National Aeronautics and Space Administration

The SPoRT REPORT

SPoRT Quarterly
October – December 2009

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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

Fifth Science Advisory Committe Meeting

The Fifth SPoRT Science Advisory Committee (SAC) meeting was held November 18–20, 2009 in Huntsville, Alabama. The objective of the SAC meeting was to provide a comprehensive overview of recent accomplishments to the advisory committee. The SPoRT SAC is tasked with providing feedback on recent activities and the future direction for the project. At the review, SPoRT scientists presented results of recent research-to-transition activities in all project areas, including training and product assessment. The short-term forecasting presentations highlighted the use of modifications to the Weather Research and Forecasting (WRF) model, which demonstrated forecast improvement in a variety of situations through coupling the model with high-resolution surface information provided by the GSFC Land Information System (LIS) and MODIS/AMSR-E SSTs, and the assimilation of thermodynamic information from AIRS profiles and radiances observations. The transition of these capabilities is occurring through operational forecasts at NOAA's Hazardous Weather Testbed (HWT) and through the community's use of the WRF Environmental Modeling System (EMS). Additional short-term forecasting presentations focused on the use of CloudSat observations to tune microphysical cloud processes and on the development of lightning forecast capabilities for the WRF. The latter will be demonstrated as part of the 2010 Spring experiment at the HWT.

SPoRT demonstrated significant progress in transitioning products into WFO operations to improve situational awareness and nowcasting over the last 2 years. A suite of over 30 products from MODIS, AMSR-E, AIRS, the North Alabama Lightning Mapping Array (NALMA) – a ground-based prototype of the Geostationary Lighting Mapper (GLM) on GOES-R, and special GOES products provided by NESDIS, are available in real time in AWIPS D2D at over a dozen Southern and Western Region WFOs. This large-scale real-time dissemination of products is possible through the use of Local Data Manager (LDM) software at each facility. SPoRT is integrating these products into the AWIPS II environment for seamless use by forecasters as they transition to the new display system in the coming years.

The SAC also received presentations on the regular interactions of SPoRT liaison staff with forecasters at individual WFOs.

These interactions have led to increased product use and the development of forecaster-led assessment studies on products to improve weather forecasts. The regular interactions are facilitated by site visits and through monthly coordination calls with the collaborating WFOs. The Wide World of SPoRT blog and Facebook fan page provide additional forums for forecasters and SPoRT staff members to discuss product use. SPoRT has led the development of an extensive set of training modules, which are being integrated into the NWS Learning Management System (LMS) for use by all NWS forecasters. These and other SAC presentations are viewable online at <http://weather.msfc.nasa.gov/sport/sac_reports>.

The preliminary feedback from the advisory committee was extremely positive. The committee was happy with the progress SPoRT has made on transitioning NASA observations and research capabilities to the operational weather community since the last meeting. They were also pleased with the implementation of the recommendations from the previous review (Summer 2007). The advisory committee meeting also included an interactive conference call between the SAC and all participating WFOs. The feedback from this call indicated that the SPoRT liaisons are doing an outstanding job coordinating with staff at the WFOs and that many of the SPoRT products are in regular use at the WFOs. Currently, the MODIS fog product and the MODIS SSTs composites are most widely used. SPoRT's ability to interact with end users and to tailor products to forecaster needs has been important to their successful transitions. The SAC strongly agrees with the SPoRT expansion plans to include a nationwide subset of WFOs and potentially National Centers and River Forecast Offices. This expansion will broaden the application of existing SPoRT products and open opportunities for new product transitions. This expansion should be done in collaboration with other NOAA transition activities. A final version of the SAC report will be available in early Spring.

NASA Headquarters Program Manager Dr. Tsengdar Lee addresses the committee at its recent meeting.

Recent Accomplishments

AIRS Profile Assimilation

The vertical levels in WRF/WRF-Var system have been updated from 37 levels to 50 levels. Previous results using 37 sigma levels consistently show a large surface pressure increment (up to 6 hPa) over the eastern Gulf of Mexico and the western Atlantic Ocean when AIRS is assimilated. Since the geopotential height is an integrated quantity calculated from the surface up, the surface pressure increase, together with the tropospheric temperature increase, contributes to the geopotential height increase throughout the troposphere. The surface pressure increment was traced to the 100 hPa, where the background temperature can be as large as 7 °C warmer that the AIRS observation. Part of the temperature difference was originated when the NAM analysis was projected to WRF grid during model initialization. It is most pronounced where the temperature profile undergoes a large vertical change, such as tropopause. Our original model configuration of 37 levels with 50 hPa vertical spacing near the tropopause is deemed too coarse to resolve the vertical temperature variation in the NAM analysis. Increasing the model levels to 50 with a vertical spacing of 20 hPa near the tropopause produces a WRF initial state, which is a better match with the NAM analysis. The new WRF initial state provides a better background for AIRS assimilation. It reduces the surface pressure increment in AIRS analyses (up to half of the previous values over the water). The improved analysis leads to better precipitation forecasts in both bias scores and equitable threat score. It also improves the forecasts in temperature and geopotential height.

Microphysical Adjustments in WRF Using CloudSat

Over the past several months, data from the Canadian CloudSat/CALIPSO Validation Project (C3VP) have been used to evaluate assumptions related to populations of snow crystals simulated within the NASA Goddard, single-moment, bulk water microphysics scheme. By comparing high-resolution WRF model output to C3VP observations for a synoptic-scale snowfall event, it was determined that the use of fixed values for snow crystal size distribution parameters and bulk density struggle to represent the vertical variability of each parameter that was observed for this event, and documented by previous investigators during other field campaigns. In addition, the current relationship between the diameter and fall speed of a crystal aggregate produces a much slower fall speed than suggested by C3VP observations. These findings motivated two experimental modifications to the NASA Goddard scheme: one that parameterizes the size distribution of snow crystal aggregates as a function of temperature, and another that parameterizes their qualities based upon their location within the vertical column. Each experiment included a modification to the terminal fall speed and diameter relationship, based upon C3VP surface observations. In either experiment, the size distribution and density characteristics of snow crystals were a better fit to observations than in the current, fixed value approach. In addition, it was demonstrated that the simulation of CloudSat reflectivity from spheres is inadequate, and that scattering characteristics of natural crystal shapes will produce a better fit to observed profiles.

Collaboration With NSSL on WRF Forecasts

Beginning with last year's Hazardous Weather Testbed Experimental Forecast Program at NSSL, SPoRT ran a series of daily parallel WRF runs over NSSL's Continental U.S. 4-km operational domain using SPoRT's high-resolution MODIS SSTs in place of NCEP's SSTs. The objective was to compare the operational NSSL WRF forecasts with these parallel forecasts to demonstrate the impact of the MODIS SST data. A precipitation verification was conducted on these parallel forecasts using the Meteorological Evaluation Tools (MET) software and corresponding scripts developed by SPoRT. The verification applied both Stage IV and Stage II analyses for the period of record spanning May through August 2009. SPoRT's MET scripts were also used to perform precipitation verification on a 2-year archive of nominal NSSL WRF forecasts. The results showed that, despite providing more representative details of the temperature gradients in coastal regions, the MODIS SSTs had little impact on the convective precipitation forecasts in the region of most concern to forecasters at the Storm Prediction Center (i.e., primarily inland regions well displaced from the Gulf of Mexico). This result was expected, since the MODIS SSTs should have the greatest impact on localized forecasts of sea breeze circulations and resulting convection along the Gulf Coast.

WRF/SST Forecast Impact Studies

Following the 2009 SPoRT SAC meeting, SPoRT began collaborating with the NWS Eastern Region (ER) to determine how SPoRT can provide products that can improve short-term forecasts in the Great Lakes region. The simulation of lake-effect precipitation and lake breezes can be sensitive to the representation of lake surface temperatures in local models, analogous to previous SPoRT modeling sensitivity studies with coastal WFOs in the Southern Region. To address these forecast concerns, SPoRT is customizing a satellite-based estimate of lake surface temperatures over the Great Lakes. By combining the satellite temperature product with an accurate portrayal of ice cover; the end result will replace the relatively coarse Great Lakes surface temperature product currently available within the WRF Environmental Modeling System (EMS) framework used by various ER WFOs. A real-time 4-km simulation domain over the Great Lakes was configured within the WRF EMS and implemented on December 10, 2009 to monitor the product and identify prospective case studies for further investigation. Additional research will likely include collaborative efforts with the ER WFOs adjacent to Great Lakes in order to determine the value added by including NASA datasets in their local models.

Lightning Forecasting

In the fourth quarter of 2009, SPoRT lightning researchers expanded their work on lightning forecasting by preparing to participate in new simulation exercises to be performed at GSFC using a version of WRF that will ultimately be employed at NSSL. A new lightning threat algorithm was added to the WRF postprocessing software to allow evaluation of the three lightning threats in the standard hourly snapshot data saved during each model run. Preliminary results appear to be reasonable for two cases examined thus far. Because lightning can exhibit significant variability on time scales shorter than 1 hr, efforts are also planned to add the McCaul et al. (2009) algorithm directly to the actual WRF model itself, to permit calculation of fields of hourly maxima of the lightning threats in addition to the instantaneous hourly snapshot field values available from the post-processor. Once this code is added and the results verified, the new WRF code will be delivered to NSSL in time for the Spring 2010 Experiment.

Additional work has shed light on why the WRF-predicted lightning threat field values were apparently too large for one of the CAPS ensemble cases studied in 2009. For the May 2, 2008 case, the most intense lightning activity was centered in two supercells in north Mississippi at a range of 300 km from Huntsville, well beyond the recommended maximum range of 150 km within which reliable spatial resolution of storms can be achieved by LMA data. The two storms were only about 40 km apart, and were disposed along a radial from Huntsville, and thus were maximally susceptible to flash clustering ambiguities using the default settings in our LMA flash cluster algorithm. A special version of the flash algorithm was built that used tighter spatial proximity criteria, and this algorithm eliminated the long-duration ambiguous flash complexes, produced an increase in total flashes, and yielded an approximate doubling of the peak flash rate density in the storms. The latter is consistent with successful resolution of the two storms that were previously treated as one. The newer inferred peak flash rate density now agrees within about 15% with the peaks estimated from the WRF simulated storms, an accuracy that is comparable with that found in the May 11, 2008 CAPS simulations.

Related Activities

SPoRT Co-op Student Receives Ph.D. — Andrew Molthan, NASA MSFC Cooperative Education Student, received his Ph.D. degree from the UAHuntsville on December 18, 2009, under SPoRT sponsorship. His dissertation entitled, "Validating and Improving a Single-Moment Bulk Water Microphysics Scheme Using Observations From the NASA CloudSat Cloud Profiling Radar," describes the use of NASA CloudSat observations to tune cloud model parameterization schemes to improve forecasts of winter precipitation events. Andrew has accepted a full-time position in the NASA MSFC Earth Science Office to continue this research.

Dr. Andrew Molthan celebrates with his faculty advisor Dr. Gary Jedlovec after the hooding ceremony.

Recent Publications and Presentations

Journal Articles/Publications (now in print)

Books

Jedlovec, G., 2009: Automated Detection of Clouds in Satellite Imagery. Geoscience and Remote Sensing, (G. Jedlovec, editor), In-Teh, Croatia, ISBN 978–953–307–005–6 (also available <www.intechweb.org>).

Conferences/Workshops Papers/Presentations

AMS Annual Meeting Papers and Conference Presentations

- A Modeling and Verification Study of Summer Precipitation Systems Using NASA Surface Initialization Datasets. Jonathan L. Case (ENSCO), et al.
- Evaluation of Enhanced High Resolution MODIS/AMSR-E SSTs and the Impact on Regional Weather Forecast. Luke D. Schiferl (University of Wisconsin), et al.
- Improving the Representation of Snow Crystal Properties within a Single-Moment Microphysics Scheme. Andrew L. Molthan (NASA), et al.
- NASA SPoRT GOES-R Proving Ground Activities. Geoffrey T. Stano (ENSCO), et al.

Other Meeting Papers and Conference Presentations

- AGU Meeting 2009, San Francisco, CA: "Exploring Alternative Parameterizations for Snowfall with Validation from Satellite and Terrestrial Radars." Andrew L. Molthan (NASA), et al.
- National Weather Association Meeting 2009, Norfolk, VA, "The transition of high-resolution NASA MODIS sea surface temperatures into the WRF Environmental Modeling System." Case, J.L. (ENSCO), et al.

Proposals Submitted/ Funded

- NASA ROSES09 A.40: Earth Science for Decision Making: Gulf of Mexico Region — A Coastal Flood Modeling System for Guiding Decision-Making Processes in the Gulf of Mexico Region under Future Climate Scenarios — PI: Craig Mattocks (University of North Carolina – Chapel Hill) and Gary Jedlovec (NASA/SPoRT).
- NOAA-NESDIS-NESDISPO-2010-2001902: Research in Satellite Data Assimilation for Numerical Weather, Climate and Environmental Forecast Systems — Assimilation of IASI Profiles and Radiances into a Regional Prediction Model — PI: Bradley Zavodsky (NASA/SPoRT) and Shih-Hung Chou (NASA/SPoRT).

Visitors

SAC committee meeting

- Tsengdar Lee (NASA Headquarters)
- Bill Baumann (ENSCO)
- Jack Kain (NOAA/OAR)
- Ron Gelaro (NASA/GSFC/GMAO)
- Rusty Billingsley (NWS/Southern Region)
- Allen White (NOAA/ESRL)
- Bill Sjoberg (General Dynamics)
- Brian Motta (NOAA/ESRL)
- Jeff Waldstreicher (NWS/Eastern Region)
- Elizabeth Valenti (WorldWinds, Inc.)

Learn about SPoRT

- Andrea Donnellan (NASA Headquarters)
- Robbie Hood (NOAA)
- Rear Admiral Phillip Kenul (Army)
- Ken Gertz (VP Research, University of Maryland)
- Steve Weiss (NOAA/SPC)
- Jack Bevin (NOAA/NHC)

Calendar of Upcoming Events

- AMS Annual Meeting, January 17–21, 2010, Atlanta, GA
- Earth Observing Mission Applications Workshop, February 1–3, 2010, Colorado Springs, CO
- NWS Science Services Division (SSD) Chiefs Meeting, March 2, 2010, Huntsville, AL
- WFO Collaboration Workshop, March 3–4, 2010, Huntsville, AL
- Lightning Proxy/Data Assimilation Workshop, March 2010, Norman, OK
- Interagency NextGen Weather Research Review and Coordination Meeting, March 22–24, 2010, Boulder, CO
- 2010 ILDC/ILMC — Lightning's impact on society, April 19–22, 2010, Orlando, FL
- NOAA Testbed Workshop, May 3–5, 2010, Boulder, CO
- Satellite Training Workshop, May 18–21, 2010, Boulder, CO
- GOES-R Proving Ground Meeting, May 24–25, 2010, Boulder, CO
- IGARSS, July 26–30, 2010, Honolulu, HI

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