SPoRT Report

Science Mission Directorate
National Aeronautics and Space Administration

Short-term Prediction and Research 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 Assimilation

One of the mission goals for the Atmospheric Infrared Sounder (AIRS) is to provide sounding information of sufficient accuracy such that the assimilation of the new observations—especially in data sparse regions—yields improvement in weather forecasts. Coupled with the Advanced Microwave Sounding Unit (AMSU), AIRS provides radiance measurements used to retrieve temperature profiles with an accuracy of 1 K over 1 km layers and moisture profiles with an accuracy of 15% in 2 km layers under both clear and partly cloudy conditions. Explicit use of level-by-level error estimates allows for the use of the highest quality AIRS profiles in the assimilation process to provide improved initial conditions for numerical weather prediction.

This work provides a methodology to selectively assimilate AIRS temperature and moisture data into a regional analysis/forecast model. Using the ARPS Data Analysis System (ADAS), temperature and moisture profiles from the Version 5.0 EOS science team retrieval algorithm are used to update a background field from the NCEP North American Mesoscale (NAM) Model. The AIRS-enhanced analyses are, then, used as initial fields for the Weather Research and Forecasting (WRF) model for short-term (0-48 h) regional forecasts. The model was run for 33 days between 17 January and 22 February 2007 to study the collective impact of the assimilation of AIRS data over that time frame.

Preliminary results indicate that AIRS profiles have had limited positive impact on temperature, mixing ratio, and associated height fields. Figure 1 shows comparisons between the control and AIRS-assimilated runs and 50 rawinsonde observations east of 105^{o}W at the 36-hr forecast for the study period. The control (black) is too cool in the lower troposphere and too warm in the upper troposphere; it is too dry in the lower and upper troposphere and too moist in the middle troposphere. AIRS (red) reduces temperature bias at most levels by ≈0.3^{o}C in the lower and upper levels and changes low and mid-level moisture by as

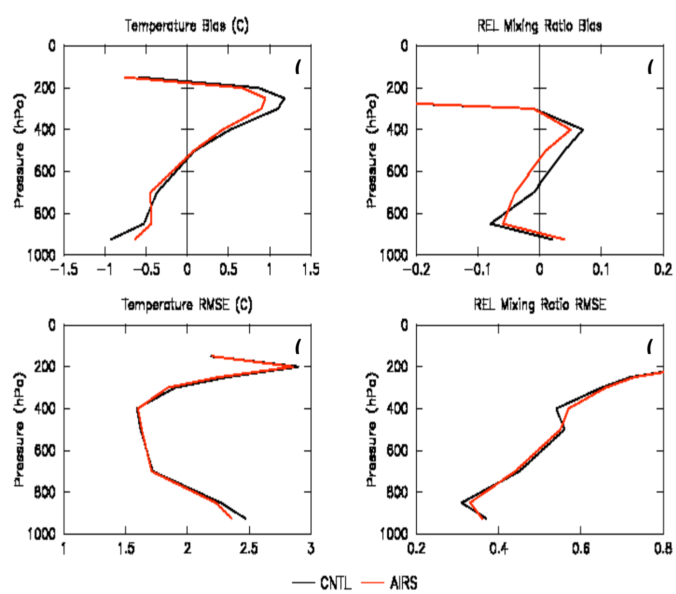

Figure 1. Cumulative statistics for 36-h forecasts from 33 days from mid-January to mid-February of temperature bias (^{o}C) (FCST – OBS) (a), and RMS error (^{o}C) (c) and mixing ratio bias (FCST – OBS) (b) and RMS error (d). The units for mixing ratio are the normalized moisture compared to the overall moisture at a given level.

much as 5% at some levels, while the RMS errors remain the same. The impact of the assimilation of

AIRS profiles on subsequent precipitation forecasts is shown in Figure 2. The AIRS data improves on the precipitation forecast at 36 hours when compared to the NCEP Stage IV precipitation data east of 105°W. For each precipitation threshold, AIRS yields a higher equitable threat score (bars; a measure of forecast hits and misses compared to Stage IV observations) and bias score (lines; a measure of forecast coverage compared to Stage IV observations) closer to one—both of which indicate improvements in the precipitation forecast with the inclusion of AIRS data. While the overall results are encouraging, the day to day performance variations need to be evaluated in more detail.

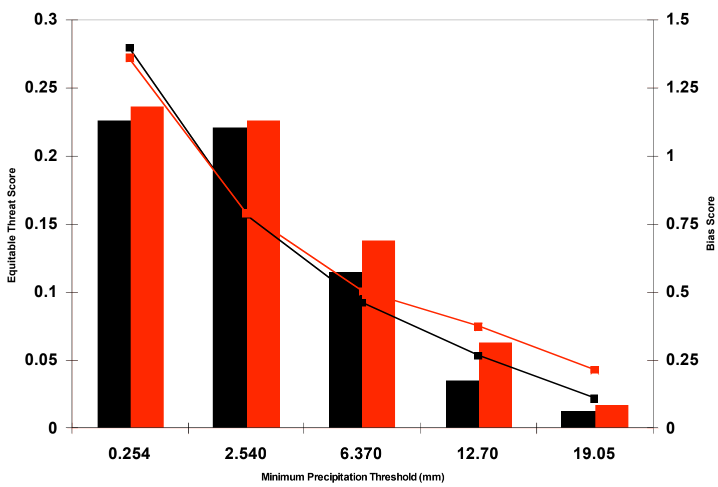

Figure 2. Equitable threat scores (ETS; bars) and bias scores (lines) for 6-h cumulative precipitation ending at the 36-h forecast, which is representative of the overall trends in the statistics.

Example of Improved Sea-Breeze Simulation using the Land Information System (LIS) and Weather Research and Forecasting (WRF) model

The SPoRT Center is conducting experiments using the NASA Goddard Space Flight Center Land Information System (LIS) in conjunction with the Weather Research and Forecasting (WRF) model in order to evaluate the impacts of high-resolution lower boundary data derived from NASA systems and tools on regional short-term numerical guidance (0–24 hours). The SPoRT experiment compares WRF simulations over Florida during May 2004 initialized with land surface data from a 2-year spin-up of the Noah land surface model (LSM) within LIS (hereafter LISWRF) versus a Control configuration that uses interpolated NCEP Eta model data to initialize the land surface on a nested domain with 9-km and 3-km horizontal grid spacing. The LIS spin-up run was forced by North American Land Data Assimilation System analyses (*Mitchell *et al.* 2004) and used the same vegetation and soil databases as in the Control WRF. The LIS was run on the exact WRF simulation grids, ensuring maximum compatibility between the LIS and WRF land surface variables.

The sensitivity simulation from 1200 UTC 6 May 2004 is a good example of how the land surface initialization can impact the atmospheric sensible weather on a clear day. The initial 0–10 cm volumetric soil moisture difference field between the LISWRF and Control at 1200 UTC 6 May (Figure 3) indicates that LIS is drier than the Control (i.e. Eta model values) by more than 10% over parts of north Florida, southwestern Georgia, and the Bahamas, with a smaller magnitude of drying over a large portion of the Florida peninsula. LIS is more moist by 2–8% over southeastern Georgia and extreme south Florida near the Everglades. These soil moisture differences closely follow the pattern of soil texture across the domain (not shown), as the drying of the soils is largely controlled by soil type and corresponding hydraulic properties (**Chen *et al.* 2007).

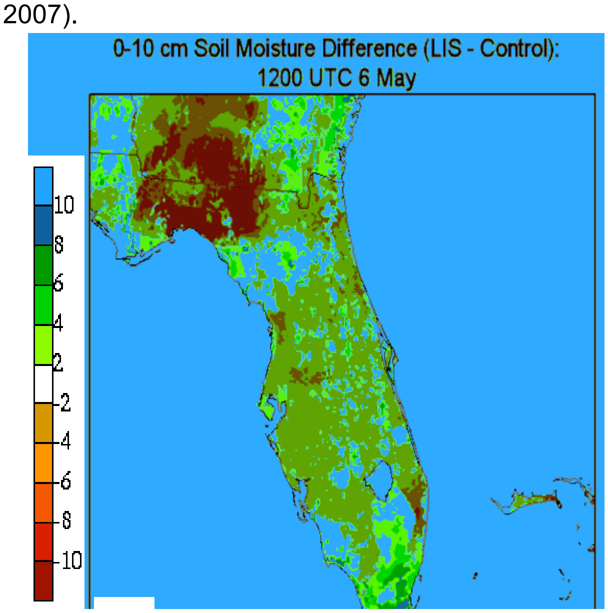

Figure 3. Initial 0–10 cm volumetric soil moisture difference between the LIS and Control (%) on 1200 UTC 6 May 2004.

The drier initial LIS soil fields over north Florida impacted the evolution of the simulated sea-breeze fronts on 6 May. Figure 4a shows a noticeable separation between the LISWRF and Control sea-breeze fronts at the 11-hour forecast near Perry, FL (40J, highlighted in Figure 4a), with the LISWRF sea-breeze front (colored) having advanced further inland relative to the Control sea-breeze front (gray shaded). This inland penetration difference is consistent with the increased land-sea temperature contrast that can be inferred from the LISWRF run, based on the 1–3°C positive differences in predicted 2-m temperatures over a large portion of north Florida (LIWRF – Control in Figure 4b). The narrow band of negative differences in predicted 2-m temperatures close to the coast indicates the greater penetration of post-sea-breeze marine air in the LISWRF run relative to the Control simulation.

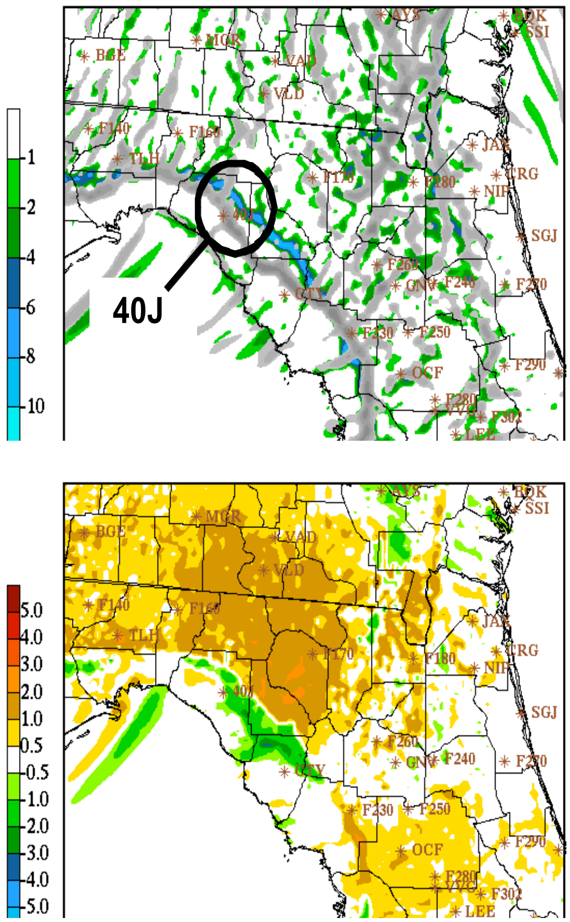

Figure 4. The 1200 UTC 6 May 2004 11-hour forecast of (a) 10-m divergence (x 10^{4} s^{-1}; color indicating LISWRF convergence and gray shading indicating Control convergence), and (b) 2-m temperature differences (°C, LISWRF – Control).

At 40J, the LISWRF daytime forecast 2-m temperatures began about the same as in the Control run, but warmed much more quickly than the Control and stayed at least a few degrees warmer through 2200 UTC (Figure 5, top panel). In addition, the LISWRF 2-m dewpoints were several degrees lower than the Control 2-m dewpoints between 1300 UTC and 2100 UTC, almost exactly the same as the observed 2-m dewpoints during those hours (Figure 5, second panel). Based on these results, it can be inferred that the lower LISWRF soil moisture near 40J is more representative due to the improved 2-m temperature and dewpoint forecasts during much of the daylight hours.

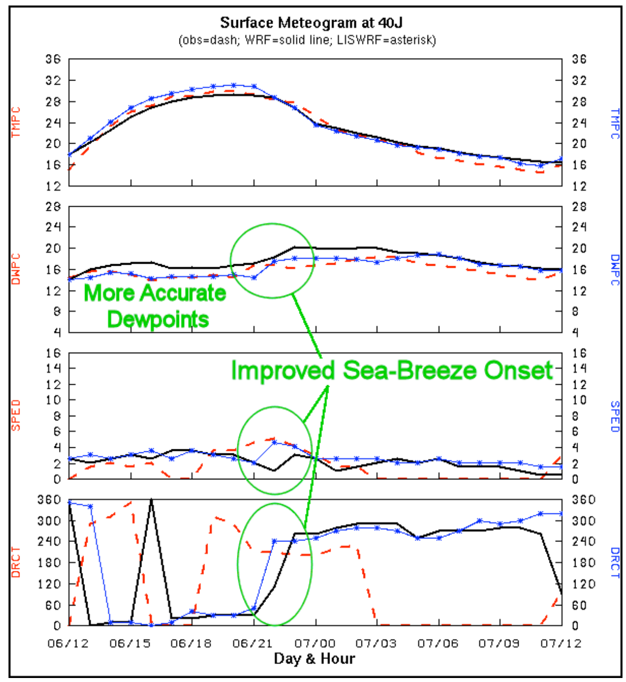

Figure 5. A meteogram plot at Perry, FL (40J) of temperature (°C), dewpoint (°C), wind speed (m s^{-1}), and wind direction (degrees). The graphs compare hourly WRF forecasts interpolated to the station location from the Control simulation (solid line) and LISWRF run (solid line with asterisks) to observations (dashed line).

A noteworthy feature at 40J is the improved timing of the sea-breeze passage in LISWRF compared to the Control. The sea-breeze passage is accompanied by an increase in 2-m dewpoints and 10-m wind speed, and a shift to a southwesterly wind direction. According to the observed traces (dashed lines), the actual sea-breeze passage occurred at about 2100 UTC. Meanwhile both the Control and LISWRF simulated the sea-breeze frontal passage too late at 40J. However, the sea-breeze onset occurred one hour earlier in the LISWRF (2200 UTC) relative to the Control (2300 UTC), closer to the observed timing at 2100 UTC.

The 6 May case helps to illustrate the impact of the drier initial soil moisture over north Florida and south Georgia in the LISWRF simulation. The pattern of warmer LISWRF 2-m temperatures in Figure 4b correlates closely with the pattern of drier 0–10 cm soil moisture in Figure 3. Consequently, a larger land-sea temperature contrast exists across the portion of north Florida where the LISWRF sea breeze is seen to penetrate inland more rapidly than in the Control simulation. This example of improved sea-breeze timing indicates that the higher-resolution land surface initial conditions of LISWRF can have a favorable impact on sensible weather features in a coastal region experiencing a quiescent environment. Improved sea-breeze prediction in coastal zones also has implications on potential improvements to predictions of summertime convective initiation over such regions, which could be a follow-on phase of this current study.

References

Mitchell, K. E., and Coauthors, 2004: The multi-institution North American Land Data Assimilation System (NLDAS): Utilization of multiple GCIP products and partners in a continental distributed hydrological modeling system. J. Geophys. Res.,* ***109,* *D07S90, doi:10.1029/2003JD003823.*

Chen, F., and Coauthors, 2007: Description and evaluation of the characteristics of the NCAR High-Resolution Land Data Assimilation System. J. Appl. Meteor. Climatol.,* ***46, *694-713.*

Recent Accomplishments

LIS/WRF Studies

- First draft of a manuscript to be submitted to the AMS Journal of Hydrometeorology has been prepared.
- Ran LISWRF simulations using high-resolution initialization data for both the land (LIS) and sea-surface temperatures (derived from MODIS).
- Produced verification statistics over both land and water sites for LISWRF+MODIS SST runs.

NWS Miami SST Case Studies

- Completed all SPoRT parallel WRF runs using MODIS SSTs in initial conditions for the NWS Miami domain, with 710 pairs of 27-hour simulations for comparison/verification from mid February through August.
- Began generating surface verification statistics.
- Identified a list of potential severe weather cases for analysis.

NWS HQ AWIPS collaboration

- Outlined a joint project plan for SPoRT collaborations with NWS HQs

CI product under NWS evaluation

- Conducted WFO training on convective initiation (CI) products
- Collected WFO surveys on use of CI product

Near real-time AIRS profile assimilation

- Completed preliminary analysis of assimilation statistics for January 17 – February 22, 2007 case study

http://weather.msfc.nasa.gov/sport/airsassimilation/simpleindex.html.

- Prepared posters for EUMETSAT conference

JCSDA Workshop

- Will McCarty participated in the three-week Joint Center for Satellite Data Assimilation (JCSDA) Applications of Remotely Sensed Observations in Data Assimilation workshop at the University Maryland in College Park, MD.

Recent Publications and Presentations

Peer-reviewed Publications

In print

Haines, S. L., G. J. Jedlovec, and S. M. Lazarus, 2007: A MODIS Sea Surface Temperature Composite for Regional Applications. *Trans. Geosci. Rem. Sens.*, **45**, No. 9, IEEE, 2919-2927.

In press

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

Student Theses

Gatlin, P. N., 2007: Severe weather precursors in the lightning activity of Tennessee Valley thunderstorms. M.S. thesis, Dept. of Atmospheric Science, The University of Alabama in Huntsville, 99 pp.

Conferences/Presentations

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

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

Jedlovec, G. J., and S. L. Haines, 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.

Proposals submitted/endorsed or under review

- Rapid Prototype Capability proposal – submitted to NASA's RPC Council, July 2007

- Supported 3 proposals as co-investigators for the ROSES 2007 ROSES – Decision Support Through Earth Science Research Results, June 2007
- Supported 3 proposals as co-investigators for the ROSES 2007 ROSES – Accelerating Operational Use of Research Data, September 2007

SPoRT Team Members Highlight

The SPoRT program has hired two new team members, Kevin Fuell (UAH) and Geoffrey Stano (ENSCO). Highlights of their careers and role in the SPoRT program are found below.

Kevin Fuell (UAH)

Mr. Kevin Fuell recently joined the SPoRT program through the University of Alabama Huntsville (UAH). Kevin has a Master's degree from Purdue University (1997) where he studied tropical meteorology, specifically focusing on the variability of the convection in the eastern Pacific due to El Nino and La Nina events. Kevin spent two years with the Coast Survey Development Laboratory (1998-1999) of NOAA/NOS working to implement the LAPS model over the Chesapeake Bay. LAPS output is used to initialize hydrodynamic models that forecast the water level in the Bay, which is critical to commercial shipping. Over the last 8 years (2000-2007) he has been a part of The COMET Program of UCAR in a variety of roles as a meteorologist. Kevin worked on the AWIPS Validation Effort, the IFPS training team, and spent the bulk of his time developing distance-learning for the Marine Meteorology Professional Development Series of the NWS. As a member of SPoRT Kevin's initial work will be to serve as a liaison to the NWS offices that receive its data, ensuring that products are readily available within AWIPS and AWIPS II, developing educational materials to illustrate the value of these products, and evaluating the resulting benefit to the forecast.

Geoffrey Stano (ENSCO)

Dr. Geoffrey Stano joined the SPoRT team in September 2007 to assist in SPoRT activities as a liaison between NASA's Earth Observing research and the National Weather Service. Dr. Stano earned his degree while seeking ways to develop an empirical forecast technique for predicting the cessation of lightning activity in thunderstorms for the U.S. Air Force's 45th Weather Squadron. His work has become a verification of the 30/30 lightning safety rule. He has a diverse background in both research and operations. His research has been with total lightning, particularly lightning cessation as well as convective initiation. Operationally, he has been an assistant meteorologist for the Intercontinental Chemical Transport Experiment (INTEX-B), a volunteer meteorologist with the State of Florida Emergency Operations Center during the 2004 hurricane season, and a meteorology intern with the City of Orlando Operations Center.

Visitors

- Jason Tuell (NWS Headquarters) – discuss collaborations with SPoRT on data transition to AWIPS II
- Mark Wheeler (ENSCO) and Danny Sims (FAA) – collaborations with SPoRT on future projects
- Kevin Fuell (COMET) – visit to learn more about the SPoRT program.
- Greg Stumpf (NSSL) - here for a collaborative visit, and to install a beta version of the Four-dimensional Storm Scale Investigator (FSI) radar visualization tool.
- Andrew Futrell (student), - one of Robbie Hood's summer students, as part of job shadow program.
- Sam Beckman (NWSTC) – visit was part of an office familiarization/visitation program.

Calendar of Events

- **October 9-11, 2007** - AIRS Science team Meeting, Greenbelt, MD
- **October 15-19,** 2007 - NWA Annual Meeting, Reno, NV
- **January 21-25**, 2008 - AMS Meeting, New Orleans, LA

SPoRT Points of Contact

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