Sandy Supplemental Grant Recipient Quarterly Progress Report

Quality Control and Impact Assessment of Aircraft Observations in the GDAS/GFS

Award Number: NA13NWS4830022

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

For the Period
1 April 2014 – 30 June 2014

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: NA13NWS4830022

Project Title: Quality Control and Impact Assessment of Aircraft Observations in the GDAS/GFS

PI: Dr. David Santek

NOAA Sponsor: Andrew Collard and Stephen Lord

NOAA Sponsoring Organization: NOAA NWS/EMC

Reporting Period: 1 April 2014 – 30 June 2014

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

III. Research Progress

Radiosondes vs. Aircraft data: Spatial coverage

It is desirable to determine if there exists sufficient temporal and (vertical) spatial coverage of in-situ aircraft observations (u,v,T,q) in the location of existing radiosonde launch-sites. In particular, we wish to perform an investigation into whether it is feasible to systemically or strategically eliminate certain radiosonde launches and instead rely on the available coverage by nearby aircraft. Such an investigation would be valuable for future decision-making about the growth and continued maintenance of the radiosonde network.

Here we want to evaluate the coverage, in space and time, as well as the quality of the observations provided by the aircrafts, compared to the existing radiosonde data.

Figure 1 presents the vertical coverage of the aircraft (top panel) and sondes (bottom panel) averaged every 0000/1200 UTC period 1 May – 31 July 2012. Sonde coverage over Alaska and much of the northern US is not well duplicated by aircraft measurement. On the other hand, over the coasts and the eastern part of the US, there exists a high percentage of duplication by nearby ascending/descending aircraft, often reaching over 80% coverage in the vertical (orange dots). Analyses of 0000 UTC and 1200 UTC coverage separately do not yield substantially different results. Likewise, there appears to

be no substantial difference between the warm-season (Fig. 1) and a cold-season analysis from 1 December 2012 – 31 January 2013 (not shown).

Beyond the analysis of aircraft data coverage, an evaluation of aircraft data quality (as compared to radiosonde data) is merited. We are currently pursuing an investigation of vertical profiles of humidity and temperature from aircraft data, and comparing these profiles to nearby radiosondes. Suitable test-locations will be chosen for experimental exclusion of radiosondes, based on the temporal coverage, (vertical) spatial coverage, and quality of nearby aircraft observations. A simulation will be performed parallel to the control run with these radiosondes removed, and an analysis of the resulting forecast model performance will be done. These experiments will be done in-line with the data-inclusion experiment utilizing aircraft moisture observations, making use of the same control run.

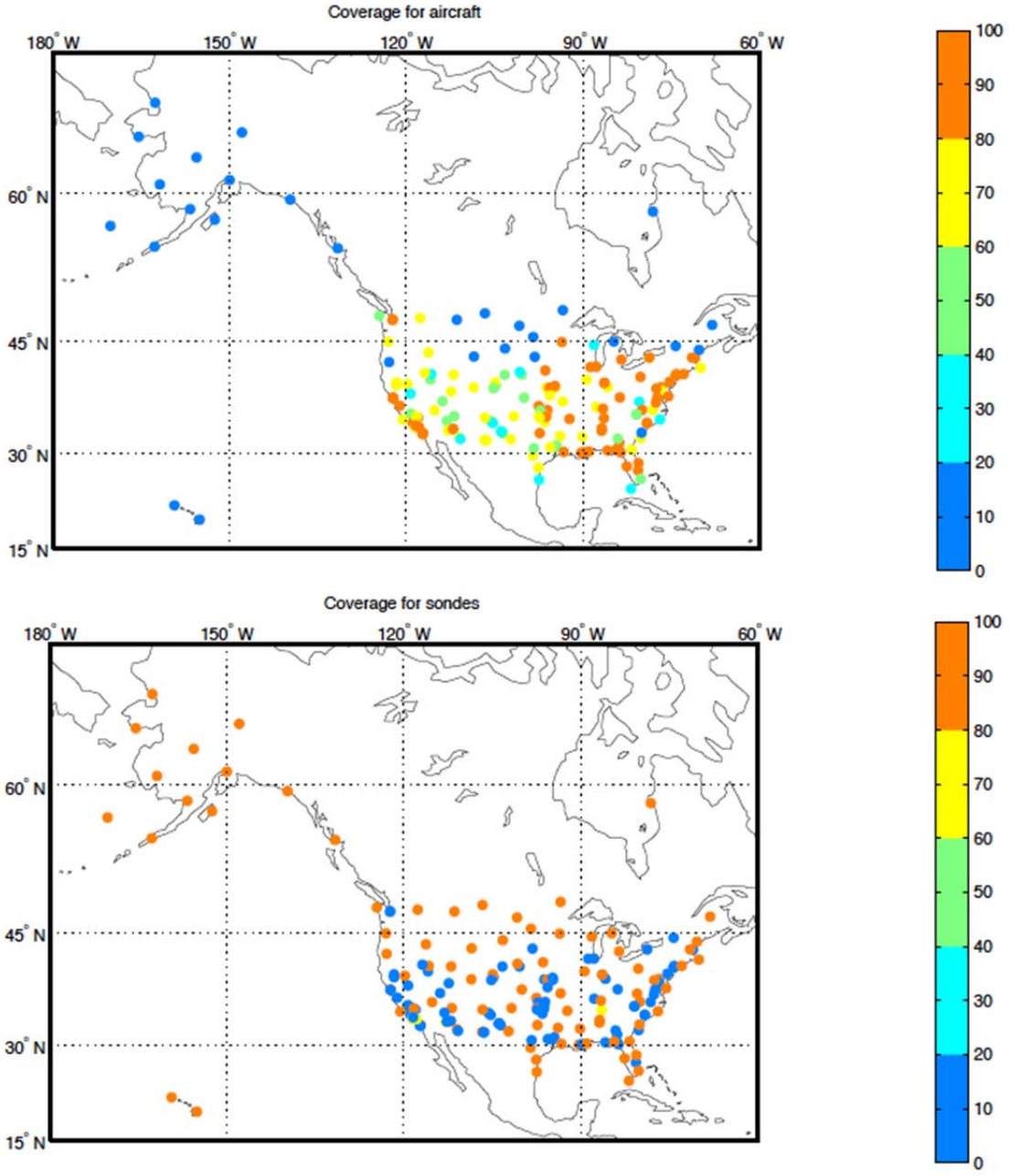

Figure 1: Number of levels (in %) where aircrafts (top panel) and sondes (bottom) provide data over USA, averaged every 0000/1200 UTC 1 May – 31 July 2012. Observations from radiosondes and aircraft within 250 km and 6 hours of the radiosonde launch are placed within 50 pressure-bins to determine percent of total coverage.

Resolved Issues and/or Risks

None.

New Issues and/or Risks

Continued delays in release of a stable T670-resolution, Lagrangian formulation of the GDAS/GFS has halted progress on the model simulation portion of this study. Until a stable model can be delivered to researchers, limitations on computer resources restrict the use of the T574 Eulerian formulation of the GDAS to single-cycle-only, which is able to produce some statistics on assimilation of the data, but not evaluate forecast impact. Problems with a release of a stable model version that can be utilized, given limited computing resources, have existed since the previous quarterly report.