National Aeronautics and Space Administration

SPoRT Quarterly
April – June 2010

# The SPoRT REPORT

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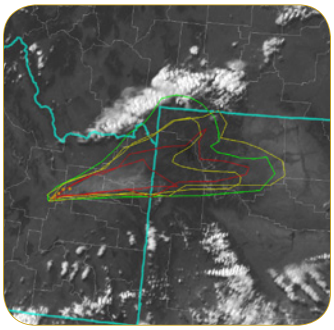
Short-term Prediction Research and Transition (SPoRT) Center
NASA Marshall Space Flight Center (MSFC), Huntsville, AL
http://weather.msfc.nasa.gov/sport/

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

### Next Generation AWIPS



The National Weather Service's main Decision Support System, Advanced Weather Interactive Processing System (AWIPS) has been around for over 12 years. AWIPS II, the replacement for AWIPS, has been under development for the past few years. Current plans are to begin implementing the new software and hardware at Weather Forecast Offices in calendar year 2011. AWIPS II is a Java-based system, designed with a service-oriented architecture. This will allow developers to create more sharable code across all levels of the NWS, and be able to access data independent of its location.

SPoRT plans to have its entire suite of products available in AWIPS II when the NWS DSS becomes operational. To integrate unique NASA data in the most advantageous way, SPoRT is developing AWIPS II software modules, called plug-ins. Over the last few months, Jason Burks (Huntsville WFO Information Technology Officer) has been leading the SPoRT AWIPS II team in developing several of these plug-ins for basic data and derived product ingest and display. Recent plug-ins developed by Kevin McGrath to display fire hotspot and smoke area data now provide the capability to display the NOAA/NESDIS Hazard Management System (HMS) and the University of Maryland's Fire Information for Resource Management System (FIRMS) products on GOES or MODIS imagery in AWIPS II. The HMS hot spots are ingested as ASCII data and the significant smoke extent polygons in Keyhole Markup Language (KML). The visible image above shows a smoke plume in southeastern Idaho, captured by GOES West at 2345Z on July 12, 2010. The orange dots represent fire/hotspot detections while the polygons represent smoke detections (red="heavy" smoke, yellow="medium" smoke, and green="light" smoke).

AWIPS II's modular nature allows for the development of separate plug-ins to ingest these three different data sets (two separate ASCII formats and the polygons in KML). These plug-ins perform processing necessary to read, process, and store each "record" of information in the AWIPS II internal database (or an HDF5 file, which is used mostly for image and gridded data). The modularity allows great flexibility in AWIPS II's visualization application called CAVE (Common AWIPS Visualization Environment). Separate plug-ins were developed to visualize each of these products.

# SPoRT Involvement in Spring Program

Three SPoRT team members participated in the 2010 Spring Experiment in Norman, OK. The annual Spring Experiment is hosted by the Hazardous Weather Testbed and contains two separate components: the Experimental Forecast Program (EFP) and Experimental Warning Program (EWP). Mr. Jonathan Case and Dr. Bill McCaul attended the EFP during the weeks of May 17 and June 1, respectively, while Dr. Geoffrey Stano participated in the EWP during the week of June 7.

This year's Experimental Forecast Program (EFP) had three focus areas:

1. Severe weather experimental outlooks with probabilities of severe hail, wind, and/or tornadoes for two time windows at 2000–0000 UTC and 0000–0400 UTC.

2. Quantitative Precipitation Forecast (QPF) experimental outlooks focusing on probabilities of exceeding 0.5 inch and 1.0 inch in 6-hour windows from 1800–0000 UTC and 0000–0600 UTC.

3. Aviation experimental convective outlooks forecasting coverage of 25,000 ft echo tops (18+ dBZ) and reflectivity exceeding 40 dBZ at 2100, 2300, and 0100 UTC, as well as a day-2 outlook.

The EFP activities had a heavy reliance on high-resolution numerical weather prediction guidance from both ensemble and deterministic models run by the Centers for Analysis and Prediction of Storms (CAPS), the National Severe Storms Laboratory (NSSL), and National Center for Atmospheric Research. CAPS provided a set of 26 high-resolution modeling members that used a variety of initial conditions from the National Centers for Environmental Prediction Short-Range Ensemble Forecasts, analyses that assimilated radar data, and a wide range of different physics schemes. Most model runs were done at 4-km grid mesh using the Weather Research and Forecasting (WRF) model. The 4-km NSSL WRF model also provided unique deterministic output fields to aid in severe weather forecasting, including a forecast total lightning threat (from McCaul et al., 2009) and hourly maximum quantities of reflectivity, updraft helicity, 10-m wind speeds, among others. The hourly maximum quantities help to depict the evolution of convective features in between the regular hourly model output by keeping track of the maximum values at every grid point during the model integration (Kain et al., 2010). These unique products in the NSSL WRF represent SPoRT contributions to the EFP.

SPoRT participants noted that due to the quantity of data to examine combined with the time constraints of delivering the experimental products, participants primarily relied on the high-resolution guidance from the CAPS ensemble output fields. There was not much opportunity to examine the experimental WRF lightning threat forecasts because the fields were only available in a single deterministic model (i.e., the NSSL WRF). In the future, SPoRT model-based products would receive greater visibility in the EFP if implemented within the CAPS ensemble model suite, especially given the large number of ensemble members.

The Experimental Warning Program's (EWP) mission is to improve the nation's hazardous weather warning systems by fostering collaboration between forecasters and researchers. This mission is wide ranging as it incorporates components of the Geostationary Operational Environmental Satellite (GOES)-R Proving Ground and focuses on many topics, including multi-radar multi-sensor products, new satellite-derived products, and total lightning. This year SPoRT provided total lightning data to the program from the North Alabama, Washington, DC, and Kennedy Space Center networks, developed the pseudo-Geostationary Lightning Mapper (PGLM) product and training module, and assisted The University of Alabama in Huntsville (UAH) in providing their convective initiation product to the EWP.

Due to the nature of the program, participants have the time to investigate new, experimental products that may otherwise be difficult to test during real-time National Weather Service operations. Throughout the experiment, forecasters were introduced to the PGLM and explored the possible benefits of what a similar product may provide once the Geostationary Lightning Mapper is launched aboard GOES-R. Feedback was overall positive, with forecasters appreciating the high temporal resolution and commenting that the PGLM is an excellent situational awareness tool. The PGLM can help prevent "tunnel vision" when forecasters have many storms on radar as the PGLM indicates which storms may be intensifying. Also, the PGLM gave forecasters a lead time of ≈10 minutes before the first cloud-to-ground lightning strike was observed.

Forecasters at the EWP provided ideas to enhance and improve the existing products. In one case (Fig. 1), forecasters overlaid the PGLM on an infrared satellite image. The IR imagery alone enables forecasters to examine the coldest cloud tops, but this can prove less useful if a cirrus shield develops. The PGLM allowed forecasters to narrow their focus on where the actual updraft cores were located. In another case, discussions with forecasters led to the development of a maximum flash density "track" product to better visualize when a storm was intensifying. A prototype of this product (Fig. 2) shows the maximum source density values over a 9-hour time span. Further development of this product may lead to a simple tracking product allowing forecasters to quickly visualize a lightning jump ahead of severe weather.

SPoRT's participation within the EFP and EWP was quite productive. SPoRT was able to contribute unique modeling products and awareness to the community on future satellite capabilities with the PGLM and UAH products. SPoRT also received important feedback on how to improve these products, ensuring a successful transition of SPoRT's research to the operational community.

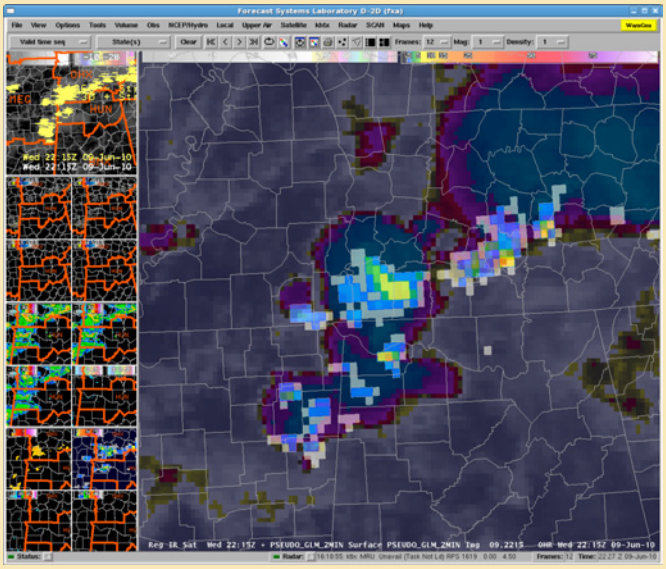


Figure 1: The PGLM flash extent density overlaid with a GOES infrared satellite image from 9 June 2010. The PGLM indicates where the main convective updrafts are underneath the cirrus shield.

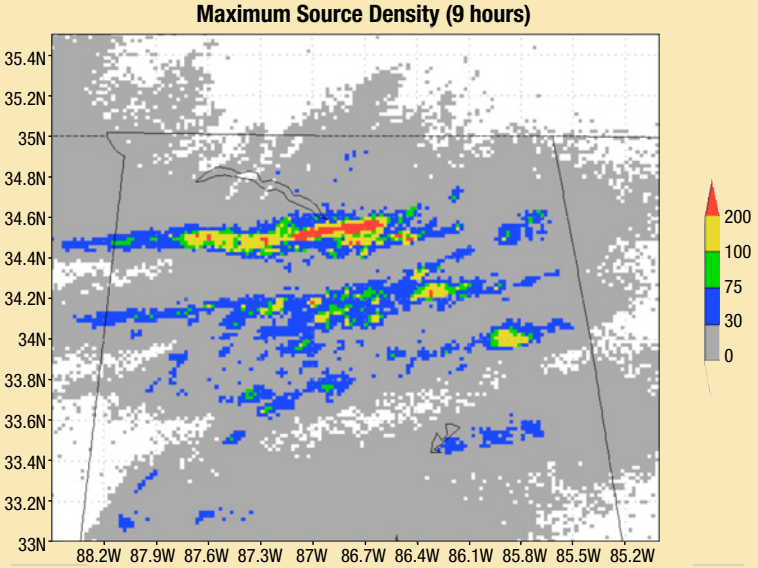



Figure 2: Prototype maximum density "track" product suggested by forecasters at the EWP and produced by SPoRT covering a 9-hour window. The color curve is designed to highlight when storms intensify.

### References:


Kain, J.S., S.R. Dembek, S.J. Weiss, J.L. Case, J.J. Levit, and R.A. Sobash, 2010: Extracting unique information from high resolution forecast models: Monitoring selected fields and phenomena every time step. *Wea. Forecasting*, In Press.

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.


# Recent Accomplishments

## WRF LIS Studies

A tailored configuration of the LIS that uses the Noah land surface model is being run over Alabama and portions of surrounding states to support a summer convective initiation (CI) study headed up by the National Weather Service forecast office in Birmingham, AL (NWS BMX). Effective 1 June, the NWS BMX is issuing near daily experimental CI "polygons" on their public Web site to focus on regions likely to have thunderstorm development during the midday and afternoon hours. To support this effort, SPoRT is providing hourly LIS output such as soil moisture and surface heat fluxes on a 1-km mesh grid out to 2100 UTC each day to give the forecasters an awareness of the land surface conditions that might contribute to favored thunderstorm formation. The summer experimental CI products will continue through August.

## CloudSat

Satellites such as CloudSat and other remote sensors are best applied to the problem of model validation when cloud microphysics outputs are converted to an equivalent, remotely sensed variable through the use of a satellite simulator. Research staff at NASA Goddard Space Flight Center have provided SPoRT staff with their Satellite Data Simulator Unit (SDSU). In order to appropriately simulate CloudSat reflectivity, the SDSU must be modified to calculate the scattering characteristics of ice crystals and aggregates, as well as the assumptions of various WRF microphysics schemes. Current work at SPoRT focuses on implementing nonspherical ice crystal scattering within the SDSU, adapting the code for use with other microphysics schemes, and simulating the C3VP synoptic-scale snowfall event with additional microphysics schemes that incorporate a wide array of size distribution and density assumptions.

## AIRS Profile Assimilation

After showing improved overall precipitation forecasts with assimilation of AIRS profile data for a 37-day case study period, the research focus shifted towards analysis of individual cases to demonstrate how AIRS enhances the precipitation forecast. An outstanding case of improved precipitation forecast occurred on February 12–13, 2007 over Eastern Texas and Western Louisiana with an approaching squall line and severe thunderstorms. Compared to the background, AIRS profiles assimilated over clear skies of the Gulf of Mexico — where conventional upper-air observations are very sparse — ≈24 hours before the peak of convective activities showed a warmer and moister boundary layer and cooler upper-level temperatures. These profile changes resulted in increased instability from higher convective available potential energy (CAPE) in the model initial conditions. The enhanced instability in the analysis fed into the approaching convective system and resulted in a line of convective storms in the forecast with AIRS profiles that was more representative of the actual storms than the control (no AIRS) forecast. This also led to stronger updrafts and more unstable equivalent potential

temperatures in the AIRS forecast in the region of the convection.

With success in producing improved analyses using AIRS profiles, SPoRT has pushed forward with development of a real-time AIRS-enhanced 3D analysis product. This product can be used as a situational awareness tool to complement upper air observations over data void regions (such as the Gulf of Mexico and northern Mexico) or to get a preview of what the synoptic-timed radiosonde observations might show. It could be used to initialize local WFO model runs to forecast moisture return and advection of unstable air from undersampled regions to improve convective forecasts. Based on guidance from the Huntsville WFO, the analysis product is produced at 0900 and 2100 UTC for the eastern two-thirds of the continental United States. This summer, SPoRT is testing the situational awareness capabilities of the product in improving convective potential guidance with assimilation of AIRS profiles by applying an AIRS and no AIRS analysis to locations where convection is forecasted and assessing stability parameters to test the impact of the AIRS profiles on the instability. Additionally, SPoRT is examining AIRS profile impact on short-term forecasts for a couple of notable moisture return cases including a Central California flash flood and strong wind event from October 13-14, 2009 and the Nashville flooding event from April 30-May 1, 2010.

## Training Activities

A large effort was made by Geoffrey Stano to incorporate existing total lightning training with new materials on the Pseudo-GLM product in support of GOES-R Proving Ground activities at the Hazardous Weather Testbed's Spring Experiment. This and other SPoRT developed lightning training are now on the NOAA Learning Management System with more modules to be entered into the system in the near future. In addition, a training module on the SPoRT ADAS has been started and will be completed by the next quarter in preparation for a gridded verification project with NWS Southern Region.

## MODIS/GOES Hybrid Imagery

This relatively new hybrid product combines the MODIS and GOES data in order to have a continuous loop of satellite imagery (and future products) while incorporating high-resolution polar-orbiting data where available. Testing of the MODIS/GOES Hybrid has occurred internally by Kevin Fuell and Matt Smith. The benefits of this product are evident at smaller scales and hence relevant subsets of the larger CONUS domain have been created for select WFOs. Initial transition to the co-located Huntsville WFO will occur with Nashville and Mobile to follow. Some WFOs will be asked to evaluate a derivative of this product that will serve as a proxy to the GOES-R ABI instrument in support of SPoRT's GOES-R Proving Ground activities.

## WFO Corner

This new section to the quarterly allows SPoRT's WFO partners the opportunity to contribute their recent collaborative activities. Sharing this information will ensure that all our partners are able to benefit and be involved in relevant SPoRT projects. Please consider having the SPoRT focal point in each WFO send a few sentences as warranted. For this initial writeup we note that the NWS/SPoRT Coordination calls have been changed to monthly and are "themed." WFOs can attend based on topic interest with the hope that individual absence will not be more than two consecutive calls. The April call reviewed actions from the Partnership Workshop, introduced new SPoRT blog capabilities, and kicked off the ingest of the Enhanced MODIS SST composite product. The May call focused on the SPoRT ADAS and its use for gridded verification. In June the topic was new total lightning networks and a primer for future call discussions about how to use the data in warning operations. Upcoming topics for July, August, and September, respectively are determining common modeling projects, AIRS data transition plan, and review of BMX use of LIS during summer convective initiation project.

**Application Integration Meteorologist (AIM) position in the Huntsville WFO.** Last year, NWS Southern Region Director, Bill Proenza, and NASA Headquarters Program Manager, Tsengdar Lee, agreed to jointly fund a new position in the Huntsville WFO to support additional SPoRT transition to operation activities to Southern Region weather offices. The NWS filled the Applications Integration Meteorologist (AIM) position in June with Brian Carcione. Brian brings 7 years of forecasting experience, his expertise in computer applications, and strong interpersonal skills to the position. His responsibilities will include working directly with SPoRT staff to develop and transition NASA observations and research capabilities into the NWS operations across the Southern Region, focusing on new products and displays in AWIPS2.

**SPoRT visit to Mobile NWS office**
SPoRT staff visited the Mobile NWS forecast office on May 7 to discuss recent use of SPoRT data in forecast operations. The staff at the Mobile WFO continues to be steady users of SPoRT products. Jeff Medlin, the Science and Operations Officer, indicated that at least half of his staff regularly view the data. In addition to the use of high-resolution MODIS imagery to improve situational awareness and the detection of low clouds and fog, the monitoring of source regions of agricultural fires also is a primary use of the NASA satellite data. Local runs of a regional weather forecast model continues to be an emphasis in the office, with the SPoRT SST data and land surface model configurations playing a key role in forecast improvement on a local scale. The Mobile forecast office also has played a key role in providing weather support for emergency management agency operations associated with the Gulf of Mexico oil spill. The Mobile office provides support for one of two disaster response command centers in the area. The office uses various satellite data, surface and atmospheric observations, and a variety of atmospheric models to provide the requested weather support. They also run an ocean wave model to provide ocean wave height information. The high resolution NASA satellite data and forecast model applications have been used to support daily briefings to the Command Center staff.

# Related Activities

### USRP Student Interns provide case study analysis

SPoRT is hosting three student interns under the NASA Undergraduate Student Research Project (USRP) — Michelle Cipullo and Robert James, both North Carolina State University atmospheric science students, and Danielle Kozlowski, an atmospheric science student studying at the University of Missouri.

During the summer months in the southeastern United States, forecasters have difficulty forecasting convective initiation. Thunderstorm occurrence is deemed "random," due to their sporadic appearance and a lack of atmospheric forcing detectable by traditional observations. Differences in soil moisture, soil type, land and vegetation cover around the southeastern United States varies depending on location, and could possibly be the focus mechanism for these afternoon thunderstorms. NASA intern Robert (Robbie) James explored the use of the NASA Land Information System (LIS) to take into account these varying soil types and how the moisture within them interacts with the Earth's energy budget, perhaps generating mesoscale boundaries, to focus convective initiation. The use of LIS may better predict summer convection by identifying boundaries in land surface characteristics correlations between land characteristics contributing to areas of convection. The SPoRT team has been actively working with the National Weather Service Office in Birmingham, AL, to incorporate LIS products into their operational forecasting methods. The project for this summer identifies case dates throughout summer 2009, where synoptic forcing was weak, and identify any boundaries in the land surface characteristics that may have lead to convective initiation.

Lake effect precipitation is common in the Great Lakes region, particularly during the late fall and winter. Synoptic processes of lake effect precipitation are well understood by operational forecasters, but individual forecast events still present a challenge. Locally run, high-resolution models can assist the forecaster in identifying the onset and duration of precipitation, but model results are sensitive to initial conditions, particularly the assumed surface temperature of the Great Lakes. The NASA SPoRT Center has created a Great Lakes Surface Temperature (GLST) composite, which uses infrared estimates of water temperatures obtained from the MODIS instrument aboard the Aqua and Terra satellites, or other coarser resolution infrared data when MODIS is not available, and ice cover maps produced by the NOAA Great Lakes Environmental Research Lab (GLERL). The MODIS product provides 1 km high-resolution data four times daily. These data are implemented into the Weather Research and Forecast (WRF) model Environmental Modeling System (WRF-EMS), which is used within forecast offices to run local, high-resolution forecasts. Michelle Cipullo is analyzing the sensitivity of the model forecast to the GLST product with a case study of the Lake Effect Storm Echinacea, which produced 10 to 12 inches of snowfall downwind of Lake Erie, and 8 to 18 inches downwind of Lake Ontario. The analysis compares a forecast using the default Great Lakes surface temperatures in the WRF-EMS model to the enhanced MODIS sea surface temperature data to study forecast impacts. Early results suggest that the MODIS product shows areas of decreased band intensity over cooler waters. This study will compare the intensity of the snow storm and GLSTs measured by the current forecasting product and the enhanced MODIS product with verification data to see which method more accurately forecasts the event. This single case study is the first part of an examination to determine how MODIS data can be applied to improve model forecasts in the Great Lakes region.

One of SPoRT's many projects this summer is to compare the thermodynamic structure of the atmosphere derived from the Atmospheric Infrared Sounder (AIRS) with control analyses that include no AIRS data to demonstrate the utility of AIRS data to nowcasting for the pre-convective (and convective) environment. AIRS is a satellite sounding instrument that provides temperature and moisture profiles of the atmosphere, which when blended with a model first guess from the Advanced Research Weather Research and Forecasting (WRF-ARW) model, can address the above forecast challenge. Beginning at the end of May, SPoRT began producing a twice-daily real-time 3D AIRS-enhanced analysis product. AIRS profiles are unique in that they give a three-dimensional view of the atmosphere that is not available through the current rawinsonde network. AIRS has two overpass swaths across North America each day, one valid at 0900 UTC and the other at 2100 UTC. This is helpful because the rawinsonde network only has data from 0000 and 1200 UTC at specific point locations. Danielle Kozlowski is conducting a study which includes comparisons of Convective Available Potential Energy (CAPE), Convective Inhibition (CIN), Relative Humidity (RH), wind, and precipitable water to understand how well AIRS is representing the atmosphere in comparison to the control. SPoRT will transition the AIRS product to their partners at the Huntsville Weather Forecast Office (WFO) if this summer's tests reveal added value to the pre-convective and convective forecast problem.

## Other

### SPoRT Team Receives Group and Individual Achievement Awards

The NASA MSFC Science and Mission Systems (S&MS) Office Awards Ceremony Celebration on June 16. The entire SPoRT team received recognition "for significant accomplishments in demonstrating the utility of NASA observations and research capabilities to improve weather forecasting." The SPoRT Principal Investigator, Gary Jedlovec, accepted the Group Achievement Award on behalf of his team. Peer awards nominees and winners were also announced in five categories (communications, teamwork, excellence, innovation, and above and beyond categories). Nominations for these prestigious awards were from peer staff members (not supervisors). Two SPoRT team members were nominated for the peer awards — Jonathan Case (innovation) and Gary Jedlovec (teamwork). Gary Jedlovec was selected and presented with the Star Performer Peer Award for teamwork.

# Recent Publications and Presentations

## Journal Articles/Publications (now in print)

Lee, T.F., C.S. Nelson, P. Dills, L.P. Riishojgaard, A. Jones, L. Li, S. Miller, L.E. Flynn, G. Jedlovec, W. McCarty, C. Hoffman, and G. McWilliams, 2010: NPOESS: Next generation operational global Earth observations. *Bull. Amer. Met. Soc.*, 91, 727–740.

Kain, J.S., S.R. Dembek, S.J. Weiss, J.L. Case, J.J. Levit, and R.A. Sobash, 2010: Extracting unique information from high resolution forecast models: Monitoring selected fields and phenomena every time step. *Wea. Forecasting*, In Press.

## Meeting/Conference Presentations

- C.B. Darden, D.J. Nadler, J. Burks, G.T. Stano, and D.E. Buechler, Total lightning information: An operational perspective 2010 ILDC/ILMC Conference — Lightning's impact on society. April 19–22, 2010

- Fuell, K. NASA/SPoRT 2010 Proving Ground Product Development and Support Activities. GOES-R Proving Ground Annual Planning Meeting, Boulder, CO, May 20, 2010

- Chou, S-H (NASA/MSFC), B.T. Zavodsky(NASA/MSFC), and G.J. Jedlovec (NASA/MSFC), Regional Precipitation Forecast with Atmospheric Infrared Sounder (AIRS) Profile Assimilation. 11th WRF User's Workshop, Boulder, CO, June 21–25, 2010

## External Workshops/ Meetings Attended

- International Lightning Detection Conference, April 19–22, 2010 — Orlando, FL (Stano)
- NOAA Testbed Workshop, May 3–5, 2010 — Boulder, CO (Jedlovec)
- GOES-R Proving Ground Meeting, May 18–19, 2010 — Boulder, CO (Jedlovec and Fuell)
- Satellite Curriculum Development Workshop, May 20, 2010 — Boulder, CO (Fuell)
- JCSDA Science Steering Committee (SSC) Meeting, June 10–11, 2010, Silver Springs, MD (Jedlovec)
- WRF Users Conference, June 21–25, 2010 — Boulder, CO (Chou)
- GSI Tutorial, June 28–30, 2010 — Boulder (Zavodsky and Chou)

## Visitors

- Jamie Kibler, Brian Hughes, NESDIS — April 5, 2010 — learn about SPoRT
- Greg Mandt — April 7–8, 2010 — learn about SPoRT
- John Evans and Eduardo Valente (GST) — April 12, 2010 — learn about SPoRT, coordinate SBIR
- John Haynes — NASA HQs Applied Science — April 13, 2010 — receive a SPoRT update
- Helen Wood, NOAA/NESDIS Senior Advisor — April 28, 2010 — learn about SPoRT
- Carven Scott, Chief, Environmental and Science Services Division, Alaska Region NWS — June 17, 2010 — discuss SPoRT collaborations with Alaska Region

## Calendar of Upcoming Events

- IGARSS, July 26–30, 2010, Honolulu, HI
- GOES-R Proving Ground OCONUS meeting, July 28–30, 2010, Honolulu, HI
- SPoRT visit to NWS Alaska Region, August 23–27, 2010
- SPoRT visit to Central Region, September 21, 2010
- AMS Satellite Conference, September 27–October 1, 2010, Annapolis, MD

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