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The SPoRT REPORT

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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

AIRS Profile Assimilation and Forecasts

The SPoRT Center is conducting research to optimally assimilate unique NASA satellite observations into a regional weather forecast model. The Atmospheric InfraRed Sounder (AIRS), aboard the EOS polar-orbiting Aqua satellite, provides near-rawinsonde-quality atmospheric temperature and moisture profiles with the ability to resolve some small-scale vertical features. Proper use of quality indicators and error estimates provided with each profile can lead to an improvement of the initial conditions, especially in the data-sparse regions. Quality indicators are used to select the highest quality temperature and moisture profiles for assimilation in both clear and partly cloudy regions. Separate error characteristics for land and water soundings are used in the assimilation process, due to the poorly defined infrared surface emissivity over land.

The SPoRT forecast/assimilation system consists of the Weather Research and Forecasting (WRF) model and its 3DVAR assimilation component (WRF-Var). The forecast domain covers the contiguous United States, western Atlantic Ocean, and the Gulf of Mexico. The WRF forecast is initialized with the North American Mesoscale (NAM) analysis and its boundary conditions are updated every 3 hr using the NAM forecasts. The forecast/assimilation cycle starts at 00 UTC and runs several hours until the AIRS overpass time is reached (usually around 07–09 UTC for the morning pass). The WRF forecast is then used as the background field for WRF-Var to assimilate AIRS profile data. The forecast continues with WRF-Var analysis as the new initial state for a forecast up to 48 hr.

Assimilation results show that AIRS profiles can produce an analysis closer to in situ observations than the background field, especially in the mid- to lower troposphere. Results for a 37-day case study period from the winter of 2007 indicate that forecasts of temperature and mixing ratio improve in the lower troposphere with irregular small degradations in the mid- and upper-troposphere values (when compared to NAM analyses). Much of the forecast improvement with the inclusion of AIRS profiles occurs over the Great Lakes region, which coincides with

the high density of storm tracks for the case study period. This indicates the usefulness of AIRS profiles in winter storm forecast. The 6-hr cumulative precipitation forecasts, verified against NCEP Stage IV precipitation data, show improvement in both bias and equitable threat scores for all precipitation thresholds. The former is a measure of precipitation area coverage, while the latter measures the precipitation location and intensity.

Knowledge and techniques developed in this study are applicable to assimilation of profiles from the Infrared Atmospheric Sounding Interferometer (IASI) and Cross-track Infrared Sounder (CrIS).

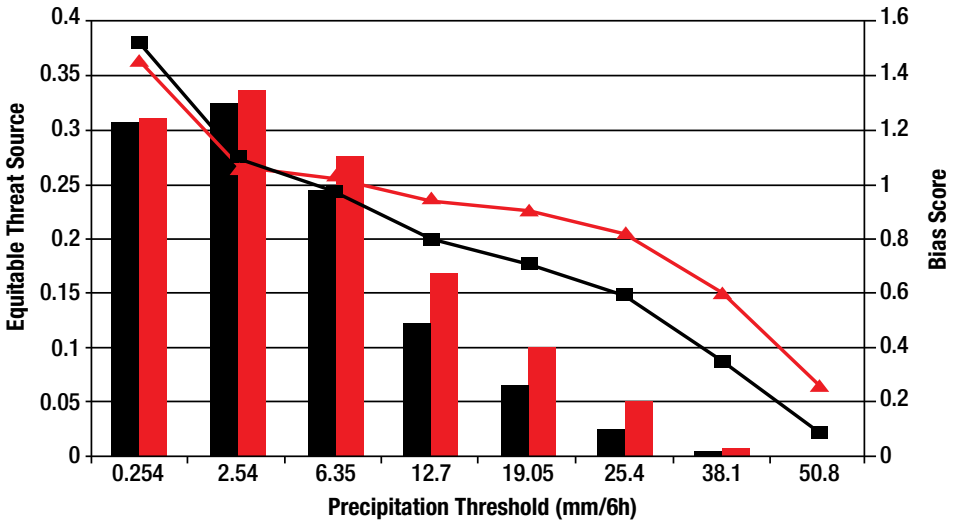

Figure 1. Overall 6-hr cumulative precipitation statistics for 37-day case study period. The bars represent equitable threat scores (left axis) and the lines represent bias scores (right axis). While black bar and line are for the control runs; red bar and line are for the AIRS runs.

Recent Accomplishments

New Users of SPoRT Data

The SPoRT program continues to generate interest in NASA data for use in the operational forecast environment. This past quarter has seen three new end users request NASA data to support their forecast operations and to provide feedback to the SPoRT program. The Peachtree City WFO, near Atlanta, Georgia, has requested the real-time feed from the North Alabama Lightning Mapping Array (NALMA). This has developed out of a partnership with the Lightning Group in Huntsville, Alabama working with John Trostel from Georgia Tech University to incorporate his total lightning sensors in the Atlanta area with the NALMA. With the successful inclusion, the NALMA data will soon begin evaluation with the Peachtree City office to determine the effectiveness of the Atlanta sensors that are far removed from the central portion of the NALMA network. Additionally, the Storm Prediction Center (SPC) in Norman, Oklahoma is looking to continue receiving real-time total lightning data from the NALMA and the Washington D.C. lightning mapping array (DCLMA). Along with the Oklahoma lightning mapping array, the SPC received these data during the Spring Program this past May and June. The current effort is for SPoRT and the Lightning Group to maintain this data stream as well as provide formal training to the SPC forecasters. Lastly, the Key West, Florida WFO has requested the MODIS product suite after learning of the utility of these products from forecasters at the WFO Miami, Florida. Key West's Kennard Kasper (Senior Forecaster), provided a very detailed listing of forecast issues for which the MODIS suite may provide assistance. In particular, the Key West office is dominated by maritime forecast concerns, where the MODIS sea surface temperature composite has been highly anticipated. Additionally, the true color composite will help detect smoke and dust plumes over the region. As the data flow is firmly established the SPoRT program will provide training as well as set up evaluations of the products.

SPoRT Visit to the Albuquerque WFO

On September 22–24, SPoRT PI Dr. Gary Jedlovec and SPoRT liaison and lightning expert Dr. Geoffrey Stano visited one of the newest partners, WFO Albuquerque, New Mexico, to discuss the use of SPoRT's forecast products. The Albuquerque county warning area is one of the largest in the country and spans the northern two-thirds of the state. Conversely to its size, this office has a limited number of surface observation sites and large gaps in radar coverage. This creates forecast challenges not always encountered by other SPoRT partner offices. The office regularly uses a number of SPoRT products including the MODIS and GOES low cloud and fog products as well as the CIRA total precipitable water product. The office's regular feedback and discussions during the visit helped illustrate many of the unique forecast concerns. In particular, the office desires help with minimum temperature forecasts, fire weather support, precipitation mapping, and lightning monitoring. In addition to these discussions, SPoRT provided additional face-to-face training for the Albuquerque staff, particularly with MODIS and total lightning observations. SPoRT is currently working to obtain the White Sands lightning mapping array data for use by the Albuquerque office.

MODIS Fog Study

The inland NWS partners (BMX, HUN, OHX, MRX) participated in evaluating the MODIS spectral difference (i.e., "fog") product for use in aviation and public forecasts of visibility restrictions during the period September 1–22. The MODIS product is used to better define the more coarse GOES imagery as well as to identify mesoscale areas of fog in river valleys and low lying topography. Interestingly, it also did well to identify fog in elevated valleys of the Cumberland and Appalachian Plateaus, sometimes prior to identification by GOES imagery. Feedback from

users was mixed. Even with the positive items previously mentioned, users thought that the product over identified areas of fog and would like to see both increased frequency of the product and better timing (i.e., closer to sunrise when fog is most likely). SPoRT is working on a modification of the product to better separate areas of low clouds from fog as well as a hybrid GOES/MODIS product that would provide greater continuity to the product while still incorporating high resolution MODIS data.

WRF/SST Forecast Impact Studies

SPoRT's summer intern, Mr. Luke Schiferl, completed the analysis of an enhanced MODIS SST product using data from AMSR-E and the European Operational Sea Surface Temperature and Sea Ice Analysis against the original MODIS SSTs during June and July 2007. These two months experienced substantial data latency in the original MODIS SSTs due to extensive cloud cover and convection in the vicinity of Florida. Results indicated that the enhanced MODIS product performed substantially better than the original MODIS composites as well as the Real-Time Global SST product. The high-resolution details of the MODIS are mostly preserved while the data latency is substantially improved in many areas. Mr. Case and Mr. Fuell contributed a WRF model sensitivity run from late June 2007, using the enhanced MODIS SST composite. The model run dramatically improved upon the 2-m temperature forecasts around the Florida Keys using the original MODIS SSTs. These results were presented at the summer intern poster presentation at Marshall Space Flight Center and will also be presented at the upcoming annual American Meteorological Society meeting.

Microphysical Adjustments in WRF Using CloudSat

Using an analysis of aircraft data obtained during the Canadian CloudSat/CALIPSO Validation Project (C3VP), two new parameterizations of the size distribution of snow crystals within the NASA Goddard microphysics scheme have been developed: one that uses a function of temperature, and another that uses a column integrated value and position of the crystals within the cloud column. Although a temperature based approach is of limited value where the temperature profile is complex or isothermal, a column integrated approach is sensitive to the ability of the model to reproduce the observed cloud depth. Both methods appear to improve upon the size distribution and density assumptions of the original scheme, although additional case studies are required to demonstrate an overall improvement. Ground based and CloudSat radar reflectivity has been used to validate improvements by demonstrating that observed radar reflectivity and model derived values are comparable. In the case of CloudSat, this involved the utilization of snow crystal databases, which provide the single scattering characteristics required to estimate attenuation and radar backscatter. Snow crystal databases have been incorporated into the NASA Goddard Satellite Data Simulator Unit, as part of an ongoing collaboration between SPoRT and NASA GSFC staff.

GOES-R Proving Ground Activities

A suite of proxy products for the Advanced Baseline Imager (ABI) are being prototyped by combing higher resolution MODIS data with standard GOES imagery. This work is being done by SPoRT to provide a near real-time ABI proxy product to end users. Much of the work by other Proving Ground partners is focused on simulations of ABI channels for use in a case study framework. In order to provide temporal continuity similar to a geostationary satellite image, sequences of half-hourly 4-km infrared GOES images are superposed with 1-km infrared MODIS swath data into the GOES image nearest in time. This allows the forecaster to loop the data in the same way as is presently done in the operational setting and avoid a "jumpy" loop of polar orbiting swaths that is not aesthetically pleasing or easily applicable. This "hybrid" GOES/MODIS product provides the opportunity to view the higher resolution ABI capabilities that will be available with GOES-R while at the same time comparing it to the present GOES imagery. This process is being applied to visible and water vapor channels, as well as other appropriate products from SPoRT's suite of products, including derived (low cloud and fog, land surface temperature, etc.) and multichannel composites (false color snow, natural color, etc.).

Optimal Interpolation to Produce a High Spatial and Temporal Resolution SST Analyses

High resolution sea surface temperature (SST) analyses are important for regional weather forecasting studies and coastal ocean applications. Recently, SPoRT developed an enhanced high-resolution SST composite product for regional applications by compositing data from NASA's MODIS, aboard both the Terra and Aqua satellites, and the Advanced Microwave Sounding Radiometer–EOS (AMSR-E), aboard the Aqua satellite. The addition of AMSR-E SST values reduces the latency of the composite SST product when MODIS data is unavailable for periods of several days due to weather patterns with persistent cloudiness. A new effort has focused on developing a high spatial and temporal resolution optimal interpolation (OI) analysis SST product, which further improves on the accuracy of a high-resolution SST product. Optimal interpolation schemes seek to combine all available information in the most efficient and accurate manner in order to produce an accurate state vector. The current OI scheme uses MODIS and AMSR-E data to produce a high-resolution product that remains robust in cloudy regimes due to its ability to spatially spread information based on covariance structures. The OI scheme is initialized with a coarse background field, and on successive days uses the previous day's analysis as the background field. In this way, high-resolution data from previous days and observations from the current day is synthesized in a way that preserves structure on days when cloud cover or data voids reduce the number of daily observations. Variance of the background field is determined by applying an empirically determined variance inflation constant to the previous day's analysis variance.

OI analyses have proven beneficial in reducing analysis error near the coast where the ability to spatially spread information becomes more important due to the lack of AMSR-E (in precipitation areas or coastal regions) and MODIS data (in areas of persistent cloudiness). In addition, quantitative measures of variance in the analysis given by the OI scheme provide a new way of diagnosing analysis error. Currently, the OI scheme is being run for several case studies to be followed by validation of the results against in situ observations.

Assessments

Several new assessments of data and products have been completed and have been posted on the SPoRT Evaluations Web page <http://weather.msfc.nasa.gov/sport/evaluations/>. SPoRT coordinated a study with several Western Region WFOS on the use of MODIS multichannel False Color composite data for ice and snow cover monitoring. Two very recent assessments have been completed on the MODIS "fog" product by the Albuquerque WFO and the total lightning data from the 2009 summer study. In addition to these, the users posted quick feedback and product assessments on the Wide World of SPoRT <http://www.nsstc.uah.edu/sportblog/> on the utility of the NASA data and products. In particular users from the Albuquerque NM, Nashville TN, Corpus Christi TX, Mobile AL, Huntsville AL, and Morristown TN forecast offices have all contributed assessments of how they use specific data for a given forecast issue. See Albuquerque NM entry under the "MODIS" category for an example of how the spectral difference product was used in a way that had not previously been discovered.

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Training

Prior to the start of the MODIS Fog Intensive Study for Fall 2009, SPoRT created and released a short (7.5 min) training module on this product. SPoRT staff continue to work on topics related to MODIS and other unique NASA data to serve as a primer for our users. These modules are useful to both SPoRT users and those in the GOES-R Proving Ground who would like more formal training for participants of the SPC Spring Experiments for 2010.

Visitors

October 1st—Brian Motta from the Forecast Decision Training Branch

Al Powell—NOAA/NESDIS/STAR, September 10.

Publications

Lee, T., C. Nelson, P. Dills, L.P. Riishojgaard, A. Jones, L. Li, S. Miller, L.E. Flynn, G. Jedlovec, W. McCarty, C. Hoffman, and G. McWilliams, 2009: NPOESS: Next Generation Operational Global Earth Observations. Bull. Amer. Met Soc., in press.

Darden, C. D. Nadler, B. Carcione, R. Blakeslee, G. Stano, D. Buechler: Utilizing Total Lightning to Diagnose Convective Trends. Bulletin of the American Meteorological Society, accepted.

McCaul, E. W., Jr., S. J. Goodman, K.M. LaCasse, and D. J. Cecil, 2009: Forecasting lightning threat using cloud-resolving model simulations. Wea. Forecasting, 24, 709–729. (also highlighted as a Paper of Note in Bull. Amer. Meteorol. Soc., 90, June issue).

McCarty W., G. Jedlovec, T. L. Miller (2009): Impact of the assimilation of Atmospheric Infrared Sounder radiance measurements on short-term weather forecasts. J. Geophys. Res., 114, D18122, doi:10.1029/2008JD011626.

Conference Papers/Presentations

Stano, G. T., R. Blakeslee, C. Darden, and E. W. McCaul: NASA SPoRT GOES-R, Proving Ground activities utilizing lightning mapping array observations. Southern Thunder Workshop, Cocoa Beach, Florida, 28–30 July 2009.

Nadler, D., C. Darden, J. Burks, G. Stano, and D.E. Buechler, 2009: An Operational Perspective of Total Lightning at WFO Huntsville. Southern Thunder 2009.

Blakeslee, R.J., H.J. Christian, J. Bailey, D.E. Buechler, J. Hall, E.W. McCaul, G. Stano, 2009: Description and Status of the North Alabama Lightning Mapping Array, Southern Thunder 2009.

Buechler, D.E., R. Boldi, R. Blakeslee, and G. Stano, 2009: The North Alabama Lightning Warning Product, Southern Thunder, 2009.

Stano, G. T., M. Ba, C. Darden, and J. Burks, Visualization of operational total lightning data. Southern Thunder Workshop, Cocoa Beach, Florida, 28–30 July 2009.

Darden, C., M. Coyne, C. Palmgren, S. McCloud, C. Schultz: Utility of Local Radar Data in the Warning Decision Making Process. National Weather Association Annual Meeting, Norfolk, Virginia, October 2009.

Proposals submitted/accepted

Incorporating Non-Spherical Ice Crystals Within Simulations of CloudSat Reflectivity and a Single-Moment Microphysics Scheme, Andrew Molthan (PI), NASA ROSES 2009.

Upcoming Events

National Weather Association Annual Meeting, Norfolk, VA, Oct. 19–22, 2009—Case presentation.

AIRS Science Team Meeting, Greenbelt, MD, Oct. 13–16, 2009—Zavodsky presentation.

GOES-R Users Workshop, Madison, WI, Nov. 2–5, 2009—Jedlovec GOES Proving Ground presentation.

SPORT Science Advisory Committee (SAC) Meeting, Nov. 18–20, 2009.

AGU 2009 Fall Meeting, San Francisco, CA, Dec. 14–18, 2009.

AMS Annual Meeting, Atlanta, GA, Jan. 17–21, 2010.