Sandy Supplemental Grant Recipient Quarterly Progress Report

CIMSS Participation in NOAA Laboratory Activity for Observing System Simulation Experiments

Award Number: NA14OAR4830094

The National Oceanic and Atmospheric Administration
National Environmental Satellite Data and Information Service
Center for SaTellite Applications and Research (STAR)

For the Period
1 Jan 2015 – 31 Mar 2015

On behalf of
The Cooperative Institute for Meteorological Satellite Studies (CIMSS)
Space Science and Engineering Center (SSEC)
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I. Introduction

Cooperative Institute Description

The Cooperative Institute for Meteorological Satellite Studies (CIMSS) is a collaborative relationship between the National Oceanic and Atmospheric Administration (NOAA) and the University of Wisconsin-Madison (UW-Madison). This partnership has and continues to provide outstanding benefits to the atmospheric science community and to the nation through improved use of remote sensing measurements for weather forecasting, climate analysis and monitoring environmental conditions. Under the auspices of CIMSS, scientists from NOAA/NESDIS and the UW-Madison Space Science and Engineering Center (SSEC) have a formal basis for ongoing collaborative research efforts. CIMSS scientists work closely with the NOAA/NESDIS Advanced Satellite Product Branch (ASPB) stationed at the UW-Madison campus. This collaboration includes a scientist from the National Climate Data Center (NCDC), who joined the NOAA NESDIS employees stationed at CIMSS.

CIMSS conducts a broad array of research and education activities, many of which are projects funded through this Cooperative Agreement with NOAA. This Cooperative Agreement identifies four CIMSS themes:

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.

CI Management and Organizational Structure

CIMSS resides as an integral part of the Space Science and Engineering Center (SSEC). CIMSS is led by its Director, Dr. Steven Ackerman, who is also a faculty member within the UW-Madison Department of Atmospheric and Oceanic Sciences. Executive Director Wayne Feltz provides day-to-day oversight of the CIMSS staff, science programs, and facilities. The education and outreach activities at CIMSS are coordinated by Senior Outreach Specialist Margaret Mooney. The individual science projects are led by University Principal Investigators (PIs) in conjunction with a strong and diverse support staff who provide additional expertise to

the research programs. CIMSS is advised by a Board of Directors and a Science Advisory Council.

The CIMSS administrative home is within the Space Science and Engineering Center (SSEC), a research and development center within the UW–Madison's Office of the Vice Chancellor of Research. The independent CIMSS 5-year review panel for administration wrote that they were "…impressed by the people, systems and processes in place." The SSEC mission focuses on geophysical research and technology to enhance understanding of the Earth, other planets in the Solar System, and the cosmos. To conduct its science mission on the UW-Madison campus, SSEC has developed a strong administrative and programmatic infrastructure. This infrastructure serves all SSEC/CIMSS staff.

The CIMSS mission includes three goals:

- 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;
- Stimulate the training of scientists and engineers in the disciplines involved in atmospheric and earth sciences.

Executive Summary of CI Banner Research Activities

CIMSS is a collaboration between NOAA and UW–Madison that has increased the effectiveness of research and the quality of education in the environmental sciences. In a *Space Policy* article in 1986, William Bishop, former acting Director of NESDIS, noted, "Remote sensing from space can only thrive as a series of partnerships." He used CIMSS as a positive working example of the government-academia partnership, noting "The Institute pioneered the computation of wind speeds at cloud heights by tracking cloud features from image to image. These are now a stable product provided from the satellites to the global models at the National Meteorological Center." CIMSS continues to be a leader in the measurement of winds from satellite observations and leads the way in many other research endeavors as outlined above. There is great value to NOAA and UW-Madison in this long-term collaboration known as CIMSS.

II. Funded Project

Award Number: NA14OAR4830094

Project Title: CIMSS Participation in NOAA Laboratory Activity for Observing System Simulation Experiments

PI: Dr. Jun Li
PM: Dr. Zhenglong Li

NOAA Sponsor: Robert Atlas, NOAA/OAR/AOML

NOAA Collaborator: Timothy J. Schmit, NOAA/NESDIS/STAR

NOAA Sponsoring Organization: NOAA OAR

Reporting Period: 1 January 2015 – 31 March 2015

Description of Task I Activities

Primarily activity involves quarter reporting.

NOAA Strategic Goal(s)

NOAA Mission Goals

1. Climate Adaptation and Mitigation: An informed society anticipating and responding to climate and its impacts
2. Weather-Ready Nation: Society is prepared for and responds to weather-related events

NOAA Strategic Plan-Mission Goals

1. Serve society's needs for weather and water
2. Understand climate variability and change to enhance society's ability to plan and respond
3. Provide critical support for the NOAA mission

Research Progress

1. Besides LEO AIRS, the satellite orbit simulator has been expanded to include many other instruments, such as CrIS, IASI/Metop-a, IASI/Metop-b, AMSU-A from NOAA satellites, Aqua and Metop-a/b, ATMS, etc. cRTM will be used together with the orbit simulator to simulate radiance measurements from existing satellite sensors. These additional simulated radiances could be added to the control run to make a comprehensive quick r-OSSE.

2. A different option was selected in WRF to define the 72 sigma levels to better represent the lower atmosphere in quick r-OSSE.

3. Experiments were carried out with the new sigma levels to evaluate the value-added impacts of high temporal sounding information from GEO AIRS on Hurricane Sandy track forecast. Figure 1 shows similar results as before: GEO AIRS soundings have positive impact on hurricane track forecast compared with LEO AIRS, especially after 30 hours.

4. To understand why the GEO AIRS only shows improvements after 30 hours of forecast, the forecast ceiling is identified through assimilating the perfect observation from the NR (T+Q). The forecast from this experiment is considered the forecast ceiling. No forecast is expected to exceed this ceiling. Figure 2 shows that the GEO AIRS is approaching the forecast ceiling for the whole forecast period. As a

matter of fact, the experiment of RAOB alone also shows comparable track forecast as the ceiling. This makes it difficult for GEO AIRS to make further improvements for the first 30 hours of the forecast.

5. A new relocation technique of hurricane called parcel displacement (PD) method is developed with the Lagrangian viewpoint, which relocates the TC structure by directly moving each air parcel to its new location. Geometrical relations and mathematical/statistical theories can be applied to determine the displacements for the air parcels. As an example shown in Figure 3 the bias of hurricane center before relocation is 29.7 km; after relocation, it is reduced to 6.6 km, which is less than the horizontal resolution of the model (16 km in this case). The structure characteristics of the moved TC are only slightly changed. The next step we will test how to use this technique to improve the hurricane forecast in our quick r-OSSE.

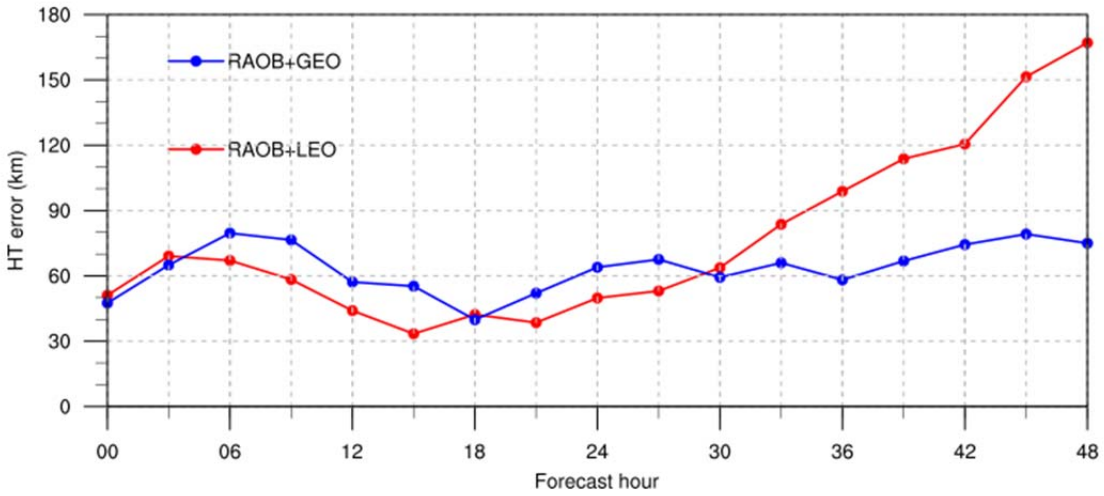

Figure 1. . Impact of GEO AIRS on Hurricane Sandy track forecast versus that of LEO AIRS. Notice the improvement by GEO AIRS for the last 18 hours of forecast.

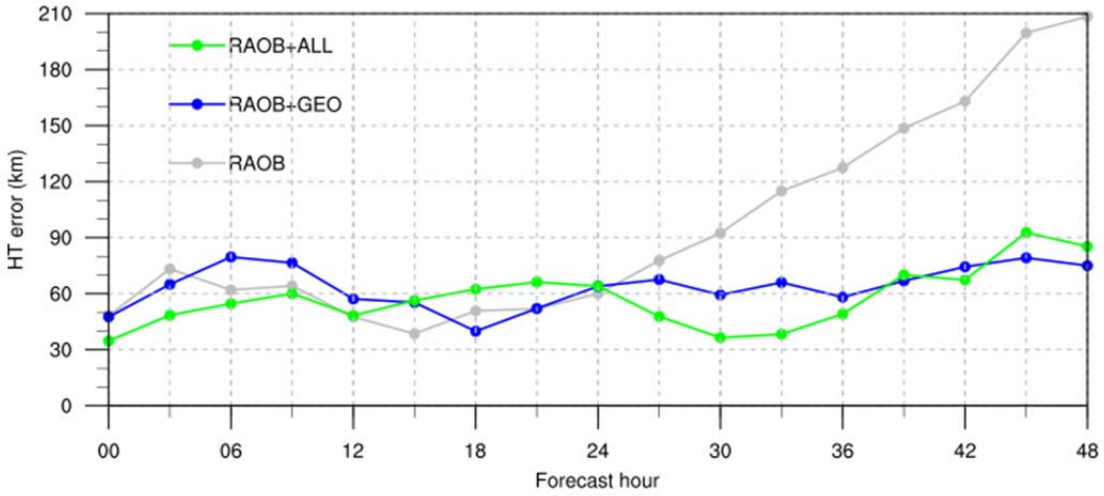

Figure 2. The forecast ceiling (green) of Hurricane Sandy track compared with GEO AIRS+RAOB (blue) and RAOB alone (gray). Note the GEO AIRS has comparable impact as the forecast ceiling for almost the whole forecast period. Both GEO+RAOB and RAOB alone are comparable to forecast ceiling for the first 24 hours.

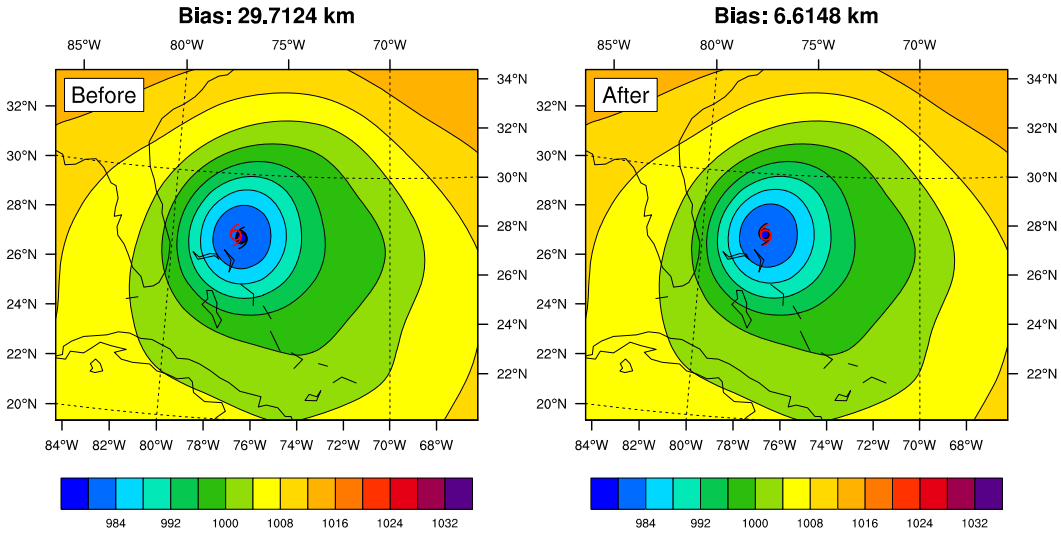

Figure 3: The sea level pressure field before relocation (left) and after relocation (right) for hurricane Sandy at 00 UTC, 27 October 2012. The red symbol is the observed hurricane center location, while the blue symbol is the calculated model hurricane center location.

Resolved Issues and/or Risks

None

New Issues and/or Risks

None