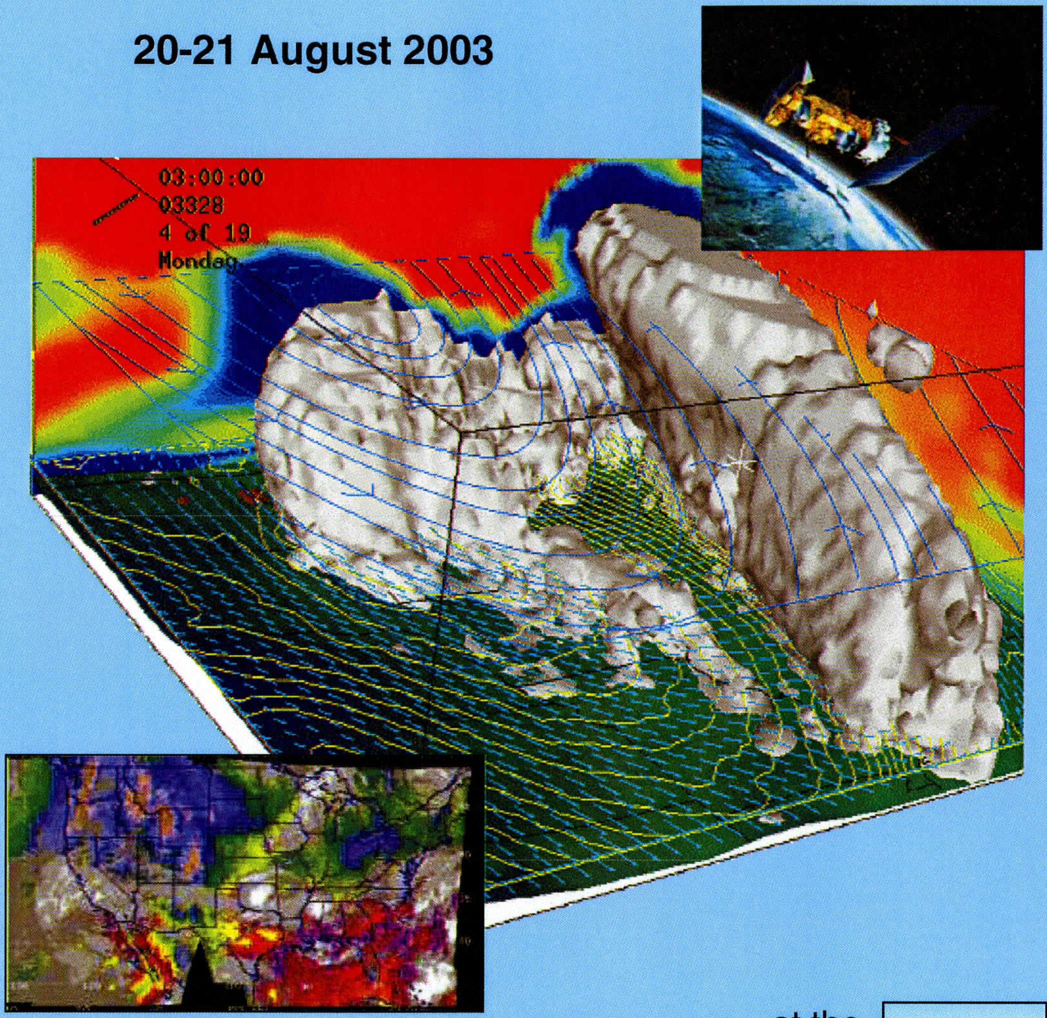
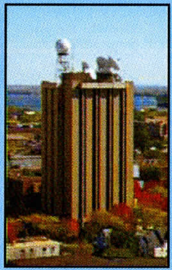
Workshop on Satellite Data Applications and Information Extraction

20-21 August 2003



at the



University of Wisconsin-Madison
Cooperative Institute for Meteorological Satellite Studies
Madison, WI

NOAA Satellite and Information Services
National Environmental Satellite, Data, and Information Service

Report on the

Workshop on Satellite Data Applications and Information Extraction

20-21 August 2003

at the

University of Wisconsin-Madison
Space Science and Engineering Center
Madison, WI

Sponsored by the NOAA National Environmental Satellite, Data, and Information Service (NESDIS) Office of Research and Applications (ORA) and the Cooperative Institute for Meteorological Satellite Studies (CIMSS)

Report compiled by
Gary S. Wade and Jeffrey R. Key
Office of Research and Applications
National Environmental Satellite, Data, and Information Service
National Oceanic and Atmospheric Administration

25 November 2003

Table of Contents

Introduction

A workshop was convened to begin planning for the utilization of new and future satellite products by weather forecasters in the field. The workshop sought to identify the most effective ways to present information to forecasters. Developing systems for capturing, viewing, and utilizing the critical information from these observations and combining them with conventional observations for a comprehensive and dynamic flow of information is the challenge that must be engaged.

This workshop concentrated on (1) current satellite capabilities and use, especially products from the Geostationary Operational Environmental Satellite (GOES), (2) capabilities of new and near-future satellites, (3) product displays, and (4) analytical tools and requirements. Data mining and information extraction techniques included the consideration of geospatial databases and presentations, principal component analysis, and application to the National Weather Service (NWS) Interactive Forecast Preparation System (IFPS).

The agenda was arranged to help address these fundamental issues:

- Satellite data and product utilization today
- Needs and requirements for the near-term
- Satellite capabilities through the next decade
- Mining the data for key information/parameters

The workshop was limited to approximately 25 participants. Two or three brief (10-15 minute) presentations began each session, followed by guided and open discussion, intended to engage an exchange of needs, capabilities, and ideas.

The workshop was hosted at the Space Science and Engineering Center (SSEC), University of Wisconsin-Madison (UW) by the Cooperative Institute for Meteorological Satellite Studies (CIMSS) and the Advanced Satellite Products Team (ASPT) of the NOAA National Environmental Satellite, Data, and Information Service (NESDIS) Office of Research and Applications (ORA). It is anticipated that future workshops within NOAA/NESDIS/ORA will continue the effort to connect researchers and users in the field, and thus, to help effectively develop the future satellite product suite.

Meeting Summary (with presentation synopses)

Welcome and Participant Introductions

Hank Revercomb, Director of SSEC, provided introductory remarks. He said that future satellite systems will provide a tremendous amount of new data, which challenges us to develop new ways to extract information. Madison is certainly an appropriate place to host this first workshop, following on the legacy of Professor Verner Suomi, who developed the spin scan camera for geostationary satellites and who initiated the first interactive satellite display system (McIDAS).

Al Powell, NOAA/NESDIS/ORA discussed the ways in which satellite data are currently used. The conventional way of presenting satellite data is to generate the product and make it available through data centers. Few tools are provided for obtaining information from the data product, and it is difficult to use the data to make economic and policy decisions. The next step is to combine different datasets, e.g., satellite data and model fields, and compute higher-level variables that can be used to make decisions.

Users want data combined with other (non-weather) information to make key decisions, to put information in context, and to derive knowledge from the fusion of multiple products, grids, algorithms, etc. So, one needs tools to support the knowledge derivation process. For example, a flood mapping tool may combine high-resolution satellite data, a digital elevation model, measurements of river depth, a relational database of structures (e.g., homes) in the floodplain, and a flood wave model to show exactly what homes will be flooded under various conditions.

We need to take on new ideas with controlled execution ("NICE"). We need user configurable applications, plug-in tools and algorithms, and a common infrastructure to succeed in a NICE environment.

The following discussion points were raised by the participants. Where does the role of the government end in the development of such tools? It often is not clear, but the government should not compete with private industry. How can a system such as the floodplain mapping example be applied to weather forecasting? Possibilities might be a plume model used for heat index applications or an integrated system used for assessing hurricane damage. What specifically can NESDIS do to help realize this vision of integrated information systems? Change data formats? Open up AWIPS (the NWS Advanced Weather Interactive Processing System)? This is seldom clear, but we are sure that we need to stop simply throwing data products "over the fence" to operations and expect that they will provide a useful product. The first step is for the research and operations sides to start talking!

Session 1: Current NESDIS Products

Jaime Daniels and **Gary Gray**, NOAA/NESDIS/ORA, summarized current NESDIS products. Issues important for the effective utilization of satellite products remain: timeliness, accuracy, coverage, information content, format, and presentation. Conclusions from the 1999 NWS field assessment of GOES sounder products highlighted: heightened forecasters' situational awareness to potential watch/warnings scenarios, the issuance of improved forecast products in over 79% of all active weather situations, and sounder use, especially for trend information.

Operational GOES products at NESDIS include temperature and moisture soundings, clear-sky radiances, atmospheric stability indices, surface skin temperature, cloud-top pressure and temperatures, cloud amount, cloud-drift winds, water vapor motion winds, and ASOS-SCP (satellite cloud product). Winds are not yet available in AWIPS, but will be soon.

Challenges identified include the need to reduce product latency, to improve product quality control and monitoring, and to deliver experimental satellite products into the hands of forecasters (AWIPS and the Internet), data fusion, new display capabilities and forecaster tools (DPI, training, etc.), and new improved instruments.

Audience feedback included the following comments and suggestions. Incorporation of satellite products into AWIPS is slow mainly because of limited bandwidth and computing power. Systems often need to be updated to handle new products. In addition, GOES Sounder data are not being used much in some NWS offices. One problem is that it hasn't been "advertised". It is suggested that data producers better advertise what their new products are and how they can be used when they are added to AWIPS. The AWIPS version at CIMSS is old, so it is difficult to create timely VISITview training sessions when it is not known sufficiently as to what is in the current version of AWIPS at NWS offices. It was mentioned that training from COMET has been successful in the NPOESS development program.

Gary Wade, NOAA/NESDIS/ORA, spoke on GOES data products. ASPT/CIMSS has a history of generating and providing its research products in real-time. GOES Sounder derived product imagery (DPI) and its animation, made available on the Web, is an effective means to display data from GOES, which specifically emphasizes its temporal and horizontal strengths.

Bob Rabin, NOAA/OAR/National Severe Storms Laboratory (NSSL), discussed the use of data at NSSL in Oklahoma, where radar is the most used data source. Interestingly, it seems that the newer forecasters use satellite data less than the older forecasters, who were exposed to, and gained experience with, satellite data before radar data were readily available.

Forecasters pride themselves on the human part of forecasting, not just relying on numerical weather prediction models. For example, they might see small-scale features in the wind and divergence fields that models do not simulate. One problem with model use is that the forecaster does not generally know what data are, or are not, used in the model.

At NSSL they do use a number of web-based products, e.g., wind vectors and divergence fields plotted on satellite images. They are experimenting with combining various datasets, bringing together diverse meteorological data to examine time series. Forecasters do this mentally, but primarily in a qualitative way.

Another application of satellite data is to use the skin temperature to "mine" information about surface wetness based on how quickly the surface heats over the course of a day compared to a monthly climatology. Other applications include fire weather forecasting.

Discussion issues focused on these new "tools". Although some products are developed in a "build it and they will come" motivation, others are requested or suggested by forecasters. Feedback from NWS offices is critical for improvement and is encouraged. Accompanying documentation and accessibility are also very important characteristics for products promoted and used on the Web. Drought and fire applications are relevant to NWS forecasters.

Session 2: New and Near-Future Satellites

Kathy Strabala, CIMSS, described the sensors and products from NASA's Earth Observing System (EOS) polar-orbiting satellites. Data from Terra and Aqua are obtained via direct broadcast at CIMSS. AIRS (Atmospheric Infrared Sounder) and MODIS (Moderate Resolution Imaging Spectroradiometer) are particularly important sensors for meteorological applications. A number of near real-time products are generated: calibrated and geo-located radiances, cloud mask, cloud properties (height, temperature emissivity, phase), and atmospheric profiles. The coverage ranges from the Mexican Yucatan Peninsula to the Arctic Circle, covering most of CONUS. New products will be added in the future: sea surface temperature (SST), aerosol, snow cover/lake ice, surface reflectance, scene classification, cloud optical properties, and AIRS level-2 products.

CIMSS MODIS products are provided to the Short-term Prediction Research and Transition Center (SPORT) and the Canadian Ice Service, among others. SPORT, in Huntsville, AL, also posts these CIMSS products on their website. SPORT is funded by NASA.

Tim Schmit, NOAA/NESDIS/ORA, discussed the future operational geostationary satellite system. The Advanced Baseline Imager (ABI) will be a geostationary instrument with higher spatial and temporal resolution than the current GOES imagers. Spectral bands will change, e.g., three water vapor bands rather than one. The future Hyperspectral Environmental Suite (HES) sounding instrument will provide full disk sounding, and at a rate five times faster than current geostationary sounders. It will have sharper weighting functions than the current GOES. The vertical resolving power increases because the noise decreases with so many channels. The HES-CW (Coastal Water) is to be a specialized imager with at least 14 channels at 300 m resolution.

Discussion on a few aspects of future satellites followed. The HES is being built for NOAA by NASA. Current products will certainly be better with the new satellites, but there will also be exciting new products such as inversion detection, cloud phase, surface emissivity, and the whole HES-CW approach. Some of these new products will be of indirect value to forecasters by improving model forecasts (e.g., surface emissivity use), while others will be used directly, e.g., cloud phase, which is very important when examining developing storms. Satellite products remain useful for examining real-time changes, which are entities that the models do not necessarily handle well given model generation at certain times and time scales.

Session 3: Satellite Data and Geographical Information Displays

Sam Batzli, UW's Environmental Remote Sensing Center, provided an overview of Geographic Information Systems (GIS). A GIS is a computer system capable of assembling, storing, manipulating, and displaying geographically referenced information. There are both commercial and free GIS programs. GIS systems are growing in popularity. One NOAA cross cutting priority is an integrated environmental observation and data management system. The National Center for Atmospheric Research (NCAR) 10-year plan includes a GIS initiative.

Some examples of ongoing NOAA GIS work include work by the National Geophysical Data Center (NGDC) on coastal zone mapping, coral reef information systems, and a coastal risk atlas. A recent NCAR workshop summarized needs as (1) increasing communication among researchers and practitioners using GIS in meteorology and climatology, (2) developing organization-wide GIS infrastructure (e.g., data formats), and (3) training atmospheric science researchers and practitioners in the use of GIS. GIS applications at the UW-Madison Environmental Remote Sensing Center (ERSC) include lake clarity, land cover change detection, spatial databases, and Web mapping.

Thoughts on potential integration scenarios with varied data sources were espoused. What if severe weather warnings included an in-path risk index for population, landmarks, land cover, and utilities? What if urban heat sinks could be factored into regional or micro-climate forecasts or climate change? What if GIS-based agricultural productivity forecasts could link soil models with real-time meteorological inputs? How can long-term climate change modeling improve land use planning at a statewide scale?

Specific next steps were suggested. GIS practitioners need to learn about McIDAS, netCDF, real-time data, and data archiving. Meteorologists need to trade data sets with GIS users/developers and begin to forge crosswalks and linkages. GIS users/developers and meteorologists need to identify common areas of interest and focused projects.

The discussion involved potential applications favorable to a GIS framework and more relevant to meteorological problems, e.g., tornado swaths mapped out for forecasters and time changes or image looping.

Ralph Meiggs, NOAA/NESDIS/OSDPD, stated the objectives of the NESDIS Office of Satellite Data Processing and Distribution (OSDPD): to provide users with the ability to layer and manipulate SSD (Satellite Services Division) products, provide products via web/internet, provide OSEI (Operational Significant Event Imagery) products as a more useful GeoTIFF, and produce these products on the fly.

Current datasets that OSDPD can handle include GOES SST, any McIDAS AREA file, text files, GOES image derived winds, Northern Hemisphere (NH) snow and ice. These are all in different formats and data structures. OSDPD is also developing an interactive mapping service, working on some geodatabase development, and building a metadata generator.

Marlene Patterson, NOAA/NESDIS/OSDPD, provided a demo of the OSDPD GIS on the Internet: a web interface allows for user-selectable layering of satellite-derived fire information (GOES, AVHRR, and MODIS algorithms) with NWS SPC (Storm Prediction Center) fire potential areas.

The workshop participants showed considerable interest in the addition of ancillary information to the satellite products, such as product quality flags, included as metadata, or terrain fields readily available for simultaneous mapping needs. Currently, the common lack of interoperability between data formats and systems often hinders the integration desired by the user. In an example shown of fire products from satellite, the addition of a cloud mask to the suite of products was suggested to inform viewers of where the satellite is unable to detect fires.

Dave Santek, SSEC, discussed the Man computer Interactive Data Access System (McIDAS), which was first released in 1973. It was originally developed to track clouds. McIDAS integrates many types of meteorological data through interactive and background product generation.

The Abstract Data Distribution Environment (ADDE) is used as a powerful means for local and remote data access. ADDE has read and write servers and can be used independent of McIDAS. It can read McIDAS, HDF, SAA (Satellite Active Archive) Level 1b, and raster files and can write all these, except HDF. It also can write netCDF; SAA writing is in progress. GeoTIFF input/output capability is being developed.

Some discussion ensued on why the NWS uses AWIPS rather than McIDAS. Although many factors (technical as well as administrative) were involved in the development of AWIPS, McIDAS actually had been a strong presence in many parts of the NWS, and is still influential. McIDAS was initially used for satellite imagery and related applications in NWS national centers, as well as later, in the form of RAMSDIS PC workstations, in many NWS field offices while AWIPS was being developed and deployed. Most of the satellite products now in AWIPS are generated within or originate from McIDAS environments. New three dimensional display versions of AWIPS are effectively built upon Vis5D software, which is part of the McIDAS package, developed at SSEC.

Tom Whittaker, CIMSS, gave examples of visualization tools that he and others are developing. The new tools today are network enabled (collaborative, read/write data across the network), written in Java and Python, and with no end-user cost. The focus tools are VISITview, Unidata's Integrated Data Viewer (IDV), NASA's Image Composite Editor (ICE), and hyper-spectral tools.

VISITview was developed for NWS/NESDIS teletraining. It is used for real-time collaborations, distance learning, and weather briefings. IDV allows for combining datasets and viewing them. ICE was developed at SSEC for the NASA Earth Observatory website. It provides for a flexible display and analysis of satellite images, but is mainly for web applications. Hyper-spectral analysis tools start to address the needs of algorithm development for hyper-spectral data. Such tools are being developed to integrate disparate data (e.g., MODIS, S-HIS), to provide local or remote data access, and to provide user extensibility.

The future is here! Remote data access should be extensively provided via DODS/OpeNDAP and ADDE. There should be spatial and temporal integration to provide a consistent data model, convenient network-enabled collaborations, and end-user configurability.

Discussion on how the issues and concerns with the "new tools" may apply to McIDAS, particularly with respect to hyper-spectral data, focused on data servers as the common thread, while applications may be different.

Session 4: Data Mining and Information Extraction Techniques

Joan Forester, U.S. Army Research Lab, described data fusion. Fusion-based knowledge is employed for military application. Why do we need to have data fusion? Information volume exceeds the war-fighter's capabilities to develop the situational understanding required for planning and acting within the adversary's decision cycle.

The goal is to facilitate quick war fighting decisions that fully leverage the huge volumes of available information. The approaches employ cognitive engineering and user-centered design, blackboard architecture, exploitation of DARPA rapid knowledge formation technologies, and leverage of semantic web techniques.

Vipin Kumar, University of Minnesota, gave an example of using data mining techniques to discover patterns in the climate system. The data sources were meteorological stations, satellites, and model fields. Can data mining techniques be used to find patterns in the data, e.g., clusters of areas with similar SST variability? An application showed that the clusters are strongly correlated with four El Nino indices. It was found that one cluster in particular was more strongly correlated with temperature in many regions of the globe than the El Nino index. This essentially defines a new climate index. The same can be applied to sea level pressure. Pairs of clusters emerge that are strongly correlated with the Arctic Oscillation (AO) and the North Atlantic Oscillation (NAO), resulting in an "index" that is simpler than the AO empirical orthogonal function (EOF) concept.

Potential satellite applications of this data mining include detecting patterns such as trajectories and fronts, finding relationships between leaf area index and topography of a river drainage basin, and finding relationships between fire frequency and elevations.

Roy George, Clark Atlanta University, provided another example of data mining for climate analysis. The data mining techniques were clustering algorithms and algorithms for feature extraction and knowledge discovery. The motivation is to find, within data rich environments, the cluster of most interest, using a data based approach. Technically, the fuzzy K-means clustering method is used to reduce an initially large set of clusters to the few of interest. The application of clustering with precipitation data in the southeast U.S. revealed regions that have been recognized as climatologically distinct.

Don Hillger, NOAA/NESDIS/ORA, discussed principal component analysis (PCA) of multispectral imagery to simplify, or reduce, the amount of data, to less, but more informative, products. The original spectral channels can therefore be replaced by a smaller number of PCs. Important combinations of channels can result which show the detection of atmospheric and surface features not readily obvious in the original imagery.

Session 5: Satellite Data Use in Today's NWS

Due to the fact that the NWS forecasters had already contributed significantly in the previous discussions and given the time constraints, this informal session was not held.

Session 6 (Day Two): Roundtable Discussions

Day two of the workshop started with a tour of the Space Science and Engineering Center, followed by a rotation of three demonstrations. **Sam Batzli** and **Tim Olsen** (UW) led a hands-on experience in the ERCS GIS computer laboratory. **Scott Bachmeier** (CIMSS) illustrated how the VISITview software is used collaboratively and for remote training. **Tom Rink** (CIMSS) showed development of interactive software for examining a 3-D "data cube". The rest of the morning was dedicated to discussions of the previous day's presentations and of future work.

Gary Wade guided the group through a set of slides provided by **Kevin Schrab**, NWS, entitled: *NOAA's National Weather Service – Satellite Data Utilization 2010-2020.* This talk was given by **Jack Hayes** in May 2003 at the NOAA Hyper-spectral Workshop. Topics included the expanded use of communication networks (NOAAPORT, NWS-Net, AWIPS wide area network), enhanced satellite data integration into AWIPS, enhanced use (assimilation) of satellite data in models, and steady improvement in model forecasts.

Future NWS expectations were listed as (1) sensor performance - improved detection of critical parameters (inversions, fog), additional parameters (cloud and surface properties), increased horizontal/vertical resolution, and improved accuracy and latency, and (2) service enhancements – improved support to core missions and new services. One overarching challenge is to develop an end-to-end solution - seamless research to operations, integrated observing system, efficient information extraction techniques, and effective training.

Many of the issues, concerns, and plans described in Hayes' slides were reiterations of what the workshop participants had already been discussing over the last day and a half, providing a solid review of the problems facing (satellite) researchers and field forecasters. Indeed, it was remarked that the needed efforts, described in the presentation, are actually the types of things that we are doing now! The critical need for provision of error characteristics with the satellite products was again stated, if satellite product use is to be improved in NWP.

<u>Questions for discussion</u>

- Can data mining techniques create new products for forecasters? Applications to climatology were described. It is not clear what applications there may be for operational meteorology.
- What new products from current and future satellite systems will be of interest to forecasters? Possibilities include cloud fields (characteristics: phase, etc.) and low-level atmospheric temperature inversions.
- What can we do to increase the use of satellite data, in general and specifically for forecasters? We should make efforts to bring satellite data directly into IFPS (the NWS' Interactive Forecast Preparation System). Currently satellite and other data cannot be viewed simultaneously within IFPS. We can increase availability of data beyond NOAAPORT, e.g., with ADDE servers and the Web. For example, if high-resolution MODIS data are available, how can we access it? We can develop new products, particularly when new sensors come on-line.
- How can information technology, operational environmental products, and integrated tool suites help users make better decisions? An end-to-end project may provide some answers.
- What mechanisms can be implemented to better connect research and operations (e.g., discussion groups, product oversight groups, additional workshops)?

Recommendations

Participants agreed that data producers are already delivering useful products to the data users and that the users provide some feedback. But it was clear that these activities could and should be extended and enhanced. Thus, the workshop participants made the following recommendations:

1. Continue and enhance communication between data producers and data users.
2. Improve data accessibility, particularly on the Web.
3. Forge collaborations between the meteorological and GIS communities.
4. Develop an end-to-end project that involves data producers and data users.

These are described in more detail in the following paragraphs.

<u>Recommentation #1: Continue and enhance communication between data producers and data users</u>. The initial effort of this workshop should be promoted and continued by

- compiling a (this) workshop final report,
- assembling and making available the individual presentations from the workshop,
- encouraging further discussion and collaboration, especially with respect to recommendation #4, by subscribing to and using an e-mail list group (send a message to majordomo@ssec.wisc.edu with "subscribe sat2info" in the body),
- and having quarterly discussions on progress and issues.

This workshop report and electronic presentations are available on the Web at http://stratus.ssec.wisc.edu/meetings/data_ws/.

While the above action items can begin on a case-by-case and individual basis, a second workshop would help solidify the outcome of this workshop. One way to broaden the participation in this activity is to rotate sponsorship among the NESDIS cooperative institutes. CICS (Cooperative Institute for Climate Studies) in Maryland would provide an emphasis on climate applications as well as tap into more local NWS Eastern and Southern Region forecasters. CIRA (Cooperative Institute for Research in the Atmosphere) in Colorado might emphasize mesoscale and/or image applications and attract NWS Central, Western, and Southern Region forecasters. Such a hosting rotation would promote more diversity in workshop participation as well as more interaction between the cooperative institutes themselves. Travel funding from NESDIS is vital to support an appropriate and sufficient number of NWS, ORA, academic, and other expert participants. A second workshop should be held 9-12 months from the time of the first, i.e., May – August of 2005. One possibility is to hold the workshop as a special session during Hyperspectral Workshop, August 17-19, 2004, in Madison, Wisconsin.

Although the approach of "data mining" was discussed in the first workshop, the goal of identifying potential applications of satellite data mining to shorter-term weather forecasting was not sufficiently realized. A second workshop should continue to explore such possibilities, particularly if forecasters could identify specific problems in which data miners would want to become engaged. Such synergy, although desired, did not occur in this workshop. A second workshop should also seek engage a greater number of NWS participants.

Recommentation #2: Improve data accessibility. Forecasters stated that not all products have to be within AWIPS to be useful. Products available on the Web are commonly used in forecast offices. However, some are poorly documented and difficult to find. So a first step would be to enhance data accessibility with a Web "portal" (a well-organized page of links to real-time products) and make existing documentation more visible (e.g., the GOES Product Catalog at http://orbit-net.nesdis.noaa.gov/arad/fpdt/goescat_v4/). Discussions on common grids and data formats should be pursued in the future.

Recommentation #3: Forge collaborations between the meteorological and GIS communities. Geographic Information Systems are becoming increasingly important in operational settings. The GIS and meteorological communities should foster their use by identifying common areas of interest. The starting point is the development of an end-to-end project, as described in the next recommendation.

Recommentation #4: Develop an end-to-end project. The end-to-end project starts with the development of a product and ends with a demonstration of its use in an operational forecasting environment. It will therefore involve data producers and data users. Possible topics include fog detection and traffic, cloud depiction, or local snowfall patterns, e.g., Colorado storm. The tasks involved in the project include:

- Explore physical retrievals and data mining techniques to develop a new or better product.
- Make the data and products available in a GIS.
- Use VISITview to collaborate with other researchers and to train users.
- Demonstrate real-time use of the product within a NWS Forecast Office.

Initial plans are to provide "new", and otherwise not readily available, satellite-derived products to the NWS Central Region (CR). This is to be a demonstration that provides easy access to the latest developments in satellite data within the standard AWIPS environment of a NWS office. Solicitation of interest in potentially beneficial satellite products, from CIMSS, should be made to CR Science and Operations Officers (SOOs) in an attempt to determine what offices would care to participate initially with preliminary products provided to CR. Eventually, all NWS offices could take advantage of research products added to the standard AWIPS data suite. Although the activity would not fully involve all the workshop participants, it nevertheless fulfills the primary objective of the workshop: improving the use of satellite-derived products.

Current satellite products being considered for provision to CR include, but are not limited to:

- layered precipitable water data from GOES,
- high resolution MODIS products (e.g. cloud phase),
- forecast imagery and clouds from the CIMSS Regional Assimilation System (CRAS), in which GOES cloud and layered moisture information are assimilated, and
- cloud top pressure data from GOES Imager.

Recommendation #1 should be completed as soon as possible, including preliminary discussions of the time and place of a second workshop. Recommendation #2 should be completed before the next workshop. Initial efforts in response to Recommendation #3 will be directed toward the end-to-end project of Recommendation #4. The project will begin immediately, and progress will be reported at the second workshop.

Concluding Remarks

In summary, this first workshop was a productive one. It improved the lines of communication between data producers and data users, explored the possibilities of new techniques in information extraction, enumerated the quantity, quality, and nature of current satellite-derived data products, described future satellite systems and products, and made clearer the needs of weather forecasters. While the workshop had a variety of goals, its success was a result of the degree to which it addressed how to better provide research and operational products to forecasters in the field and to the atmospheric community at large.

Appendix 1: Web Sites With Near Real-Time or Proto-type Satellite Data

Workshop participants listed the following websites for access to real-time or sample satellite data. They are listed in alphabetical order by link. The list is extensive, though not exhaustive.

CIMSS Realtime GOES Page
http://cimss.ssec.wisc.edu/goes/realtime/

Advanced Baseline Imager:
http://cimss.ssec.wisc.edu/goes/abi

Hyperspectral Environmental Suite:
http://cimss.ssec.wisc.edu/goes/abs

SSEC direct broadcast:
http://eosdb.ssec.wisc.edu/modisdirect

NOAA/NESDIS/ORA real-time GOES products:
http://orbit-net.nesdis.noaa.gov/goes

RAMSDIS online:
http://www.cira.colostate.edu/RAMM/ramsdol.main.html

NOAA Fire detection:
http://www.firedetect.noaa.gov

ERSC MODIS imager server:
http://www.lakesat.org

Landsat data (TM data updated daily):
http://www.landsat.org

NOAA Operational Significant Event Imagery (OSEI):
http://www.osei.noaa.gov

NOAA Satellite Services Division (SSD) products:
http://www.ssd.noaa.gov

VISITview:
http://www.ssec.wisc.edu/visitview

SPORT – Short Term Prediction:
http://wwwghcc.msfc.nasa.gov/sport

Appendix 2: Participant List

Tom Achtor
SSEC / CIMSS
UW-Madison
1225 W. Dayton St.
Madison, WI 53706
608-263-4206
Tom.Achtor@ssec.wisc.edu

Scott Bachmeier
SSEC / CIMSS
UW-Madison
1225 W. Dayton St.
Madison, WI 53706
608-263-3958
Scott.Bachmeier@ssec.wisc.edu

Sam Batzli
Environmental Remote Sensing Center
UW-Madison
1225 W. Dayton St., 12th Floor
Madison, WI 53706
608-263-3126
sabatzli@wisc.edu

Jaime Daniels
NOAA/NESDIS/ORA/FPDT
5200 Auth Road, Room 711
Camp Springs, MD 20746-4304
301-763-8204x143
Jaime.Daniels@noaa.gov

John Eise
Science and Operations Officer
NOAA/NWS @ MKX (Milw)
N3533 Hardscrabble Road
Dousman, WI 53118-9409
262-965-5061x766
John.Eise@noaa.gov

Joan Forester
US Army Research Lab
Aberdeen, MD
410-278-4977
forester@arl.army.mil

Matt Friedlein
NOAA/NWS @ LOT (Chi)
707 16th Street
Mendota, IL 61342
815-834-0673
Matt.Friedlin@noaa.gov

Roy George
Clark Atlanta Univ DCIS
Dept. of OS
Clark Atlanta University
Atlanta, GA 30314
404-880-8000x6953
rkavil@bellsouth.net

Gary Gray
Raytheon for NOAA/NESDIS
Camp Springs, MD
301-763-8067
Gary.Gray@noaa.gov

Don Hillger
NOAA/NESDIS/ORA/RAMMT
CIRA - Colorado State University
Fort Collins, CO 80523-1375
970-491-8498
Don.Hillger@noaa.gov

Jeff Key
NOAA/NESDIS/ORA/ASPT
UW-Madison
1225 W. Dayton St.
Madison, WI 53706
608-263-2605
Jeff.Key@noaa.gov

Vipin Kumar
AHPCRC
EE/CS 4-192
University of Minnesota
Minneapolis, MN 55455
612-626-1596
vipin.kumar@cs.umn.edu

Gary McWilliams
US Army Research Lab
Adelphi, MD
301-394-2053
gmcwilliams@arl.army.mil

Ralph Meiggs
NOAA/NESDIS/OSDPD
5200 Auth Road, Room 510
Camp Springs, MD 20746-4304
301-763-8142x137
Ralph.Meiggs@noaa.gov

Tim Olsen
Environmental Remote Sensing Center
UW-Madison
1225 W. Dayton St., 12th Floor
Madison, WI 53706
608-263-2086
tpolsen@facstaff.wisc.edu

Marlene Patterson
NOAA/NESDIS/OSDPD
5200 Auth Road, Room 510
Camp Springs, MD 20746-4304
301-763-8142x140
Marlene.Patterson@noaa.gov

Al Powell
NOAA/NESDIS/ORA
5200 Auth Road, Room 701
Camp Springs, MD 20746-4304
301-763-8127x101
Al.Powell@noaa.gov

Bob Rabin
NOAA/OAR/NSSL
UW-Madison
1225 W. Dayton St.
Madison, WI 53706
608-263-4030
Bob.Rabin@noaa.gov

Mark Ratzer
NOAA/NWS @ LOT (Chi)
333 W. University Drive
Romeoville, IL 60446
815-834-0600x468
Mark.Ratzer@noaa.gov

Hank Revercomb
UW-SSEC
UW-Madison
1225 W. Dayton St.
Madison, WI 53706
608-263-6758
Hank.Revercomb@ssec.wisc.edu

Tom Rink
SSEC / CIMSS
UW-Madison
1225 W. Dayton St.
Madison, WI 53706
608-265-2324
Tom.Rink@ssec.wisc.edu

Ken Rizzo
NOAA/NWS @ MKX (Milw)
N3533 Hardscrabble Road
Dousman, WI 53118-9409
262-965-5061x642
Kenneth.Rizzo@noaa.gov

Dave Santek
SSEC / CIMSS
UW-Madison
1225 W. Dayton St.
Madison, WI 53706
608-263-7410
Dave.Santek@ssec.wisc.edu

Tim Schmit
NOAA/NESDIS/ORA/ASPT
UW-Madison
1225 W. Dayton St.
Madison, WI 53706
608-263-0291
Tim.J.Schmit@noaa.gov

Kathy Strabala
SSEC / CIMSS
UW-Madison
1225 W. Dayton St.
Madison, WI 53706
608-263-8752
Kathy.Strabala@ssec.wisc.edu

Gary S. Wade
NOAA/NESDIS/ORA/ASPT
UW-Madison
1225 W. Dayton St.
Madison, WI 53706
608-263-4743
Gary.S.Wade@noaa.gov

Tom Whittaker
SSEC / CIMSS
UW-Madison
1225 W. Dayton St.
Madison, WI 53706

608-262-2759
Tom.Whittaker@ssec.wisc.edu

Appendix 3: Agenda

Wednesday, 20 August 2003

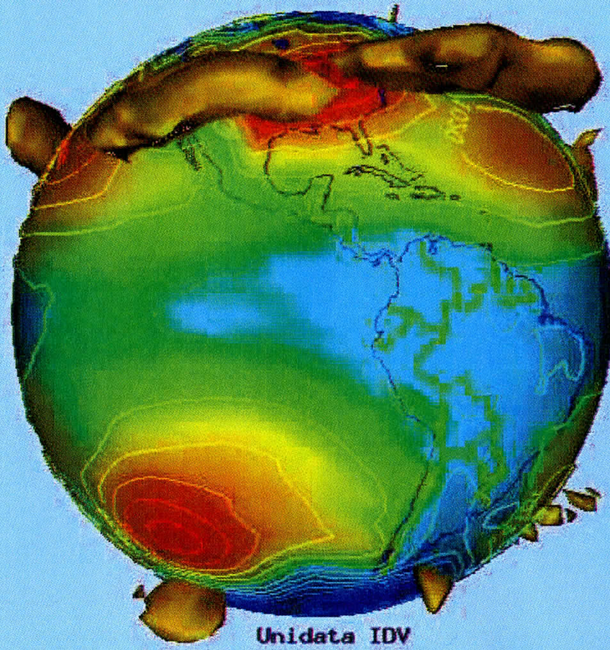
0800 AM	Coffee, tea, donuts, bagels
0830 AM	Welcome and Participant Introductions - Key/Wade SSEC - Revercomb NESDIS Research and the Needs of the User Community - Powell
0915 AM	Session 1: Current NESDIS Products (More than pretty pictures) - Daniels, Wade, Rabin
1000 PM	Session 2: New and Near-Future Satellites (Whetting our appetite) - Strabala, Schmit
1030 AM	Session 3: Satellite Data and Geographical Information Displays (Getting to our data) - Whittaker, Santek, Meiggs, Patterson, Batzli
Noon	Lunch at Urban Pizza
0130 PM	Session 4: Data Mining/Information Extraction Techniques (Getting to our information) - Forester, Kumar, George, Hillger
0300 PM	Session 5: Satellite Data Use in Today's NWS (What the experience is now) - NWS FO staffers
0415 PM	Start general discussion with wrap-up of Day 1; agenda adjustment, if needed, for Day 2
0600 PM	Group dinner at Great Dane (for those interested)

Thursday, 21 August 2003

0800 AM	Coffee, tea, donuts, bagels
0830 AM	Building tour and demonstrations: VISITview (Bachmeier - room 351) Data cube (Rink - room 239) ERSC Lab (12th floor)
1000 AM	Session 6: Roundtable Discussions (Sift and winnow) Follow-up discussions from Day 1 Questions that motivated the workshop:

- How can satellite research better serve forecast operations in the field?
- What mechanisms can be implemented to better connect research and operations (e.g., discussion groups, product oversight groups, additional workshops)?
- Can data mining techniques create new products for forecasters?
- What new products from current and future satellite systems will be of interest to forecasters?
- Are there satellite products and/or tools that are not in AWIPS but should be?
- How can information technology, operational environmental products, and integrated tool suites help users make better decisions?

Noon	Adjourn Lunch at UW Memorial Union Terrace
PM	Open (further discussions, small meetings, and/or demonstrations)



NOAA Satellite and Information Services

National Environmental Satellite, Data, and Information Service