jr.	NASA Langley Research Center	NOAA GOES-R Aviation AWG
	Kenneth Pryor	NOAA	
Wayne Feltz	John Mecikalski	University of Alabama	NASA ASAP
	Haig Iskendarian	MIT Lincoln Labs	
Wayne Feltz	Larry Cary	University of Alabama	NOAA GOES-R Lightning
Wayne Feltz	John Moses	NASA GSFC	NASA ROSES Websensor Technology

CIMSS Scientist	Collaborating Scientist(s)	Institute	Project Title
Wayne Feltz	Lt Col Kurt Brueske Russell Schneider Steve Silberburg Doris Hood	DOD AFWA NOAA SPC NOAA AWC NOAA/NASA SMG	NOAA GOES-R Proving Ground
Wayne Feltz	Randy Baker	United Postal Service	NOAA WVSS-II Validation
Wayne Feltz	David Helms	NOAA	NOAA OST Network of Networks
Wayne Feltz	Philip Ardunay	Raytheon	AMS Satellite Meterology Com
Colleen Mouw	Noel Urban	Michigan Technological Institute	The carbon balance of Lake Superior: modeling lake processes and understanding impacts on the regional carbon budget
Colleen Mouw	Steven Greb	Wisconsin DNR	Inland lake remote sensing
Colleen Mouw	James Yoder	Woods Hole Oceanographic Institution	Phytoplankton cell size in the global ocean
Chris Velden	Jo Schmetz	EUMETSAT	Development of a universal portable winds software package
Chris Velden	Mary Forsythe	UKMET Office	Examination of AMV layer-mean heights
Chris Velden	Iliana Genkova	ECMWF	Improved assimilation of AMVs in ECMWF model
Chris Velden	John LeMarshall	ABOM	Improved AMV derivation algorithms
Chris Velden	Ken Holmlund	WMO	Co-Chairs (ex-officio) of the International Satellite Winds Working Group
Chris Velden	Kurt Brueske	AFWA	U.S. Air Force satellite winds product program
Chris Velden	Randall Pauley	FNMOC	Support for the operational NAVY satellite winds assimilation effort
Chris Velden	Louis Uccellini	NCEP	Study on model forecast “dropout” cases and mitigation
Chris Velden		MIT Lincoln Labs	Porting of the CIMSS automated AMV software package for mesoscale data production in potential future aviation applications
Chris Velden	Robert Rabin	NSSL	Use of the CIMSS AMV algorithm for mesoscale winds and applications to severe weather

CIMSS Scientist	Collaborating Scientist(s)	Institute	Project Title
Chris Velden	John Mecikowski	UAH	Hurricane intensity diagnostics
Chris Velden	Mark DeMaria	NESDIS/RAMMB	Development of a microwave-based hurricane rapid intensity indicator (GOES-R project)
Chris Velden	Hui Liu, Jeff Anderson	NCAR	Optimizing high-resolution satellite data assimilation in a mesoscale (WRF-DART) hurricane model (ONR project)
	James Doyle, Jeff Hawkins	NRL-MRY	
	John Knaff	NESDIS/RAMMB	
	Sharan Majumdar	University of Miami	
Chris Velden	Pat Harr, Russ Elseberry	Naval PostGrad School	Extratropical Transition of Tropical Cyclones and downstream impacts (NSF project)
	Sarah Jones	Karlsruhr University	
Chris Velden	Jeff Hawkins, Peter Black, Rolf Langland, Carolyn Reynolds	NRL-MRY	Support for Tropical Pacific field campaign (TPARC) and Tropical Cyclone data targeting activities through Office of Naval Research
	Sharan Majumdar	University of Miami	
Chris Velden	Will Komaromi, Sharan Majumdar	University of Miami	Thesis committee for study on Tropical Cyclone behavior and model initialization uncertainties
Chris Velden	Mike Montgomery	NPS	PREDICT tropical cyclone genesis field program support and science post analysis (NSF project)
	Chris Davis	NCAR	
	Lance Bosart	University of Albany	
Chris Velden		Taiwan Weather Bureau	AMV datasets for operational assimilation in CWB models (CWB project)
Chris Velden	Feng Lu	CMA	Stereo techniques for AMV and cloud height assignments (CIMSS visiting scientist)
Chris Velden	Kazuki Shimoji	JMA	AMV tracking algorithm studies (CIMSS visiting scientist)
Chris Velden		AMS	Chair (ex-officio) of the Satellite Technical Advisory Committee
Chris Velden	Jeff Hawkins	NRL-MRY Joint Typhoon Warning Center	Satellite Applications to Tropical Cyclones (NRL project)

CIMSS Scientist	Collaborating Scientist(s)	Institute	Project Title
Chris Velden	Andrew Burton	ABOM	Advanced Dvorak Technique implementation in the Australian TC region
Chris Velden	Jeff Keppert	WMO	Co-Leaders of the International Workshop on Tropical Cyclones VII
Chris Velden	Jack Beven	NOAA-NHC	Evaluation of operational Advanced Dvorak Technique and AMSU hurricanes intensity algorithms
Chris Velden	Jason Dunion	NOAA-HRD	The effects of the Saharan Air Layer on hurricane activity (GIMPAP project)
Chris Velden	Michael Turk	NESDIS-SAB	Implementation of the ADT into NESDIS operations (PSDI project)
Chris Velden	Jaime Daniels	NESDIS-STAR	Numerous projects to advance the CIMSS/NESDIS AMV processing package (GIMPAP, psdi and GOES-R/AWG projects)
Chris Velden	Gary Jedlovec	UAH-SPORT	MIMIC tropical cyclone displays for TWC
Allen Huang	Wei Gao	East China Normal University	Research and Dvelopment of a Real-time Air Quality Monitoring and Forecasting System
Allen Huang	Roger Saunders	UK Met Office	Development of GPU based high performance RTTOV
Allen Huang	Peter Wang	Central Weather Bureau, Taiwan	DB CRAS
Allen Huang	Li-Mei Huang	Central Weather Bureau, Taiwan	Satellite Wind data Sets
Allen Huang	Tsengdar Lee	NASA HQ	IMAPP
Allen Huang	John Overton	NOAA IPO	IPOPP
Allen Huang	Mitch Goldberg	NOAA STAR	CIMSS Participation in the GOES-R Algorithm Working Group (AWG)
Allen Huang	Gary Jedlovec	NASA MSFC	UW Cooperative Agreement in Support of NASAS/MSFC Broad Area of Nowcasting and Other Related Activities
Allen Huang	Carl Schoeneberger	Orbital Systems	Dual-band Polar Orbit Satellite Data Receiving, Processing & Analyzing System

CIMSS Scientist	Collaborating Scientist(s)	Institute	Project Title
Allen Huang	Michael Ropp	Northern Plains Power Technology	Development of the use of satellite based data to predict cloud transients in photovoltaic (PV) systems
Chris Schmidt	Saulo Freitas	INPE-CPTEC	Applications of WF_ABBA fire products in air quality transport modeling
Chris Schmidt	Alberto Setzer	INPE-CPTEC	Analysis of long-term fire dynamics and impacts in the Amazon using integrated multi-source fire observations
Chris Schmidt	Louis Giglio	NASA GSFC/SSAI	Comparison of MODIS and GOES fire products
Chris Schmidt	Mark Ruminski	NOAA/NESDIS/SSD Hazards Mapping System	Integration of the WF_ABBA fire product in the Hazards Mapping System
Chris Schmidt	Gilberto Vicente	NOAA/NESDIS/OSDPD	Transfer of WF_ABBA upgrades to NESDIS Operations (G-PSDI)
Chris Schmidt	Jeffrey Reid	Naval Research Lab	Global Geostationary Satellite Remote Sensing of Fires in Support of FLAMBE
Chris Schmidt	Philip Bothwell	NSSL SPC	GOES Biomass Burning Research and Applications
Chris Schmidt	Yunye Yu	NOAA NESDIS	GOES-R AWG Fires
Chris Schmidt	Ivan Csiszar	NOAA NESDIS	Analysis of long-term fire dynamics and impacts in the Amazon using integrated multi-source fire observations
Chris Schmidt	Dana Sullivan	Sonoma Technology	Applications of WF_ABBA fire products in air quality monitoring and modeling
Chris Schmidt	Sundar Christopher	University of Alabama Huntsville	Applications of WF_ABBA fire products in the RAMS model for aerosol modeling
Chris Schmidt	Valerio Tramutoli	University of Basilicata, Potenza, Italy	Comparison of RST and WF_ABBA with SEVIRI data over Italy
Paul Menzel	Rolf Stuhlmann	EUMETSAT	MTG-IRS mission planning team
Paul Menzel	Steve Platnick	NASA GSFC	MODIS cloud properties
Paul Menzel	Filomena Romana	IMAA, Potenza, Italy	Remote Sensing Summer Schools
Paul Menzel	Mervyn Lynch	Curtin University, Perth, Australia	Raincloud trends over Washington

CIMSS Scientist	Collaborating Scientist(s)	Institute	Project Title
Liam Gumley	Jim Gleason	NASA GSFC	NPOESS Preparatory Project Atmosphere PEATE
Liam Gumley	Rich Ullman	NOAA	International Polar Orbiter Processing Package

Appendix G: Memorandum of Understanding

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Washington, D.C. 20230
OFFICE OF THE ADMINISTRATOR

AUG 1 1980

July 29, 1980

Dr. Verner E. Suomi
Director, Space Science
and Engineering Center
University of Wisconsin
Madison, Wisconsin 53706

Dear Vern:

I am very pleased to send you a signed copy of the Memorandum of Understanding between NOAA and the University of Wisconsin-Madison for the establishment of the Cooperative Institute for Meteorological Satellite Studies.

Congratulations, and every good wish for continuing success of the outstanding research work that brings together the University and NOAA in long-term cooperation.

Cordially yours,

Earl

Earl G. Droessler
Director of University Affairs

Enclosure

ok ES

10TH ANNIVERSARY 1970-1980
National Oceanic and Atmospheric Administration
A young agency with an historic
tradition of service to the Nation

MEMORANDUM OF UNDERSTANDING

Between

THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

And

THE BOARD OF REGENTS OF THE UNIVERSITY OF WISCONSIN SYSTEM

ON BEHALF OF THE UNIVERSITY OF WISCONSIN-MADISON

Concerning the Establishment of the

COOPERATIVE INSTITUTE FOR METEOROLOGICAL SATELLITE STUDIES

I. INTRODUCTION

The National Oceanic and Atmospheric Administration (NOAA), through its National Environmental Satellite Service (NESS), and the University of Wisconsin-Madison (the University) have collaborated in the area of meteorological-satellite research for over a decade. This Memorandum of Understanding (MOU) between NOAA and the University (collectively referred to herein as the Parties) reaffirms their common interest in meteorological research using satellite technology and provides a basis for future cooperative research efforts.

II. PURPOSE

This MOU establishes the Cooperative Institute for Meteorological Satellite Studies (CIMSS). The purpose of CIMSS is to:

1. Foster collaborative research between NOAA and the University in those aspects of atmospheric science which exploit the use of satellite technology;
2. Serve as a center at which scientists and engineers working on problems of mutual interest may focus on satellite-related research in atmospheric studies; and
3. Stimulate the training of scientists and engineers in the

disciplines involved in the atmospheric sciences.

III. MEMBERSHIP IN CIMSS

CIMSS research activities will be conducted by individuals serving as members in accordance with the terms of the agreement executed pursuant to Section IV(B)(1)(g) of this MOU.

A. Members shall be appointed by the Director on the basis of their ability to contribute to the objectives of CIMSS.

B. Appointments shall be for a one-year term, subject to renewal for another one year term upon recommendation of the Council.

C. Except as provided in Section III(D) hereof, any person is eligible to be appointed a member of CIMSS.

D. An employee or officer of the Federal Government may not serve as a member of CIMSS.

IV. ADMINISTRATIVE STRUCTURE OF CIMSS

A. Executive Board

1. There is established an Executive Board of CIMSS (the Board), which shall have the following responsibilities:

a. To make recommendations to the Dean of the University Graduate School for the Directorship of CIMSS;

b. To review and approve the policies, research themes, and priorities of CIMSS;

c. To prepare an annual evaluation of CIMSS programs and activities, with appropriate recommendations;

d. To review the CIMSS budget;

e. To approve the appointment of members of the Council established by Section IV(C) of this MOU; and

f. To review and approve such further implementing agreements as may be entered into pursuant to Section VI of this MOU.

2. The Board shall consist of the following individuals or their designees:

   a. The Director of NESS;

   b. The Director of NOAA University Affairs;

   c. The Dean of the University Graduate School;

   d. The Director of the NESS facility in Madison;

   e. The Director of the Space Science and Engineering Center (SSEC) of the University;

   f. The Chairman of the Department of Meteorology of the University; and

   g. The Director of CIMSS, who will serve as a non-voting member.

3. The Board may invite one additional scientist, who need not be affiliated with either Party, to serve as an ad hoc advisor to the Board. Such person shall be well qualified to evaluate the program of CIMSS, to judge its performance and to make appropriate suggestions for change.

4. The Dean of the University Graduate School shall act as Chairperson of the Board.

5. The Board shall meet at least once a year, at the call of the Chairperson. Additional meetings of the Board may be called by the Chairperson or a majority of the members.

6. Decisions of the Board shall be by majority vote of those members present and voting.

B. The Director

1. There is established the position of Director of CIMSS (the Director), whose responsibilities shall include:

   a. Assuming scientific leadership by contributing actively to the development of research programs and involving local and visiting scientists in CIMSS activities;

   b. Reviewing and assessing of all research proposals sent to outside agencies;

   c. Serving as a non-voting member of the Board;

   d. Administration of CIMSS;

   e. Assuring accountability for all funds supplied to CIMSS;

   f. Presentation of annual report of research results to the Board;

   g. Responsibility for drafting memoranda of understanding describing the terms and conditions for each individual member's association with CIMSS. Such memoranda of understanding must be approved by the individual member involved and the organization, if any, with which he or she is affiliated.

2. The Director shall be appointed by the Dean of the University Graduate School (the Dean). In making the appointment, the Dean shall consider the views of the Council and the recommendations of the Board.

3. The Director shall serve for a five-year term. The appointment may be terminated earlier by the Dean after consultation with the Board.

4. An employee or officer of the Federal Government may not serve as Director.

C. The Council

1. There is established a Council, which shall advise the Director in the following areas:

   a. Establishment of the broad scientific content of CIMSS programs;

   b. Promotion of cooperation between the Parties;

   c. Maintenance of high scientific and professional standards;

   d. Appointment and renewal of members of CIMSS;

   e. Adoption of appropriate rules and allocation of space and facilities for the operation of CIMSS; and

   f. Preparation of proposals and reports of CIMSS activities.

2. The Council shall consist of three employees of NESS, one of whom shall be the Director, Office of Research, NESS, and three members of the University holding regular academic appointments. They shall be recommended for approval of the Board by the Director of CIMSS.

3. The Director of CIMSS will serve as Chairperson of the Council.

4. The Council shall meet periodically at the call of the Chairperson.

V. RESPONSIBILITIES OF THE PARTIES

A. Joint Responsibilities

1. The University and NOAA will collaborate in planning for and expediting the provision of suitable facilities and housing.

2. Through their representation on the Board, both Parties shall endeavor to provide policy direction to and assure appropriate professional standings in CIMSS.

3. NOAA and the University will share administrative costs in a manner consistent with their practices and policies.

4. Each party will take full financial and operational responsibility for its own employees physically located in, or holding positions in, CIMSS and agrees promptly to consider and adjudicate any and all damage claims which may arise directly or indirectly from the operation of CIMSS.

B. <u>Responsibilities of the University</u>

The University will:

1. Provide suitable space and office facilities to CIMSS on campus and will make its special satellite research facilities in SSEC available to CIMSS.

2. Exercise responsibility for all business and financial matters relating to the operation of CIMSS. CIMSS will operate as a unit of the Space Science and Engineering Center, with a separate, identifiable operating budget within the University and with separate accounts maintained for each major research theme.

3. Provide the Director with clerical and administrative assistance, including accounting services.

C. <u>Responsibilities of NOAA</u>

NOAA will establish and maintain a research group, organizationally reporting to the Director, Office of Research, NESS, collocated with CIMSS in Madison, Wisconsin, and engaged in joint research activities. This group will consist of a minimum of 5 to a maximum of 15 members and its residence costs, if any, will be covered in a separate agreement between the SSEC and NESS.

VI. IMPLEMENTING AGREEMENTS

The Director, Office of Research, NESS, and the Director of CIMSS are authorized to execute on behalf of the Parties, such additional agreements as may be necessary to carry out the purposes of this MOU. Any such agreements must be approved by the Board.

VII. FINANCIAL COMMITMENTS

This MOU does not constitute a financial commitment on the part of either Party. Financial support for the CIMSS program shall be subject to the ordinary budgetary and administrative procedures of NOAA and the University.

VIII. TERM

This MOU is effective as of the date of signature by both Parties and will continue in force until terminated. Either Party may terminate upon one year's written notice to the other Party.

IX. MODIFICATION

Proposals to modify the terms of this MOU can be initiated by NOAA or the University or by the Board and are subject to approval by the Administrator of NOAA and the Chancellor of the University.

NATIONAL OCEANIC AND
ATMOSPHERIC ADMINISTRATION

Administrator
NOAA

Date: 7/14/80

BOARD OF REGENTS OF THE
UNIVERSITY OF WISCONSIN SYSTEM

Chancellor
University of Wisconsin - Madison

Date: MAY 13, 1980

Director
Research Administration - Financial

Date: 5/21/80

Appendix H: UW-CIMSS Board of Directors and Science Advisory Council

UW-CIMSS BOARD OF DIRECTORS

Martin Cadwallader, Chair
Dean, UW-Madison Graduate School

Steven A. Ackerman
Director, CIMSS

Henry E. Revercomb
Director, Space Science and Engineering Center, UW-Madison

Jonathan Martin
Chair, Department of Atmospheric and Oceanic Sciences, UW-Madison

Mary Kicza
Assistant Administrator for Satellite and Information Services, NOAA/NESDIS

Alfred Powell
Director, Center for Satellite Applications and Research, NOAA/NESDIS

Jeff Key
Chief, Advanced Satellite Products Branch, NOAA/NESDIS

Jack A. Kaye
Assoc. Director for Research, NASA

Franco Einaudi
Director, Earth-Sun Exploration Division of the Sciences and Exploration Directorate, NASA Goddard Space Flight Center

Lelia Vann
Director, Science Directorate, NASA Langley Research Center

UW-CIMSS SCIENTIFIC ADVISORY COUNCIL

Steven Ackerman	Director, CIMSS
Allen Huang	Distinguished Scientist, CIMSS
Chris Velden	Senior Scientist, CIMSS
Trina McMahon	Professor, UW-Madison Engineering
Annemarie Schneider	Professor, UW-Madison, SAGE
Ralf Bennartz	Professor, UW Department of Atmospheric and Oceanic Sciences
Graeme Stephens	Professor, Department of Atmospheric Science, Colorado State Univ.
Bob Ellingson	Professor, Department of Meteorology, Florida State University
Steve Goodman	GOES-R Program Scientist, NOAA/NESDIS/ORA
Ingrid Guch	Chief, Atmospheric Research and Appl. Division, NOAA/NESDIS/ORA
Steve Platnik	Aqua Deputy Project Scientist, EOS Sr. Project Scientist (acting), NASA Goddard Space Flight Center
Pat Minnis	Senior Research Scientist, NASA Langley Research Center

Appendix I: UW-CIMSS Graduate Students

1979-1980
Michael Kalb MS (NOAA/NESDIS)
Tony Siebers MS (NOAA/NWS)
Jim Block MS (private sector)

1980-1981
Jim Zandlo MS (private sector)
Roberta Marshment MS (private sector)

1981-1982
George Diak PhD (CIMSS emeritus)
Roy Spencer PhD (NASA/Marshall)
Chris Velden MS (CIMSS)
David Keller MS (U.S. Air Force)

1982-1983
John Bates MS (NOAA/NCDC)
Gin-Rong Liu MS (Taiwan National Univ)

1984-1985
David Donahue MS (NOAA/NESDIS)
Stacey Heikkinin MS
Martin Mlynczak MS (NASA/LaRC)

1985-1986
John Bates PhD (NOAA/NCDC)
Allen Huang MS (CIMSS)
Chris Moeller MS (CIMSS)
Craig Burfeind MS (private sector)

1986-1987
Louis Garand PhD (Environment Canada)
Gin-Rong Liu PhD (Taiwan National Univ)
Gary Jedlovec PhD (NASA/Marshall)
Fred Wu MS (CIMSS, NOAA/NESDIS)
Maria Perrone MS (Rutgers University)
Tim Schmit MS (NOAA/ASPB)

1987-1988
Nelson Ferreira PhD (INPE, Brazil)
Richard Frey MS (CIMSS)
Arlindo Arriaga MS (EUMETSAT)
Grant Carlson MS (NASA/Marshall)

1988-1989
Hyosang Chung MS (Korea Met Agency)
Laurie Rokke MS (NOAA/GOES Program Office)
Liam Gumley MS (NASA/GSFC, CIMSS)
Kurt Brueske MS (U.S. Air Force)
Murty Divakarla MS (private sector)
Elaine Prins MS (CIMSS, private sector)
Chris Scheuer MS (NASA/LaRC)

1989-1990
Allen Huang PhD (CIMSS)
Fred Wu PhD (CIMSS, NOAA/NESDIS)
Steve Nieman MS (CIMSS, private sector)
Walt McKeown MS (Navy)
Hai Yan Zhang MS (CSU)

1990-1991
Arlindo Arriaga PhD (EUMETSAT)
Peter Keehn MS (NASA/GSFC)
Yanni Qu MS (NESDIS, private sector)

1991-1992
Robert Purser PhD (NOAA/NCEP)
Kathy Strabala MS (CIMSS)

1992-1993
Daphne Zaras MS (NOAA/NSSL)
Chia Lee MS (CIMSS)
Rongrong Xie MS (NOAA/NESDIS)
Jason Li MS (NASA/GSFC)

1993-1994
Walt McKeown PhD (U. S. Navy)
Gilberto Vicente PhD (NASA, NOAA)
Xiaohua Wu PhD (Univ. of Chicago)
Wayne Feltz MS (CIMSS)
Tim Olander MS (CIMSS)

1994-1995
Yanni Qu PhD (NOAA/NESDIS, private sector)
Susan Faust MS (NOAA/NWS)

Lan Ge MS (NOAA/NESDIS)
Ben Ho MS (NASA/LaRC)

1995-1996
Jack Dostalek MS (CSU CIRA)
Nick Nalli MS (NOAA/NESDIS)
Brad Hoggatt MS (private sector)
Dan DeSlover MS (CIMSS)

1996-1997
Jay Heinzelman MS (SSEC)
Phil Politowicz MS (private sector)

1997-1998
Ben Ho PhD (NASA Langley)
Bormin Huang PhD (CIMSS)
Paul van Delst PhD (CIMSS, SAIC)
Gideon Kinyodah MS (Kenya Met Office)
Rose Shie MS (computer science)

1998-1999
Mike Friedman PhD (Oregon State, AMS)
William Badini MS (private sector)
Jason Dunion MS (NOAA/AOML)
Rhett Grauman MS (NOAA/NWS)
Shaima Nasiri MS (CIMSS and TX A&M)

1999-2000
Erik Olson MS (CIMSS)
Chris Schmidt MS (CIMSS)
Nick Nalli PhD (CIMSS, NOAA)
Bormin Huang PhD (CIMSS)

2000-2001
Nick Bower PhD (from Curtin Univ)
Monica Harkey MS (UW, MATC)
Michael Pavlonis MS (CIMSS, NOAA/ASPB)
Kurt Brueske PhD (Air Force)
Paolo Antonelli PhD (CIMSS)

2001-2002
Brian Kabat MS (Air Force)
Hong Zhang MS (CIMSS)
Sarah Thomas Bedka MS (CIMSS, NASA/LaRC contractor)

2002-2003
David Turner PhD (PNL, CIMSS, AOS)
Greg Gallina MS (CIMSS, NOAA/VAC)

2003-2004
Giulia Pannegrossi PhD (Italy)
Greg McGarragh MS (NASA/LaRC)
James Hawkinson MS (CIMSS)
Xuanji Wang PhD (CIMSS)
Mark Gray MS (NASA/GSFC)
Xuanji Wang PhD (CIMSS)

2004-2005
Amato Evan MS (CIMSS, Univ. Virginia)
Fang Wang MS (CIMSS)
Nathan Uhlenbrock MS (CIA)
Shaima Nasiri PhD (TX A&M)
Michael Mores MS (CIMSS
Jason Brunner MS (CIMSS)

2005-2006
Robert Holz PhD CIMSS)
Jay Hoffman MS (CIMSS)
Michael Richards MS (Hebrew Univ, FAA)

2006-2007
Justin Sieglaff MS (CIMSS)
Brent Maddux MS (CIMSS)
Jessica Staude MS (CIMSS/SSEC)
Richard Dvorak MS (CIMSS)
Yinghiu Lui PhD (CIMSS)

2007-2008
Alex Harrington MS (private sector)
David Santek PhD (CIMSS/SSEC)
Matthew Lazzara PhD (CIMSS/SSEC)

2008-2009
Li Bi PhD (NRL)
Amato Evan PhD (CIMSS, Univ. Virginia)
Zhenglong Li PhD (CIMSS/SSEC)

Appendix J: GOES Products in NOAA Operation Centers from UW-CIMSS

GOES Products in NOAA/NESDIS Operations from UW-CIMSS

Imager

Derived Product Images
- Water vapor
- Lifted Index
- Skin Temperature

Winds from multiple satellites
- High density infrared
- High density visible
- High density 3.9 µm

Clouds
- CO2 absorption method
- GSIP

Hurricanes
- Intensity estimates from the Advanced Objective Dvorak Technique

Biomass Burning
- WF_ABBA

Sea Surface Temperature
- SST via work of X. Wu

Clear-ski Brightness Temperature
- Box-averaged

Sounder

Derived Product Images
- Water vapor
- Lifted Index
- Skin Temperature
- CAPE
- Single FOV DPI

Winds
- 7.0 µm
- 7.5 µm

Images
- Select bands

Clouds
- Site-specific Cloud Product
- Single FOV product DPI
- Cloud amount, cloud height

Retrievals
- Temperature profiles
- Moisture profiles
- Layer PW
- Clear-sky Brightness Temperature
- Single FOV retrievals

GOES Products from UW-CIMSS that are used operationally but not in OSDPD

Derived Product Images
- Convective Signatures

Winds from multiple satellites
- Derived wind fields (shear)
- Derived wind fields (divergence)
- Derived wind fields (mean layer wind)
- Global winds

Clouds
- Global mask
- Convective cloud mask

Hurricanes
- Intensity estimates from the Advanced Objective Dvorak Technique
- Saharan Air Layer Analysis

Biomass Burning
- Time Series

Ozone
- Total Column Ozone

Appendix K: SSEC-CIMSS Participation in Field Programs

	Satellite Instrument Designs, Studies, & Cal Val	Instrument & Subsystem Developments	Field Programs
1979	HIS for GOES Sounding		
1980			
1981			
1982			
1983		HIS ER-2 Instrument [1983-5]	
1984			
1985			
1986			Kitt Peak; COHMEX, SE US; FIRE 1, Wisconsin – HIS
1987	GHIS, GOES Mod –to replace filter wheel with FTS		
1988			GAPEX, Denver – Uplooking HIS
1989	GAP, Geo for EOS Trace Gas Sounding		
1990	ITS, Interferometer Sounder, EUMETSAT (led study effort, formed basis for)	AERI Groundbased system for DOE ARM Program [1990-6] Marine AERI [1995-7] Scanning HIS smaller aircraft instrument for UAW, ER2, DC8, WB-57 [1996-8] NAST-I Aircraft inst. For NPOESS Program [1997-8] GIFTS On-board Calibration Subsystem	
1991			CaPE/SERON, SE US; FIRE 2 Kansas – HIS, SPECTRE – AERI
1992			STORMFEST, SGP – HIS, AERI
1993			CAMEX 1, Atlantic Coast – HIS, AERI
1994	Small FTS for NASA New Millennium Program		ASHOE, New Zealand – HIS
1995			Gulf of Mexico – HIS, AERI; CAMEX 2 – HIS
1996			SUCCESS, SGP – HIS; CSP, TWP-AERI
1997	IMG Cal/Val Geo Imaging FTS Sounders, currently GIFTS (NASA LaRC lead, Utah State University sensor module) AIRS Cal/Val		WINCE, Wisconsin – HIS, AERI; FIRE 3, Alaska – HIS; SHEBA – AERI
1998			Wallops '98 – NAST, HIS; CAMEX 3, Atlantic/Gulf – NAST (ER2) SHIS (DC8); NOAA K, Dryden – SHIS (ER2); AERI

1999		**[2001-2005]** **SSEC Absolute Temperature Calibration Demonstration Using Miniature Phase Change Cells** **(IR&D Program)**	**WINTEX, Wisc (ER2) – NAST, SHIS, AERI; KWAJEX, Kwajalein – SHIS DC8); Wallops '99 – NAST, Intessa**
2000			**SAFARI, S Africa – SHIS (ER2); AFWEX, SGP – NAST (Proteus); SHIS (DC8); WISC-T2000, Wisconsin – SHIS (ER2)**
2001	**CrIS EDU Char**		**Texas-2001 – SHIS (ER2); Trace-P, Pacific Rim – NAST (Proteus)** **CLAMS, NASA Wallops – SHIS (ER2), NAST (Proteus)**
2002	**TES Cal/Val** **GIFTS EDU Char**		**IHOP – SHIS (ER2); NAST (Proteus); CRYSTAL, NAST (Proteus)**
2003			**THORPEX – SHIS and NAST (ER2);** **MAINE - SHIS and NAST (ER2)**
2004			**MPACE – SHIS and NAST;** **TAMDAR – AERIbago;**
2005			**TAMDAR – AERIbago;** **WVSS-II - AERIbago** **AVE - SHIS**
2006	**GIFTS/AERI** **Uplooking Cal Val**		**NASA CR-AVE SHIS**
2007	**CLARREO IR Instrument Design Support**	**CLARREO Advanced Technology Developments: On-orbit Absolute Radiance Source (OARS) & FTS**	**JAIVEx Houston, TC4 (ER2)**
2008			
2009			
2009	**Future GEOCAPE Cal/Val Activity**	**AERI Thermodynamic Retrievals**	**GEOCAPE PreValidation Deployment - AERIbago**
2009	**Water Vapor Sensing System-II Validation**		**WVSS-II - AERIbago**

Appendix L: Awards

2010

Thomas Achtor and Wayne Feltz: 2010 University of Wisconsin Police Department Community Service Award for Providing Weather Forecasts for Special Events in Camp Randall Stadium

2009

Steven Ackerman: AMS Teaching Excellence Award
Annie Lenz: AMS Father James B. Macelwane Award, which recognizes an original undergraduate student research paper
Jeff Key: NOAA Administrator's Award for scientific leadership and excellence in support of domestic and international polar observing activities during the International Polar Year
Chris Velden: Elected to Fellow of the American Meteorological Society
Amato Evan, Yinghui Liu, and Xuanji Wang: University of Wisconsin-Madison's NOAA-CIMSS Collaboration Award for innovative uses of operational weather satellites to understand climate change and to quantify trends in the global climate system.
Jun Li and Mat Gunshor: University of Wisconsin-Madison's NOAA-CIMSS Collaboration Award for developing NOAA's Strategic Satellite Plan to balance requirements, observation capabilities, and resources.
Steven Ackerman: State University of New York at Oneonta Distinguished Alumnus Award
Colleen Mouw: NASA MPOWIR (Mentoring Physical Oceanography Women to Increase Retention) selected speaker – competitive selection of a junior female physical oceanographer to give a seminar at a NASA research center
Chian-Yi Liu: Second Prize in Oral Presentation, Sixth Annual NOAA/NESDIS/CoRP Symposium
Jordan Gerth: Wisconsin Space Grant Consortium Graduate Fellowship Award
Chian-Yi Liu: Henry Vilas Travel Grant
Jun Li: University of Wisconsin-Madison's NOAA-CIMSS Collaborative Award for developing NOAA's Strategic Satellite Plan to balance requirements, observation capabilities, and resources
R. Bradley Pierce: NASA Group Achievement Award for outstanding accomplishments in the successful Arctic Research of the Composition of the Troposphere with Aircraft and Satellites (ARCTAS) mission in Alaska and Canada

2008

David Tobin: International Radiation Commission's Young Scientist Award
Chian-Yi Liu: University of Wisconsin Graduate Mentor Award
Tim Schmit: GOES-10 XGOHI Appreciation Certificate
Jeff Key and Andrew Heidinger: NOAA Bronze Medal: "For innovative uses of operational weather satellites to understand climate change and to quantify trends in the global climate system"
Tim Schmit: NOAA Bronze Medal: "For developing NOAA's Strategic Satellite Plan to balance requirements, observation capabilities, and resources"
Tim Schmit: NASA group award for "providing the next generation (GOES-13) of advanced weather satellites"
Zhenglong Li: Henry Vilas Travel Grant
Pat Heck: NASA Group Achievement Award to CERES Team
Wayne Feltz: NASA LaRC Paul Holloway Technology Transition Award

2007

W. Paul Menzel: Special Award from EUMETSAT in recognition of unremitting contributions to satellite remote sensing and exemplary leadership in the cooperation between the world's meteorological satellite operators

W. Paul Menzel: American Meteorological Society Fellow in recognition of outstanding contributions to the atmospheric sciences

Jun Li: NASA/JPL's Certificate of Appreciation in grateful recognition of the contributions to the success of the AIRS project

W. Paul Menzel: Distinguished Alumni Fellow Award from the Department of Physics at UW-Madison for achievements in atmospheric physics

Jordan Gerth: National Weather Association Meteorological Satellite Applications Award

Tim Schmit: NOAA Bronze medal: "For reducing costs and increasing satellite earth science global data distribution and archiving through world-leading R&D in data compression."

Pat Heck: NASA Paul F. Holloway Non-Aerospace Technology Transfer Award to ASAP Team

W. Paul Menzel: Department of Commerce Silver Medal for using geostationary measurements to estimate hourly sea surface temperatures that have expanded understanding of ecosystems, weather, and climate

Todd Schaak: NASA Group Achievement Award for outstanding accomplishments in the successful Intercontinental Chemical Transport Experiment Mission (INTEX B)

Anthony Wimmers and Michael Pavolonis: NASA Paul F. Holloway Non-Aerospace Technology Transfer Award (aviation group award, for the contribution to MODIS volcanic ash algorithm development)

2006

W. Paul Menzel: Distinguished Career Award

Wayne Feltz: NASA Honors Group Achievement Award (ASAP)

2005

Andrew Heidinger: DOC Silver Medal for developing and implementing a novel method for inter-calibrating satellite instruments

Jeff Key: DOC Silver Medal for significantly advancing the usefulness of satellite data over the polar regions in weather forecasts

Steven Ackerman: Dorothy Howard Prize for Folklore and Education for the website and project Wisconsin Weather Stories, Folklore and Education Section of the American Folklore Society

Elaine Prins: NASA award for support of the IDEA effort

Todd Schaak: NASA Group Achievement Award for outstanding accomplishments in the successful Intercontinental Chemical Transport Experiment Mission (INTEX A)

Pat Heck: NASA Group Achievement Award to Earth Sciences Application Team

Wayne Feltz: NASA Aviation Safety and Security Program Award for Outstanding Contributions to Aviation Weather Safety Research and Development

CIMSS Tropical Cyclone Group: NOAA/NCEP Certificate of Appreciation by the National Hurricane Center

2004

Anthony Wimmers: NASA Group Achievement Award for Earth Sciences Applications

Steven Ackerman: UW-Madison Vilas Research Associate

Zhenglong Li: Schwerdtfeger Award for excellent performance in first year graduate studies, University of Wisconsin

Liam Gumley: NASA Group Achievement Award for Earth Sciences Applications Team Air Quality Project

2003

Chris Velden: Office of the Federal Coordinator for Meteorology Hagemeyer Award
Jun Li: Certificate of Recognition by NASA for the creative development of technically significant software which has been accepted and approved by NASA, entitled "Moderate Resolution Imaging Spectroradiometer (MODIS) Production Software – Atmospheric Profiles"
Chris Moeller: "Customer Service Excellence Award" from NASA/GSFC for MODIS work
Steven Ackerman: Society of Academic Author's Talby prize to "recognize excellence in visuals in textbooks and other learning materials"
Bryan Baum: NASA Group Achievement Award, NASA Goddard Space Flight Center, awarded to the Earth Observing System (EOS) Aqua Mission Team
Liam Gumley: NASA Certificate of Recognition for Development of Technically Significant Software: MODIS Atmospheric Profile
Tom Whittaker: Russel L. DeSouza Award from the Unidata community
Steve Ackerman: NASA Group Achievement Award to CRYSTAL-FACE Science Team

2002

Jun Li: U.S. National Space Club and National Oceanic and Atmospheric Administration's David Johnson award for the exceptional and unique contributions to the development of sounding retrieval algorithms for the nation's civil operational geostationary and polar-orbiting environmental satellites and leadership in defining the high-spectral resolution sounders for the next generation of satellites
Tony Schreiner: NOAA Team Member of the Month

2001

Elaine Prins: NOAA Employee of the Month Award
W. Paul Menzel: Department of Commerce/NOAA Bronze Medal for scientific leadership, both nationally and internationally, in the area of operational space-based remote sensing
Chris Velden, Tim Olander, and Steve Wanzong: American Meteorological Society Banner Miller Award

2000

Tom Whittaker and Scott Bachmeier: NOAA/NESDIS Office of Research and Applications Trainers of the Year for their work on VISITview
Jun Li: International TOVS Study Conference (ITSC)'s first prize for poster "Further Development of International ATOVS Processing Package (IAPP)."
Tim Schmit: Department of Commerce Silver Medal for developing products with data from the latest generation of geostationary satellites

Appendix M: SSEC Data Center

Overview

The SSEC Data Center mission is to create and maintain the facilities, human expertise and technology necessary to provide SSEC/CIMSS scientists and their collaborators with the highest quality geophysical data in a timely fashion, and to provide real-time data access, archive and retrieval services as necessary to support SSEC/CIMSS scientific programs.

Summary of Data Reception and Storage Capabilities

The Data Center has five L-Band Antennas, one of which can automatically track high inclination geostationary satellites. The five antennas give us the ability to ingest and archive all four GOES satellites in situations where they are sending data simultaneously. We have two C-Band Antennas and will soon have a third to act as a back up. We also have an X-Band antenna for receiving EOS polar orbiting data; the antenna is able to cover nearly the entire 48 states and portions of Canada, Mexico and the Gulf of Mexico.

The Data Center has over 1,000 TB of disk space holding over 30 years of GOES data, and nearly a decade of non-GOES geostationary satellite data.

Staffing

The SSEC Data Center is staffed Monday through Friday from 7:30 AM to 11:00 pm Central time. We have three FTE ~100% time: an Archivist & Computer Operator (1st shift), a Computer Operator (1st shift), and a Computer Operator (2nd shift).

The average experience ingesting, distributing, and archiving satellite data of our Data Center staff members is over 20 years. The experience of our staff ingesting, distributing and archiving satellite data is an important reason for the high quality of our data and products and the 99.9% success rate of receiving and archiving GOES data over the past decade.

We have five other experts providing various portions of their time, including the Program Manager, a System Programmer, a Data Base Programmer, a Research Specialist (PM assistant), and our Antenna/Communication technician. Finally, we employ two student programmers.

Data Holdings and Services

The SSEC Data Center collects, quality controls, distributes and archives data from a number of geostationary and polar orbiting environmental satellites. Users of the data include SSEC/CIMSS and ASPB scientists in house, SSEC/CIMSS collaborators, the Unidata community (over 150 universities and colleges), other government agencies (e.g., NTSB), and private sector companies. The following is a summary of the on-line and archived data holdings SSEC makes available to its scientists and other users.

Real-time data availability

Dataset	Reception	Reception Formats	End user formats	Access
Geostationary Satellites				
GOES-East 75° W	Direct Broadcast in Real-time	GVAR	AREA, Netcdf, GEOtiff, Flatfiles	ADDE
GOES-West 135° W	Direct Broadcast in Real-time	GVAR	AREA, Netcdf, GEOtiff, Flatfiles	ADDE
GOES-Test	Direct Broadcast in Real-time	GVAR	AREA, Netcdf, GEOtiff, Flatfiles	ADDE
GOES-South America 60° W	Direct Broadcast in Real-time	GVAR	AREA, Netcdf, GEOtiff, Flatfiles	ADDE
Meteosat at 0° E	Network Relay in Real-time	Open MTP	AREA, Netcdf, GEOtiff, Flatfiles	ADDE
Meteosat at 57° E	DOMSAT Relay in Real-time	HRIT	AREA, Netcdf, GEOtiff, Flatfiles	ADDE
FY2 at 86° E	Network ADDE Relay ~30 minute delay	McIDAS AREA	AREA, Netcdf, GEOtiff, Flatfiles	ADDE
FY2 at 124° E	Network ADDE Relay ~30 minute delay	McIDAS AREA	AREA, Netcdf, GEOtiff, Flatfiles	ADDE
MTSAT at 140° E	DOMSAT in Real-time	HRIT	AREA, Netcdf, GEOtiff, Flatfiles	ADDE

Dataset	Reception	Reception Formats	End user formats	Access
Polar Orbiting Satellites				
NOAA-15	DOMSAT Relay in real-time and DDS network relay	Level-0, Level-1 GAC, LAC, & HRPT	AREA, Netcdf, GEOtiff, Flatfiles, Level-1	ADDE, FTP
NOAA-16	DOMSAT Relay in real-time and DDS network relay	Level-0, Level-1 GAC, LAC, & HRPT	AREA, Netcdf, GEOtiff, Flatfiles, Level-1	ADDE, FTP
NOAA-17	DOMSAT Relay in real-time and DDS network relay	Level-0, Level-1 GAC, LAC, & HRPT	AREA, Netcdf, GEOtiff, Flatfiles, Level-1	ADDE, FTP
NOAA-18	DOMSAT Relay in real-time and DDS network relay	Level-0, Level-1 GAC, LAC, & HRPT	AREA, Netcdf, GEOtiff, Flatfiles, Level-1	ADDE, FTP
NOAA-19	DOMSAT Relay in real-time and DDS network relay	Level-0, Level-1 GAC, LAC, & HRPT	AREA, Netcdf, GEOtiff, Flatfiles, Level-1	ADDE, FTP
METOP	DDS network relay	Level-1 FRAC, AMAX, DCSX, MHSX, HIRX, IASI	AREA, Netcdf, GEOtiff, Flatfiles, Level-1	ADDE, FTP
EOS-Aqua	Direct Broadcast and network relay as backup	Level-0, Level-1, Level-2	AREA, Netcdf, GEOtiff, Flatfiles, Level-0, Level-1	ADDE, FTP
EOS-Terra	Direct Broadcast and network relay as backup	Level-0, Level-1, Level-2	AREA, Netcdf, GEOtiff, Flatfiles, Level-0, Level-1	ADDE, FTP

Dataset	Reception	Reception Formats	End user formats	Access
Non-Satellite Data				
NOAAport Model Output	DOMSAT Relay automatically backed up via network using LDM IDD	GRIB1, GRIB2	McIDAS GRID	ADDE, THREDDS
NOAAport Text Observations and reports	DOMSAT Relay automatically backed up via network using LDM IDD	Raw Text, McIDAS MD	Text, McIDAS MD	ADDE
NOAAport NEXRAD radar	DOMSAT Relay automatically backed up via network using LDM IDD	NIDS	McIDAS AREA, Netcdf, GEOtiff, Flatfiles	ADDE
CONDUIT (Hi-RES) Model Output	LDM via CONDUIT feed	GRIB2	McIDAS GRID, GRIB2	ADDE, FTP

<u>Archive Data availability (all online)</u>

Dataset	Period of Record
SMS-(1&2), GOES-(1-7)	1978-1996
GOES-(8-14)	1994-Present
Meteosat	1992-1995 (Atlantic/Eastern US coverage), 1999-Present (Europe, Indian Ocean Coverage)
GMS/MTSAT	1998- Present
FY2	2005- Present
Kalpana	2004-Present
Observational data	1976-Present
Model Output (GRIDs & GRIB)	1996-Present
WX Text	1996-Present

Besides the data reception, archiving and serving data, additional Data Center activities include:

- Ingesting over 235 GB of data per day, and archiving over 150GB per day;
- Providing data and maintaining the Unidata Local Data Manager (LDM) real-time broadcast to over 150 universities and colleges;
- Generating and maintaining real-time data products for the SSEC Web site;
- Assisting NOAA and SOCC with initial post-launch instrument and bit stream checkout with periodic check-ups during the instrument lifetime;
- Providing satellite data to NOAA for data they do not receive (e.g., GOES-10, China's FY-2, India's Kalpana) and acting as a data backup to their system;
- Processing user data requests and product generation for real-time and archived data;
- Providing help desk support to users of the SSEC Desktop Ingestor (SDI);
- Testing software changes for the SDI-104 and providing information for the user's manual; and
- Acting as a focal point for satellite information.

Recent NOAA/SATEPs interactions include the following:

- Provided NESDIS/STAR with 5+ years of full resolution Meteosat 8 and 9 data via online archive;
- Provided NESDIS/STAR with GOES-13 data, until ESPC's system was operational;
- Provided ESPC with first visible and infrared full disk images from GOES-14 when ESPC had a failure on their system;

- Worked with ESPC on specifying modifications to the GVAR to handle navigation parameters that were no longer stored in the Block0 portion of the signal;
- Provide NOAA/ESPC with real-time data from the Chinese FY2C and FY2D geostationary satellites;
- Re-navigate and supply NOAA/ESPC with near real-time re-navigated Kalpana (India) geostationary satellite data;
- Ingest, process, and relay EOS direct broadcast data for NWS AWIPS systems;
- Ingest, process, and relay NOAA POES polar products for NWS AWIPS systems;
- Provide NOAA/ESPC data ingest backup for MTSAT and GOES
    - 21.6 GB   Aug 2009
    - 1.5 Gb   Sept 2009
    - 13 GB   Oct 1 – Oct 11 2009
- Provide general data access to NOAA/ESPC (includes GOES, MSG, MTSAT, FY2, NOAAport, and Kalpana)
    - 678 GB   July 2009
    - 1.2 TB   Aug 2009
    - 1.0 TB   Sep 2009
    - 390 GB   Oct 1 – Oct 11 2009
- Provided NOAA/ESPC with GOES-13 archive data to troubleshoot a noise issue (no other sites had this data).

Challenges

- Data Safety, which is broken down into two parts:
    - Data integrity: Ensuring that the bytes that were archived are accurately stored and retained, and that any problems are identified and remedied. As the size of archives increase, ensuring what is saved is preserved in tact becomes more challenging.
    - Data backups: Data needs to be backed up and maintained in two locations in the event of catastrophic loss. This is time consuming, and expensive.
- Data Formats: Ensuring data is in a format that can be used by as many software packages as practical, without compromising the integrity of the original data.
- Data Serving: Providing the user with easy access to data (searching and retrieval) without the need of Data Center staff assistance.
- Metadata Inventory: Improve methods for the user to search for the data that they need.
- Power and cooling: The Data Center plans to add another 72 KW UPS to its existing two -72 KW UPS. It also will expand its current inline rack cooling system.

Antenna Resources

Antenna Diameter	Type	Pointing Location	Uses
11 meter	C-Band	Fixed 87° W	DOMSAT relay, MSG, Wallops relay
7.3 meter	L-Band	Fixed 75° W	GOES-East
7.3 meter	C-Band	Fixed 101° W	DOMSAT relay MTSAT, Gilmore Polar relay, NOAAport
4.6 meter	L-Band	Fixed 135° W	GOES-West
4.5 meter	L-Band	Fixed 75° W	GOES-East Backup or GOES checkout
4.5 meter	L-Band	Fixed 60° W (auto-tracking for high inclination orbits)	GOES-South America
4.4 meter	X-Band	180° elevation over 360° azimuth tracking capable	EOS (Aqua & Terra)
3.7 meter	L-Band	Fixed 90° W	Testing/Spare (not research quality)
6.3 meter	C-Band	Fixed; Currently being installed. Due to be operational Spring 2010	Heated backup to 7.3 meter and 11 meter antennas

Appendix N: The Schwerdtfeger Library

Overview

The Schwerdtfeger Library was dedicated in 1983 to support the research activities of the Space Science and Engineering Center, including the Cooperative Institute for Meteorological Satellite Studies (CIMSS), and the instructional programs of the Department of Atmospheric and Oceanic Sciences at the University of Wisconsin-Madison. The Library collects and preserves unique material and provides access to earth and space science research resources. The Schwerdtfeger Library's web site is developed with the research interests of CIMSS and SSEC scientists in mind.

Library staff use existing state of the art tools, both available from standard sources and developed in-house to efficiently meet current and anticipated client research needs. Services offered include, but are not limited to: extensive reference, research and technical services; teaching; access to print and electronic collections; participation in local and international information networks, interlibrary loan and digital resource construction.

Most research questions that the library addresses, are long-term, intensive projects, requiring committed staff with solid access to resources. The following examples illustrate a few of the ways the Schwerdtfeger Library concretely supports the varied research interests of CIMSS.

Capabilities: Research Support

1. **Green Card Applicant Support**

Five years ago, library staff offered to write letters of support, in addition to bibliography preparation and citation documentation, for green card applicants, many of whom are CIMSS researchers. Letters document the applicant's publishing history, but also provide an explanation of the importance of the scholarly journals chosen, their impact in the discipline, where they are indexed, and the import of conference papers. Recognizing the impact of these letters, the campus is now asking applicants to obtain a letter of support from a librarian, using ours as a model.

2. **Research Support for Authors**

During the summer of 2006, Erik Conway, historian at the Jet Propulsion Laboratory, visited the Schwerdtfeger Library to conduct research using Verner E. Suomi's personal papers and publications. His book, *Atmospheric Science at NASA: A History*, documents the important work of Suomi in the area of satellite meteorology. Library staff worked with Mr. Conway over the course of several weeks to provide access to our extensive collections. Mr. Conway's book, published in 2008 by the Johns Hopkins University Press, includes acknowledgement of our library staff.

Library staff work with researchers, from around the world, many of whom are CIMSS colleagues, who are gathering information to support their research. Many of these contacts are ongoing, over the course of years.

3. **Bibliographies**

The Schwerdtfeger Library creates and maintains subject bibliographies to support the ongoing research of CIMSS. For example:

1. The *GOES-R Bibliography* captures publications of the GOES-R Project Team: http://library.ssec.wisc.edu/resources/goesr/goesr.php

2. The *FTIR Bibliography* is a comprehensive compilation of publications chronicling the history of CIMSS and SSEC scientists who study infrared radiances obtained from ground-based and airborne instrumentation: http://library.ssec.wisc.edu/resources/ftir/ftir.php
3. *CIMSS Publications* displays the publications of the Institute's scientists: http://library.ssec.wisc.edu/resources/cimss/cimss.php#20052009
4. The Library also produces individual bibliographies for each scientist, many of whom use these listings on their personal homepages: http://library.ssec.wisc.edu/publications/affiliation.php
5. *ITAR information* tracks the history, policy development, legislation, and news about the International Traffic in Arms Regulations (ITAR): http://library.ssec.wisc.edu/resources/itar/

4. **Electronic Journal Access**

The Schwerdtfeger Library is one of several campus libraries that jointly fund electronic access to journals of the American Geophysical Union. These and many other electronic journals require partnerships to fund access, and are crucial to supporting the research interests of CIMSS scientists.

Additionally, the library monitors and purchases new publications or makes recommendations to the campus for materials that support on-going and new research interests of CIMSS scientists.

Journals can be accessed from the Schwerdtfeger Library Electronic Journals: http://library.ssec.wisc.edu/resources/ejournals/

5. **Using a Citation Analysis to Explore Mission Success: Paper Published in BAMS**

Since 2004, the Schwedtfeger Library has compiled and reported metrics on publishing history and patterns of CIMSS authors that Steve Ackerman, its director, has utilized in annual and base funding reviews. Steve Ackerman and Jean Phillips received funding from Thompson Scientific and the CIMSS base grant to further the analysis. With the help of Dan Bull and Tom Achtor, they expanded the investigation to include additional parameters and trends.

The paper, *Using a Publication Analysis to Explore Mission Success*, was published in the October 2009 issue of BAMS. The paper examines the mission success of CIMSS by using bibliometric methods that include quantitative, descriptive and citation analyses. We developed a methodology to facilitate examination of patterns in research, publishing and collaborations, quantification and categorization of research partners, classification of topics, historical and emerging areas of research; and publishing venues. These patterns, over a 12-year period, were used to assess whether the Institute is achieving its mission goals of: 1) fostering collaborative research, 2) becoming a center of excellence, and 3) educating scientists and students.

Findings show that a self-study of publishing activities yields useful results about programmatic strengths and weaknesses and could be used as a first step of a larger study of federal government research and programmatic evaluation

6. **Suomi Web Site**

Schwerdtfeger Library staff developed an extensive web site devoted to the life and professional accomplishments of Verner E. Suomi, Father of Satellite Meteorology, and founder of CIMSS. The web site is being used extensively by researchers in-house and around the world who are interested in the broad work of this atmospheric science visionary.

The site includes Dr. Suomi's: Biography and general history, curriculum vitae, awards, professional publications, archive of personal papers, ATS image database, film loops (ATS imagery and others), and interactive timeline of significant events and achievements: http://library.ssec.wisc.edu/SuomiWebsite/index.html

7. **Assisting Authors with Copyright Decisions**

Scholarly publishing is rapidly changing and many scholars are taking a more active role in managing their copyrights. Librarians are assisting them with these decisions, making them aware of their rights as an author. In 2007 the UW-Madison Faculty Senate passed a resolution encouraging faculty to control their copyright and recommended the use of an endorsed author addendum. Many other universities have made similar endorsements.

In addition, librarians are actively talking with scientists about publishing venues, open access, and other copyright issues. See, for example,

- What's New With Intellectual Property: http://library.ssec.wisc.edu/resources/news/news.php?htm=2008-04.htm
- Copyright Policies of Scientific Publishers: http://library.ssec.wisc.edu/resources/news/news.php?htm=2006-03.htm
- Faculty Senate Passes Resolution: http://library.ssec.wisc.edu/resources/news/news.php?htm=2007-05.htm

8. **Unique Materials**

The Schwerdtfeger Library's physical collection includes thousands of items that are unique to the UW-Madison campus and in many instances, the Schwerdtfeger Library is the only source for the item nationally. Some of the collections include: German language research materials, V.E. Suomi papers, VAS materials, and ATS and other satellite photograph collections.

9. **Resource for Grant Announcements**

The Schwerdtfeger Library supports CIMSS scientists by filtering grant announcements in order to aid discovery of funding very specific to their research needs. In addition to grant announcements, the library has created and maintains a grants information page on its web site to assist researchers with other related needs: http://library.ssec.wisc.edu/grants/

Capabilities: Teaching and Outreach

1. **Information Resources in the Atmospheric Sciences, Current and Historical**

Schwerdtfeger Library staff develop and deliver lectures outlining tools that students and staff can use to uncover current or historical information in the atmospheric sciences. Lectures focus on specific subject databases, methods of information retrieval, search query constructions, discussion of peer-review and types of source material, and evaluation techniques.

Students use these new skills to support the research they are conducting with CIMSS, SSEC and other scientists.

2. **The Suomi Science Museum**

The Suomi Science Museum Committee is working to spread the word about the museum concept. The Committee has won approvals from the campus and the State of Wisconsin and is enumerated in the 2009-2011 State budget. The Committee, with Paul Menzel as principal investigator, received $100K from the National Oceanic and Atmospheric Administration.

Committee members are giving talks to local audiences to promote the idea and establish the importance of our noteworthy history in satellite remote sensing. One of the lectures, recorded by Wisconsin Public Television, is playing to audiences across the state: http://www.biotech.wisc.edu/webcams/Index.aspx

Additionally, the SSEC's weather globe was featured at the Madison Children's Museum, the UW Space Place and the Milwaukee Children's Museum, all in the past year. Rick Kohrs has programmed the globe to feature numerous types of data from the SSEC Data Center and built a touch-screen interface for museum visitors.

Work continues to raise awareness with industry partners and others. The museum committee has planned an exhibition and reception to commemorate the 50th anniversary of satellite meteorology and its roots at the University of Wisconsin.

Challenges for the Future

1. Intellectual property: Scholarly publishing is changing and publishing venues, open access, and other copyright issues will become more prevalent and need the guidance of information professionals.
2. Federal library closures: There have been many federal library closures and staff reductions in the past several years. There are numerous issues involved, not the least of which is maintaining access to federally supported scientific research, because this material is used by both federal and university researchers and whether the burden of research support will shift to academic libraries if federal libraries are de-funded.
3. Budget constraints at state and federal level: Libraries that are state-supported, and those that are not, are experiencing huge challenges in their ability to continue to provide materials, electronically and in traditional formats, to meet the education and research demands of their students and faculty. Demands for scholarly and other materials in electronic form will continue to increase. University of Wisconsin-Madison libraries are discussing staffing reductions and library consolidations as possible ways to deal with budget reductions.
4. Increasing research needs with static staffing levels: As the volume of information increases, so does the need for information filtering and verification. Experienced information professionals are able to search and analyze effectively because they know how to search, which tools are available to the subject area and which of those will yield the best results. Demands for these skills and services are increasing.
5. Restructuring of UW-Madison research and graduate education units: If the reorganization is implemented as proposed, it may negatively affect the provision of information services and research support.

Appendix O

Budget Narrative for
The Continuation of the
Cooperative Institute for Meteorological Satellite Studies (CIMSS)
at the University of Wisconsin-Madison

We request a total dollar amount of $60,000,000 for the period 1 July 2010 through 30 June 2015 to fund Task I management activities and Task II and III research and education activities as described in the proposal narrative. A five year total of $1,450,000 ($290,000 each year) is proposed for Task I. Detailed explanations of the Task I budget information is given below. A general explanation of Task II and Task III budgeting is also provided. The estimated costs to conduct the activities described in this proposal are itemized in the budget pages provided.

Task II and Task III budget requests refer to potential funding for individual research projects that will be competitively reviewed and awarded by NOAA through modifications to the Cooperative Agreement between NOAA and the UW-Madison. The Task II and III cost estimates are based largely on historical programs funded by NOAA to CIMSS, and are also based on CIMSS research themes described in the proposal narrative.

Personnel – Task I only
This section identifies the staff required and their time commitment (hours needed) to conduct the work in Task I in this proposal. Salary information is provided in the SF424A and the UW-Madison Excel budget sheets. To calculate hourly rates for salaried employees, the formula is Total Salary divided by billable hours. Hourly rates are calculated using a base of 1,350 billable hours for Faculty and 1,757 billable hours per year for Academic Staff. The base for research interns, research associates, and graduate students is 1,800 billable hours. Undergraduates are paid on an hourly basis, so no computation is required. Vacation, holiday and sick leave time is not charged directly to the projects. For budgets with duration greater than one year, we use a 2% inflation factor to labor rates to account for cost of living adjustments. To achieve the goals of this proposal we estimate an approximate total effort for the 5 years follows:

Name	Title	Classification	Hours	% Effort
Steven Ackerman	Principal Investigator	Academic Staff	628	9%
Thomas Achtor	ED - Science	Academic Staff	1350	15%
Leanne Avila	Web Master	Academic Staff	1975	22%
Researcher-TBD	Researcher	Academic Staff	1802	20%
Maria Vasys	Program Assistant	Classified Staff	2350	26.1%
Visiting Scientist	Visiting Scientist	Academic Staff	5400	60%
Graduate Student	Research Assistant	Student	4500	50%
Student Hourly	Undergraduate Student	Student	2100	>1%

Participant Activity Summary
Steve Ackerman as PI and Director of CIMSS will oversee all management, research and education project activities and is responsible for required reporting.
Tom Achtor as Executive Director will manage the daily activities of CIMSS, working with the CIMSS Director on management issues.
Leanne Avila is the CIMSS Webmaster and document editor, providing support for the CIMSS web home pages and CIMSS publications.
A Researcher to be determined will work on any Task I projects identified by the Director

Maria Vasys is the CIMSS Program Assistant providing management support to the Director and Executive Director and organizational support for CIMSS staff.
A Visiting Scientist to be determined will work on projects of interest to NOAA and identified by the CIMSS Director.
A Graduate Student to be determined will work on projects of interest to NOAA where specific research project funding has not been identified. This is often the first year of funding for a Master level student.
Undergraduate students will work on projects of interest to NOAA and identified by the CIMSS Director

Fringe Benefits
Fringe rates are dependent on employee classification (which is listed under the Personnel section). Please see the below table for a detailed summary of how the fringe benefit rate is calculated at the University of Wisconsin-Madison:

University of Wisconsin-Madison
Components of the 2009-2010 Fringe Benefit Rate

Benefit Category	**Faculty & Academic Staff**	**Classified Staff**	**LTE**	**#1**	**#2**	**#3**	**#4**	**Student**
Income Continuation	0.1	0.2						
Unemployment Comp.	0.1	0.1	1.2					
Worker's Comp.	0.2	0.2	0.2					
Social Security	6.1	6.2	6.2	6.2		5.0		2.4
Medicare	1.4	1.4	1.4	1.4		1.0		0.6
Health Insurance	16.2	27.0	5.3	17.5	26.0		13.5	
Life Insurance	0.1	0.1						
Retirement	13.3	13.6	4.4					
Prior Year Adj.	1.0	1.7	2.3	1.4	1.5		2.5	0.5
Totals	**38.50%**	**50.50%**	**21.00 %**	**26.50 %**	**27.50 %**	**6.00 %**	**16.00 %**	**3.50%**

#1 Research Associates and Grad Interns
#2 Research Assistants, Project, and Teaching Assistants, Pre-Doc Fellows and/or Trainees
#3 Ad Hoc Program Specialists, Undergraduate Assistants and Undergraduate Interns
#4 Post-Doc Fellows and/or Trainees

Travel – Task I only
Task I travel costs are for the UW-Madison management team to attend meetings of interest to NOAA. The travel budgets in this proposal are based on recent history regarding the amount of travel needed to support the project, interact with collaborators, and present results. The SSEC travel office monitors current airfares, hotel costs, car rentals, taxi fares, etc and provides estimates for travel costs for frequent meeting sites. The UW-Madison, in accordance with Wisconsin state law, reimburses actual travel costs for hotel and meal expenses up to a certain maximum rate. All travel must be approved by the SSEC/CIMSS administration. Travel costs are reviewed by the SSEC travel office and one of the SSEC Executive Directors.

To support Task I research, trips have been budgeted at a total cost of $13,700 per year. We request

a) $3,800 for 1 trip for 5 people at 2 days each to attend the CIMSS Board and/or Council meetings held in Madison. This travel support is for non UW-Madison university members of the Board and Council.
b) $9,900 for 4 trips for 2 people at 5 days each to attend science meetings that held in Washington DC. This is primarily for the Director and Executive Director to attend meetings in Washington DC.

Please see the summary below for details regarding the number of trips, estimated number of days, and rates used for determining the total amount per trip. The travel information is identical for each of the 5 years of the proposal.

Travel Detail (each year)

a) Trips for Board and Council Members (5)

	fares		subtotal	
Airfare	5	450	2250	
	# days	cost / day		
Hotel	10	90	900	
Meals	10	40	400	
Taxi: airport	10	25	250	
				3,800

b) Trips for PI(4), ED(4) / 5 days each / Washington DC

	fares		subtotal
Airfare	8	450	3600
	# days	cost / day	
Hotel	20	250	5000

Meals	20	40	800		
Washington Metro	20	5	100		
Taxi airport	16	25	400		
				9,900	
Travel Total					13,700

Capital Equipment – Task I
Capital Equipment refers to hardware purchases exceeding $5,000. If Capital Equipment is requested through a proposal, a separate budget page is provided with details on the equipment required, and a quote from the vender is provided in the budget narrative. Capital Equipment purchases are to be vested with the UW Space Science and Engineering Center. There is no Capital Equipment budgeted for Task I.

Supplies – Task I
We are requesting funding of $10,657 for Parts, Materials, Fees and Services for the 5 year period. These items are required to support the research infrastructure of a particular project. They include items such as data disks and tape cartridges, small computer peripherals, off the shelf computer software such as compilers, computer maintenance licensing agreements, conference registration and abstracts, and in-house publishing. Costs are based on current estimates and recent purchases with our contracted providers.

Construction
This program does not expect to perform any construction or renovation.

Other

Publications costs are based on a $140 per page charge, which is the standard rate for refereed journal publications from the American Meteorological Society. Publication size is based on historical evidence from previous NOAA projects and expected publications from this project in the coming year. For Task I, we anticipate two publications per year of 15 pages each, for a total of $4,200 every year and a total cost of $21,000 for the 5 year period.

Tuition Remission is assessed by the University for graduate student employees to pay for out of state tuition costs. It is a fixed dollar amount of $8,000 per student per year regardless of appointment percentage and is excluded from the Indirect Cost. One graduate student creates a Tuition Remission cost of $8,000 each year for Task I. We request a total of $40,000 for the 5 year period.

University Indirect Cost, currently at 48.5%, is directly negotiated with the U.S. government and is charged to all budget items except capital equipment purchases over $5,000 and student tuition remission, which are free of Indirect Cost. The first $25,000 of a subcontract award is subject to university Indirect Cost; any award above $25,000 is free of Indirect Cost.

Matching

We do not expect any cost matching for this proposal.

Cost Sharing

We are cost sharing 1% of PI Steven Ackerman's labor with a five year total of $9,105 which includes his salary and fringe benefits.

Severability

While the budgets presented herein cover the entire period of the CIMSS four and a half year Cooperative Agreement, it is recognized that each research task is comprised of many individual research projects. Proposals for these projects will be individually reviewed and funded for periods that fall within the four and a half year proposal timeframe. The budgets herein are severable. Further, because the proposal is divided into major tasks, it can be severed proportionately as needed. Since the Cooperative Agreement operates on a research collaboration basis, results of research conducted with the funds under this agreement will (to the point of being severed) be documented and submitted to NOAA/NESDIS as the University of Wisconsin CIMSS product, unless other specific arrangements are made.

Budget: Continuation of CIMSS at the University of Wisconsin-Madison

5 Year Budget Plan: 1 July 2010 to 30 June 2015

Summary of Tasks I - III

	Year 1: 2010-11	Year 2: 2011-12	Year 3: 2012-13	Year 4: 2013-14	Year 5: 2014-15	5 Year Total
Task I: CIMSS management support, including general education and outreach activities	$ 290,000	$ 290,000	$ 290,000	$ 290,000	$ 290,000	$ 1,450,000
Task II: Research involving direct collaboration with NOAA scientists, including research collaborations with ASPB	$ 9,910,000	$ 9,910,000	$ 9,910,000	$ 9,910,000	$ 9,910,000	$ 49,550,000
Task III: Research involving minimal collaboration with NOAA scientists, including that from other NOAA competitive programs	$ 1,800,000	$ 1,800,000	$ 1,800,000	$ 1,800,000	$ 1,800,000	$ 9,000,000
Total by Year	$ 12,000,000	$ 12,000,000	$ 12,000,000	$ 12,000,000	$ 12,000,000	$ 60,000,000

Budget: Continuation of CIMSS at the University of Wisconsin-Madison

5 Year Budget Plan: 1 July 2010 to 30 June 2015

Summary of Tasks I-III by Cost Category

	Year 1: 2010-11	**Year 2: 2011-12**	**Year 3: 2012-13**	**Year 4: 2013-14**	**Year 5: 2014-15**	**5 Year Total**
Salaries-Academic Staff	4,932,126	4,897,272	4,804,029	4,781,410	4,811,591	24,226,428
Fringe Benefits-Academic Staff (38.5%)	1,898,869	1,885,450	1,849,551	1,840,843	1,852,463	9,327,176
Salaries-Research&Project Assistant	244,800	249,696	254,690	259,784	264,979	1,273,949
Fringe Benefits-Research&Project Assistant (27.5%)	67,320	68,666	70,040	71,441	72,869	350,336
Wages-Classified Staff	10,193	9,997	9,177	9,152	9,336	47,855
Fringe Benefits-Classified Staff (50.5%)	5,147	5,048	4,634	4,622	4,715	24,166
Wages-Student Hourly Workers	25,000	25,500	26,010	26,530	27,061	130,101
Fringe Benefits-Student Hourly Workers (3.5%)	875	893	910	929	947	4,554
Subtotal Salaries, Wages and FB	7,184,330	7,142,522	7,019,041	6,994,711	7,043,961	35,384,565
Travel	280,000	300,000	320,000	340,000	360,000	1,600,000
Publications	252,000	252,000	280,000	280,000	280,000	1,344,000
Materials and Services	113,721	133,088	147,963	152,293	163,851	710,916
Total Direct Cost	7,830,051	7,827,610	7,767,004	7,767,004	7,847,812	39,039,481
University Indirect Cost (48.5%)*	3,833,949	3,796,390	3,766,996	3,766,996	3,806,188	18,970,519
Student Tuition Remission	96,000	96,000	96,000	96,000	96,000	480,000
Subcontracts	150,000	150,000	200,000	200,000	150,000	850,000
Capital Equipment	90,000	130,000	170,000	170,000	100,000	660,000
Total Administrative Costs	12,000,000	12,000,000	12,000,000	12,000,000	12,000,000	60,000,000

*University Indirect Cost also includes the overhead of the first $25,000 for each subcontract, three subcontracts are budgeted so the total amount subject to overhead is $75,000

Budget: Continuation of CIMSS at the University of Wisconsin-Madison

5 Year Budget Plan: 1 July 2010 to 30 June 2015

Task I: CIMSS management support, including general education and outreach activities

	Year 1: 2010-11	**Year 2: 2011-12**	**Year 3: 2012-13**	**Year 4: 2013-14**	**Year 5: 2014-15**	**5 Year Total**
Salaries-Academic Staff	86,859	87,748	88,996	88,887	88,742	441,232
Fringe Benefits-Academic Staff (38.5%)	33,441	33,783	34,264	34,222	34,165	169,875
Salaries-Research&Project Assistant	20,400	20,808	21,224	21,649	22,082	106,163
Fringe Benefits-Research&Project Assistant (27.5%)	5,610	5,722	5,837	5,953	6,073	29,195
Wages-Classified Staff	10,193	9,997	9,177	9,152	9,336	47,855
Fringe Benefits-Classified Staff (50.5%)	5,147	5,048	4,634	4,622	4,715	24,166
Wages-Student Hourly Workers	6,600	5,049	4,578	4,086	3,572	23,885
Fringe Benefits-Student Hourly Workers (3.5%)	231	177	160	143	125	836
Subtotal Salaries, Wages and FB	168,481	168,332	168,870	168,714	168,810	843,207
Travel	13,700	13,700	13,700	13,700	13,700	68,500
Publications	4,200	4,200	4,200	4,200	4,200	21,000
Materials and Services	2,340	2,465	1,903	2,035	1,914	10,657
Total Direct Cost	188,721	188,697	188,673	188,649	188,624	943,364
University Indirect Cost (48.5%)	91,529	91,518	91,506	91,495	91,483	457,531
Student Tuition Remission	8,000	8,000	8,000	8,000	8,000	40,000
Total Administrative Costs	288,250	288,215	288,179	288,144	288,107	1,440,895
Cost Sharing						
PI Steven Ackerman 1% Labor Cost with Fringe Benefits	1,750	1,785	1,821	1,856	1,893	9,105
Grant total for Administrative Costs	290,000	290,000	290,000	290,000	290,000	1,450,000

Budget: Continuation of CIMSS at the University of Wisconsin-Madison
Task I: 5 Year Summary
1 July 2010 - 30 June 2015

		Hours	Rate	Salary	Fringe	Cost	Totals
I.	Labor and Fringe Benefits						
	PI - Steven Ackerman	628		$61,181	$23,556	$ 84,737	
	ED - Thomas Achtor	1350		98,742	38,015	136,757	
	Webmaster-Leanne Avila	1975		62,127	23,919	86,046	
	Researcher - TBD	1802		91,229	35,124	126,353	
	Prog. Asst. - Maria Vasys	2350		47,855	24,166	72,021	
	Visiting Scientist	5400		127,953	49,261	177,214	
	Research Assistant	4500		106,163	29,195	135,358	
	Student Hourly	2100		23,885	836	24,721	
	Subtotal			$619,135	$224,072		$843,207
II.	Travel (each year)						
a)	Board and Council University Attendees Only 1 trip / 5 people / 2 days / Madison					19,000	
b)	CIMSS Travel 4 trips / 2 people / 5 days each / Washington DC					49,500	
							68,500
III.	Publications: 30 pages @ $140 per page (each year)						21,000
IV.	Parts, Materials, Fees and Services						10,657
V.	University Indirect Cost at 48.5%						457,531
VI.	Student Tuition Remission						40,000
	TOTAL						$1,440,895
VII.	Cost Sharing PI Steven Ackerman 1% Labor Cost withFringe Benefits						9,105
VIII.	GRANT TOTAL						$1,450,000

Budget: Continuation of CIMSS at the University of Wisconsin-Madison
Task I: Year 1
1 July 2010 - 30 June 2011

		Hours	Rate	Salary	Fringe	Cost	Totals
I.	Labor and Fringe Benefits						
	PI - Steven Ackerman	125	93.60	$11,700	$4,505	$ 16,205	
	ED - Thomas Achtor	270	70.27	18,974	7,305	26,279	
	Webmaster-Leanne Avila	400	30.23	12,092	4,655	16,747	
	Researcher - TBD	400	48.77	19,506	7,510	27,016	
	Prog. Asst. - Maria Vasys	520	19.60	10,193	5,147	15,340	
	Visiting Scientist	1080	22.77	24,587	9,466	34,053	
	Research Assistant	900	22.67	20,400	5,610	26,010	
	Student Hourly	600	11.00	6,600	231	6,831	
	Subtotal			$124,052	$44,429		$168,481
II.	Travel						
	a) Board and Council University Attendees Only 1 trip / 5 people / 2 days / Madison					3,800	
	b) CIMSS Travel 4 trips / 2 people / 5 days each / Washington DC					9,900	
							13,700
III.	Publications: 30 pages @ $140 per page						4,200
IV.	Parts, Materials, Fees and Services						2,340
V.	University Indirect Cost at 48.5%						91,529
VI.	Student Tuition Remission						8,000
	TOTAL						$288,250
VII.	Cost Sharing PI Steven Ackerman 1% Labor Cost withFringe Benefits						1,750
VIII.	GRANT TOTAL						$290,000

Budget: Continuation of CIMSS at the University of Wisconsin-Madison
Task I: Year 2
1 July 2011 - 30 June 2012

		Hours	Rate	Salary	Fringe	Cost	Totals
I.	Labor and Fringe Benefits						
	PI - Steven Ackerman	126	95.47	$12,030	$4,632	$ 16,662	
	ED - Thomas Achtor	270	71.68	19,354	7,451	26,805	
	Webmaster-Leanne Avila	400	30.84	12,334	4,749	17,083	
	Researcher - TBD	381	49.74	18,951	7,296	26,247	
	Prog. Asst. - Maria Vasys	500	19.99	9,997	5,048	15,045	
	Visiting Scientist	1080	23.22	25,079	9,655	34,734	
	Research Assistant	900	23.12	20,808	5,722	26,530	
	Student Hourly	450	11.22	5,049	177	5,226	
	Subtotal			$123,602	$44,730		$168,332
II.	Travel						
	a) Board and Council University Attendees Only 1 trip / 5 people / 2 days / Madison					3,800	
	b) CIMSS Travel 4 trips / 2 people / 5 days each / Washington DC					9,900	
							13,700
III.	Publications: 30 pages @ $140 per page						4,200
IV.	Parts, Materials, Fees and Services						2,465
V.	University Indirect Cost at 48.5%						91,518
VI.	Student Tuition Remission						8,000
	TOTAL						$288,215
VII.	Cost Sharing PI Steven Ackerman 1% Labor Cost withFringe Benefits						1,785
VIII.	GRANT TOTAL						$290,000

Budget: Continuation of CIMSS at the University of Wisconsin-Madison
Task I: Year 3
1 July 2012 - 30 June 2013

		Hours	Rate	Salary	Fringe	Cost	Totals
I.	Labor and Fringe Benefits						
	PI - Steven Ackerman	126	97.38	$12,270	$4,724	$ 16,994	
	ED - Thomas Achtor	270	73.11	19,741	7,600	27,341	
	Webmaster-Leanne Avila	400	31.45	12,581	4,844	17,425	
	Researcher - TBD	371	50.74	18,823	7,247	26,070	
	Prog. Asst. - Maria Vasys	450	20.39	9,177	4,634	13,811	
	Visiting Scientist	1080	23.69	25,581	9,849	35,430	
	Research Assistant	900	23.58	21,224	5,837	27,061	
	Student Hourly	400	11.44	4,578	160	4,738	
	Subtotal			$123,975	$44,895		$168,870
II.	Travel						
	a) Board and Council University Attendees Only 1 trip / 5 people / 2 days / Madison					3,800	
	b) CIMSS Travel 4 trips / 2 people / 5 days each / Washington DC					9,900	
							13,700
III.	Publications: 30 pages @ $140 per page						4,200
IV.	Parts, Materials, Fees and Services						1,903
V.	University Indirect Cost at 48.5%						91,506
VI.	Student Tuition Remission						8,000
	TOTAL						$288,179
VII.	Cost Sharing PI Steven Ackerman 1% Labor Cost withFringe Benefits						1,821
VIII.	GRANT TOTAL						$290,000

Budget: Continuation of CIMSS at the University of Wisconsin-Madison
Task I: Year 4
1 July 2013 - 30 June 2014

		Hours	Rate	Salary	Fringe	Cost	Totals
I.	Labor and Fringe Benefits						
	PI - Steven Ackerman	126	99.33	$12,516	$4,819	$ 17,335	
	ED - Thomas Achtor	270	74.58	20,135	7,752	27,887	
	Webmaster-Leanne Avila	375	32.08	12,031	4,632	16,663	
	Researcher - TBD	350	51.75	18,113	6,974	25,087	
	Prog. Asst. - Maria Vasys	440	20.80	9,152	4,622	13,774	
	Visiting Scientist	1080	24.16	26,092	10,045	36,137	
	Research Assistant	900	24.05	21,649	5,953	27,602	
	Student Hourly	350	11.67	4,086	143	4,229	
	Subtotal			$123,774	$44,940		$168,714
II.	Travel						
	a) Board and Council University Attendees Only 1 trip / 5 people / 2 days / Madison					3,800	
	b) CIMSS Travel 4 trips / 2 people / 5 days each / Washington DC					9,900	
							13,700
III.	Publications: 30 pages @ $140 per page						4,200
IV.	Parts, Materials, Fees and Services						2,035
V.	University Indirect Cost at 48.5%						91,495
VI.	Student Tuition Remission						8,000
	TOTAL						$288,144
VII.	Cost Sharing PI Steven Ackerman 1% Labor Cost withFringe Benefits						1,856
VIII.	GRANT TOTAL						$290,000

Budget: Continuation of CIMSS at the University of Wisconsin-Madison
Task I: Year 5
1 July 2014 - 30 June 2015

		Hours	Rate	Salary	Fringe	Cost	Totals
I.	Labor and Fringe Benefits						
	PI - Steven Ackerman	125	101.32	$12,665	$4,876	$ 17,541	
	ED - Thomas Achtor	270	76.07	20,538	7,907	28,445	
	Webmaster-Leanne Avila	400	32.72	13,089	5,039	18,128	
	Researcher - TBD	300	52.79	15,836	6,097	21,933	
	Prog. Asst. - Maria Vasys	440	21.22	9,336	4,715	14,051	
	Visiting Scientist	1080	24.64	26,614	10,246	36,860	
	Research Assistant	900	24.54	22,082	6,073	28,155	
	Student Hourly	300	11.91	3,572	125	3,697	
	Subtotal			$123,732	$45,078		$168,810
II.	Travel						
	a) Board and Council University Attendees Only					3,800	
	1 trip / 5 people / 2 days / Madison						
	b) CIMSS Travel					9,900	
	4 trips / 2 people / 5 days each / Washington DC						
							13,700
III.	Publications: 30 pages @ $140 per page						4,200
IV.	Parts, Materials, Fees and Services						1,914
V.	University Indirect Cost at 48.5%						91,483
VI.	Student Tuition Remission						8,000
	TOTAL						$288,107
VII.	Cost Sharing						
	PI Steven Ackerman 1% Labor Cost withFringe Benefits						1,893
VIII.	GRANT TOTAL						$290,000

Budget: Continuation of CIMSS at the University of Wisconsin-Madison
Travel Detail Task I (for each year)
1 July 2010 to 30 June 2015

a) Trips for Board and Council University Attendees Only (5)

	fares		subtotal	
Airfare	5	450	2250	
	# days	cost / day		
Hotel	10	90	900	
Meals	10	40	400	
Researcher - TBD	10	25	250	
				3,800

b) Trips for PI(4), ED(4) / 5 days each / Washington DC

	fares		subtotal	
Airfare	8	450	3600	
	# days	cost / day		
Hotel	20	250	5000	
Meals	20	40	800	
Washington Metro	20	5	100	
Taxi airport	16	25	400	
				9,900

Travel Total	13,700

Budget: Continuation of CIMSS at the University of Wisconsin-Madison

5 Year Budget Plan: 1 July 2010 to 30 June 2015

Task II: Research involving direct collaboration with NOAA scientists, including research collaborations with ASPB

	Year 1: 2010-11	Year 2: 2011-12	Year 3: 2012-13	Year 4: 2013-14	Year 5: 2014-15	5 Year Total
Theme 1: Satellite Meteorology Research and Applications	6,441,499	6,738,499	5,994,945	6,456,349	6,555,844	32,187,136
Theme 2: Satellite Sensors and Techniques	1,490,955	1,338,000	1,784,554	1,560,735	1,277,024	7,451,268
Theme 3: Environmental Models and Data Assimilation	1,531,050	1,263,750	1,635,000	1,432,566	1,581,630	7,443,996
Theme 4: Outreach and Education	446,496	569,751	495,501	460,350	495,502	2,467,600
Total Direct Costs	9,910,000	9,910,000	9,910,000	9,910,000	9,910,000	49,550,000

See budget narrative in proposal text for budget details and explanations 49,550,000

Budget: Continuation of CIMSS at the University of Wisconsin-Madison

5 Year Budget Plan: 1 July 2010 to 30 June 2015

Task III: Research involving minimal collaboration with NOAA scientists, including that from other NOAA competitive programs

	Year 1: 2010-11	**Year 2: 2011-12**	**Year 3: 2012-13**	**Year 4: 2013-14**	**Year 5: 2014-15**	**5 Year Total**
Theme 1: Satellite Meteorology Research and Applications	1,172,700	1,170,000	1,172,412	1,188,000	1,146,420	5,849,532
Theme 2: Satellite Sensors and Techniques	267,300	267,300	272,673	268,515	274,455	1,350,243
Theme 3: Environmental Models and Data Assimilation	270,900	272,700	265,815	252,900	290,025	1,352,340
Theme 4: Outreach and Education	89,100	90,000	89,100	90,585	89,100	447,885
Total Direct Costs	1,800,000	1,800,000	1,800,000	1,800,000	1,800,000	9,000,000

See budget narrative in proposal text for budget details and explanations

Publications of the Cooperative Institute for Meteorological Satellite Studies, 2000-2009
Reviewed and Gray Literature

2000 Reviewed Literature

Anderson, M. C.; Norman, J. M.; Meyers, T. P., and Diak, G. R. An analytical model for estimating canopy transpiration and carbon assimilation fluxes based on canopy light-use efficiency. Agricultural and Forest Meteorology v.101, no.4, 2000, pp265-289

Baum, Bryan A.; Kratz, David P.; Yang, Ping; Ou, S. C.; Hu, Yongxiang; Soulen, Peter F., and Tsay, Si-Chee. Remote sensing of cloud properties using MODIS airborne simulator imagery during SUCCESS. 1. Data and models. Journal of Geophysical Research v.105, no.D9, 2000, pp11,767-11,780.

Baum, Bryan A.; Soulen, Peter F.; Strabala, Kathleen I.; King, Michael D.; Ackerman, Steven A.; Menzel, W. Paul, and Yang, Ping. Remote sensing of cloud properties using MODIS airborne simulator imagery during SUCCESS. 2. Cloud thermodynamic phase. Journal of Geophysical Research v.105, no.D9, 2000, pp11,781-11,792.

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