



SPoRT Quarterly
January–March 2010

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

Evaluating Simulations of Snowfall Produced by WRF and the NASA Goddard Single-Moment Microphysics Scheme

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. This includes a high-resolution WRF model forecast (1 km), radar reflectivity from the 94-GHz CloudSat radar, the C-band, dual-polarimetric radar at King City, Ontario, aircraft probes capable of measuring the size distributions of precipitating ice crystals and calculated values representing crystal size distribution and density for comparison to assumptions within the NASA Goddard scheme (Figure 1). 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.

Although a temperature-based approach has merit and is supported by relationships from other field campaigns,

a parameterization with temperature struggled to represent conditions in the lowest 3 km of vertical profiles for the C3VP event. Due to the synoptic-scale pattern for this event, warm air advection produced a temperature profile with little variability and a weak elevated inversion. These factors contribute to a temperature profile with minimal variability, and the approach of a temperature-based parameterization failed to represent the continued aggregation of crystals as they continued to fall. The nearly isothermal temperature profile contributed to a narrow range of simulated size distributions and bulk densities, while observations contained more variability. By incorporating a column-based approach, using a path integration of vapor excess with respect to ice, the selected variable incorporates information from the temperature profile while ignoring the effects of temperature profile shape through the

column integral. This parameterization was capable of representing the full-range of size distributions and bulk densities for snow crystals, although it was only tested for a single case and will be highly sensitive to the model's ability to represent the vertical profile of water vapor and an appropriate cloud depth.

During attempts to evaluate model performance with CloudSat observations, it was determined that current efforts using Mie scattering spheres were insufficient. Mie scattering spheres suffer from resonance effects for sizes larger than approximately 1 mm at the CloudSat 94 GHz frequency, which results in a poor simulation of radar backscatter from naturally occurring crystals. During the C3VP campaign, aircraft crystal probe imagery and surface fall speed relationships suggested a dominance of snow aggregates. Therefore, CloudSat reflectivity was simulated from WRF model output

by assuming that simulated snow mass could be represented as aggregates in radar backscatter calculations. The use of aggregates in backscatter calculations resulted in simulated CloudSat reflectivity profiles with shapes comparable to observations, subject to biases between simulated and naturally occurring aggregates. The impact of a temperature or column-based parameterization can be observed in simulated CloudSat reflectivity, where the column-based approach allows for continued aggregation among simulated snow crystals and subsequently, a better representation for the shape of the simulated CloudSat reflectivity profile versus a temperature-based approach or the use of constants within the current NASA Goddard scheme. Combined, observations from C3VP helped to identify size distribution and density errors in the NASA Goddard forecast, while the CloudSat radar profiles helped to evaluate model performance through remote sensing.

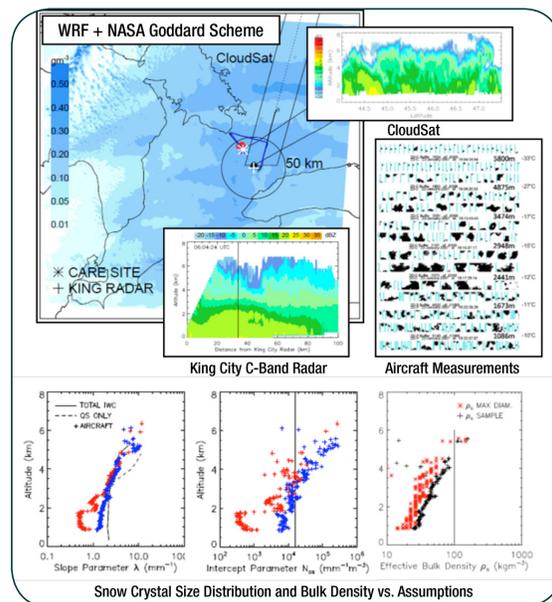


Figure 1: Model forecast developed for the C3VP snowfall event and various data sets used in an evaluation of the NASA Goddard single-moment, bulk water microphysics scheme.

Recent Accomplishments

New Total Lightning Activities for 2010

With the start of the new year, SPoRT has several new total lightning activities underway. In collaboration with the lightning group at the NSSTC, SPoRT is transitioning total lightning data from the Lightning Detection and Ranging (LDAR) network at the Kennedy Space Center to SPoRT's partners at WFO Melbourne and Spaceflight Meteorology Group. Currently, these WFOs cannot view these data in their AWIPS workstations. Forecasters have overcome this liability, but have expressed great interest in receiving LDAR in AWIPS. This will allow forecasters to overlay other meteorological observations with their LDAR data in the same way that SPoRT's partners with access to the North Alabama Lightning Mapping Array (NALMA) can do now.

SPoRT's work with total lightning is expanding beyond providing data only from the NALMA. The most recent example is the LDAR data located at

Kennedy Space Center, but also includes the possibility of data from White Sands, New Mexico and supporting forecasters using total lightning from the Washington, D.C. Lightning Mapping Array. These and many of the other total lightning networks use different products to display data. These include source densities (pieces of individual lightning flashes), flash extent densities, as well as variations using 1- or 2-km and 1- or 2-minute data. As SPoRT works with more networks, it becomes important to look at the differences that occur based on which product is used. SPoRT has performed a preliminary analysis of a series of severe thunderstorms from April 19, 2009. The early results from our small sample indicate that the higher spatial and temporal products for both source densities and flash extent densities are hampered by smaller overall values, making the detection of a lightning jump (a common precursor to severe weather) more difficult. From our small sample set the source density products at 2-km resolution but 1- or 2-minute temporal resolution as well as the flash extent density at 2-km by 1-minute resolution produced the best results.

Lastly, SPoRT in conjunction with the lightning group will be providing raw total lightning data to the 2010 Spring Experiment in Norman, Oklahoma. This effort has expanded from the earlier 2009 participation. This year, data from the North Alabama, Washington D.C., and Kennedy Space Center total lightning networks will be provided to go along with the Oklahoma network. These data will be processed to create a total lightning flash extent density product at the resolution of the future Geostationary Lightning Mapper instrument. This will be used with the Experimental Warning Program supporting GOES-R Proving Ground efforts. In addition to these data, SPoRT is providing a training module discussing the data, personnel with total lightning experience for face-to-face training, and working with WFO Huntsville to provide archived cases should no real-time events be available.

Enhanced MODIS SST in the Hands of Operational Users

The enhanced MODIS/AMSR-E SST and associated latency products are in the hands (i.e., AWIPS/D2d) of operational forecasters at the Mobile WFO.

They recently completed the change from the MODIS-only product, including new color curves to match SPoRT Web graphics. Steve Miller and Ray Ball of Mobile worked closely with SPoRT to make this data viewable in AWIPS. The Mobile WFO is doing initial testing of the product before wider distribution to SPoRT Southern Region partners. Steve commented, "What I am seeing with the Enhanced SSTs is great." The MODIS Enhanced SST is a weighted combination from MODIS, AMSR-E, GOES/POES, and OSTIA SST data, which has reduced the data latency and improved the composite accuracy.

WRF LIS Studies

An option was developed and implemented to initialize the WRF Environmental Modeling System (EMS) with land surface output fields from the SPoRT real-time configuration of the Land Information System (LIS), currently run over a south-eastern U.S. domain. The LIS land surface initialization option is officially supported in the public release of the WRF EMS version 3.1. SPoRT also provided support to the NWS offices at Miami, FL and Mobile, AL to help configure their local WRF/EMS model runs to use both the SPoRT/LIS and SPoRT/SST datasets. Both of these offices are now successfully initializing their local model runs with both the 3-km LIS land surface and 1-km enhanced SST datasets from SPoRT.

Collaboration With NSSL on WRF Forecasts

SPoRT implemented Dr. McCaul's forecast lightning threat algorithms (McCaul et al., 2009) into the real-time 4-km WRF model run at NSSL. The forecast lightning threats provide calibrated output of NSSL/WRF predicted lightning flash rates based on the model graupel flux at -15°C , vertically integrated ice and a blend of these two fields. The implementation included special code to compute the maximum hourly output of these fields in order to depict lightning flash rates between the hourly model output times. The fields have been added to the real-time NSSL/WRF Web page at <http://www.nssl.noaa.gov/wrf/>.

(Reference: McCaul, E. W. Jr., S. J. Goodman, K. M. LaCasse, and D. J. Cecil, 2009: Forecasting lightning threat using cloud-resolving model simulations. *Weather and Forecasting*, 24, 709–729.)

WRF/SST Forecast Impact Studies

SPoRT developed an option to use the enhanced SPoRT high-resolution SSTs in GRIB-2 format, as well as the Great Lakes sea-ice mask product in GRIB-2 format for initializing the WRF EMS. Both of these datasets were developed and refined this past quarter to include data from a separate analysis over the Great Lakes. These two options are officially supported in the public release of the WRF EMS version 3.1.

Lightning Forecasting

SPoRT lightning forecasting researchers compiled preparations to participate in new simulation exercises at GSFC using a version of WRF that will ultimately be employed at NSSL. Tests gave reasonable results, and a version of the code used in creating lightning threat output was successfully ported to the NSSL WRF. New code was added to the WRF postprocessing software to evaluate the point-by-point hourly cumulative maxima of the three lightning threats in the standard hourly data saved during each model run. These data are publicly viewable on the NSSL WRF Web site www.nssl.noaa.gov/wrf/. Preliminary results appear to be reasonable for the cases examined thus far.

SPoRT scientists have decided to perform a quantitative evaluation of the NSSL WRF lightning algorithm performance by comparing the predicted peak flash rate densities to observations from the North Alabama and Oklahoma LMA networks, for at least two major cases. One case will be the tornadic supercell outbreak of 10 April 2009, which was well-documented by the NALMA. An Oklahoma case will be selected from among the Spring 2010 cases run by NSSL. Since transfer of the algorithm to the CONUS-wide region has required some modifications to the algorithm for the sake of improving generality, we

plan to use the results of the new case studies to publish details of the algorithm changes. Dr. Bill McCaul has been invited to participate in the NSSL/SPC Spring Experiment 2010, and plans to attend from May 31 to June 4. Focus will be on use and assessment of the lightning threat output. Forecasters are particularly interested in seeing how well the algorithm performs on high-based "dry" storms that are common in the western states during the summer.

SPoRT Meets With SSD Chiefs on Expansion

The SPoRT team met with the NWS Science Services Division (SSD) Chiefs on May 2 to outline plans for the expansion of SPoRT transitions to WFOs outside the Southern Region. During the meeting the SSD Chiefs reviewed SPoRT activities and recent accomplishments. The SSD Chiefs were impressed with the accomplishments and with the SPoRT paradigm of matching data to forecast problem, developing solutions in a testbed environment, providing training on the new data and tools, and assessing the impact of the solution on forecast improvement. SPoRT and the SSD Chiefs agreed in principal to a phased expansion, first using existing SPoRT products in other regions and then developing solutions to forecast problems unique to other parts of the country.

SPoRT is already working with forecasters in other regions on a limited basis. SPoRT has worked closely with the Great Falls WFO (in the Western Region) over the last 5 years. They make extensive use of the SPoRT MODIS false color snow product to map snow cover and monitor melting conditions that could lead to extensive spring-time flooding. They also use MODIS data to detect and monitor the location of wildfires and smoke conditions in order to provide the necessary fire weather support in their region. The MODIS data and products provide detailed imagery over this high latitude region where GOES coverage is

poor. Last year SPoRT began working with several Eastern Region WFOs as well, providing high resolution water temperature data over the Great Lakes with the SPoRT enhanced MODIS/AMSR-E product. The water temperatures in the lakes significantly influence lake effect snow events in the Eastern and Central Regions. SPoRT is also providing WRF forecast products as part of their multimember ensemble case study and real-time scenarios.

The phased approach will initially focus on working with a few WFOs in each region. In the Western Region, expansion of collaborations like that with Great Falls is possible as well as working with coastal WFOs on providing additional satellite data and model analyses to map atmospheric rivers of moisture responsible for major flooding events in the region. The Central Region WFOs face a variety of forecast problems that encompass those of the other regions. Initial focus could be on using MODIS products such as the low cloud and fog product to assist in TAF preparation and issuing visibility restrictions. The Eastern Region may initially benefit from using the SPoRT enhancements to regional modeling applications through the WRF EMS v3.1. This recent version includes the GSFC/Land Information System, LIS, (as implemented with high-resolution options by SPoRT) and the MODIS/AMSR-E high-resolution SST/lake temperature data. SPoRT will visit the various regional Headquarters in the coming months to finalize the first phase of the expansion process. The second phase of the SPoRT expansion will likely include an emphasis on new forecast problems in these regions, including the Alaska and Pacific Regions.

SPoRT Collaborative Partners Workshop

SPoRT's collaborations with National Weather Service (NWS) Weather Forecast Offices (WFOs) serve as the basis for demonstrating the value of transitioning research to operations and the utility of unique NASA data and capabilities. The SPoRT/NWS Collaborative Partners

Workshop held March 3–4, 2010, was intended to review the value SPoRT has been providing to NWS operations and to discuss methods for enhanced collaborations. All SPoRT NWS partners were invited to attend and make a 15-minute presentation. Most partners were located in the NWS Southern Region (SR), but the list of attendees included two representatives from the Great Falls, MT WFO and a member of the Spaceflight Meteorology Group (SMG). In all, 11 of 13 partners were able to attend. Staff from the WFOs presented results of how imagery and products from SPoRT were adding value to forecast issues such as low clouds and fog, marine convection and cloud ceilings, supporting space launch forecasts, air mass and pressure analyses, flooding potential from snow melt and/or ice jams, snow cover modification of surface temperature, mesoscale precipitation and wind events predicted by local numerical models (i.e., the WRF-EMS), and severe weather warning using total lightning. These presentations and associated discussions not only enlightened SPoRT staff, but also served to meet the attendee's main expectation of learning how their peers are applying SPoRT data and understanding how this same value can be applied to their own WFO. In addition, a variety of SPoRT staff informed the attendees of current projects and their future direction within SPoRT's major focus areas (Situational Awareness, i.e., imagery and associated products from unique NASA instruments, Modeling and Data Assimilation, and Total Lightning). This provided an opportunity for SPoRT partners to learn about new project areas, connect to appropriate SPoRT staff, and plan initial steps to collaborate with that particular project. These SPoRT presentations included discussions on using AIRS profiles to assist with moisture transport, the Land Information System (LIS) surface and soil analyses, and SPoRT's efforts to collaborate with more total lightning networks. Discussions occurred throughout the presentations, but a block of time was reserved to identify ways to improve collaborations. Several ideas and actions were presented.

- Improved Web interface for SPoRT staff support and assessments
- Focused bimonthly teleconferences with subsets of partners' offices
- Including a Partner section in the SPoRT Quarterly and Biannual Report
- Expansion of the SPoRT ADAS to more partners
- Further quantify enhancements to model initial conditions (LIS and enhanced SSTs)
- A shift toward a project-based approach to obtain more quantitative results
- Emphasis on conference and e-journal publications
- Birmingham convective initiation project
- Huntsville total lightning/microburst project
- Great Falls MODIS false color implementation SPoRT's WFO partners have indicated that the workshop was a great success. Additionally, SPoRT and its NWS partners reaffirmed their commitment to continue collaborations as well as working to improve this model and how to extend this value to targeted partners in other regions.

Call for Proposals:

ROSES10 A.24 Computing and Operational Use of NASA Data (NOI: 7/15/2010: Proposal Due Date: 9/17/2010), <http://nspires.nasaprs.com/external/> Section 2.1 of the ROSES10 opportunity solicits proposals that address the acceleration of operational use of NASA research data. NASA encourages more rapid use of NASA's observations in operational weather predictions. Research and development proposals are sought to accelerate the operational use of NASA data. Proposals may be in areas of transitioning existing research data into the operational environments or of developing algorithms in the operational environment to accept future National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project (NPP) (now called the Joint Polar Satellite System, JPSS) or decadal survey instrument data. Proposals using models, data assimilation systems, or weather

information systems other than those currently employed by an operational entity will not be considered. Collaboration with the SPoRT at NASA Marshall Space Flight Center is encouraged. Additional information on the role SPoRT will play in these collaborative efforts can be found on our Web site at <<http://weather.msfc.nasa.gov/sport/>>.

In support of Principal Investigators responding to the ROSES10 A.24 section 2.1 solicitation, the SPoRT will agree to participate as an unfunded collaborator under the following conditions:

- SPoRT is briefed before NOI on the scope of the project.
- The final submitted proposal is made available to SPoRT PI Dr. Gary Jedlovec. <gary.jedlovec@nasa.gov>.

For proposals that anticipate the development of NASA products to address particular operational forecast issues, SPoRT will work with funded projects to:

- Integrate the derived product or solution into the AWIPS/AWIPS 2 environment or other appropriate decision support system.

- Work with the PI and his/her team to develop the appropriate training modules on the use of the product in the users decision support system.
- Assess the impact of the transitioned product on weather forecast operations.

In support of the proposal development effort, SPoRT will provide downloadable text on its Web site to support the proposed activity.

Recent Publications and Presentations

Journal Articles/Publications (Now in Print)

Darden, C.B., D.J. Nadler, B.C. Carcione, R.J. Blakeslee, G.T. Stano, and D.E. Buechler, 2010: Utilizing Total Lightning Information To Diagnose Convective Trends. *Bull Amer. Meteor. Soc.*, 91, 167–175.

External Workshops/ Meetings attended

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), Sujay V. Kumar (SAIC/GSFC), Jayanthi Srikishen (USRA), and Gary J. Jedlovec (NASA MSFC) 24th Conference on Hydrology, Atlanta, GA, January 17–21, 2010.
- Evaluation of Enhanced High Resolution MODIS/AMSR-E SSTs and the Impact on Regional Weather Forecast. Luke D. Schiferl (University of Wisconsin), Kevin K. Fuell (UAH), Jonathan L. Case (ENSCO), and Gary J. Jedlovec (NASA MSFC)—14th Conference on Integrated Observing and Assimilation Systems

for Atmosphere, Oceans, and Land Surface (IOAS-AOLS), Atlanta, GA, January 17–21, 2010.

- Improving the Representation of Snow Crystal Properties within a Single-Moment Microphysics Scheme. Andrew L. Molthan (NASA), Walter A. Petersen (NASA), Jonathan L. Case (ENSCO), and Scott R. Dembek (USRA)—15th Symposium on Meteorological Observation and Instrumentation, Atlanta, GA, January 17–21, 2010.
- NASA SPoRT GOES-R Proving Ground Activities. Geoffrey T. Stano (ENSCO), Kevin K. Fuell (UAH), Gary J. Jedlovec (NASA), Sixth Annual Symposium on Future National Operational Environmental Satellite Systems-NPOESS and GOES-R, Atlanta, GA, January 17–21, 2010.
- Results from assimilating AMSR-E soil moisture estimates into a land surface model using an Ensemble Kalman Filter in the Land Information System (LIS). Clay B. Blankenship (USRA), William L. Crosson (USRA), Jonathan L. Case (ENSCO), and R. Hale, 22nd Conf. on Climate Variability and Change, Atlanta, GA, January 17–21, 2010.

- Great Lakes Workshop—March 22–24, Toronto (Molthan) present paper The NASA Short-term Prediction Research and Transition (SPoRT) Center: Opportunities for Collaboration in the Great Lakes Region.
- A presentation on the WRF lightning forecasting research was given to a Lightning Proxy/Data Assimilation Workshop in Norman, OK, on March 16, 2010. The presentation was made by Dr. Steve Goodman, in McCaul's absence.

Proposals submitted/ funded

Submitted

- NASA ROSES09 A.41: (Molthan PI)– Developing Products from the Science of Terra and Aqua for Weather Analysis and Forecasting.
- NASA ROSES09 A.41: (Jedlovec Co-I)– Implementation of MODIS Terra and Aqua data in the development of high resolution Sea Surface Temperature Products (Jorge Vazquez–JPL, PI).
- NASA ROSES09 A.41: (Zavodsky Co-I) – Retrieval of Planetary Boundary Layer Properties from AIRS for Investigations of Land-Atmosphere Interactions, (Joseph Santanello GSFC, PI)
- NASA ROSES09 A.41: (Zavodsky unfunded collaborator) AIRS Level-2 Product Enhancement and Error Characterization (Christopher Barnet NOAA/NESDIS/STAR, PI).

Visitors

- Steve Weiss–NOAA/NWS/SPC Science and Operations Officer–learn about SPoRT
- Chris Siewert–SPC/GOES-R Liaison– (March 9-10) coordinate SPoRT GOES-R PG activities
- Bill Lapenta–NOAA/NWS/EMC – (March 23-24)–get an update on SPoRT
- Luke Schiferl–University of Wisconsin– (March 8-9)–learn about SPoRT, visit UAH Atmospheric Science Department
- Will McCarty (UMBC/GSFC)–(February 17–19) Seminar Speaker and get an update on SPoRT
- Jeffrey Clift (ENSCO)–learn about SPoRT
- UAH President David Williams and member of the UA Board of Regents (January 27) NWS office tour discussion of UAH/SPoRT interactions

SSD Chiefs meeting (March 2)

- Rusty Billingsley–NOAA/NWS/SR SSD Chief
- Bernard Meisner–NOAA/NWS/SR
- Andy Edman–NOAA/NWS/WR SSD Chief
- Ted Funk–NOAA/NWS/Louisville WFO
- Ken Johnson–NOAA/NWS/ER SSD Chief
- Steve Goodman–NOAA/NESDIS/GOES-R Project Scientist

SPoRT Collaborative Partners Workshop (March 3-4)

- Brian Guyer, WFO Albuquerque
- Kevin Laws, WFO Birmingham
- Alex Tardy, WFO Corpus Christi
- Lance Wood, WFO Houston/Galveston
- Chris Darden, WFO Huntsville
- Doug Schneider, WFO Knoxville/Tri-Cities
- Tony Cristaldi, WFO Melbourne
- Jeffrey Medlin, WFO Mobile
- Henry Steigerwaldt, WFO Nashville
- Brian Hoeth, Spaceflight Meteorology Group
- Gina Loss, WFO Great Falls
- Dave Bernhardt, WFO Great Falls
- Mike Johnson, NWS OS&T

Calendar of Upcoming Events

- Visit by Greg Mandt (NOAA/GOES-R Program Office), April 7–8
- International Lightning Detection Conference/International Lightning Meteorology Conference, Orlando, FL, April 19–22, 2010
- NOAA Testbed Workshop, May 3–5, Boulder, CO
- GOES-R Proving Ground Meeting, May 18–19, 2010, Boulder, CO
- Satellite Training Workshop, May 20, 2010, Boulder, CO
- NSSL Experimental Forecast Program and GOES-R Proving Ground Spring Experiment, May 17–June 22, Norman, OK
- WRF Users Conference, June 21–25, Boulder, CO
- GSI Tutorial, June 28–30, Boulder, CO
- IGARSS, July 26–30, 2010, Honolulu, HI
- AMS Satellite Conference, September 27–October 1, Annapolis, MD

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