



SPoRT Quarterly
October – December 2007

The SPoRT REPORT

Short-term Prediction Research and Transition (SPoRT) Center
NASA Marshall Space Flight Center (MSFC), Huntsville, AL
<http://weather.msfc.nasa.gov/sport/>

The SPoRT Center is a NASA-funded project to transition unique observations and research capabilities to the operational community to improve short-term weather forecasts on a regional scale. While the direct beneficiaries of these activities are selected Weather Forecast Offices (WFOs) in the Southern Region, the research leading to the transitional activities benefits the broader scientific community.

Quarterly Highlights

AIRS Radiance Assimilation

One of the primary mission goals of the Atmospheric Infrared Sounder (AIRS) is to improve weather forecasting. The instrument provides high-spectral resolution measurements of the thermal infrared spectrum, providing 2,378 spectral channels from 3.74 to 15.4 μm . While other work at SPoRT focuses on the assimilation of retrieved profiles of temperature and moisture, work to assimilate direct radiance measurements is also being performed, eliminating the retrieval error from the total error of the observation and thus strengthening the impact of the observation on the analysis.

Will McCarty (SPoRT Ph. D. candidate, NESSF Fellowship recipient) has investigated the impact of the assimilation of AIRS radiances in the framework of the National Centers for Environmental

Prediction/Environmental Modeling Center (NCEP/EMC) operational North American Model (NAM) at SPoRT, with cooperation and resources from the Joint Center for Satellite Data Assimilation (JCSDA) and NCEP/EMC. Though the operational NAM runs to 84 hr, the focus of verification has been on the short-term (0–48 hr) forecasts as per the mission of SPoRT. The JCSDA has effectively shown that the use of AIRS measurements within an assimilation system can significantly improve medium-range forecasts (Le Marshall et al. 2006) within the NCEP operational Global Forecast System (GFS).

The experiment conducted for the SPoRT program considers forecasts, run four times daily, from April 9–16 2007. A Control run is performed using all data operationally assimilated in

the NAM data assimilation system. For the experiment, AIRS radiances are used in addition to that of the Control. The AIRS measurements are capable of detecting small-scale features in temperature and moisture in regions that are otherwise sparsely observed. By improving the initial analyses, the corresponding forecasts integrated from these initial states are also improved. It is noted that the Advanced Microwave Sounding Unit (AMSU) onboard Aqua is not assimilated in either run. Assimilation is performed using the Gridpoint Statistical Interpolation (GSI) three-dimensional variational (3D-Var) assimilation suite, which acts as the operational assimilation suite for both the GFS and the NAM at NCEP.

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Results from the addition of AIRS to a system mimicking the operational NAM have been positive. The incorporation of AIRS measurements results in the improved characterization of the troposphere in data void regions. In considering the 500 hPa height anomaly correlations in Figure 1, a forecast improvement of 3 hr is observed (for the 48 hr forecasts) by the addition of AIRS data to the data assimilation system. This improvement is defined as the time difference between the correlation of the AIRS forecasts to the corresponding analyses and the time at which the Control has an equal correlation value. For all forecasts spawned in the experiment, forecasts are improved consistently at 48 hrs throughout the troposphere and down to the surface, as also shown at 1,000. These height anomaly correlations are performed over the continental United States.

The impact of including AIRS radiance measurements in the data assimilation on precipitation is shown in Figure 2. At 25 mm/6 hr, which is roughly an inch of rain in a 6-hr period, the bias and the Equitable Threat Scores (ETS) are improved by 8% and 7% over the control, respectively, showing that the AIRS data is improving the forecast of the heavier precipitation regions as well. Though the AIRS experiment and control forecasts tend to have a bias toward the occurrence of precipitation below 25 mm per 6 hrs, the ETS over most of these lighter rain thresholds are improved.

The next stage for this research is to investigate the assessment of cloud contamination. Techniques in the GSI will be compared to the CO2 sorting technique, which has been developed locally, validated, and implemented within the GSI system.

References

Le Marshall, J., Jung, J., Derber, J., Chahine, M., Treadon, R., Lord, S.J., Goldberg, M., Wolfc, W., Liu, H.C., Joiner, J., Woollen, J., Todling, R., van Delst, P., and Tahara, Y., 2006: Improving Global Analysis and Forecasting with AIRS, Bull. Amer. Meteor. Soc., 87, 891-894.

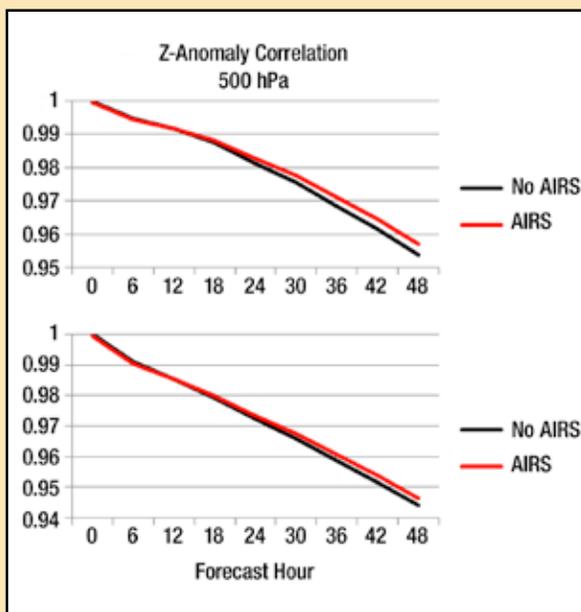


Figure 1. Height anomaly correlations for the control (black) and the AIRS experiment (red) at 500 hPa (top) and 1,000 hPa (bottom) for forecasts spawned during April 9–16 2007.

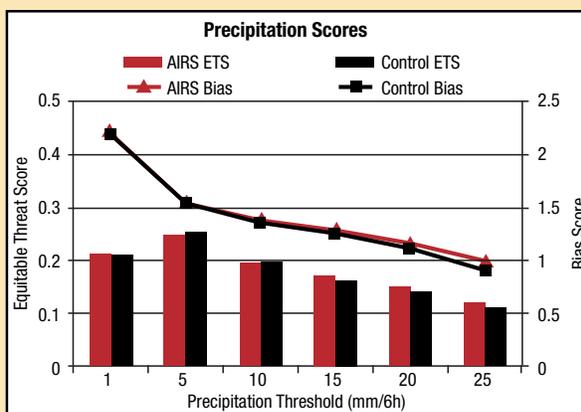


Figure 2. Bias (line) and equitable threat (bars) scores for the control (black) and the AIRS experiment (red) for all 48 hr forecasts spawned during April 9–16 2007. The precipitation threshold is defined as the minimum value of precipitation rate to be considered an event.

Science Advisory Committee (SAC) Report

The SPoRT Science Advisory Committee (SAC) met for the fourth time on June 12–14, 2007 in Huntsville, Alabama to review recent progress of the SPoRT activities. The SAC members in attendance at the review were Tsengdar Lee, Allen White (attending for Marty Ralph), Bernard Meisner (attending for Rusty Billingsley), Chris Barnet (attending for Mitch Goldberg), Ronald Gelaro, Ralph Petersen, and Bill Bauman (Chair). The two and a half day review, which occurs every 18–24 months, included technical presentations on major research and transition topics by staff scientists as well as a visit to the Huntsville NWS Forecast Office (collocated with SPoRT at the National Space Science and Technology Center, NSSTC). The SAC report commended SPoRT scientists for their work on its MODIS SST composite product and transition activities, its AIRS data assimilation work, and profile dissemination plans, and collaboration with the GSFC land surface community (through the LIS). The specific SAC recommendations are being used as program guidance to better address NASA's weather focus area goals and the needs of the operational weather community. The SPoRT program has already begun to act on many of the recommendations in the report. For example, additional staff members have been hired to provide a more engaged interface with the end users. A strategic plan is being developed to guide our present and future activities. More regular reporting of our accomplishments will be made to the SAC and the community through an interim report, distributed during nonreview years. The next SPoRT SAC meeting is tentatively planned for June of 2009.

Recent Accomplishments

AIRS Profile Assimilation in WRF

A month-long series of forecasts using temperature-only AIRS profiles has been completed and the forecasts have been compared to verifying rawinsonde and stage IV precipitation data. The removal of the moisture profiles leads to slight improvements in the temperature and moisture fields, especially in the first 24 hours, and to improvements in precipitation scores at most of the earlier forecast times and precipitation thresholds; but some degradation occurred at later forecast times. A physical understanding of these results is being evaluated.

Transitioning to WRF/VAR

The transition of the current modeling system to that based on variational techniques has continued. The new assimilation/forecast system consists of the most up-to-date WRF modeling system: WRF Preprocessing System (WPS), WRF-VAR, and WRFV2.2.1. A real-time script to execute the new system is currently under development.

LIS/WRF Studies

This work analyzed and compiled results of LIS/WRF simulations including MODIS SSTs in the initial conditions. The addition of the MODISS SST fields seem to have little effect on inland surface fields.

WRF/SST collaborative Work With NWS Miami, FL

The WRF simulations were rerun without Local Analysis and Prediction System (LAPS) analyses in the initial conditions due to a problematic cold temperature bias in the LAPS fields. Initial results indicate that MODIS SST positive impact is reduced when product latency degrades. (Note, a recent ROSES proposal, if funded, will develop a method to use AMSR-E data to reduce the latency in the MODIS SST composites). Current work is assessing easterly flow cases with rain shower activity in which MODIS SSTs seem to have a consistent positive impact on WRF simulations.

Collaboration With National Severe Storms Laboratory (NSSL)

Operational 36 hr WRF forecasts produced by NSSL (and made available in AWIPS to Huntsville forecasters) are being used as supplemental forecast guidance in the office operations.

Recent Publications and Presentations

Peer-Reviewed Publications

In Print/In Press

LaCasse, K.M., Splitt, M.E., Lazarus, S.M., and Lapenta, W.M., 2007: The Impact of High Resolution Sea Surface Temperatures on the Simulated Nocturnal Florida Marine Boundary Layer, *Mon Wea. Rev.*, in press.

Accepted

Jedlovec, G.J., Haines, S.L., and LaFontaine, F., 2008: Spatial and Temporal Varying Thresholds for Cloud Detection in GOES Imagery. *IEEE Transactions in Geoscience and Remote Sensing*. Accepted for publication. — The paper describes a robust day and night cloud detection algorithm which uses only two spectral channels to identify the presence of clouds in satellite imagery. The algorithm uses a unique data compositing approach to generate spatially and temporally varying thresholds which are used in four spectral and spatial cloud tests. The resultant cloud product is used to mask out cloud-contaminated pixels in the derivation of atmospheric and surface parameters from the data. Although applied to GOES data, the scheme has been modified for the MODerate-resolution Imaging Spectrometer (MODIS) on the NASA Terra and Aqua satellites and is a key algorithm used to produce products for SPoRT. A manuscript describing the algorithm modifications for MODIS, its validation, and application to other satellite sensors is being prepared for a follow-on publication.

Conference Papers/Presentations

Case, J.L., LaCasse, K.M., Dembek, S.R., Santos, P., and Lapenta, W.M., 2007: Impact of MODIS high-resolution sea-surface temperatures on WRF forecasts at NOAA/NWS Miami, FL. Abstracts, 32nd National Weather Association Annual Meeting. 14–18 October, Reno, NV.

Jedlovec, G.J., and Haines, S.L., 2007: Spatial and Temporal Varying Thresholds for Cloud Detection in Satellite Imagery. *IEEE Geosciences and Remote Sensing Society (IGARSS) 2007 – Sensing and Understanding Our Planet*. 23–27 July, Barcelona.

McCarty, W., and Jedlovec, G., 2007: Assimilation of Hyperspectral Radiances into Short-Term Forecasting Models. 15th Conference on Satellite Meteorology and Oceanography, CDROM, AMS, Amsterdam.

Molthan, A.W.M. Lapenta, and Jedlovec, G.J., 2007: Application of NASA A-train to evaluate clouds simulated by the WRF model. Symposium on recent developments in atmospheric applications of radar and lidar. AGU

Zavodsky, B.T., Chou, S-H, Jedlovec, G.J., and Lapenta, W.M., 2007: The Impact of Near-Real-Time Atmospheric Infrared Sounder (AIRS) Thermodynamic Profiles on Regional Weather Forecasting. 15th Conference on Satellite Meteorology and Oceanography, CD-ROM, AMS, Amsterdam.

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Proposals Submitted/Endorsed or Under Review

SPoRT supported 3 proposals as co-investigators for the ROSES 2007 ROSES–Accelerating Operational Use of Research Data, September 2007

- Development of Sea Surface Temperature High-Resolution Composite Data Sets for the Short-Term Prediction Research and Transition (SPoRT) Activity, Use SPoRT compositing technique with MODIS/AMSR-E SST data. PI: Jorge Vazquez (JPL), Gary Jedlovec, Co-I.
- Enhancement of an operational sea surface temperature product, PI: Steven Lazarus (FIT), Gary Jedlovec, Co-I.
- Accelerating the use of NASA satellite data in SPoRT for climate and air quality assessment in southeastern United States. Transition air quality products to WFOs. PI: Sundar Christopher (UAH), Gary Jedlovec, Co-I.

Proposals—Accepted

The following proposals submitted to the Research Opportunities in Space and Earth Sciences (ROSES) 2007 research announcement for ideas to integrate NASA Earth science research results into decision support systems have been accepted with SPoRT as a Co-Investigator:

- “NASA Products to Enhance Energy Utility Load Forecasting,” Dr. Jill Engle-Cox of Battelle, PI
- “Application of Satellite Data to Enhance FAA Tactical Forecasts of Convective Initiation and Growth,” Dr. John Mecikalski of UAH, PI.

External Meetings

- AIRS Science team Meeting, October 9–11, 2007, Greenbelt, MD–B. Zavodsky presentation on AIRS data assimilation results
- NWA Annual Meeting, October 15–19, 2007, Reno, NV–J. Case paper presentation on WRF/LIS work
- Fall AGU Meeting, December 3–7, 2007–A. Molthan poster presentation on work with CloudSat and GSFC microphysical schemes in WRF

Visitors

- Teresa Fryberger (Director, NASA Applied Science Program)
- Danny Simms (FAA, Air Traffic Control System Command Center)
- Mark Wheeler (ENSCO)
- John Bailey, Duane Armstrong, Joseph Grant, Bill Graham, Jean Ellis, Callie Hall, Bruce Spiering, and Craig Peterson (Stennis Space Center, Science & Technology Division)
- Bill Parsons (KSC Center Director)
- Matt Carrier (Florida State University)
- Kevin Pruitt and Robert Gillen (ENSCO)

Calendar of Events

- AMS Annual Meeting–January 21–25, 2008–New Orleans
- AWIPS II TO8 Demo–February 7, 2008, Silver Springs, Maryland
- NASA Fire Science Meeting–February 20–22, 2008, Maryland
- Satellite Algorithm Test Bed Workshop–February 26–27, 2008, Suitland, Maryland.
- EOS Data to Huntsville NWS/WFO 5–Year Anniversary Celebration–March 3, 2008.

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