National Aeronautics and Space Administration

NASA Short-Term
Prediction Research
and Transition Center

2012 SPoRT Biennial Report

Looking north along I-65 as a tornado enters the west side of Cullman, AL on April 27, 2011.

Preface

As the Short-term Prediction Research and Transition (SPoRT) project enters its 13th year demonstrating the weather and forecasting application of real-time Earth Observing System (EOS) measurements, the casual SPoRT fan will notice that the project has grown significantly in the last few years. While the number of end users collaborating with SPoRT has grown to over twenty Weather Forecast Offices and several National Centers as a result of expanded collaborations with the NOAA Proving Ground projects, the project is also addressing various disaster related activities of interest to NASA's Applied Science Program. As a result, SPoRT continues to be an Agency focal point and facilitator for the transfer of NASA Earth science data and technologies to the operational weather community on a regional and local scale.

This Biennial Report provides a comprehensive description of many current research and transition activities being conducted by the SPoRT project. I am very appreciative of the efforts of Mr. Jonathan Case who exhibited strong leadership in guiding the development of the report and along with me served as technical editor for all the articles. Many SPoRT staff members have also made significant contributions to the report including Jason Burks, Kevin Fuell, Frank LaFontaine, Kevin McGrath, Andrew Molthan, Matt Smith, Geoffrey Stano, and Brad Zavodsky. This report is as much a reflection of their individual professional accomplishments as it is those of the SPoRT project in general.

Dr. Gary Jedlovec
SPoRT Co-Principal Investigator

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Executive Summary

The NASA Short-term Prediction Research and Transition (SPoRT) program is an end-to-end research-to-operations (R2O) activity focused on improving short-term weather forecasts through the use of unique high-resolution, multispectral observations from NASA and NOAA satellites, nowcasting tools, and advanced modeling and data assimilation techniques. The SPoRT program has established a successful R2O paradigm in which the end-user is involved in the entire process of (1) matching a product to a forecast problem, (2) developing a prototype solution with applicable training, (3) assessing the operational impact, and (4) determining whether the solution has addressed the forecast problem. SPoRT partners with universities and other government agencies to develop new products which are transitioned to the operational weather environment within applicable decision support systems (DSS; typically the Advanced Weather Interactive Processing System [AWIPS], next-generation AWIPS [AWIPS II], and the National Centers AWIPS [N-AWIPS]). SPoRT core activities focus on four specific areas:

- Product development and dissemination,
- Modeling and data assimilation (DA),
- Product applications in various DSS, and
- Transition, training and assessment activities to support successful R2O.

Several products have also been adapted for use at NOAA Testbeds, Proving Grounds (PGs), the National Centers for Environmental Prediction (NCEP), and for weather disaster applications. By following its successful R2O paradigm, SPoRT strives to be the focal point for the transfer of Earth Science technologies to the operational weather community.

To review accomplishments and make recommendations for future direction, the sixth SPoRT Science Advisory Committee (SAC) meeting was held from 28 February to 1 March 2012. The committee members recognized SPoRT's dedication to SAC recommendations and noted the successful broadening of SPoRT activities to other NOAA/National Weather Service (NWS) Regions outside of the Southern Region, and its participation in PGs and Testbeds. The SAC provided several recommendations including the development of a "white paper" describing future plans for modeling and DA and a focus on data fusion and the production of red-green-blue (RGB) products in support of PG activities. The SAC also recommended that SPoRT conducts a new strategic planning exercise in order to adapt to factors such as budget shortfalls, limited new NASA datasets, and NOAA emphasis on PG activities.

In product development and dissemination, significant progress has been made to advance new partnerships and increase PG activities, while maintaining and improving the current suite of satellite-based products. A collaboration with the Naval Research Laboratory (NRL) was established, resulting in the transition and evaluation of passive microwave products at the Tropical PG. The currently-supported Geostationary Operational Environmental Staellite-R Series (GOES-R) PG product suite consists of total lightning and Pseudo-Geostationary Lightning Mapper (PGLM) products, Moderate Resolution Imaging Spectroradiometer (MODIS) and Spinning Enhanced Visible and IR Imager (SEVIRI) RGBs (dust, air mass, and night-time microphysics), the "POES-GOES" hybrid products (overlay of high-resolution polar-orbiting data on top of GOES imagery), National Environmental Satellite Data and Information Service (NESDIS) quantitative precipitation estimates, and the GOES-R convective initiation (CI) outlook product. For the Joint Polar Satellite System (JPSS) PG, SPoRT has made significant advances to transition Visible Infrared Imaging Radiometer Suite (VIIRS) imagery to operational end-users, including the new Day-Night Band (DNB). Collaborations with forecast offices in Alaska and at National Centers were fostered by configuring numerous products for use in these offices. SPoRT also continued to maintain and improve its in-house products consisting of a 2-km sea surface temperature (SST) and Great Lakes lake temperature composite, total column ozone derived from the Atmospheric Infrared Sounder (AIRS), and real-time vegetation data from MODIS.

The modeling and DA activities focused on providing real-time surface datasets for initializing local NWS models within the Environmental Modeling System (EMS). SPoRT currently provides the hemispheric SST, real-time 3-km Land Information System land surface data over the southeastern Continental U.S., and 1-km MODIS green vegetation fraction for ingest into the EMS, along with accompanying instructions. An NWS Southern Region modeling collaboration was established with the forecast offices in Houston, TX and Mobile, AL to assess the impacts of these datasets on their local model forecasts of CI, and to provide in-house model verification capabilities. Data assimilation research has focused on a collaborative project with the Hydrometeorological Testbed, in which AIRS temperature and moisture profiles are assimilated over a Pacific domain to improve the tracking of atmospheric rivers affecting the U.S. West Coast. Additionally, SPoRT compared the assimilation of AIRS radiances versus profiles in a project funded by the Joint Center for Satellite Data Assimilation.

A key component of a successful transition is to ensure that SPoRT datasets can be displayed in the end-users' DSS. As the NWS begins its agency-wide upgrade to AWIPS II, SPoRT will continue to support AWIPS, while simultaneously establishing the capabilities to view all datasets in AWIPS II through the development of plug-ins. To facilitate the integration of experimental products into AWIPS II, SPoRT established the Experimental Products Development Team, which will enable partnering groups to learn the AWIPS II development process. To broaden usage in other DSS (e.g., Google Earth) and handheld devices, products are now being generated in KML/KMZ formats as well as within a tile map service.

Extensive progress was made to transition new, cutting-edge satellite datasets and products to existing and new operational partners, including PG datasets. In 2012, several NRL passive microwave products were added to the current suite of products that have been transitioned to several National Centers. SPoRT exposed more users to RGB imagery and provided training materials. Total lightning applications and training were developed with plans to continue simulated operations at the 2013 Hazardous Weather Testbed Spring Experiment. Significant accomplishments were also made to transition VIIRS imagery and DNB data to end-users. SPoRT conducted training in several new areas during 2012 for RGB products, the GOES-R CI outlook product, WindSat, PGLM, and VIIRS DNB, following the successful training methods of quick reference guides, self-paced modules, and teletraining. Operational assessments were conducted with various partners for the GOES-R CI product, PGLM, WindSat, and MODIS/VIIRS RGB imagery.

SPoRT progressed in several other areas as well, including information technology resources, a new disaster response funded project, and success metrics through the blog and publications. To keep up with the growing need for computational resources, SPoRT began procuring several new workstations to enhance computational capability and data management for real-time production, research and development, and visualization/DSS. SPoRT continued to make use of external resources available at the NASA Center for Climate Simulation at Goddard Space Flight Center, and explored the use of Cloud Computing technologies for modeling applications. The recently-funded disaster response project has the objective of advancing the use of NASA, NOAA and commercial satellites by incorporating them into the NWS Damage Assessment Toolkit. Following "Superstorm" Sandy in late October 2012, SPoRT provided VIIRS DNB data and applied RGB techniques to develop a unique "blackout composite" product that monitored the extent of power outages in the greater New York City/New Jersey region. The Wide World of SPoRT blog continued to be an important vehicle in which end-users and SPoRT personnel can evaluate products. Numerous end-users composed blog posts on the utility of real-time products, and monthly views of the blog were up substantially compared to the previous two years. SPoRT had a significant presence in several conferences, science meetings and workshops, and published numerous peer-reviewed manuscripts over the past year.

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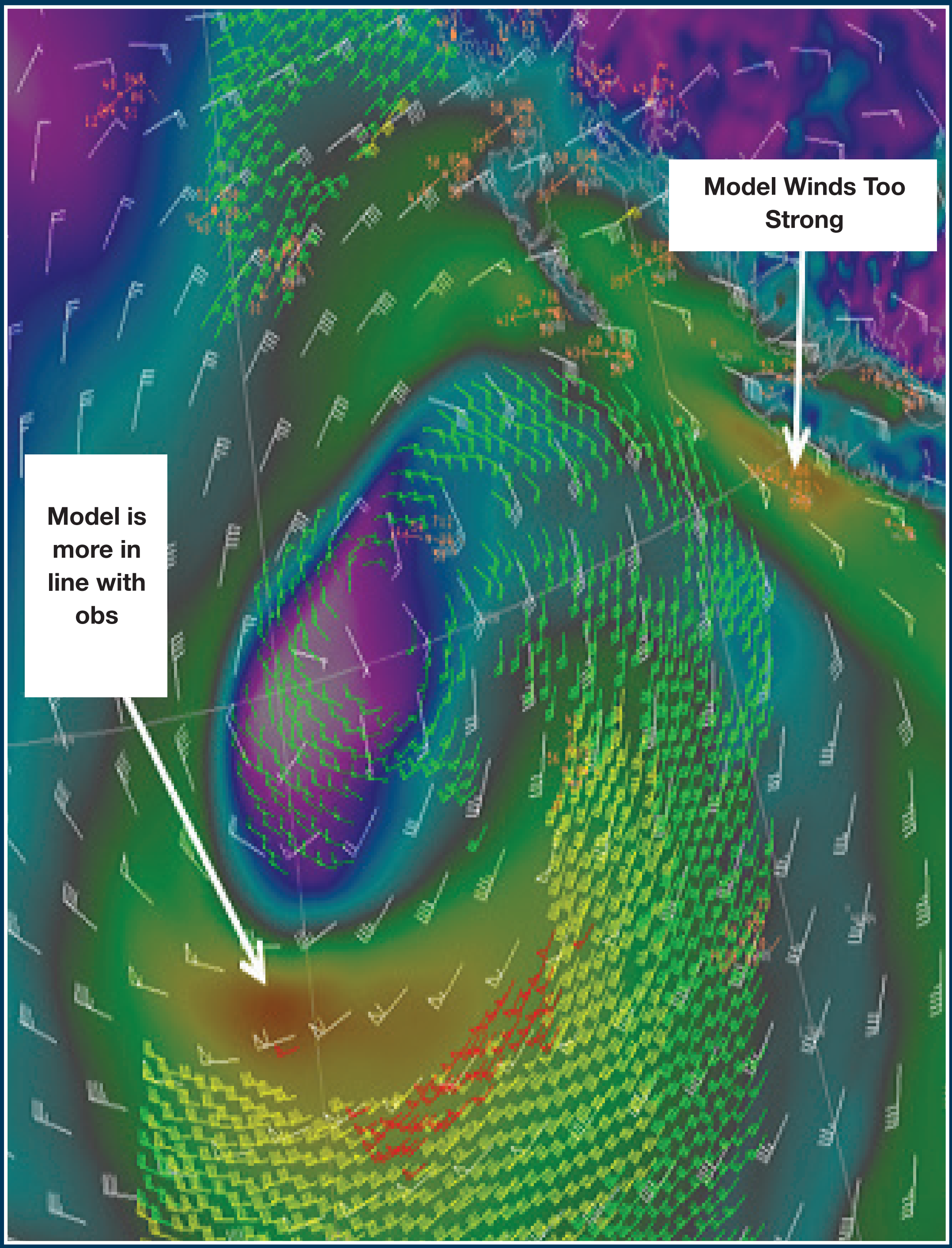
Introduction



Comparison between NWP model and WindSat-derived wind speeds.

Statement of SPoRT Mission

Established in 2002 to demonstrate the weather and forecasting application of real-time Earth Observing System (EOS) measurements, the Short-term Prediction Research and Transition (SPoRT) program has grown to be an end-to-end research-to-operations activity focused on the use of advanced modeling and data assimilation techniques, nowcasting tools, and unique high-resolution multispectral observational data from NASA and NOAA satellites to improve short-term weather forecasts. SPoRT currently partners with several universities and other government agencies for access to real-time data and products, and works collaboratively with them to develop new products which are transitioned into the operational weather environment. While the majority of the SPoRT end-users are forecasters at various National Weather Service (NWS) Weather Forecast Offices (WFOs), the adaptation and use of SPoRT products in NOAA Testbeds (Ralph et al. 2013), Proving Grounds (Goodman et al. 2012), at National Centers, and for weather disaster applications shows the relevance of SPoRT's activities to a broader segment of the weather community. In this way, SPoRT strives to be a focal point and facilitator for the transfer of Earth Science products to the operational weather community with an emphasis on short-term forecasting.

SPoRT Evolution

SPoRT core activities

To achieve its mission and vision, the SPoRT program transitions new experimental data and research technologies, and develops and tests solutions to critical forecast problems. It then integrates them into end-user decision support tools. SPoRT core activities are funded by the Research and Analysis program at NASA Headquarters (HQ) and focus on the use of NASA satellite and ground-based observations and research capabilities for 1) product development and dissemination, 2) modeling and data assimilation, 3) product use in various end-user decision support systems (DSS), and 4) transition, training and assessment.

The product development activities include the use of real-time or near real-time data streams from instruments such as the Moderate Resolution Imaging Spectroradiometer (MODIS), Atmospheric InfraRed Sounder (AIRS), Advanced Microwave Scanning Radiometer for EOS (AMSR-E; or AMSR-2 on the Global Change Observation Mission), Tropical Rainfall Measuring Mission (TRMM) sensors, and ground-based lightning networks. These products are disseminated to various end-users at WFOs and National Centers for nowcasting and short-term weather forecasting activities. The modeling and data assimilation activities focus on the use of satellite data to provide improved initial conditions for regional weather models such as the Weather Research and Forecasting (WRF) model, either alone or in conjunction with the NASA Land Information System (LIS). SPoRT partners with local WFOs and other regional modeling teams to develop WRF configurations which use these data sets to address particular forecast problems. SPoRT has found that regular use of its products results from integration of the data into end-user DSS, and emphasizes transitions to the Advanced Weather Interactive Processing System (AWIPS), National Centers-AWIPS (N-AWIPS), and the next generation AWIPS (AWIPS II) DSS. Training is a key component to successful use of the new experimental products. SPoRT develops various training tools adapted to end-user needs. An assessment of the utility of transitioned products provides important feedback to product developers and documents the impact of the experimental products to address forecast issues. The successful SPoRT paradigm of research-to-operations is illustrated by the diagram in Figure 1, which shows the process of matching a forecast problem to a product or

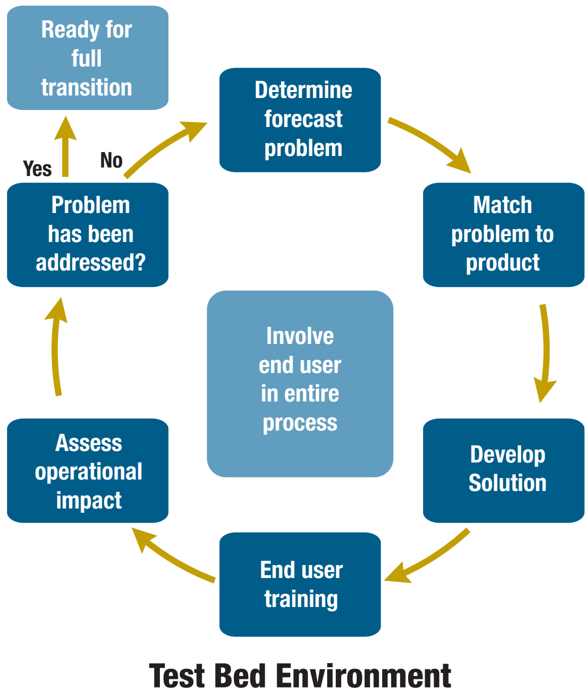


Figure 1. The SPoRT paradigm for successful transition of research data to the operational weather community.

research technique, developing a prospective solution, and continuing to iterate with end-users through training and assessments until the product reaches full maturity.

Increased presence in GOES-R/ JPSS PG activities

Back in 2009, SPoRT was asked by the NOAA Geostationary Operational Environmental Satellite series-R (GOES-R) Program to assist in the development, implementation, and participation in a new "Proving Ground (PG)" activity (Goodman et al. 2012) to support the early use of data and products from the GOES-R satellite sensors to be launched in 2015. In 2011, the Joint Polar Satellite System (JPSS) Program made a similar request which has led to significant SPoRT efforts in these areas.

Review of February 2012 SAC Meeting and Recommendations

The sixth SPoRT Science Advisory Committee (SAC) meeting took place 28 February through 1 March 2012 at the National Space Science and Technology Center in Huntsville, Alabama. The focus of the SAC is to review the accomplishments of the SPoRT program and to make recommendations for future activities and initiatives. The three-day meeting included a review of current SPoRT activities, an AWIPS II demonstration, and a conference call between the SAC and the SPoRT end-users. The SAC documented its findings and recommendations (Billingsley et al. 2012) and several of the key findings are highlighted below. The presentations made to the SAC are available in the library on the SPoRT web site at http://weather.msfc.nasa.gov/sport/library/.

The SAC was impressed with the implementation of the recommendations from the previous review and recognized SPoRT's continuing dedication to the advisory committee concept. The most significant previous recommendation implemented by SPoRT was the broadening of the scope of SPoRT user activities to include WFOs in other NWS Regions, and participation in the GOES-R PG, Suomi-National Polar-orbiting Partnership (Suomi-NPP) PG, and the NOAA Hazardous Weather Testbed (HWT) in Norman, OK. The SAC said it was "clear that SPoRT had exceeded these expectations".

Formal presentations were made to the SAC in the four key areas of SPoRT's research to transition activities: 1) products, 2) modeling and data assimilation, 3) decision support systems, and 4) transition, training and assessment.

The SAC indicated that SPoRT's contribution to the GOES-R and JPSS PGs was outstanding over the past few years and it believes that these new proving ground related products should be fused with other observations (like in the GOES-Polar Orbiting Environmental Satellite [POES] hybrid product) to the fullest extent possible. The development and use of Red-Green-Blue (RGB) products in the U.S. is still in its infancy and operational forecasters have been slow to adopt the use of RGB data. However, the SAC said that SPoRT should remain a prominent developer and transition partner for the RGB products in support of PG activities, and lead the training efforts on the products. "The fusion of the Cross-track Infrared Sounder (CrIS) water vapor and ozone channels with Visible Infrared Imaging Radiometer Suite (VIIRS) imagery should be pursued to continue the use of an 'air mass' RGB product into the JPSS era."

The SAC recognized SPoRT's significant investment in local modeling and data assimilation activities and the vital role SPoRT has played in supporting WFO collaborators with local modeling efforts. Notably, the addition of data sets available to the NWS Science and Training Resource Center Environmental Modeling System (EMS) has provided a pathway for transition since the model has been maintained for NWS by the National Centers for Environmental Prediction (NCEP) and the NWS Forecast Decision Training Branch in Boulder. However, the SAC was unclear on the current and future role of SPoRT in helping the NCEP Environmental Modeling Center (EMC) improve global/ regional operational modeling systems and the specific forecast issues regarding some of the data assimilation activities. The SAC suggested that SPoRT write a "white paper" describing the purpose and future plans regarding modeling and data assimilation activities.

The SAC applauded SPoRT's continual efforts to demonstrate new visualization capabilities on AWIPS II. This work not only helps forecasters by integrating imagery and data onto the new operational system, but improves SPoRT's visibility with NOAA and NWS HQ.

Strategically, the SAC believes the future plans for SPoRT are mostly sound. However, they noted that several key factors are likely to change over the coming years which will influence the environment in which SPoRT operates including budget shortfalls, limited new NASA datasets, the increased availability of a variety of new international datasets, and NOAA's emphasis on proving ground activities. The SAC recommended that SPoRT engage in a new strategic planning exercise to ensure its readiness to adapt to these changes. SPoRT should also consider involvement in several new activities including collaboration with the Hydrometeorology Testbed (HMT) on the use of RGB products to monitor transport of aerosols across the Pacific Ocean, and collaborations with the NOAA National Water Center in Tuscaloosa, Alabama. SPoRT should establish dialog with other NOAA Cooperative Institutes and universities to look for opportunities to leverage the work they are doing with VIIRS and assist other initiatives by sharing their lessons learned.

Management, Personnel, and Organization

Management/funding sources

The research and transition activities of SPoRT are supported by the Research and Analysis program of the Earth Science Division of NASA HQ under the auspices of Dr. Tsengdar Lee. Dr. Gary Jedlovec (one of three initial Principal Investigators on the project) continues to lead the overall activities of SPoRT. The functional break down of the SPoRT team is shown in Figure 2, which indicates that the working groups are aligned with the four core functions of the SPoRT program, namely, 1) products, 2) modeling and data assimilation, 3) decision support systems, and 4) transition, training and assessment. SPoRT core activities are augmented with additional NASA and NOAA funding obtained through competitive opportunities such as Research Opportunities in Space and Earth Sciences (ROSES; both Research and Analysis, and Applied Science solicitations), and NOAA GOES-R and JPSS research opportunities. While SPoRT core activities comprise the majority of the activities, the additional projects leverage off the core activities to provide an effective return on the additional investments. The SPoRT team members participating in each work group are listed in Appendix A.

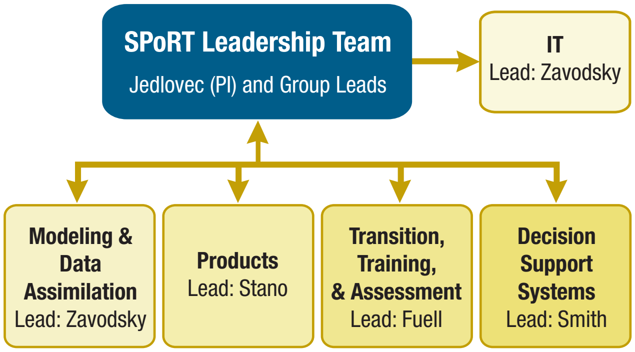


Figure 2. SPoRT team structure and group leads.

External collaborators

Given the limited resources available through various funding sources, SPoRT partners with external collaborators for access to real-time data and selected products, and involves the operational weather forecast community for product assessment and impact. Real-time polar orbiting satellite data are obtained from direct readout facilities at the University of Wisconsin (i.e., the Space Science and Engineering Center) and University of Alaska Fairbanks (i.e., the Geographical Information Network of Alaska), the NOAA/NESDIS Cooperative Institute for Meteorological Satellite Studies (CIMSS), near real-time data warehouses such as the NASA Land Atmospheres Near-real-time Capability for EOS (Murphy et al. 2011), and through collaborations with NOAA / NESDIS and the Naval Research Laboratory (NRL) in Monterey, CA. Additional near real-time data and products are obtained from the NOAA/NESDIS Satellite Analysis Branch (SAB) and the NOAA/NESDIS Cooperative Institute for Research in the Atmosphere (CIRA). These sites are indicated by red dots on the map in Figure 3. While the distribution of SPoRT products to all 122 NWS WFOs and nine National Centers is possible, limited resources constrain the collaborations to a select number of end-users throughout the country. SPoRT knows that regular, collaborative interaction with end-users facilitates optimal transition and use of research data to address challenging forecast issues by the end-user. Therefore, SPoRT chooses to work with a limited number of WFOs in each Region and various National Centers (i.e., NCEP's Storm Prediction Center [SPC], Ocean Prediction Center [OPC], Weather Prediction Center [WPC; formerly the Hydrometeorological Prediction Center], Aviation Weather Center [AWC], and National Hurricane Center [NHC]) as indicated on the map in Figure 3.

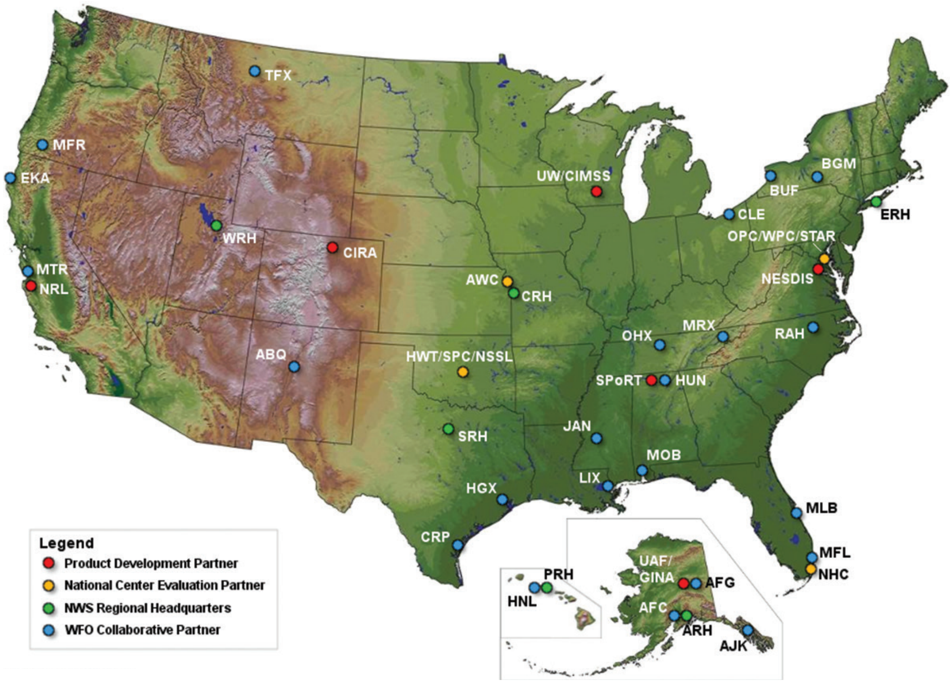


Figure 3. Map of product development partners, National Center evaluation partners, NWS Regional Headquarters, and NWS WFO collaborative partners, according to the legend provided.

Report Structure

This annual report layout follows the structure of SPoRT core functions described above. Recent SPoRT progress is presented in the area of its products (Section 2), modeling and data assimilation activities (Section 3), decision support systems (Section 4), transition training and assessments (Section 5), and information technology (Section 6). Each section includes a brief introduction that describes the historical context of SPoRT activities in each area and how recent SPoRT activities have addressed recommendations from the 2012 SPoRT SAC meeting. Section 7 describes the recent NASA ROSES disaster response funding that SPoRT won this past year, highlighting the support and products provided during "Superstorm" Sandy on the U.S. East Coast. The metrics used to define success in SPoRT activities are presented in Section 8 followed by references, and appendices.

Over the past couple years, SPoRT has substantially increased its presence in satellite proving grounds, including the GOES-R PG, GOES-R visiting scientists proposals, and JPSS PG activities associated with the Suomi-NPP satellite. SPoRT participation in each of these areas is highlighted within the upcoming sections in the appropriate context.

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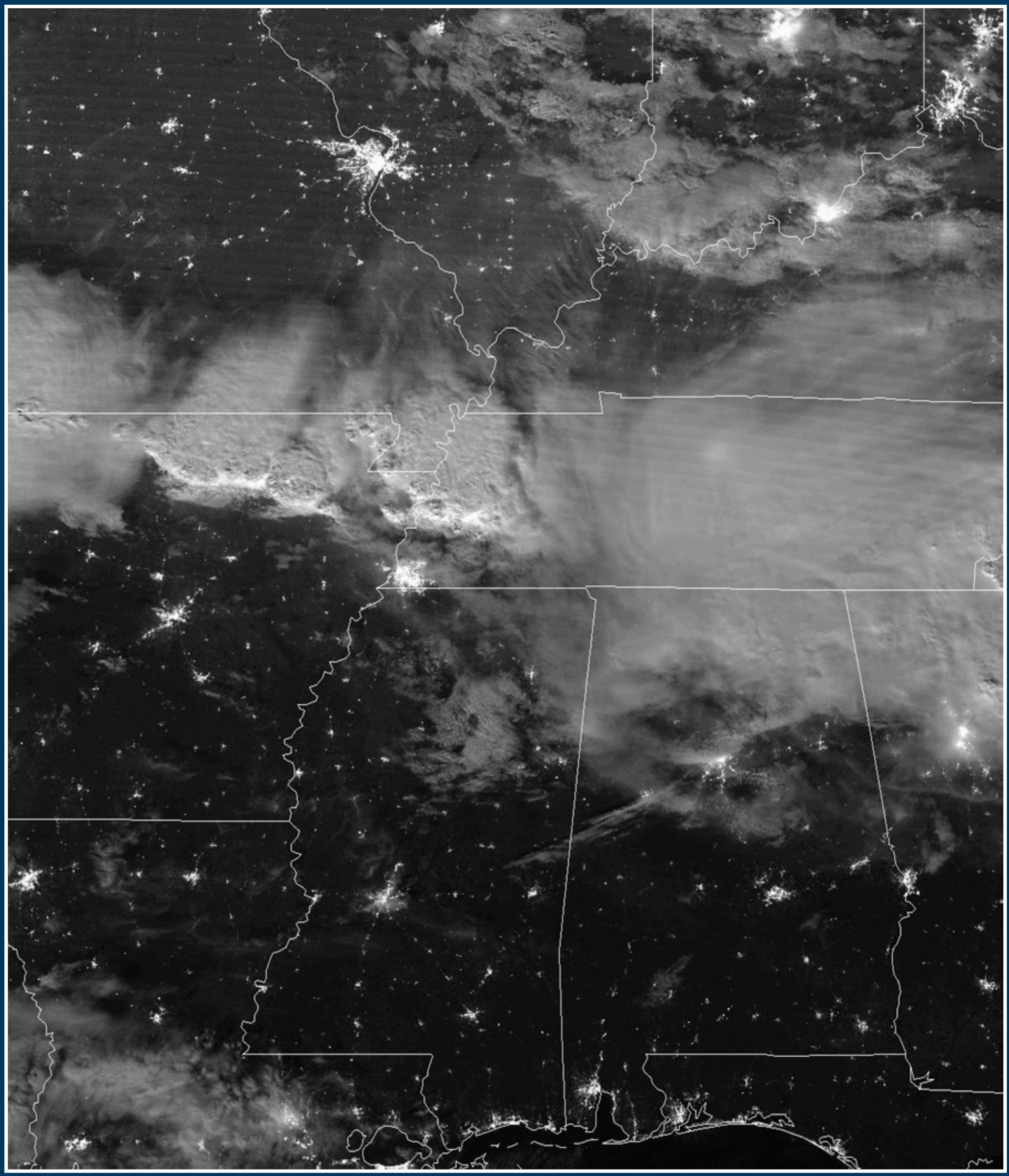
SPoRT Products


Clouds, lightning, and city lights detected by the Suomi-NPP Day-Night Band sensor.

Introduction

The SPoRT program has undergone a major transition in the past five years, starting with the SAC recommendations from 2007 through similar meetings in 2009 and 2012. In 2007, SPoRT's partnership was focused on five NWS WFOs and expanded to 11 Southern Region offices and the Great Falls, Montana office in Western Region by the time of the 2009 SAC. The 2009 SAC meeting was a pivotal moment for the SPoRT program. Here, SPoRT was credited as, "…having evolved from an ad hoc collaborative effort between NASA and a few NWS field offices to a formal and fully engaged research and transition operation." During this meeting, discussions focused on SPoRT's activities and collaborations with operational partners, and how SPoRT's activities had matured for additional growth. The 2009 SAC recommended that SPoRT 1) should expand the scope of the program to include a nationwide subset of collaborations, 2) aggressively promote itself as the transition testbed for application of unique NASA data sets and how they are linked with future NOAA datasets, and 3) actively seek out partnerships with other NOAA/NWS testbeds.

By the 2012 SAC meeting, the SPoRT team was widely praised for the implementation of these recommendations at both the strategic and individual scale. SPoRT is now supporting operational products to more than 20 partner WFOs (including representation from each NWS region). In addition, SPoRT is actively collaborating with several National Centers (SPC, NHC, OPC, and WPC). This expansion involves SPoRT's core activities, and now includes a significant contribution to the GOES-R and JPSS proving grounds. SPoRT's contributions reflect the program's paradigm of supporting its end-users by understanding their forecast concerns and matching the best products to those concerns. Today, the SPoRT program maintains a wide range of products that provide value-added enhancements to its partners and demonstrate future capabilities using existing NASA datasets. Several key products include POES-GOES hybrid imagery, RGB composites derived from European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) "best practices" to better support multi-spectral observations, and the development of Pseudo Geostationary Lightning Mapper products which now are the de facto demonstration and training tool for total lightning in the GOES-R proving ground.

Expanding SPoRT's core competencies has led to a greater national presence for the program. This national exposure is greatly illustrated by SPoRT's efforts to transition VIIRS data from Suomi-NPP. SPoRT quickly integrated with several national entities to provide VIIRS Day-Night Band (DNB) data to assess and track power outages across New York and New Jersey in the aftermath of Superstorm Sandy (results highlighted in Section 7). SPoRT's efforts to establish itself as a transition testbed have been recognized by the community. SPoRT has expanded collaborations with the University of Alabama in Huntsville (UAH), CIRA, NESDIS, and NRL, which are supporting the GOES-R Convective Initiation Algorithm (UAH), layered precipitable water products (CIRA), quantitative precipitation estimation products (NESDIS), as well as passive microwave products (NRL) for use at NHC.

The following sub-sections describe the suite of products that SPoRT distributes to end-users. These include products developed and maintained in-house, those obtained from the NRL collaboration, products emanating from PG activities, and those developed for outside the Conterminous U.S. (CONUS) for end-users in Alaska and Hawaii. For reference purposes, a complete list of SPoRT products and the accompanying forecast challenges are given in Appendix B.

In-House SPoRT Products

SST and Great Lakes Surface Temperature (GLST) Product

The SPoRT Sea Surface Temperature (SST) product consists of time latency-weighted swaths of MODIS infrared (IR) SST measurements in cloud-free regions (based on Haines et al. 2007), blended with POES-GOES SST analyses from NESDIS (Nalli et al. 2004), and the European's global Operational Sea Surface Temperature and Sea Ice Analysis (Stark et al. 2007). To preserve horizontal detail, MODIS is given the largest weight relative to the other data sources, with the newest cloud-masked swaths receiving the greatest weight. The composites are generated at 2-km horizontal grid spacing from 0°N to 80°N latitude and 130°E to 10°E longitude (domain shown in Figure 4a).

Embedded within the hemispheric-scale SST composite is a unique analysis over the Great Lakes region (Figure 4b). To obtain Great Lakes Surface Temperature (GLST),

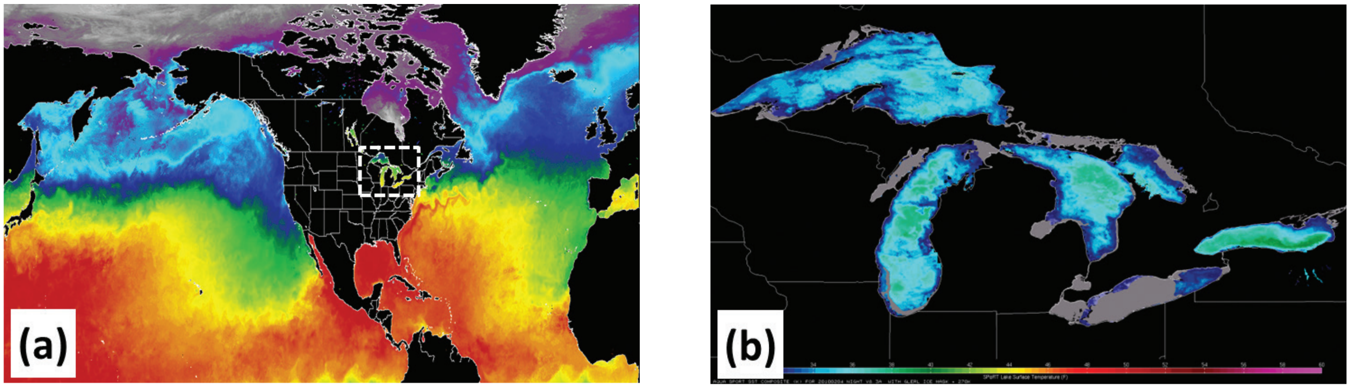


Figure 4. Depiction of the (a) twice-daily SPoRT SST domain, covering much of the union between the northern and western hemispheres, and (b) embedded GLST and ice extent analysis domain, as denoted by the box in (a). Gray shading indicates regions of ice cover in the GLST analysis, where GLST is set to 270 K at ice-covered grid points.

MODIS IR is blended with the Great Lakes Surface Environmental Analysis data (GLSEA2; Schwab et al. 1999) from the NOAA Great Lakes Environmental Research Laboratory (GLERL). Oftentimes in the fall and winter, MODIS IR data are unavailable in parts of the Great Lakes due to persistent cloud cover. Thus, reliable background GLST data from the GLSEA2 product is important to maintain a quality product.

The lake ice cover extent is established using data from the National Ice Center analysis (http://www.natice.noaa.gov/products/great_lakes.html), in which a grid pixel is flagged as ice-covered based on fractional ice exceeding 90%. For initializing ice cover in the WRF model and EMS, GLST is set to 270 K at ice points, thereby enabling ice cover initialization in the model based on a simple threshold approach.

Several previous studies by SPoRT have illustrated the utility of using variations of the SPoRT SST composites in numerical modeling simulations, including LaCasse et al. (2008), Case et al. (2008b), Schiferl et al. (2010), and Case et al. (2011a).

In the past year, the SPoRT SST composites were expanded from a CONUS+ domain to one that covers much of the northern and western hemispheres. Because of this expansion, the horizontal grid spacing was increased from 1 km to 2 km — a necessary change in order to accommodate the expanded domain. In addition, the previous iteration of the SPoRT SST lost the AMSR-E SST information in December 2011, which was used to help fill-in data in MODIS cloud-masked regions. To back-fill the loss of AMSR-E, SPoRT included the NESDIS POES-GOES SST analysis as a “background field” behind the MODIS IR SST data.

Over the Great Lakes, SPoRT had been using background GLST data from Remote Sensing Systems (REMSS) in the previous CONUS+SST product. However, the REMSS SST product has been consistently latent during the past year such that SPoRT decided to replace this information with more timely data from the GLSEA2 product. Ice cover over the Great Lakes remains unchanged.

AIRS Total-Column Ozone

The current recipe for construction of the air mass RGB product is based on EUMETSAT recipes designed for for Spinning Enhanced Visible and IR Imager (SEVIRI) data. It assigns red intensities to correspond to temperature and moisture above any present cloud tops and differences in cloud emissivity at the 6.2 and 7.3 μm wavelengths. Green intensities correspond to temperature differences between the surface and any intervening cloud-free layer where there is significant ozone concentration and surface emissivity differences among the 9.7 and 10.8 μm channels in cloud free conditions. The blue color corresponds to more traditional applications of single band water vapor imagery. Thus, regions of low water vapor and high ozone concentration will appear as a deep red coloration in the final false color imagery. Many times, these regions highlight high potential vorticity (PV) associated with stratospheric air intrusion into the troposphere. At the beginning of 2012, Michael Folmer, satellite champion at WPC and OPC identified these features associated with PV anomalies in EUMETSAT’s SEVIRI and MODIS air mass RGB imagery provided by SPoRT. To help with verification of the stratospheric ozone in these regions, SPoRT began disseminating a near-real-time total ozone product generated by LANCE from the NASA AIRS instrument in N-AWIPS format. AIRS is collocated with MODIS on the Aqua satellite which are used together to produce direct match-ups between the ozone features and the red coloration in the MODIS air mass imagery. The MODIS air mass and AIRS ozone products were used in tandem by forecasters at WPC and OPC to determine whether a developing cyclone was interacting with upper-level PV anomalies for multiple storms during 2012. An example of the AIRS product in N-AWIPS and how it is associated with an air mass RGB product is shown in Figure 5 for a North Atlantic storm at the end of November 2012. A number of posts to the Wide World of SPoRT blog were made on the use of this product, followed by a manuscript describing the utility of the air mass RGB and AIRS total ozone products (Zavodsky et al. 2013).

Daily MODIS Vegetation

On 1 June 2010, SPoRT began generating a daily Green Vegetation Fraction (GVF) dataset over the CONUS at 0.01° (~1 km) grid spacing over the domain shown in Figure 6. The GVF represents the fraction of a grid pixel containing photosynthetically active vegetation. The data are derived from near real-time swaths of MODIS Normalized Difference Vegetation Index (NDVI) that SPoRT receives from the University of Wisconsin Direct Broadcast. Grids of latency-weighted NDVI are produced using a similar technique to the current SPoRT SST product. Details on how the SPoRT GVF data are calculated for modeling applications are found in Case et al. (2011b).

A sample comparison between the default monthly climatology and the real-time SPoRT-MODIS GVF on 30 August 2012 is shown in Figure 6. The climatological GVF (panel a) represents a linear time-interpolation from the monthly climatology (given by one value for the 15th of each month) to 30 August. The monthly GVF climatology is the default dataset in the public WRF model and the EMS, and was derived from the Advanced Very High Resolution Radiometer using a collection of NDVI data from 1985 to 1991 (Gutman and Ignatov 1998; Jiang et al. 2010). Besides being a dated product that is static from year-to-year, the grid spacing of the climatology GVF (0.144°, or ~16 km) is approximately an order of magnitude coarser than the SPoRT-MODIS product (~1 km).

The differences in the level of detail are quite prevalent when comparing the climatological GVF to the SPoRT-MODIS GVF (panel b). While the large-scale patterns

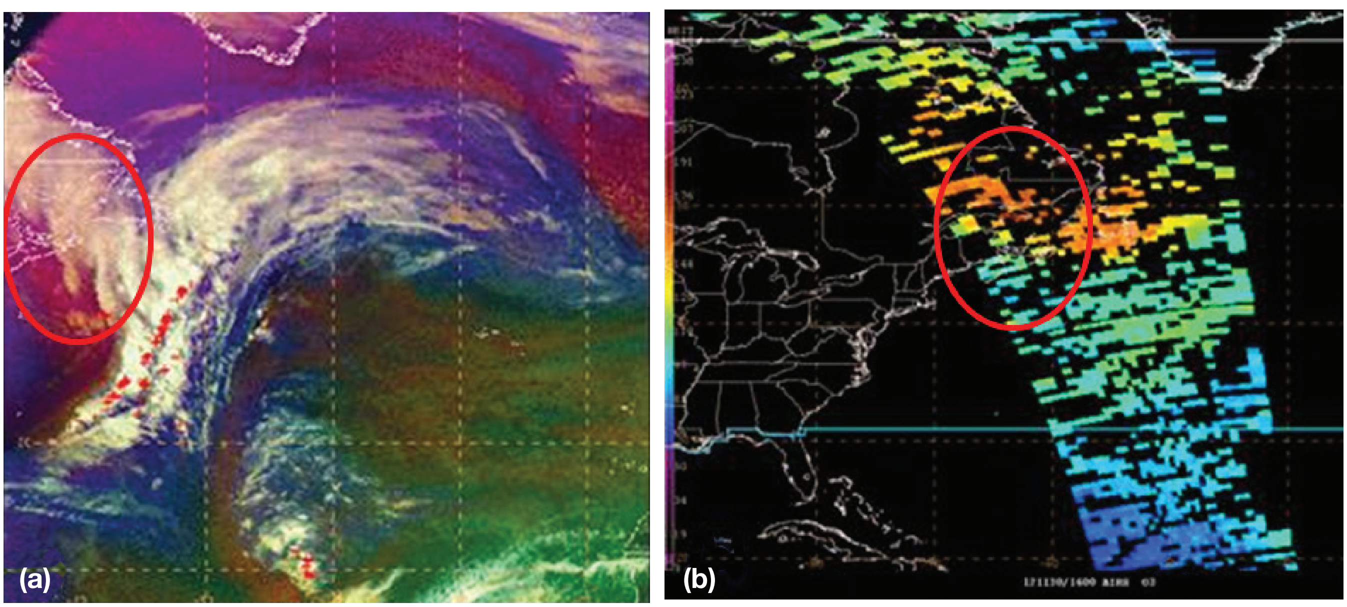


Figure 5. Sample comparison between (a) SEVIRI air-mass RGB image over the northern Atlantic, and (b) AIRS total column ozone experimental product over the eastern U.S. and western Atlantic. Images are displayed in N-AWIPS format as used by WPC/OPC for a rapidly-developing cyclone in the North Atlantic on 30 November 2012. The highest ozone (and PV) is still downstream of the maturing storm. Graphics courtesy of Michael Folmer, Satellite Champion at WPC/OPC (GOES-R and JPSS National Centers Perspective Blog).

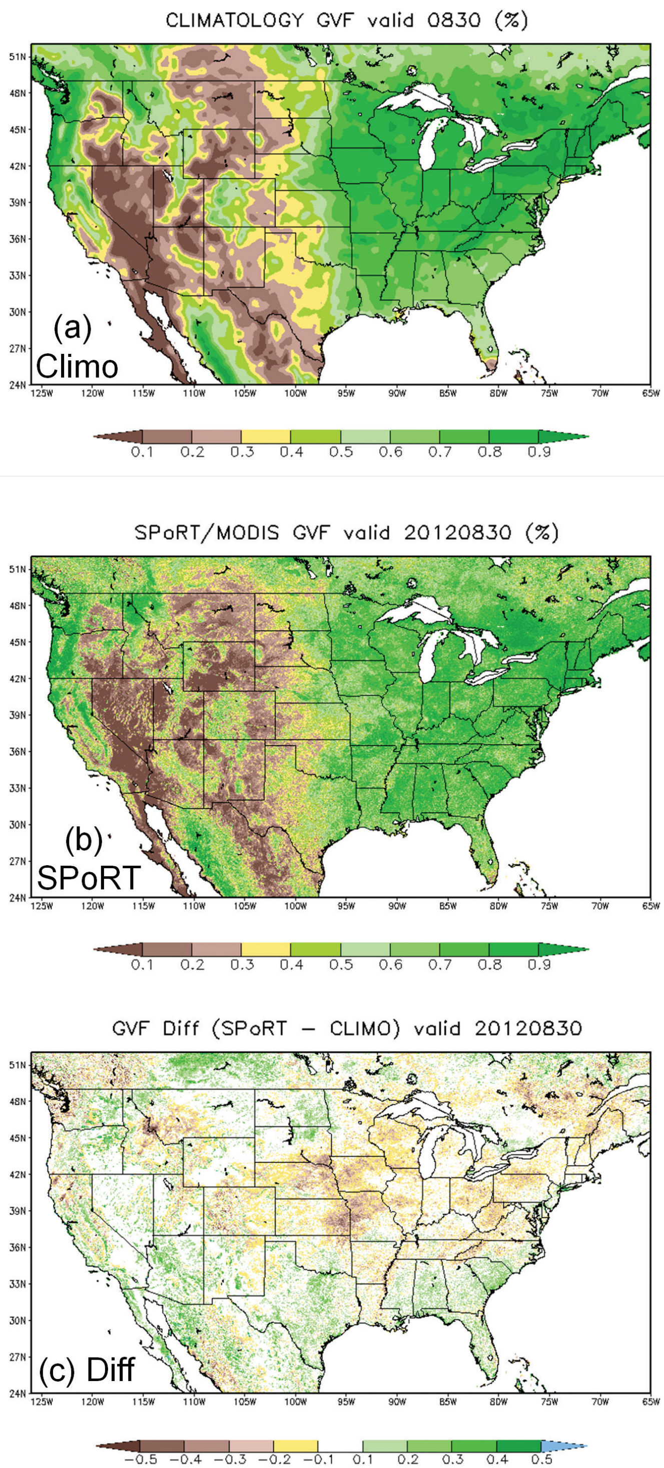


Figure 6. Comparison between the (a) EMS default monthly GVF climatology, time-interpolated to 1 September, (b) real-time SPoRT-MODIS GVF composite produced on 30 August 2012, and (c) difference between the SPoRT-MODIS and climatology GVF.

are fairly similar, the SPoRT-MODIS GVF shows much more fine detail and also depicts lower GVF in the Midwest region, as seen in the difference plot (panel c) corresponding to the ongoing severe drought of Summer 2012. Case et al. (2012a) illustrated the potential impact of real-time SPoRT-MODIS GVF in place of climatological GVF in simulating severe weather events. The current SPoRT-MODIS GVF domain covers a region from 23°N to 55°N latitude, and 130°W to 62°W longitude. SPoRT seeks to follow-up the SPoRT-MODIS GVF with a VIIRS-based GVF product in the future.

SPoRT Collaboration With the Naval Research Laboratory

For many years, NRL has provided passive microwave brightness temperatures from various Defense Meteorological Satellite Program platform instruments such as the Special Sensor Microwave Imager (SSMI) and Special Sensor Microwave Imager/Sounder (SSMI/S), AMSR-E aboard NASA's Aqua mission, and from TRMM. This information was provided through single-channel and multispectral RGB imagery composites, centered on tropical depressions, storms, and hurricanes of interest to the operational weather forecasting community. Leveraging the existing capability to import these RGBs and other data sets into AWIPS and N-AWIPS, SPoRT established a collaboration with NRL in 2012 to facilitate the transfer of NRL data sets within these DSS. NRL provides the aforementioned passive microwave data sets to SPoRT, where they are post-processed and converted into appropriate formats for display in AWIPS, N-AWIPS, and AWIPS II. This activity led to the inclusion of passive microwave data sets for evaluation during the 2012 GOES-R Tropical PG at the NHC in Miami, Florida, where the products were well-received. SPoRT continues to collaborate with NRL and transition passive microwave data products, and expects to expand the availability of these products for non-tropical use in data void regions where the data can provide inferences of strong thunderstorms or heavy precipitation associated with frontal systems.

SPoRT Collaboration With CIRA

The SPoRT program continues to maintain a strong collaborative partnership with CIRA in Fort Collins, CO. The partnership dates to the mid-2000s when SPoRT worked with CIRA to help transition its blended total precipitable water (TPW) product to SPoRT partner forecast offices. This effort helped broaden the number of users evaluating the TPW product and providing recommendations and support for this product. This eventually led to the CIRA TPW product becoming a baseline NWS AWIPS product in 2009. Since then, both organizations have worked closely to identify collaborative opportunities that leverage the strengths of each.

Some of these collaborations are components to larger activities discussed in this report. In particular, SPoRT is collaborating with CIRA to evaluate the utility of the false color composite (SPoRT) and snow detection product (CIRA) with four western forecast offices that are partners with CIRA and/or SPoRT (i.e., Albuquerque, Boulder, Cheyenne, and Great Falls). Additionally, SPoRT and CIRA are collaborating on transitioning the newly established Colorado Lightning Mapping Array (LMA) to the Boulder and Cheyenne offices. CIRA and its partners at Colorado State University and New Mexico Tech provide the data while SPoRT provides the expertise in transitioning these data to both AWIPS I and AWIPS II, shares the available training modules, and prepares the data for use in GOES-R PG activities.

Lastly, SPoRT is coordinating with CIRA over its layered precipitable water (LPW) product, a separate development activity funded as part of the SPoRT ROSES 2010 research to operations activity. Like the original TPW product, CIRA is the product developer and SPoRT is helping to develop training material and transition these data to a wider evaluator group for assessment. The LPW product is a composite of water vapor retrievals for multiple layers using AIRS profiles and a suite of microwave sensors on polar orbiting satellites. The use of microwave data provides an advantage over infrared soundings that require a cloud-free view to see low-level moisture. The AIRS instrument is used to adjust the coarse microwave data in the product. The LPW product fills the gaps left by traditional point observations (e.g., radiosondes) and infrared channels focused only on upper-level moisture. The product shows the current vertical distribution of water vapor to aid in nowcasting rainfall totals related to flooding, and to develop added confidence in model initialization. In addition, the vertical distribution of moisture information can aid estimates of atmospheric stability compared to TPW products. Figure 7 shows an example of the CIRA LPW as displayed in AWIPS that will be evaluated in 2013.

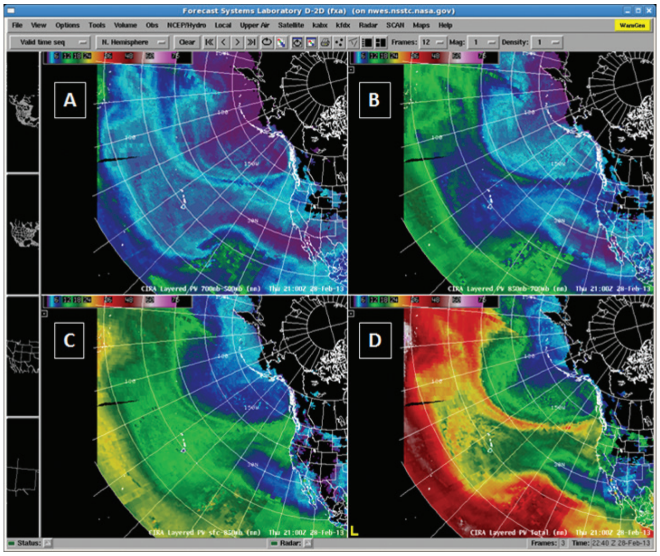


Figure 7. AWIPS I display of the four separate layers of the CIRA LPW product. The layers shown are (a) 700-500 mb, (b) 850-700 mb, (c) surface to 850 mb, and (d) TPW.

Satellite Proving Ground Activities

GOES-R Proving Ground

Total Lightning Products and Applications

Total lightning has been a core SPoRT product since it was first transitioned to the NWS Huntsville, Alabama WFO in early 2003. Since then, SPoRT has interacted with six forecast offices using three ground-based LMAs, developing extensive expertise and collaborative ties with total lightning partners. Through evaluations and discussions with forecasters, total lightning has been used to improve situational awareness, warning decision support, lightning safety, airport weather warnings, and provide lead time on the first cloud-to-ground lightning strike (Goodman et al. 2005; Demetriades et al. 2008; Darden et al. 2010; Stano et al. 2010a; MacGorman et al. 2011; Stano 2012; White et al. 2012; Stano et al. 2013a). These activities have led to SPoRT's involvement with the GOES-R PG and HWT Experimental Warning Program in preparation for the Geostationary Lightning Mapper (GLM).

During the 2009 HWT Experimental Warning Program, it was noted that the PG needed a product that more closely resembled what may be seen with the GLM aboard GOES-R. At the time, the Algorithm Working Group GLM proxy product was in development, but was not yet available for operational use. SPoRT saw this as an opportunity and subsequently developed a suite of Pseudo GLM (PGLM) products (Stano et al. 2010b, 2011;

Stano and Carcione 2012). The PGLM is not a competitor for the GLM proxy; rather it is designed to be a flash product at the GLM resolution (~10 km) that is simple to produce from any ground-based lightning mapping array. Until the proxy is available, the PGLM product suite serves as the de facto training and demonstration lightning tool for the GOES-R PG. First operational in 2010, SPoRT has since expanded to collaborate with networks in North Alabama, Washington D.C., Kennedy Space Center in central Florida, Oklahoma, and West Texas, and is actively pursuing additional ground-based total lightning network collaborations with partners in Colorado, New Mexico, and Houston, TX.

The PGLM product suite consists of three separate products. The first is the standard Flash Extent Density (FED). This gridded product plots how many flashes occur into each grid box every 1–2 minutes, depending on the network. Unlike the FED that displays the entire flash, the Flash Initiation Density (FID) is designed to plot only the origin points of flashes. Visually, this only highlights storm cores, but also indicates lightning flashes initiating in stratiform regions trailing a convective line or within an anvil. The Maximum Flash Density (MFD) product displays the largest FED value for each grid point for the past 30 minutes. Thirty minutes was intentionally chosen as that is the time period recommended for lightning safety in which an individual should remain indoors after seeing a flash or hearing thunder. Supporting these products is a PGLM training module available on the NOAA/NWS learning management system. SPoRT has used a synergistic approach between its PGLM activities and regular, ground-based total lightning activities. This is best seen in training where lessons learned from earlier total lightning projects can be applied to the PGLM in the PG. For instance, the concept of a lightning jump (Schultz et al. 2009; Gatlin and Goodman 2010; Schultz et al. 2011) was first applied to the ground-based LMA data but is now being evaluated with the GLM-resolution PGLM products. Additionally, plans are underway with WFO partners in Melbourne, FL and Morristown, TN to incorporate the PGLM product suite for developing new operational procedures and coordinating with local emergency managers, respectively.

In 2012, SPoRT expanded this total lightning activity with a GOES-R visiting scientist proposal (Stano et al. 2013b). This project extends SPoRT's efforts beyond local WFOs, as the AWC and SPC have quite different operational concerns and perspectives. SPoRT combined each individual network into one combined, national product. The resulting PGLM mosaic, which provides PGLM data over locations with available data, is being evaluated in a limited fashion with both of these National Centers and will ensure that National Center personnel are included in the preparations for GOES-R.

Lastly, total lightning has been a priority product to transition to the NWS next generation DSS, AWIPS II. A plug-in has been developed that intelligently determines the network and product type being ingested and establishes the proper visualization. This plug-in is nearing final approval for an AWIPS Test Authorization Note to be transitioned to several partner WFOs. An exciting prospect is the development of a lightning tracking tool, which will be a follow-up plug-in to the display plug-in just mentioned. This real-time tool visualizes a time series of total lightning, which has been the leading request in forecaster evaluations. The tracking tool allows a forecaster to manually select a storm of interest by setting a minimum of two storm locations from a sequence of radar imagery. Using these points, the tool interpolates the track backwards in time and projects the track forward in time based on the established storm track. The forecaster may adjust any point in the track whenever necessary to ensure that the storm track is accurate. The decision to use a manual tracker was made to avoid the problems with automated cell trackers that have extreme difficulty with merging/splitting cells and multi-cellular storms. With the track established, a pop-up window provides the time-series plot, providing an 'at-a-glance' tool for forecasters searching for lightning jumps. Lightning jumps have been documented to precede the occurrence of severe weather and tornadoes in many instances (Schultz et al. 2009; Gatlin and Goodman 2010; Schultz et al. 2011), and the time-series plot has been requested as a better method than observing source or flash densities alone. Figure 8 provides an example four-panel display of the PGLM output and tracking tool with radar data in the AWIPS II Common AWIPS Visualization Environment, highlighting a cell that produced an EF-3 tornado on 2 March 2012.

The tool can be modified to calculate the objective lightning jump algorithm developed by UAH (Schultz et al. 2009; Schultz et al. 2011) and will likely be the first step in making this algorithm operationally available.

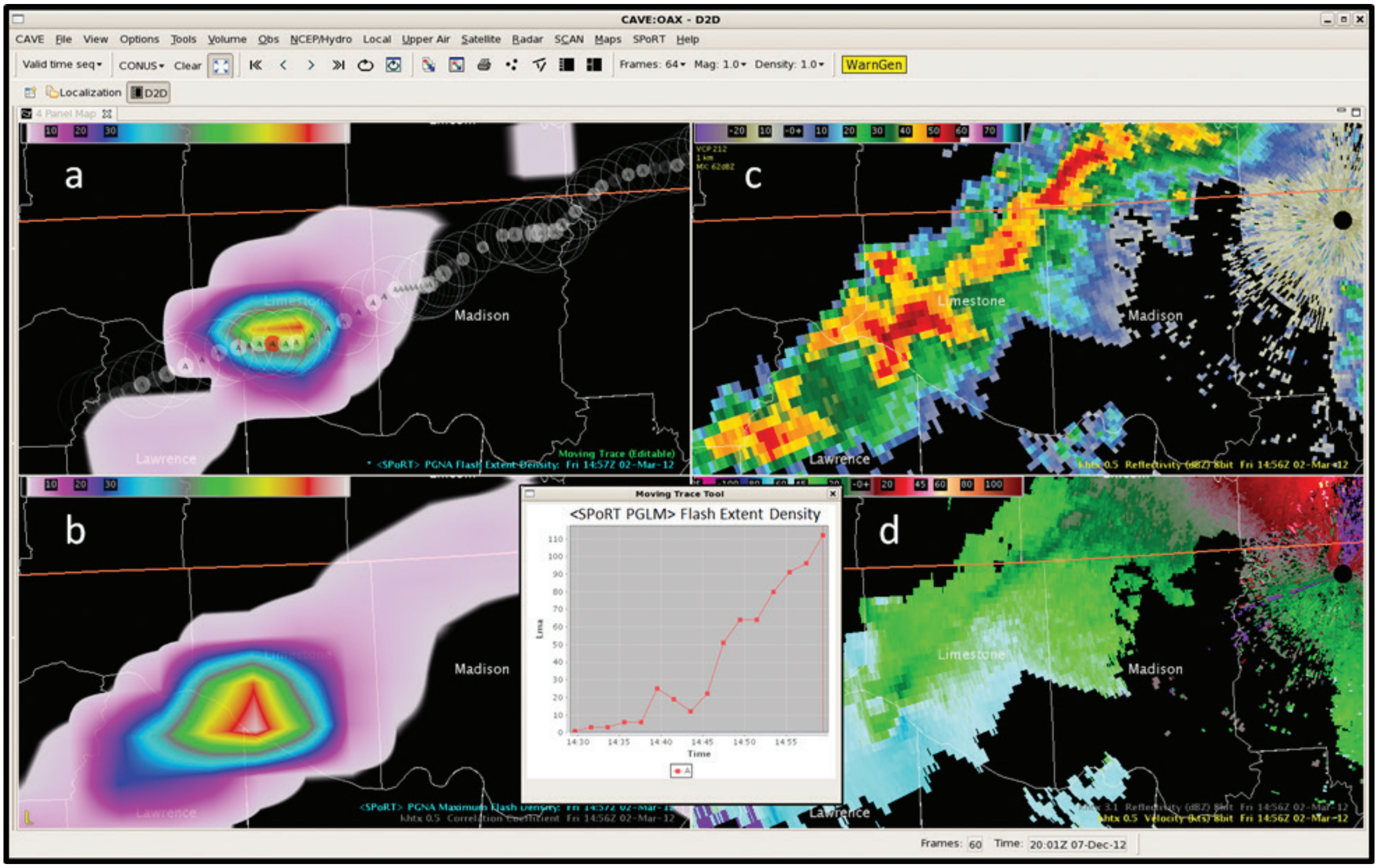


Figure 8. An example of the Pseudo Geostationary Lightning Mapper multi-panel display in AWIPS II showing (a) flash extent density, and (b) 30-minute maximum flash density, as well as (c) radar reflectivity, and (d) radial velocity from 2 March 2012. The inset shows the SPoRT lightning tracking tool output for the primary cell in Limestone county at 1456 UTC, with the full track shown in (a). This particular example shows a lightning jump in progress 14 minutes before a tornado touched down and eventually became an EF-3.

The tool may also be extended to calculate the ratio of intra-cloud to cloud-to-ground flashes (also requested in evaluations). SPoRT's initial efforts with this tracking tool have now been incorporated within a larger effort by the Meteorological Development Laboratory to create a similar tracking tool for multiple meteorological parameters and not just total lightning. Combined with SPoRT's expertise in product development and training, this tool will continue to make total lightning a vital component of SPoRT core and PG activities.

RGBs from MODIS and SEVIRI

The GOES-R satellite will provide numerous enhanced capabilities compared to the existing GOES satellite series. GOES-R will feature improved data quality and spatial resolution (up to 500 m resolution in the visible channel), more frequent temporal updates (5 min versus the current 15 min), a whole new observational capability (total lightning via the GLM), and more available spectral channels. The current GOES imager has five spectral channels, while the GOES-R satellite will feature 16 with the Advanced Baseline Imager (ABI). The additional multi-spectral capability will present a wealth of new information that can be exploited operationally. The main challenge will be finding an effective way to quickly and efficiently allow forecasters to synthesize this vast wealth of information in an operational environment.

A powerful method of synthesizing these data is through the use of RGB composites. SPoRT has produced RGB composites with MODIS data for many years, specifically with true color, false color (to distinguish between snow, cloud, and clear ground), and spectral difference (fog detection) composites. Now as part of the GOES-R and JPSS proving grounds, SPoRT is using the multispectral capabilities of the MODIS, VIIRS, and SEVIRI instruments to provide RGB composites to simulate future ABI capabilities. This work has been accelerated through the use of EUMETSAT's "best practices" guides for generating several RGB products (available online at oiswww.eumetsat.int/~idds/html/doc/best_practices.pdf). In addition to the products listed previously, SPoRT is now producing RGBs for dust detection, air mass identification, and night-time microphysics (used primarily for fog detection; example given in Figure 9). These RGBs are also being included in SPoRT's hybrid imagery products where appropriate (see next sub-section), such as merging the air mass RGB with GOES water vapor imagery.

Operationally, SPoRT provides the RGB composites as single swaths and hybrids from MODIS, VIIRS, and SEVIRI to both collaborative NWS and National Center partners. As SPoRT's RGB efforts grow, the program continues to look for opportunities to develop new RGB composites from additional instruments, such as those available on Suomi-NPP. A recent example is the creation of an RGB product using the VIIRS DNB to track power outages after Superstorm Sandy (see Section 7).

POES-GOES Hybrid Product

The hybrid concept arose in 2009 as the SPoRT program attempted to address a concern from forecasters using MODIS data in operations. Forecasters prefer the high temporal frequency of geostationary satellite data, as it is not practical to animate the infrequent swaths of MODIS imagery. The MODIS swaths from SPoRT were thus not being used to the full potential in operations. SPoRT had provided an orbit-track tool to help forecasters determine the day and time of the next Aqua and Terra satellite overpass, but forecasters found this tool unwieldy and indicated that using the MODIS data was difficult as it was not part of a general satellite loop. In short, "if they can't loop it, they won't use it (as often)."

The relatively simple solution was to take standard GOES imagery and, when a MODIS overpass was available,

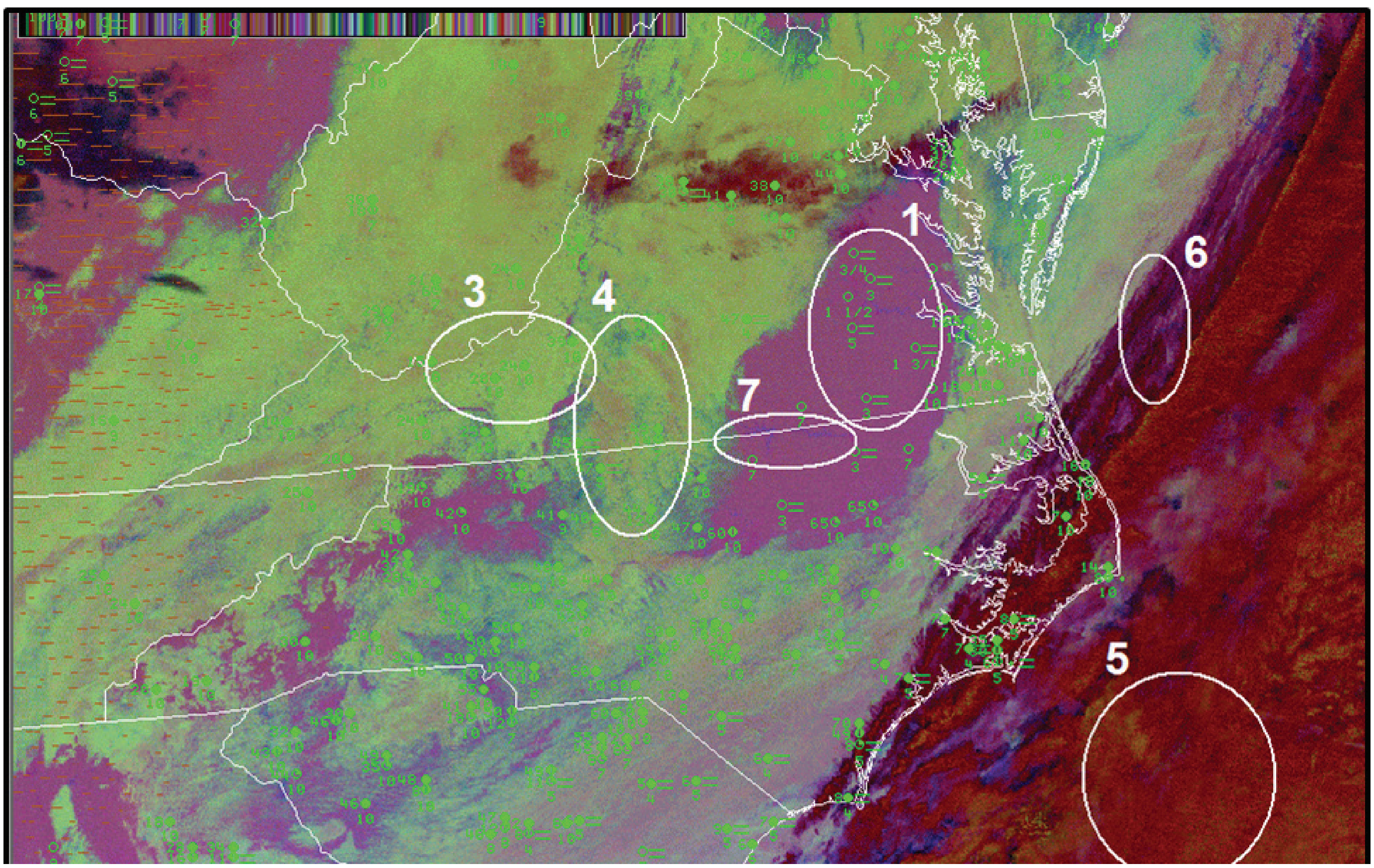


Figure 9. An annotated night-time microphysics RGB product provided to SPoRT from the Raleigh National Weather Service on the Wide World of SPoRT blog. The various regions refer to 1) shallow fog with reduced visibilities, 2) fog with probable instrument flight rule ceilings and visibilities, 3) stratus with instrument flight rules/ marginally visible flight rules ceilings, 4) mixed low and mid-level clouds with some thickness from Lynchburg, VA to Greensboro, NC, 5) high level, thick clouds, 6) pockets of high level, thin clouds, and 7) warm bodies of water associated with Kerr Lake and Lake Gaston.

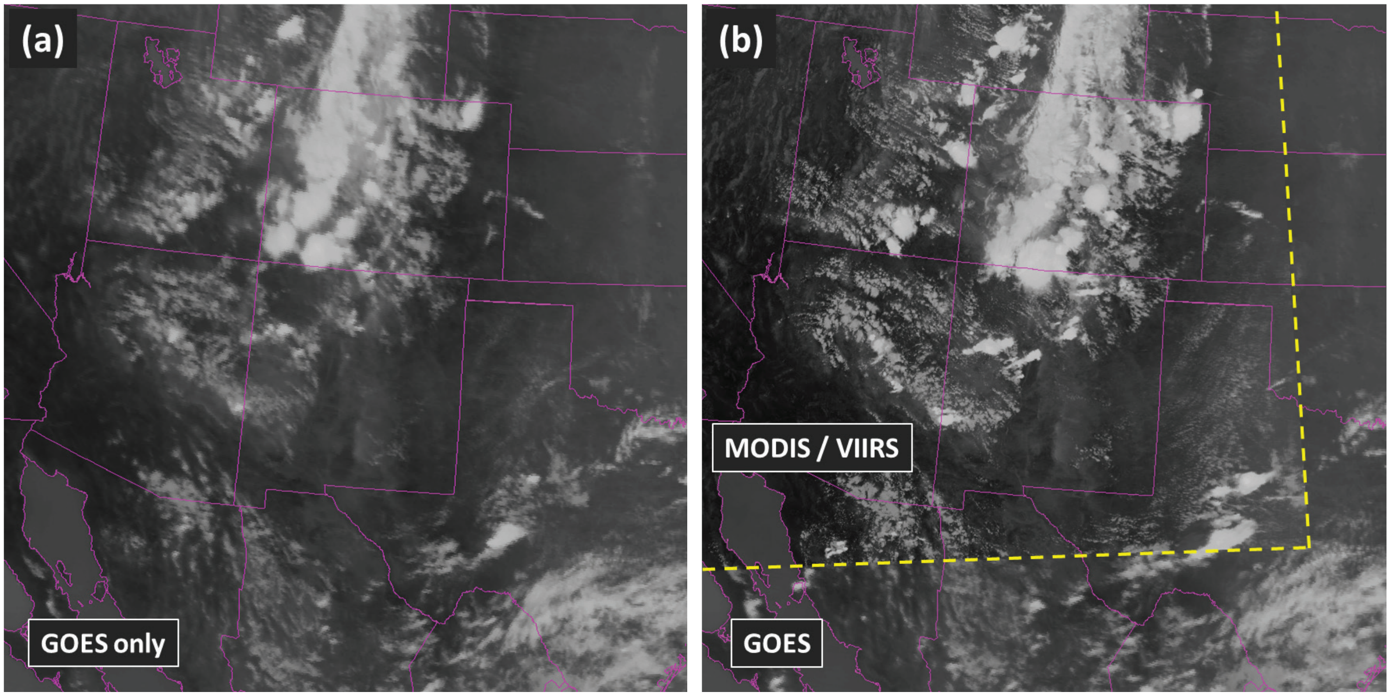


Figure 10. Sample comparison between (a) GOES-only IR image, and (b) SPoRT hybrid IR image with high-resolution polar imagery replacing the background GOES IR image, where available.

insert the higher-resolution MODIS swath into the GOES image. Where MODIS data are available, the GOES data are thus replaced. Since GOES-East and GOES-West data are received every 15 minutes, there is a maximum temporal discontinuity at the swath edges of only 7.5 minutes. This process produces imagery with minimal distortions at swath edges.

This solution became the preferred format to present several MODIS channels (e.g., visible, IR, shortwave IR, and water vapor). Once the methodology for producing the hybrid was established, it was apparent that the MODIS-GOES hybrid product could serve as an excellent GOES-R PG product because the MODIS instrument is a close approximation for the future GOES-R ABI channels. SPoRT's collaborating forecast offices readily accepted this new way of visualizing MODIS data. Several assessments of the product received strong reviews. Forecasters stated that when a MODIS pass was available, it was like "putting on a pair of glasses" when seeing the amount of detail and clarity provided by the MODIS image compared to GOES alone. The example hybrid IR image in Figure 10 illustrates this point through a comparison between the GOES-only IR image (panel a) and the hybrid image with the high-resolution polar imagery replacing GOES (panel b). The positive feedback has ensured that the hybrid product would remain a key SPoRT core product.

The hybrid format has enabled SPoRT to exploit more quickly new datasets as they become available, and to establish new partnerships. Specifically, SPoRT's involvement with Suomi-NPP and the JPSS PG allowed VIIRS data to become a new input to the hybrid. The VIIRS addition means there are approximately 30% more GOES images each day with imbedded high-resolution swath data. VIIRS has been a major enhancement because it not only provides another data source, but it also has a broader swath width and better preserves resolution to the swath edge, compared to MODIS. These features translate to more usable data that will be available more routinely over a given WFO county warning area. Now with multiple polar-orbiting data sources, the MODIS-GOES hybrid product suite was renamed to the POES-GOES hybrid product suite. The addition of VIIRS has been especially useful with collaborations in the Alaska Region.

The hybrid methodology also allows for the integration of RGB composite imagery. Instead of just inserting a single channel (e.g., infrared), an RGB composite swath can be inserted into a similar GOES image. There will not be an exact correspondence, as the current GOES does not have the same channels as MODIS, VIIRS, and the future ABI; however, some interesting products have been generated as a result. An example is the air mass hybrid, in which the MODIS air mass RGB is added to a basic GOES water vapor image. The inserted MODIS air mass RGB adds value to the rest of the GOES image by highlighting warm-dry, cold-dry, warm-moist regions and the locations of distinct air masses with these disparate properties. As with the single-channel hybrid imagery, the ability to animate data helps forecasters to retain context. Efforts are currently underway to produce a night-time microphysics RGB hybrid for improved fog detection. In this product, the background GOES data will be the spectral difference (11 – 3.9 μm) image, with the night-time microphysics RGB overlaid.

NESDIS Quantitative Precipitation Estimate

The GOES-R Quantitative Precipitation Estimate (QPE) is an Algorithm Working Group product generated by NESDIS that estimates rainfall rates and accumulations from satellite retrievals (sample image shown in Figure 11). The GOES-R QPE uses geostationary IR observations from cloud tops to infer an initial rainfall intensity estimate. These infrared observations are then calibrated with microwave observations from various available low-Earth orbit satellite instruments. The microwave observations better diagnose hydrometeors within the clouds to achieve more precise precipitation estimates. As of the end of 2012, this algorithm was being applied to GOES-East and GOES-West operationally. SPoRT is supporting NESDIS in this effort as part of its GOES-R PG activities to help transition and evaluate their products in an operational setting. The GOES-R QPE product is in the process of being transitioned to select NWS WFOs for an assessment period.

GOES-R Convective Initiation Product

UAH has been leading a collaborative effort with the National Center for Atmospheric Research and the Massachusetts Institute of Technology Lincoln Laboratory to develop a GOES-R Convective Initiation (CI) algorithm that produces a 0 – 2 hour forecast (i.e., "nowcasts") of new convective storms, specifically the occurrence of radar echoes of 35 dBZ intensity or greater. Some of these storms will produce lightning. The colored objects in the sample image (Figure 12) represent growing cumulus clouds within the GOES visible imagery. Their growth is monitored over successive 7–15 min images in GOES data using IR temperature fields. The IR fields help measure cloud-growth rates, cloud depths, and whether a cloud has ice or water particles at cloud top (usually the transition to ice leads to increased precipitation

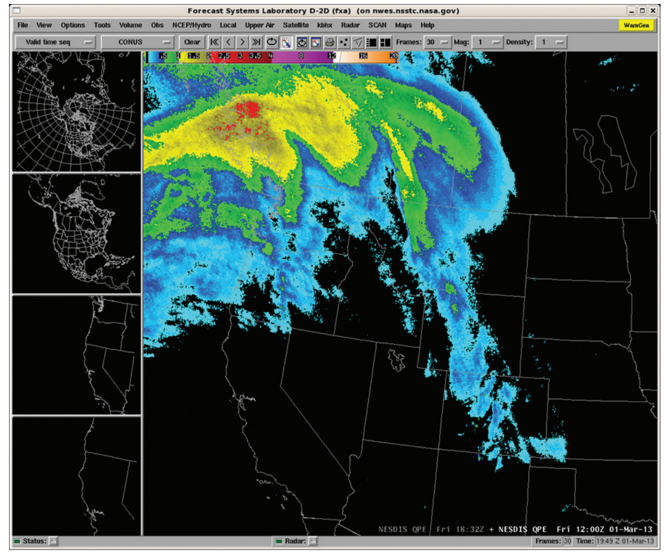


Figure 11. A demonstration image from AWIPS of the GOES-R QPE product showing 12-h accumulated precipitation (mm) ending 1200 UTC 1 March 2013, using the WFO Eureka, CA localization.

production, and suggests an occurrence of lightning). The "strength of signal" (given by colors in Figure 12) represent increasing likelihoods that a 35 dBZ echo (i.e., a heavy rain shower) will occur from a given cloud object. For objects with strength of signal values < 40 (blue colors), one can interpret these as relatively un-developed clouds, or cumulus clouds with small spatial dimensions, and therefore less likely to make significant rain in the coming 30–60 min. Warmer (orange / red) colored objects imply taller, more rapidly growing cumulus clouds that have a > 75–80 % chance of becoming a storm in the coming 30 – 60 min. One needs to note the motion of a given object to estimate the ground location where the rain will eventually fall.

The SPoRT program has been involved in transitioning the GOES-R CI product to operational end-users for evaluation. This collaboration leverages SPoRT's transition capabilities, such as active data feeds to partner organizations and liaisons to aid the UAH research efforts to coordinate evaluations with end-users. The product is presently in operational use for Flight Control Centers in the U.S. via the Corridor Integrated Weather System at Lincoln Laboratory. Also, the GOES-R CI product is being evaluated by a number of NWS WFOs and GOES-R Testbeds (i.e., HWT, AWC, and OPC) as part of the collaboration with the SPoRT program.

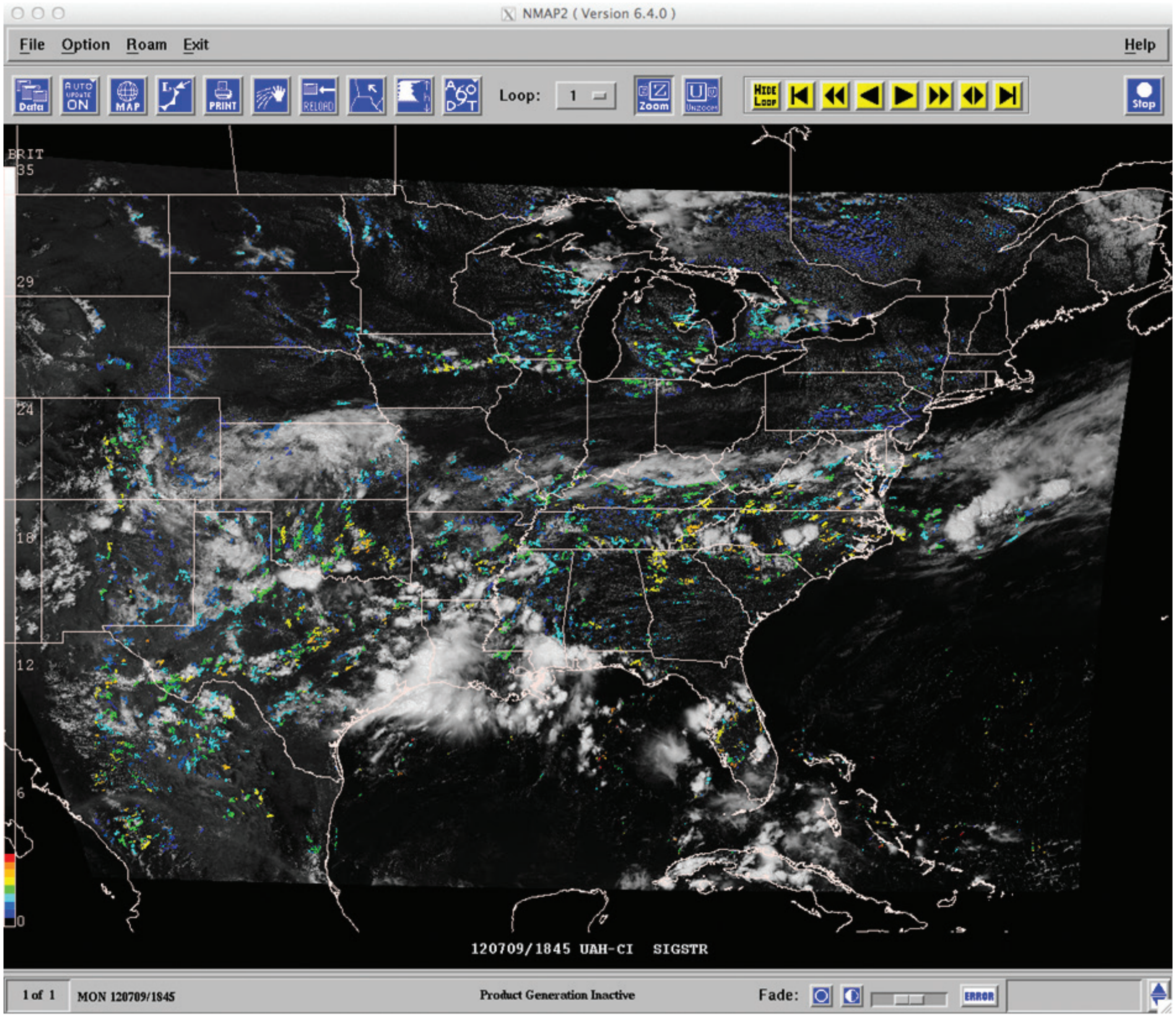


Figure 12. An example of the GOES-R Convective Initiation product highlighting growing cumulus clouds (colored sections) overlaid on a GOES visible image. Warmer colors indicate a stronger strength of signal than cooler colors. This particular example comes from an N-AWIPS display used by SPoRT's National Center partners, such as the Aviation Weather Center.

JPSS Proving Ground

The successful launch of the Suomi-NPP satellite in 2011 offers additional data of interest to the operational weather forecasting community. Several instruments aboard Suomi-NPP provide continuity of measurements from NASA's MODIS instrument, while also offering new capabilities such as the detection of city lights, fires, and moonlit clouds via the calibrated day-night band. Since the Suomi-NPP serves as a precursor to the JPSS, NOAA has established and SPoRT participates in JPSS PG activities. As with MODIS, SPoRT generates and disseminates full-resolution data sets from the VIIRS instrument. Single-channel visible, near-infrared, and infrared imagery provide high levels of detail regarding cloud formation, fog detection, and other hazards such as fire locations and smoke. In addition to single channel products, SPoRT extends the use of multispectral (RGB) products in the Suomi-NPP era by creating images from VIIRS that are equivalent to products derived from MODIS. For example, the night-time microphysics product developed by EUMETSAT and applied to MODIS by SPoRT is also produced for VIIRS. The additional orbit from Suomi-NPP, combined with high resolution (0.75 km) VIIRS data and a wider swath width extend the capabilities of the night-time microphysics product by supplementing other fog and low cloud detections from geostationary satellites and MODIS. Although the VIIRS instrument is similar to MODIS in many respects, it lacks spectral bands sensitive to atmospheric water vapor and ozone. SPoRT is therefore supplementing VIIRS data with observations from CrIS, a hyperspectral sounder with numerous water vapor bands that can be used to further refine the SPoRT RGB air mass product. The combined observations from CrIS and VIIRS provide continuity of the MODIS air mass RGB product currently used and evaluated by forecasters, as well as an example of data fusion techniques from multiple remote sensors carried on Suomi-NPP.

SPoRT also provides unique imagery from the VIIRS DNB. The DNB senses the radiance from city lights, wildfires, natural light sources such as auroras and airglow, and other man-made sources such as boats and refineries. When moonlight is available, it also provides visible imagery of the land surface, snow cover, fog, and clouds in a manner similar to daytime visible imagery. The DNB provides a plethora of new capabilities and opportunities for forecasters to learn more about night-light applications and new capabilities that have not been widely available in the operational forecasting community. SPoRT collaborated with CIRA and NRL to implement a lunar radiance algorithm that further refines the DNB product from a radiance-based image to a reflectance-based image, where reflectance is the radiance normalized by the amount of available moonlight. The normalization to a reflectance product improves the use of the data by keeping the imagery brightness and enhancements more consistent despite changes in moon phase and amount of moonlight available. These data will be transitioned to WFOs and National Centers in early 2013.

SPoRT is collaborating with NRL to develop RGB composite techniques of DNB visible reflectance and cloud-top infrared brightness temperatures in order to help discriminate between low and high clouds. Recent applications have demonstrated that the DNB can be used to help monitor the impact and recovery from disasters that produce widespread power outages (such as Hurricane Isaac and Superstorm Sandy), and that the DNB imagery can be used to identify the front lines and complex shapes of wildfires in the Intermountain West of the U.S. Collaboration with forecasters will no doubt lead to other applications not previously envisioned. Examples of some of these new capabilities with Suomi-NPP are highlighted in the Superstorm Sandy images presented in Section 7.

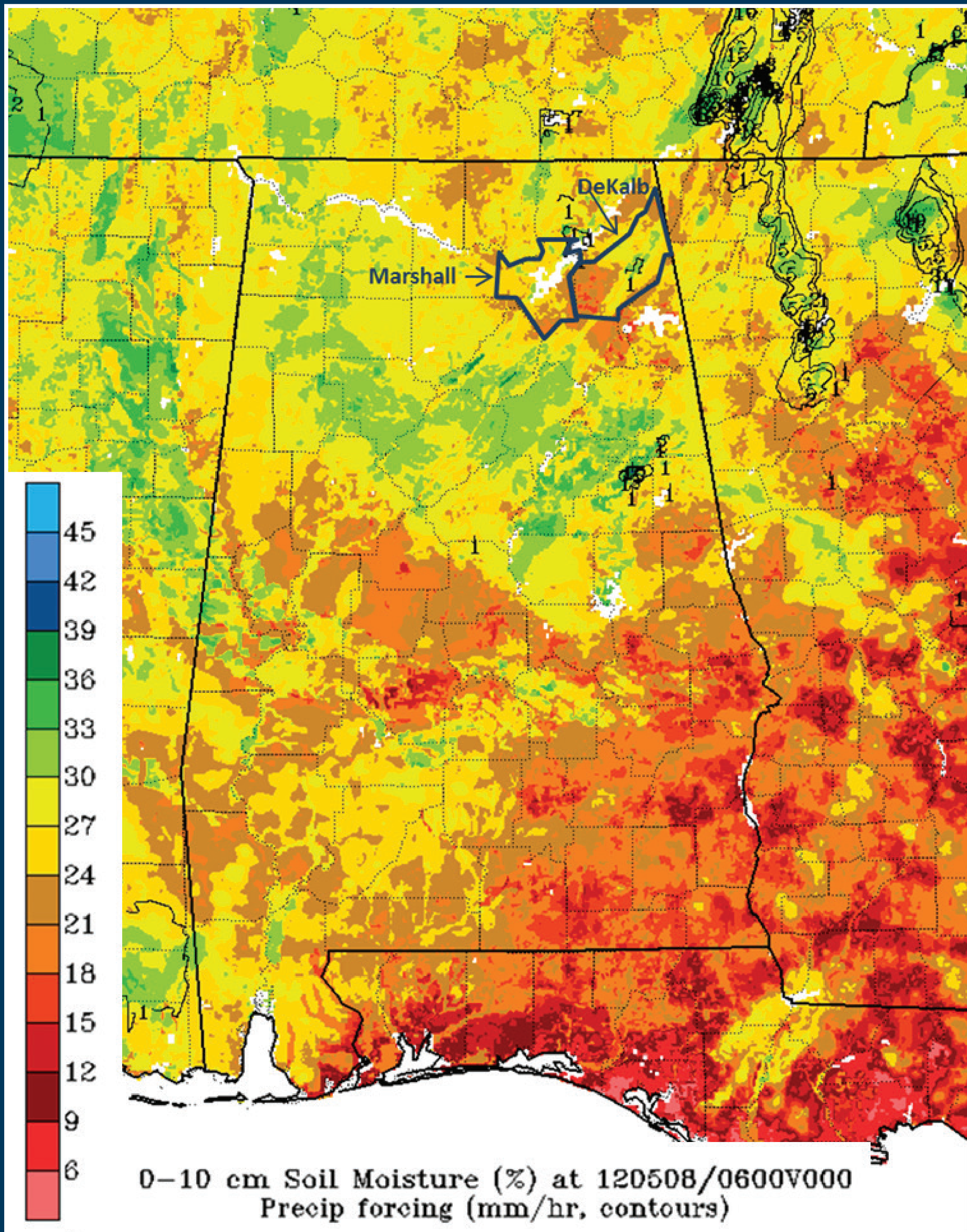
OCONUS Products

SPoRT's recent OCONUS efforts have largely been focused on the Alaska Region as part of the JPSS PG. However, partnerships with several National Centers have also created opportunities to provide new SPoRT products over much of the Atlantic and Pacific basins. At increasing distances from sub-satellite point (i.e., higher latitudes), geostationary imagery is of less value. For example, the GOES visible channel has 1-km resolution at the equator, but has an effective resolution over central Alaska of closer to 8 km. Therefore, polar-orbiting data can be quite valuable to Alaska forecasters, given the high-resolution and frequent overpasses (compared to mid- and low-latitudes). SPoRT provides POES-GOES hybrid products to Alaska Region at a slightly reduced resolution than other partner WFOs, due to the more limited bandwidth. The visible hybrid channel is generated at 0.5-km resolution, while the IR channels are produced at 1-km resolution. SPoRT is also providing MODIS and VIIRS RGB products over Alaska and surrounding waters, which helps to cover the rather extensive data-void areas in the Alaska Region.

The SPoRT collaboration with the National Centers has also led to further expansion of SPoRT products outside of CONUS. The National Centers have forecast domains that are much larger than a typical WFO. For example, NHC, WPC, and OPC all have forecast responsibilities the include parts of the Atlantic and Pacific Ocean basins in the Northern Hemisphere. SPoRT provides these National Centers with OCONUS products such as Sea Surface Temperature, oceanic overpasses of passive microwave products from polar-orbiting instruments, RGB products from the EUMETSAT SEVIRI instrument, as well as the SPoRT MODIS and VIIRS RGB products over these waters. The suite of OCONUS products consists of a sub-set of those given in Appendix B, as noted by the domain listings in the table. Finally, as collaborations with personnel in Hawaii continue to grow, SPoRT also plans to provide unique NASA and NOAA products to forecasters in the Pacific Region. SPoRT's involvement with the National Centers has opened the door for additional collaborations with the wider operational weather community beyond the current suite of partner WFOs.

3

Modeling & Data Assimilation



SPoRT-LIS used to make decisions on U.S. Drought Monitor classification at sub-county scales.

Introduction

The modeling and data assimilation team has been actively promoting SPoRT products in recent years to improve atmospheric initial conditions and representations of the land and water surfaces in local and regional modeling applications. Several datasets have been transitioned into operations at the WFO level, with research techniques published in peer-reviewed literature demonstrating the positive impact that these datasets have on model forecasts.

The SPoRT SST product began as a MODIS-only composite over the southeastern U.S., western Atlantic Ocean and Gulf of Mexico. The product was transitioned to the EMS for initializing SST in local model forecasts at partner WFOs in the southeastern U.S. The evolution of the SPoRT SST to a multi-satellite sensor product on a northern/western hemispheric scale has been supported within the EMS construct and continues to be used by numerous partner WFOs as well as other external uses of the EMS. Beginning in late 2009, the NASA LIS was configured to run the Noah land surface model (LSM) in real-time over the southern and eastern half of the CONUS to provide land surface initial conditions at a resolution consistent with local modeling applications. Daily MODIS vegetation composites have been produced at ~1-km resolution over the whole CONUS since 1 June 2010, including a method for transitioning its use within the WRF model, LIS and EMS. These three datasets form the mainstay of the NWS Southern Region modeling collaboration with the NWS WFO at Houston, TX and Mobile, AL, which is described in more detail below. The NWS Eastern Region also continues to collaborate with SPoRT in lake-effect snow forecasting applications through the use of the SPoRT Great Lakes Surface Temperature (GLST) composite embedded within the SPoRT SST product.

The crux of data assimilation activities has revolved around the assimilation of AIRS level-2 retrievals of temperature and moisture profiles. The positive benefits that can be achieved by assimilating AIRS profiles into regional models and the strategic use of partly cloudy profiles to maximize the data availability for assimilation were demonstrated in Zavodsky et al. 2012. A prototype "SPoRT-WRF" modeling framework that emulated the real-time convection-allowing WRF forecasts at NSSL (Kain et al. 2010) was evaluated at the 2011 HWT Experimental Forecast Program. This modeling system assimilated AIRS and Infrared Atmospheric Sounding Interferometer profiles each day of the Experimental Forecast Program, and included the real-time SPoRT SST, MODIS GVF and real-time LIS LSM data in the initial conditions. Based on the evaluation results, the SPoRT-WRF generally exhibited a low-level cold, stable bias during the 2011 HWT Experimental Forecast Program, which was found to be a result of the data assimilation methodology used at the time. The data assimilation technique for testing new datasets has since evolved to a cycled scheme using the Gridpoint Statistical Interpolator (GSI) 3D variational assimilation package that mimics the regional assimilation cycle at NCEP EMC. The adoption of the GSI and cycling data assimilation methodology has improved upon the biases seen during the 2011 HWT experiment. More recent activities have compared the assimilation of AIRS radiances to AIRS retrieved profiles within the GSI cycled data assimilation framework.

Following the most recent SPoRT SAC meeting in late February 2012, the SAC general recommendations for modeling and data assimilation work revolved around focusing efforts in an environment of declining budgets. The SAC emphasized that SPoRT's role in modeling and data assimilation is best suited for providing local datasets and assimilation products of added value to the WFOs, as opposed to pursuing initiatives for improving global and regional modeling at EMC and/or HWT. Given these recommendations, efforts this past year have focused on WFO collaborations in local modeling, assimilation products and research applications to address specific forecast challenges. In addition, SPoRT is better positioning itself for future opportunities to improve and expand upon land surface modeling and data assimilation activities. The following sub-sections highlights the continued activities in the local modeling arena, data assimilation activities, and efforts underway to expand collaborations and seek additional opportunities.

Modeling Activities

SPoRT datasets for WRF/EMS: SST, MODIS GVF, and LIS

SPoRT continues to maintain the three datasets for initializing surface variables for local model runs: the SPoRT SST (which includes the embedded GLST and ice analysis), LIS-Noah over the Southeastern U.S., and real-time MODIS GVF. Several upgrades have been made to these SPoRT datasets in the past year, except for the

Great Lakes ice product which has remained the same. The updates to the SST, GLST, and MODIS GVF datasets were described above in Section 2 (In-House SPoRT Products), as well as in a poster and extended abstract at the 2012 National Weather Association annual meeting (Case et al. 2012b).

As for the LIS, SPoRT has been operating a real-time configuration of the NASA LIS (Kumar et al. 2006; Peters-Lidard et al. 2007; Kumar et al. 2007) that runs the Noah LSM in an uncoupled, or offline mode, since summer 2010 (hereafter the "SPoRT-LIS"). In an offline mode, the LSM is run apart from a numerical weather prediction model, with input variables (i.e. forcing) provided by atmospheric analyses. The SPoRT-LIS is run on a domain that covers much of the eastern CONUS at 3-km grid spacing (extent of domain shown in Figure 13). The SPoRT-LIS simulation consists of a long-term integration of the Noah LSM spanning multiple years, which is restarted four times each day and driven by atmospheric analyses from the NCEP Global Data Assimilation System (GDAS; Parrish and Derber 1992; NCEP EMC 2004), North American Land Data Assimilation System Phase 2 (Xia et al. 2012), and hourly precipitation estimates from the NCEP Stage IV product (Lin and Mitchell 2005; Lin et al. 2005). To ensure data availability in real-time applications, short-term forecasts up to 15 hours from the NCEP Global Forecast System (GFS) model are used in each 6-hourly SPoRT-LIS cycle, thus providing a small forecast component to the real-time LIS. Output forced by the GFS model forecasts is over-written in subsequent cycles as NLDAS2 and Stage IV analyses become available, ensuring that the land surface model converges to a best modeled solution based on analyses and not forecasts. The real-time system is designed to provide the best modeled depiction of soil moisture and temperature, skin temperature, and snow-water equivalent at a resolution consistent with local models at NWS weather forecast offices. Case et al. (2008a) and Case et al. (2011a) demonstrated the utility of initializing local NWP models with high-resolution, consistent LSM fields from LIS over the Southeastern U.S. during the warm-season months.

Recent versions of the EMS contain an option to use LIS data for initializing land surface variables in local model runs. The SPoRT-LIS can also provide WFOs with modeled land surface fields that can aid short-term forecasting, situational awareness, and drought monitoring. Output is written into gridded binary format, thus enabling an easy incorporation into the EMS via the WRF Preprocessing System utilities. Finally, the SPoRT-LIS has been incorporating the SPoRT GVF composites since April 2011.

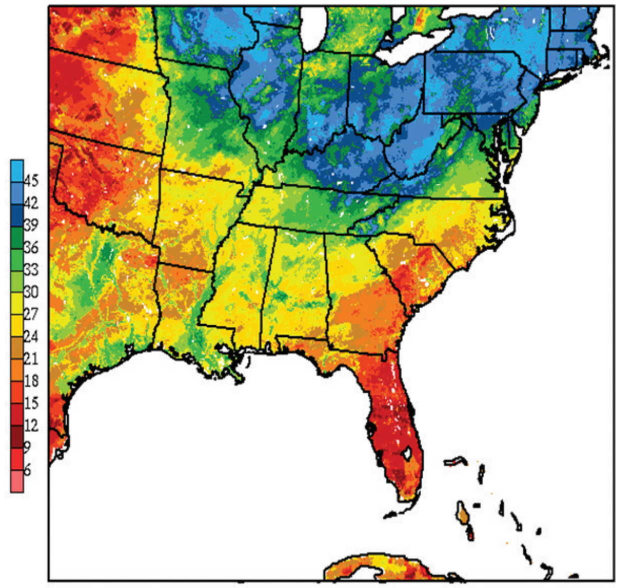


Figure 13. Sample 0-10 cm volumetric soil moisture map illustrating the extent of the real-time 3-km LIS-Noah land surface model domain for use in the EMS.

The SPoRT-LIS was upgraded in early September 2012 with several improvements. Table 1 summarizes the various real-time SPoRT LIS characteristics, aspects of the model run that have changed, and specific information on the configuration details. The upgrade is generally transparent to end-users, since file and data formats are the same. The most noteworthy modifications and improvements are:

- Updated LIS software to support an upgrade from Noah LSM version 2.7.1 to version 3.2. This upgrade includes an improved look-up table methodology for some static fields and improved handling of heat fluxes over snow-covered regions.
- Changed land-use classification (vegetation type) from the U.S. Geological Survey 24-class database to the newer International Geosphere Biosphere Programme (IGBP)/MODIS 20-class database. The IGBP/MODIS database is more up-to-date, especially for recently-expanded urban areas.
- Switched from a coarse-resolution surface albedo climatology to a look-up table methodology for surface albedo based on (a) input GVF from the high-resolution SPoRT-MODIS real-time product and (b) the

Table 1. List of configuration details of the real-time SPoRT LIS, notation as to whether the configuration is unchanged or modified, and specific noteworthy details.

Configuration Detail	Unchanged	Modified	Notes
Domain extent	X		Eastern United States
Grid spacing	X		3 km
Soil type	X		State Soil Geographic database
Land use		X	Upgraded to IGBP/MODIS 20-class vegetation type
Land surface model		X	Upgraded to Noah version 3.2 (formerly v2.7.1)
GVF database	X		Daily real-time SPoRT-MODIS Green Vegetation Fraction generated at native 0.01° resolution
Surface albedo		X	Improved look-up table methodology based on input real-time SPoRT-MODIS GVF
Atmospheric forcing (excludes precip)		X	Long-term Noah LSM integration driven by NLDAS-2 (formerly first-generation NLDAS)
Precipitation forcing	X		Hourly NCEP Stage IV precipitation analyses

newer IGBP/MODIS land-use database. An example comparison between the original climatological specification of surface albedo and the newer look-up table methodology based on real-time SPoRT-MODIS vegetation data is given in Figure 14.

- Modified the long-term atmospheric forcing (excluding precipitation) that drives the LIS-Noah LSM integration from the NLDAS to NLDAS phase 2 (NLDAS-2). The NLDAS-2 is an improved long-term satellite-era reanalysis database based on the North American Regional Reanalyses.

The upgrades to the SPoRT-LIS will help improve the representation of urban areas, the partitioning of surface heat and moisture fluxes through the use of the IGBP/MODIS land use database, better represent the surface energy budget through the use of surface albedo consistent with real-time SPoRT-MODIS GVF, and improve the soil moisture distribution in the LIS output. These impacts will in turn translate to benefits in the forecast 2-m temperature, dewpoint, and instability fields in local model forecasts using LIS initialization data, especially during the warm season.

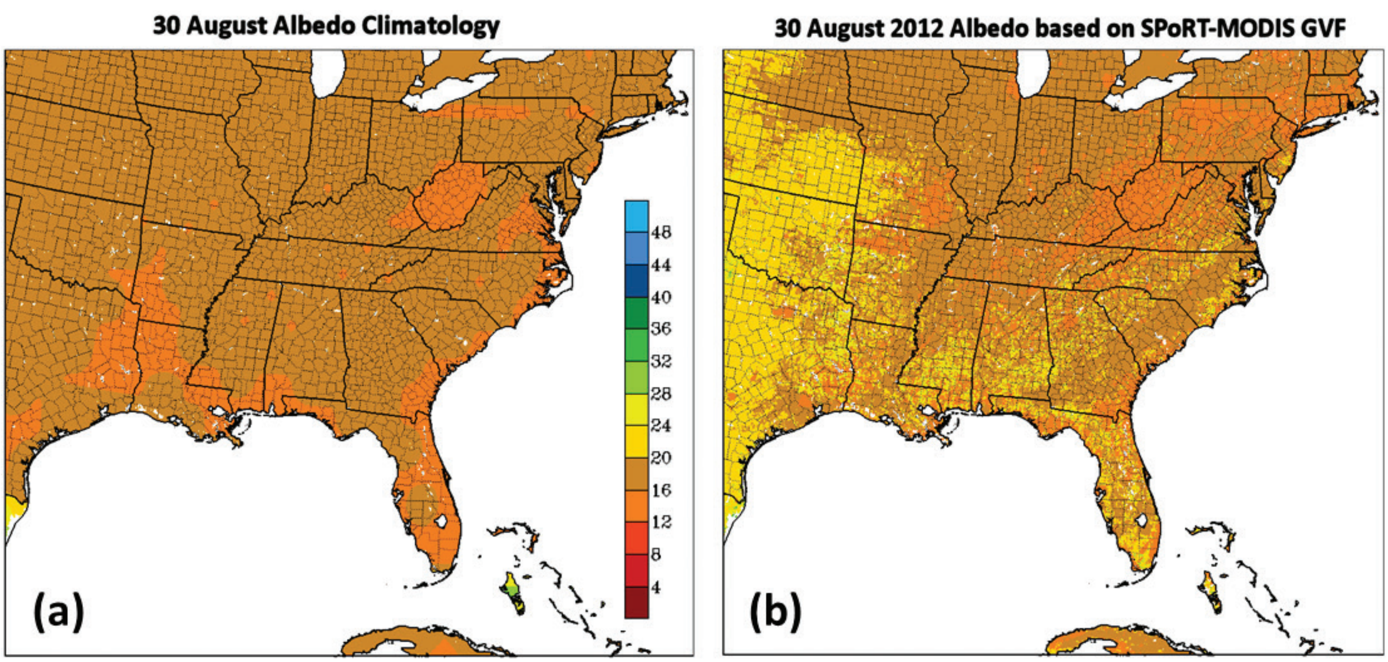


Figure 14. Comparison between (a) climatological surface albedo time-interpolated to 30 August in the former LIS configuration, and (b) surface albedo as a function of the real-time SPoRT-MODIS GVF in the upgraded LIS configuration, valid 30 August 2012. Note the higher surface albedo corresponding to lower SPoRT-MODIS GVF in the Plains and Midwest regions from Error! Reference source not found., due to the severe drought during Summer 2012

Each of these three datasets continue to be supported by the EMS for use in local modeling applications, particularly at NWS partner WFOs. SPoRT released informational documents summarizing the updates of the SPoRT SST/GLST, and SPoRT-LIS, and the actions needed to continue using these datasets in the EMS modeling framework.

Southern Region modeling collaboration

SPoRT bolstered its WFO modeling support by initiating a Southern Region modeling collaboration with the NWS Houston and Mobile offices. The joint effort was undertaken to examine the collective effects of utilizing the above three SPoRT products within the EMS. Using the National Center for Atmospheric Research Advanced Research WRF dynamical core, two EMS domains with identical model physics were established over the southeast Texas and Alabama coastlines. Details on the model initialization, integration, and physics parameterization schemes are discussed in Medlin et al. (2012). The operational runs (OPL, those including the NASA data sets) were the real-time forecasts generated daily by each WFO; SPoRT ran the control forecasts that withheld the SPoRT datasets (CTL). After a test revealed the existence of non-linear variations in model solutions due to computational platform differences, it was decided that for the purpose of removing these biases from the final evaluation that both the Houston and Mobile OPL runs as well as the CTL would be run at the NASA SPoRT Center for comparing verification results.

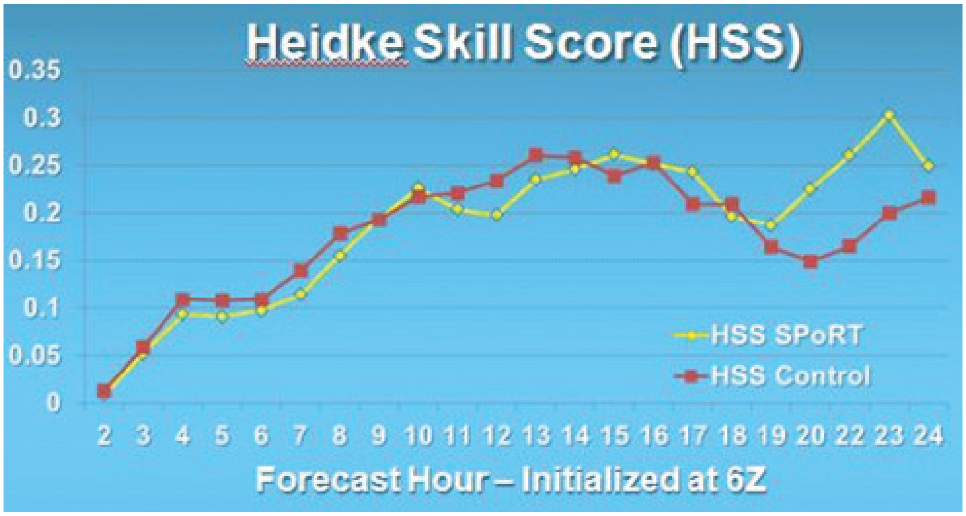
SPoRT developed and streamlined a set of Perl scripts that manage the generation of objective verification statistics using the WRF Developmental Testbed Center's Model Evaluation Tools (MET; Brown et al. 2009; Davis et al. 2009) package. As part of the collaboration, SPoRT provided assistance and training with the installation, configuration, and execution of the SPoRT-MET verification scripts so that each individual WFO could generate their own model verification statistics in-house. The SPoRT scripts and MET package were then used to compute both point and grid statistics comparing the OPL and CTL forecasts. Hourly Stage IV accumulated precipitation grids were used to perform gridded precipitation verification. For both 2-m temperature and dewpoint temperature and 10-m wind verification, hourly Meteorological Assimilation Data and Ingest System point data were used.

Preliminary results from this collaboration were presented at the 2012 National Weather Association annual meeting in Madison, WI (Wood et al. 2012) and the American Meteorological Society Severe Local Storms conference in Nashville, TN (Medlin et al. 2012). The results suggest that the inclusion of the SPoRT datasets slightly degraded the precipitation skill scores in the first several hours for a composite of numerous convective initiation case days examined during Summer 2012. In the NWS Mobile, AL model runs, the Heidke Skill Scores for 1-h accumulated precipitation were comparable to slightly lower in the forecasts using SPoRT data, but showed improved scores for the last several forecast hours (improvement from hours 19–24 in the top of Figure 15). Worth noting is that the local model runs in Mobile and Houston exhibited a negative bias in precipitation coverage overall, with the inclusion of SPoRT datasets further reducing the precipitation bias slightly (Figure 15, bottom). Since these preliminary results are not consistent with previous findings, additional sensitivity simulations are underway to investigate the possible reasons why the local EMS model configurations generally under-predicted the convective precipitation during the Summer 2012 events studied. Certain aspects of the model configuration and choice of physics parameterization schemes could have led to the overall dry bias that generally masked the contributions of the SPoRT datasets.

SPoRT plans to use this collaboration format to establish a foundation for conducting modeling experiments and near real-time verification with other partner WFOs and NWS Regions. By providing tools and training at the WFO level, the ultimate goal is to empower individual forecast offices to conduct their own modeling experiments and include routine statistical verification not normally done at the local forecast office level.

Data Assimilation Research

SPoRT worked on two main data assimilation projects during 2012, with both seeking improved data assimilation results through the use of retrieved profiles from AIRS in partly cloudy regions. The first project is a collaboration with HMT to evaluate a SPoRT AIRS-enhanced moisture analysis product; the second project is partially-funded through the Joint Center for Satellite Data Assimilation (JCSDA), and designed to evaluate regions where AIRS profiles are assimilated and AIRS radiances are excluded.



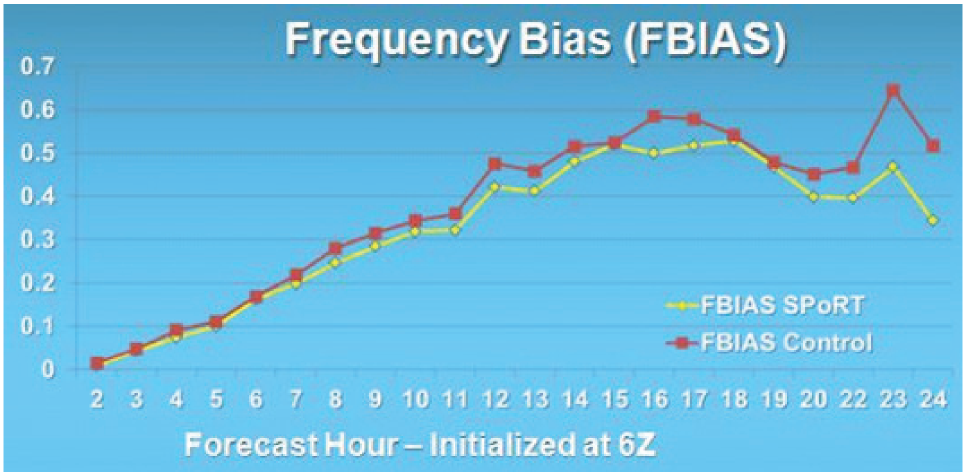


Figure 15. Heidke Skill Score (HSS, top) and Frequency Bias (FBIAS, bottom) for all 41 OPL versus CTL runs verifying hourly accumulated model precipitation in the Mobile, AL EMS domain, initialized at 0600 UTC. The verification is based on a 24-km neighborhood grid box and a threshold of ≥ 1 mm h^{-1}.

HMT project: AIRS analyses for Pacific atmospheric rivers

The goal of assimilating AIRS profiles over the Pacific is to generate a near-real time enhanced 3D moisture analysis product that could be used by West Coast Offices and WPC/OPC for diagnosing the location, extent, and magnitude of atmospheric rivers. Atmospheric rivers are narrow tongues of enhanced low-level water vapor and precipitation that propagate from the Intertropical Convergence Zone northward, and impact the West Coast of North America. When these moisture-laden streams interact with the steep orography on the West Coast, days of heavy precipitation often occur which can lead to severe flooding and landslides. Because atmospheric rivers are typically associated with cloudy regions, the cloud-free AIRS radiances that are assimilated in the GFS model may not fully capture these features. However, assimilation of AIRS profiles, which allow for assimilation of data above clouds and in partly cloudy regions, may provide an enhanced view of atmospheric river features.

The experimental SPoRT product blends a GFS analysis with AIRS observations using the GSI data assimilation system to produce a 3-D analysis of integrated water vapor that can be dissected at different levels. The analysis product can be used as either a situational awareness tool or for initialization of local EMS runs by West Coast WFOs. Figure 16 shows a comparison between a 24-h WRF forecast from the GFS analysis (i.e., “Control”), the forecast from the SPoRT AIRS-enhanced moisture analysis (i.e., “AIRS DA”), and the CIRA TPW satellite product (here used as “truth” since it is an independent data source). While the visual differences are not particularly noticeable, the assimilation of AIRS profiles reduces the errors in simulated TPW compared

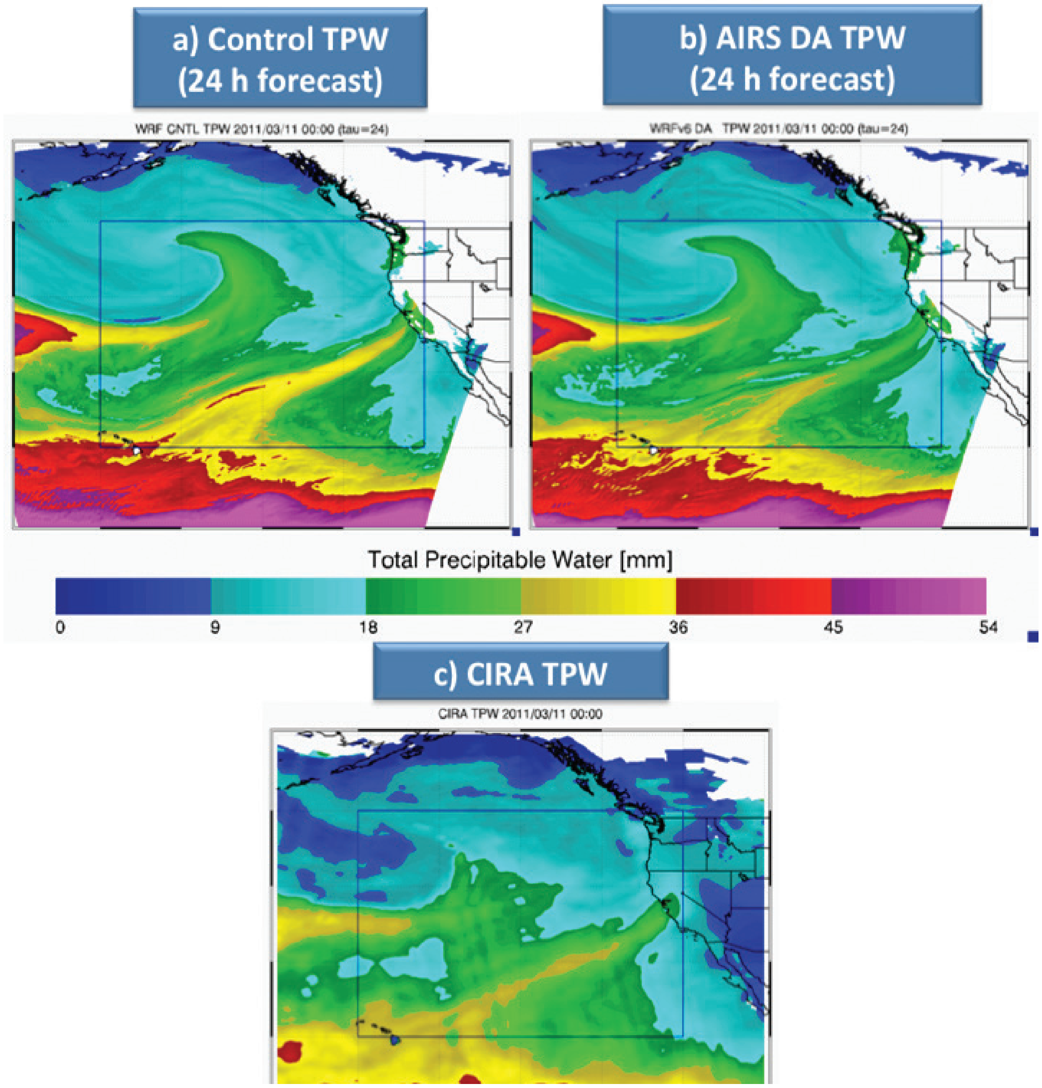


Figure 16. Comparison between a) 24-h Total Precipitable Water (TPW) forecast from the GFS analysis; b) 24 h TPW forecast from the SPoRT AIRS-enhanced analysis; c) CIRA TPW. Forecasts and CIRA observations are valid at 0000 UTC 11 Mar 2011.

to the CIRA TPW (bias reduced from 2.1 to 1.2 mm; error standard deviation reduced from 3.6 to 3.3 mm; and root mean square error reduced from 4.2 to 3.5 mm).

JCSDA project: AIRS radiance vs. profile assimilation

The objective of the JCSDA project is to use AIRS retrieved profiles to determine regions (both in a horizontal and vertical) where more information from AIRS radiances might be utilized if more accurate detection of the cloud tops were assigned. Additionally, the effects of horizontal data reduction techniques are investigated. Cloud-top pressure assigned to the observations in GSI in the AIRS radiances and the vertical extent of the highest quality data in the AIRS retrievals has been compared to independent cloud observations from MODIS. Overall, the cloud-detection algorithms used by GSI appear to do a good job of defining the cloud tops and retaining only cloud-free radiances; however, in localized regions with low clouds or partly cloudy conditions, the difference between the locations where radiance data are assimilated and profile data are assimilated results in localized improvements for the profile forecasts. Figure 17 shows a difference field (profile minus radiance) between the 500-hPa temperature anomaly correlation in the 48-h forecast for the default thinned AIRS radiance dataset, and the full AIRS profile runs for a 1-month case study from late 2011. The preliminary results show overall improvements to forecast statistics (0.667 anomaly correlation for the profile assimilation runs and 0.552 anomaly correlation for the radiance assimilation runs, between 10°S and

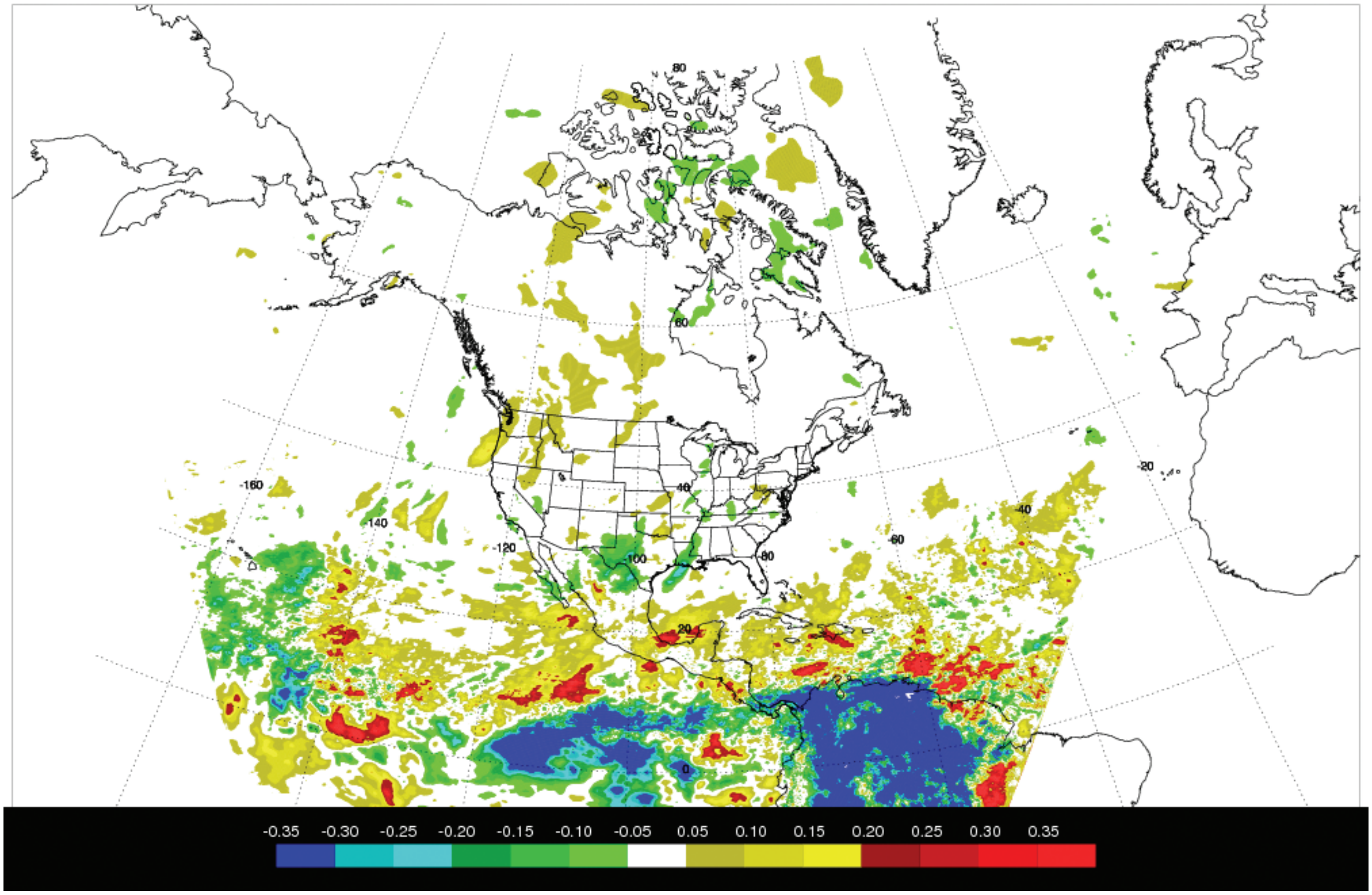


Figure 17. Difference field (profile minus radiance) between the 500-hPa temperature anomaly correlation in the 48-h forecast for thinned AIRS radiance and full AIRS profile runs for a 1-month case study from late 2011.

10°N latitude) when AIRS profiles are assimilated in the typically cloudier regions of the Intertropical Convergence Zone. While there are some areas where the radiance forecasts are improved relative to the profile forecasts (e.g., South America), the overall trend is for improved anomaly correlations in this region. A set of simulations that shows the effects of thinning will be produced in the coming year.

Ongoing and Future Pursuits

While much of SPoRT's history in modeling and data assimilation has focused on the use of instruments such as AIRS and MODIS, the first wave of new NASA Decadal Survey instruments — Soil Moisture Active Passive (SMAP) and Global Precipitation Measurement (GPM) missions — will be incorporated into SPoRT modeling and data assimilation activities. SMAP is scheduled for launch in early 2015 and contains an L-band passive microwave instrument that, when combined with an active radar, enables superior retrievals of soil moisture at higher resolution than any previous soil moisture retrieval products to date. These retrievals can be assimilated into the LIS and used to improve the lower boundary conditions for meteorological and hydrological models used by SPoRT partners. The resulting LIS assimilation products could be used to enhance situational awareness and flood/drought monitoring, as well as improve the initialization of LSM variables in local modeling applications.

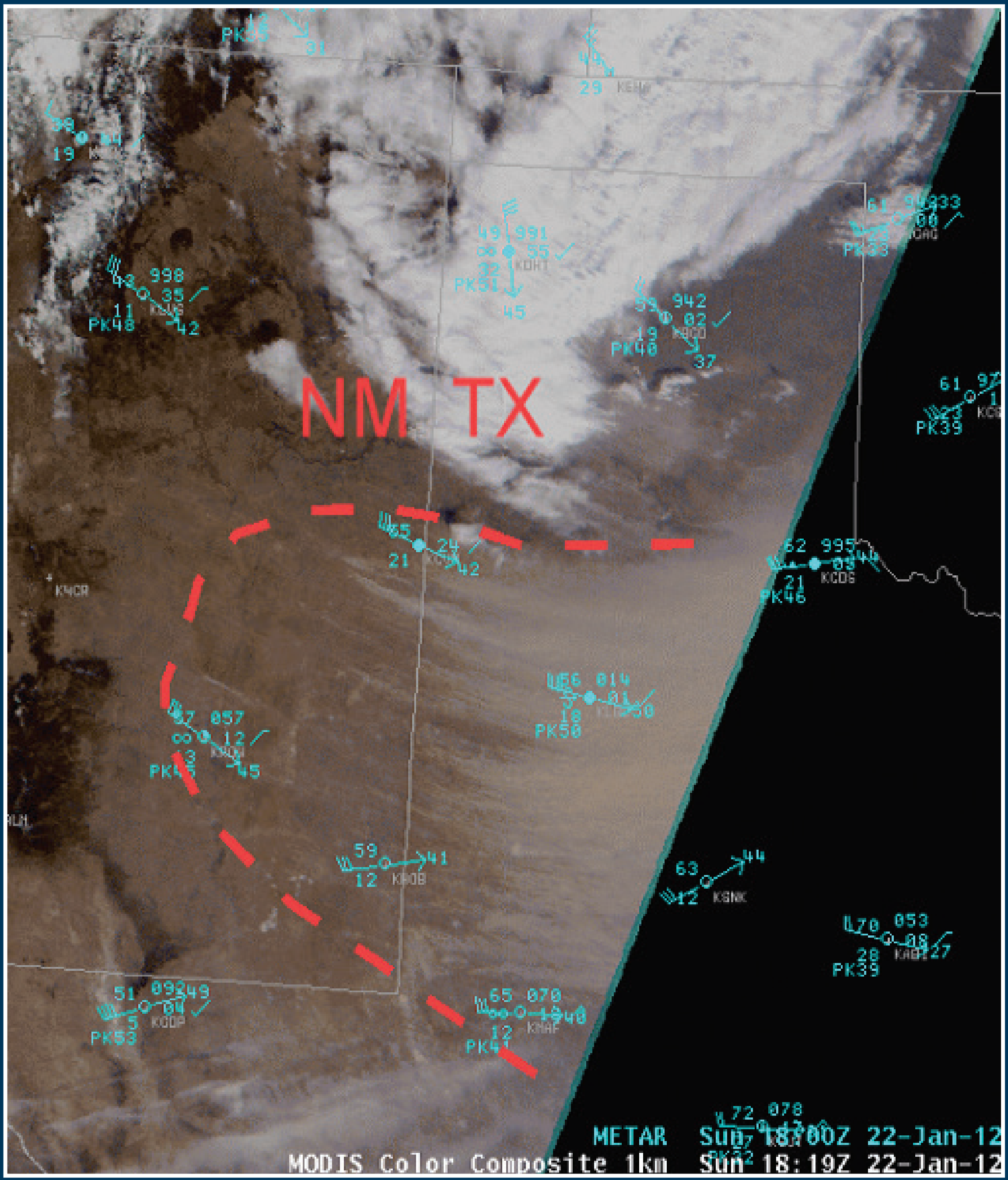
Slated for a June 2014 launch, the GPM mission consists of a core satellite that includes a dual-frequency precipitation radar and microwave imager. Combining this with the existing international constellation of satellites with passive microwave sensors will result in a global, high-temporal frequency coverage of precipitation retrievals for both climate and weather applications, which could add value to the operational forecasting community. SPoRT will participate in the transition and evaluation of various products developed by the research community. As one component of that participation, Andrew Molthan was funded as a Co-I on a ROSES 2012 project to evaluate model physics configurations compared to GPM observations.

SPoRT is also conducting research and pursuing collaborations for expanding LIS activities in other regions. In order to expand the real-time LIS beyond the southeastern half of the CONUS, SPoRT is testing new precipitation forcing datasets in LIS that cover larger geographical domains and/or have more optimal characteristics over the current Stage IV dataset. The new precipitation datasets implemented into LIS include the NSSL National Mosaic and Multi-sensor QPE and the NESDIS Next Generation GOES QPE algorithm. These two new datasets are being compared to existing, proven precipitation datasets for a one-year integration period to measure the effects on land surface model integration. The NSSL QPE dataset offers a high-resolution (~1 km) radar/rain gauge product that covers the entire CONUS, southern Canada, and northern Mexico, whereas the next generation GOES QPE product covers nearly the entire western hemisphere at ~4-km resolution. Both of these precipitation products are being explored as possible options for expanding and/or improving the real-time LIS land surface model runs.

SPoRT is also pursuing other applications of the real-time LIS beyond local model initialization. SPoRT and the NWS Huntsville WFO are exploring diagnostic applications of real-time LIS data for drought and flood monitoring by analyzing antecedent soil moisture conditions. The level of detail provided by the 3-km grid spacing in the SPoRT-LIS has the potential to improve drought monitoring on sub-county scales during the warm season when rainfall distribution can be quite heterogeneous across the southeastern U.S. In addition, antecedent soil moisture can play an important role in determining flooding potential based on the degree of soil saturation prior to a heavy rain event. Both of these areas represent ongoing research being conducted through the SPoRT/NWS Huntsville WFO collaboration.

4

Decision Support Systems



MODIS image depicting severe duststorm over West Texas.

Introduction

From SPoRT's inception, one of the driving forces has been to provide research data to end-users within their native Decision Support System (DSS). Forecasters need to have the ability to visualize SPoRT data alongside all other operational datasets. For the past 10 years, the native DSS at NWS WFOs has been primarily AWIPS. When working with the AWIPS framework, users were not easily able to write software or procedures to introduce new data or methodologies. Several years ago, the NWS contracted to upgrade to the next-generation AWIPS, or AWIPS II. From its conception, AWIPS II was designed to be extensible and flexible allowing for the inclusion of new datasets by simply adding modular software called plug-ins. As a result of the shift towards AWIPS II, SPoRT began developing plug-ins which began a major paradigm shift in the way prototype data will be transitioned to operations within the NWS DSS.

SPoRT has focused on developing plug-ins for SPoRT data to provide continuity in the use of unique experimental and research data for all partners when AWIPS II is fully implemented. Due to the popularity with several SPoRT WFO partners, some of the first plug-ins developed by SPoRT were designed to handle lightning data from any of several 3D lightning mapping networks, with a primary focus on NASA's North Alabama Lightning Mapping Array. Since then, additional plug-ins have been developed to support various SPoRT products, as described below. As the AWIPS II deployment plan overcomes various obstacles, SPoRT continues work with most partners still using AWIPS. However, since two WFO partners have successfully transitioned to AWIPS II, SPoRT must support both AWIPS and AWIPS II at least through 2013. In the meantime, SPoRT continues its work with AWIPS II plug-in development so that all current SPoRT products can be displayed in time for full deployment of AWIPS II.

SPoRT is continuing to increase its web presence with Keyhole Markup Language (KML) products (used with Google Earth). SPoRT has worked with StormCenter Communications, Inc. in an advisory sense to incorporate SPoRT KML products into their Google Earth-based EVCM (Envirocast® VisionTM Collaboration Module) software system. Many regional Emergency Managers and WFO personnel make use of their system for sharing situational awareness information among themselves and with other decision makers at all government levels. The EVCM provides visibility of SPoRT products outside traditional NWS channels.

The SAC from the February 2012 meeting had several recommendations that indirectly involved DSS. Typically, SPoRT efforts with DSS development closely correspond with product creation and improvement. After products are designed or improved, they are tested in the appropriate DSS environment. This process ensures that the products will appear correctly to end-users. Specifically, the SAC recommended that SPoRT expand the use of VIIRS data products. SPoRT has followed this recommendation by incorporating VIIRS data into routine SPoRT processing. This was initially accomplished for AWIPS; however, the products are also displayable in N-AWIPS and AWIPS II, and for the broader community with Google Earth KML files.

The SAC also recommended that SPoRT establish a process to document high-impact events and provide details on events identified only by Suomi-NPP. A major success this past year was the use of the Suomi-NPP VIIRS Day-Night-Band in monitoring the development, landfall and impacts of Hurricane Sandy. SPoRT took a lead role in providing NASA administrators, FEMA decision makers, and other stakeholders with valuable information on Sandy before and following landfall. This exhibited the utility of the VIIRS instrument for real-time weather purposes and specifically demonstrated the value of the new DNB. No other operational instrument was able to provide such high-impact value. SPoRT will work within the ROSES Disaster Response effort to develop a more automated approach to such significant events, discussed further in Section 7.

AWIPS Status

At the end of 2012, AWIPS continues to be the primary DSS with more than 95% of NWS WFOs still using it. Agency-wide AWIPS II deployment in the NWS is currently scheduled through 2015. In the meantime, SPoRT will continue to provide products to National Centers and WFO partners in N-AWIPS and AWIPS formats, respectively. SPoRT plans to support its partners who are using AWIPS II by providing data and plug-in software as soon as possible. This provision will be feasible once the AWIPS II Software Governance Policy (for software developed external to Raytheon) is enacted. SPoRT and the NWS Office of Science and Technology have worked together to determine how best to implement this policy during 2013. This policy will be required for any non-Raytheon plug-in to be used on operational systems in order to maintain the integrity of the system, while still allowing the freedom to work with new products and software.

It became apparent by Fall 2012 that complete AWIPS II deployment would be delayed in the NWS. About the same time, VIIRS data products became ready for dissemination to WFO and National Center partners. Thus, SPoRT proceeded to enact modifications to AWIPS menus and configuration files for partners still using AWIPS. These changes enabled forecasters to view VIIRS data in the same manner as they currently view MODIS data. Given the high-quality of the new VIIRS data, it is beneficial for forecasters to have access to these data as soon as possible. Implementing even minor AWIPS menu changes, however, are not typically accomplished quickly as the modifications depend upon adequate testing and personnel availability. Consequently, SPoRT must rely to a certain extent upon personnel at collaborating WFO partners to help implement all these changes. In addition, some partners opted to freeze their existing AWIPS software to ensure system stability until AWIPS II deployment, thereby preventing the accommodation of any new SPoRT products. Nonetheless, SPoRT will continue to support its products in AWIPS throughout the extended transition to AWIPS II during 2013.

AWIPS II

Transition of SPoRT products to AWIPS II

Considerable effort has been invested in streamlining the delivery and maintenance of the AWIPS II plug-ins being developed by SPoRT. This effort has involved the installation and use of a software version control system, and the creation of a delivery mechanism for all supporting files. The current SPoRT AWIPS II plug-ins have been migrated to utilize the Redhat Package Management as the delivery mechanism, which is consistent with Raytheon's delivery method for AWIPS II plug-ins. Due to the large number of supporting files used with the SPoRT plug-ins, a system of managing these files for a particular site was developed. This system has streamlined the process of delivering products using the existing plug-ins and allows for easy installation and uninstallation of SPoRT plug-ins. The system will be used to deliver files, such as menus and color maps for AWIPS II. Current SPoRT AWIPS II plug-ins add support for Lightning Mapping Array, Hazard Mapping Service Fire and Smoke, MODIS Fire, Man computer Interactive Data Access System (McIDAS) formatted satellite data, the GOES-R CI product, and ocean surface wind (scatterometer) vectors. SPoRT has begun working with both NWS Southern Region Regional Operations Center and NWS Headquarters Systems Engineering Center to test installation and operation of the SPoRT plug-ins in a testbed environment. These efforts will ensure that the software is packaged and ready to be installed on an operational system, reducing the impact and time for installation for the end-user.

Experimental Products Development Team (EPDT)

As a GOES-R partner, SPoRT realized that there was a need for the PG to have access to a group that could easily integrate new plug-ins and tools into the AWIPS II environment. The EPDT was formed during the fall of 2012 to bring together individuals to learn the AWIPS II development process, create a concerted PG voice on development issues, and to be the focal point for the integration of new PG capabilities into the AWIPS II environment. The EPDT is composed of representation from each of the NWS regions, representative NOAA Cooperative Institutes, SPoRT staff members, Global Systems Division, Meteorological Development Laboratory, Office of Hydrologic Development, and the Systems Engineering Center. In lieu of a Fall 2012 EPDT Technical Interchange Meeting (TIM; postponed due to NOAA travel restrictions), the group started holding bi-weekly conference calls. These conference calls have begun the process of training the group on methods to develop AWIPS II plugins to ingest unique datasets. The first hands-on learning TIM was held in March 2013 in Huntsville. To help the team move along, Jason Burks, SPoRT team member and EPDT lead, has been delivering training to the group. through the regularly scheduled conference calls via WebEx. The feedback and impacts of these sessions has been very positive thus far.

NCSCAT

SPoRT is collaborating with the NWS to provide ocean surface wind vector viewing capability for coastal NWS forecast offices. In AWIPS II, there are several ways to view data; these are called perspectives. A NWS WFO uses the "WFO perspective", which is similar to AWIPS I/Display-in-2-Dimensions, while National Centers such as OPC, WPC, and NHC use the "National Centers" perspective, which is similar to an N-AWIPS display. SPoRT was contacted by the NWS to help migrate the NCEP Perspective ocean surface wind vector (scatterometer) plug-in (NSCAT), so that it functions in the WFO perspective. This initial plug-in was developed by the NCEP AWIPS II development team, and will have applications in many coastal WFOs. The NCSCAT plug-in provides ingest and display capabilities for several scatterometer datasets, such as OSCAT and ASCAT. These datasets have shown to be beneficial in obtaining wind estimates over data void ocean regions. By migrating this plug-in, SPoRT would enable the NWS WFOs to view ocean surface wind vector data natively in their perspective. SPoRT has a working prototype of the converted plug-in, and is planning to deliver the plug-in for integration into the AWIPS II baseline later in 2013.

NWS Software Governance Policy

SPoRT secured funding through the GOES-R PG Visiting Scientist Program to assist in defining the NWS software governance policy for AWIPS II. Two members of SPoRT will represent the GOES-R PG Partner interests in the development of this policy. As a part of this effort, SPoRT will take an existing AWIPS II plug-in through the current software governance procedure. While moving the plug-in through the process, SPoRT will document the process and suggest changes to streamline it. This documentation will be used to enable future GOES-R PG partners to more easily navigate the governance process.

Google Earth With KML/KMZ Files

SPoRT primarily generates products to be viewed in N-AWIPS, AWIPS, and AWIPS II. A limitation of some of these DSS is their inability to display more than 95 colors (N-AWIPS) or 254 colors (AWIPS). While this may not have much effect on single-band imagery (which only utilize 256 values), it does limit the color fidelity of SPoRT's RGB products, which natively take advantage of a 24-bit color space. To remedy this, SPoRT has been generating RGB and single-band products in KML format since Summer 2012. These products are viewable by SPoRT partners and the general public in freely-available applications such as Google Earth and NASA World Wind. The 24-bit color space offered by KML allows forecasters to discern fine color gradients in the RGB imagery that would otherwise be smoothed by the aforementioned DSS. Additionally, these applications allow forecasters to overlay any of the KML products being provided by an ever-increasing list of groups, including the NWS, SPC, and NHC.

SPoRT's KML files currently reside on an FTP server, but will soon be transitioned to the SPoRT web site for greater accessibility. A web page is being developed that will provide users with a central location for all SPoRT KML files. Eventually, these products will be served via a tiled Web Mapping Service, precluding the need to dedicate computing resources for generation of KML files while also enabling the integration into mobile platforms.

DSS-Tiled Web Service and Android/IPhone Apps

In order to provide the imagery needed for the ROSES disaster work (described in Section 7), a Tile Map Service (TMS) was developed. This Open Geospatial Consortium service enables delivery of imagery to multiple end-user platforms. The data from the TMS could be easily added to the decision makers' DSS that support Open Geospatial Consortium-compliant datasets, such as ESRI's ArcGIS, as well as being easily integrated into web displays. A web display was developed using the OpenLayers JavaScript framework which allowed the data to be displayed in web browsers on desktop computers, along with mobile devices such as tablets and smartphones. This display enabled the decision makers to utilize the data along with providing the data to their personnel in the field. During Hurricane Sandy, the SPoRT TMS was used to provide imagery such as the VIIRS DNB "blackout" product, which showed the areas impacted by power outages, as well as before-and-after Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) imagery, which highlighted significant barrier-island damage to a broader community. SPoRT has also retroactively made data from previous disasters it supported available through this unique delivery method. These data can be viewed at the following URL: http://weather.msfc.nasa.gov/sport/disasters/.

5

Transition Training and Assessment

Associated Press before and after images of coastal damage caused by “Superstorm” Sandy.

Introduction

Over the last five years SPoRT has transitioned a variety of products from instruments such as MODIS, AMSR-E, AIRS, the NASA Ozone Monitoring Instrument, North Alabama Lightning Mapping Array, GOES Imager, SEVIRI, WindSat, as well as a host of passive microwave instruments. A large focus has been on the application of MODIS imagery and derived products in operations, utilizing the high-resolution capabilities to analyze mesoscale land and atmospheric features. Just as significant has been the transition of total lightning into WFO operations and GOES-R PG testbeds to educate users on the importance of total lightning for severe weather nowcasting and public safety. More recently a suite of products derived from both the GOES Sounder and Imager, SEVIRI, and several passive microwave instruments, has been transitioned by SPoRT to the NWS National Center operational users. SPoRT often fills the role of “transition partner” with other product developers to infuse new products from others into the operational user’s DSS for testing and evaluation.

Several of the recommendations from the 2012 SAC meeting were addressed by ongoing work or made a part of task plans for the Transition, Training, and Assessment group. As part of the GOES-R PG, SPoRT continues to expose more users to RGB imagery and provide training materials in collaboration with both U.S. and European agencies. This work with RGB imagery is ongoing and expanding to meet SAC recommendations. Total lightning data operational use is an area where SPoRT has a lead role in the GOES-R PG. Several training applications and cases have been developed with plans to continue simulated operational use at the NOAA HWT. SPoRT is working toward greater transition and future evaluation of VIIRS imagery and DNB data, including use in Alaska.

Product Transition

Methodology

SPoRT’s primary transition activities are with its NWS WFO partners and several NCEP National Centers (NHC, OPC, WPC, and SPC). SPoRT seeks to transition products to its end-users that complement their existing data for specific forecasting and nowcasting issues. SPoRT regularly meets with its collaborators to discuss their needs and determine appropriate products for transition. Once a product has been created internally for incorporation into the user’s desired DSS, SPoRT provides the data file either via a software package (i.e., Unidata’s Local Data Manager), ftp sites, or within Google Earth via KML files on a website. The majority of data is transitioned and distributed to WFO and NCEP users via the Local Data Manager software to reduce latency and allow users to subscribe to only the desired datasets. This accommodates the limited band width capabilities to ingest external data sets at some WFOs. SPoRT then works with the user to setup the product within the local DSS display. Initial transition of new products is done in a “testbed” mode with a small number of users. Within the testbed, users vet the product often during an intensive observation period when the product is most relevant to the given forecast challenge. This enables the product to go through a level of quality-control before being distributed to a wider operational group. It also provides lessons learned to be incorporated into training for the larger user group.

WFO Users

SPoRT works with 12 Southern Region WFOs and has been expanding its user base to other NWS Regions over the last several years (Figure 3). There is a long-standing relationship between SPoRT and the Great Falls, MT WFO, and in 2012 three other WFOs were added as SPoRT partners from Western Region. The Eureka, Monterey, and Medford offices participated in an evaluation of WindSat data and have continued their collaborations with SPoRT to begin evaluating the QPE product from NESDIS as part of the GOES-R PG, as well as the CIRA layered TPW derived product from IR and microwave soundings. Additionally, SPoRT began working to provide these same products to WFOs and River Forecast Center in the Alaska Region, and is engaged in discussions with the Pacific Region to provide a suite of MODIS and VIIRS imagery products in addition to the moisture products mentioned above. Several WFO users within the NWS Eastern Region receive a select number of products related to modeling and total lightning activities. Those WFOs using the SPoRT SST composites for model initialization include Binghamton, Buffalo, and Cleveland. The Sterling WFO is the primary user of SPoRT-provided total lightning data from the Washington D.C. network, but several other surrounding WFOs are partially covered by the network and hence have some interest and potential utility. In addition, the Raleigh WFO began ingesting a large suite of data from SPoRT in 2012, and has been actively evaluating these products.

National Center Users

In addition to NWS WFO users, SPoRT provides many of its products for use at NCEP National Centers within the N-AWIPS display system (orange circles in Figure 3). NHC continues to receive RGB imagery products from SPoRT as part of GOES-R PG activities, and expanded its suite to include passive microwave imagery in 2012. SPoRT continues to work with GOES-R PG satellite champions located at the OPC, WPC, and AWC to transition new products for evaluation. Michael Folmer collaborates with SPoRT to provide a suite of RGB imagery, derived GOES-based products, and JPSS products to SAB, WPC, and OPC users. AWC forecasters were provided various total lightning and convective initiation products via SPoRT's GOES-R PG activities and collaborations continue to evolve. SPoRT is planning to support GOES-R PG activities at these National Centers, especially in the areas of RGB imagery and total lightning product training and assessments at NHC and AWC, respectively.

Imagery to Demonstrate ABI Channels

The MODIS instrument on the Aqua and Terra satellites have provided high-resolution imagery to operational users from SPoRT since 2003. WFOs continue to use a suite of single channel imagery from MODIS to supplement the more coarse-resolution GOES imagery. In 2012, SPoRT began transitioning VIIRS data which increased the number of polar-orbiting passes a WFO receives in a given day. Longwave (11 µm) and short wave (3.9 µm) IR channels, as well as water vapor (6.7 µm, MODIS-only) and visible (0.6 µm) imagery are provided from MODIS and VIIRS. IR-based imagery is at 1-km resolution and visible imagery is at 500-m resolution. In order to make it easier for a forecaster to incorporate these into the application of the standard GOES imagery at the WFO, SPoRT has "inserted" the polar-orbiting data into a base GOES image, referred to as "hybrid" imagery (see Section 2). This allows the user to view the data within the context of the GOES imagery and hence be able to view the polar-instrument imagery insertions within the GOES animations. The hybrid imagery using MODIS and VIIRS provides an example of future capabilities from the ABI instrument on GOES-R in order to use existing, real-time remote sensing instruments to analyze mesoscale features previous not easily seen.

Assisting GOES-R Algorithm Working Groups with Product Transition

SPoRT's expertise in transitioning products into the end-user's DSS was used to assist UAH and NOAA/NESDIS related to GOES-R PG products. The new version of the UAH-developed GOES-R CI product was transitioned to WFOs, AWC, and HWT. An image format combining the GOES visible imagery and the GOES-R CI product was created by SPoRT and made available to users to reduce file size and improve visualization. Similarly, SPoRT collaborated with NESDIS developers of the official GOES-R QPE algorithm, and work began to include West Coast WFOs for transition of the GOES-R QPE. The product is provided to users in Alaska, including the River Forecast Center. Initial assessment of the QPE product by Alaska and West Coast users led to the development of other derived products of accumulated precipitation estimates ranging from 1 to 168 hours (i.e., out to 7 days).

RGB Composite Imagery as Future GEO Capability

RGB composite imagery has been provided by SPoRT to WFO operational users since 2004. In fact, the Great Falls WFO states that the use of the false color snow-cloud RGB is simply part of their "normal" operations at this point. More recently, the number of RGB products disseminated by SPoRT has increased. In 2012, SPoRT provided air mass, dust, and natural color RGB imagery using EUMETSAT's SEVIRI data to the NHC as part of the GOES-R Tropical PG. The same RGB imagery from MODIS was also provided to both National Centers and WFO users. The Huntsville, Albuquerque, and Raleigh WFOs have actively evaluated RGB imagery within their operations, including the night-time microphysics for cloud and fog discrimination, and other WFOs are benefiting from their shared experiences via the Wide World of SPoRT blog and teleconference discussions. With the launch of VIIRS on Suomi-NPP, several more high-resolution passes are available from the VIIRS instrument to create RGB imagery over the CONUS/OCONUS as part of SPoRT's GOES-R PG activities to prepare forecasters for future ABI capabilities.

Further exposure to RGB imagery is planned for WFO partners as well as National Centers. In particular, the staff at the NHC have interest in more EUMETSAT-based RGBs that diagnose microphysical properties of tropical cyclones and provide insight to storm-growth trends. While the SEVIRI instrument is used primarily in the central and eastern Atlantic areas, MODIS and VIIRS will have a more prominent role in the western Atlantic and Gulf of Mexico regions.

Training for End-users

An important goal in the transition process is to provide user-based training for products transitioned to end-users. This training describes how a particular product meets a forecast challenge and provides added value to the user's existing resources. This training is generally short in length (15–30 minutes of content) and can take a variety of forms to suit a diverse audience. SPoRT makes use of three types of training methods depending on the requirements for the product and the end-users: Quick Reference Guides, Modules, and Teletraining. The sub-sections that follow describe each of these training methods that SPoRT conducts with its collaborators and end-users. While some training (e.g., Quick Reference Guide) is developed for a small number of users in a testbed mode, other training that incorporates lessons learned and operational examples is made available in the NWS Learning Management System (LMS); in particular, SPoRT's training series on total lightning is available via the LMS in order for users to receive professional development credit.

Quick Reference Guides

For a new product like RGB imagery, it can be difficult to recall the basics of what goes into making the product and what its strengths and weaknesses are. Often RGB imagery uses four or more spectral channels to create a composite, and the resulting colors in one RGB plot can mean something vastly different than the same color scheme in a different RGB. For these reasons, SPoRT developed a "Quick Guide" for each of the RGB products it is transitioning. The Quick Guides are simply 2-page documents describing why the product is important, what to look for in the imagery, and the strengths and weakness of the product. These guides are meant to be easily accessible within the operations area, either via local intranet or hardcopy to help users quickly recall the important aspects of the training or discussions they have already had on the RGB product. Quick Guides for the air mass, dust, and night-time microphysics were created during 2012. This concept is not exclusive to RGB products, and other remote-sensing products will likely employ the same successful use of Quick Guides as has been seen with the RGBs.

Modules (self-paced, Web-based)

SPoRT uses short, web-based training modules to demonstrate the utility of unique, high-resolution imagery and other NASA and NOAA products. In 2011, the concept of hybrid imagery that combines GOES and polar-orbiting data was introduced and WFO users continue to find value with these hybrid products. In 2012, an applications module for total lightning was developed. Extensive input from experienced users, such as those at the Huntsville WFO, provided key content in creating this 3-part module. In 15-minute increments each, the module demonstrates the use of total lightning in a classic severe-weather event, a lightning safety warning case for airport staff, and a marginal severe-weather event outside of peak season. For RGB imagery, a module is being developed that focuses on the use of the air mass RGB to diagnose the phase of tropical cyclones that are transitioning to extratropical cyclones. This module is a collaborative effort with Michael Folmer at SAB/OPC/WPC. The use of the air mass RGB demonstrated the ability to more precisely analyze the change in characteristics of hurricane Phillippe over that available from standard water vapor imagery and hence, the expected change in storm strength as it showed more mid-latitude characteristics. SPoRT plans to develop

Table 2. Summary of the SPoRT training conducted during 2012, along with the audience and training method.

Training Topic	Audience	Method
Air mass RGB Imagery	WFOs and National Centers	Quick Guide, Teletraining, Module
Dust RGB Imagery	WFOs and National Centers	Quick Guide, Teletraining
night-time microphysics RGB Imagery	WFOs and National Centers	Quick Guide, Teletraining
Air mass and dust RGB Applications for NHC	NHC	Teletraining
GOES-R Convective Initiation (with UAH)	WFOs in Southern Region	Module addition, Teletraining
WindSat	WFOs Eureka, Medford, Monterey	Quick Guide, Teletraining
Pseudo-GLM Total Lightning	WFOs, HWT	Module, Presentation
VIIRS Imagery and DNB	WFOs	Teletraining

training modules on several other RGB products in addition to topics related to GOES-R PG AWGs, JPSS products, and SPoRT collaborators' use of the Land Information System.

Teletraining

Often SPoRT communicates with its operational partners via a conference call, and these calls can include short presentations by SPoRT or collaborating users for a given product. These are excellent ways to engage users in a timely fashion and to answer any questions they have on the products or their applications. If possible, SPoRT provides access to the product developer during the teleconference. The GOES-R CI algorithm developers have been able to attend teleconferences with NWS Southern Region WFO partners to prepare them for both the 2011 and 2012 Spring/Summer assessments of their product. SPoRT recorded one of these sessions and posted it on its website for local download and use. Follow-up teleconferences are used to conclude intensive observing periods where users can summarize their experiences and compare their examples to others. Such a teleconference occurred in Fall 2012 for the GOES-R CI product as well as at the end of Summer 2012 related to total lightning applications at AWC, both in preparation for GOES-R. SPoRT has continued bi-monthly calls with WFO partners to conduct teletraining in 2012 while also furthering collaborative product assessments.

Product Assessments

GOES-R CI product

The GOES-R CI algorithm uses GOES-East data to produce 0–2 h nowcasts of the likelihood of convective initiation at a location. The evaluation of the GOES-R CI product ran from 10 July to 11 August 2012 and included the Albuquerque, Huntsville, Melbourne and Miami NWS WFOs. The primary purpose of this evaluation was to gain insight from forecasters on the product's recent upgrade from a contingency table-based output (i.e., a yes/no display) to a pseudo-probabilistic output based on the strength of the satellite signal, called the Strength of Signal display, which ranges from 1 to 100 with a corresponding color scale. The Huntsville, Melbourne and Miami offices were selected to participate because they have been using the GOES-R CI product operationally for a few years. Albuquerque began using the product in 2012 just prior to the evaluation period, while a few forecasters became familiar with this version of the GOES-R CI algorithm in April at the HWT Experimental Warning Program. Training was provided via SPoRT's training page, with SPoRT members and UAH personnel available to answer questions regarding the operation of the product. During the evaluation, Huntsville upgraded its DSS to AWIPS II and was no longer able to participate in this evaluation. Miami and Albuquerque had various challenges getting the new product installed properly in AWIPS, and therefore Miami participated sporadically and Albuquerque participated initially by assessing the GOES-R CI website display, rather than the AWIPS version of the product.

Overall, this evaluation period indicated that the forecasters who used both versions of the GOES-R CI algorithm preferred the new Strength of Signal version over the previous version. Also, they reported that for the events they observed, the GOES-R CI product indicated the likelihood of CI "most of the time", and had generally less than 25% missed cells. It had demonstrable impact on their nowcast/forecast process, producing lead times for the first 35 dBZ radar echo of ~15 minutes, while a few events registered lead times of 45 minutes or longer.

PGLM

The PGLM products were assessed during 2012 at both the HWT Experimental Warning Program and for the first time at the AWC Summer Experiment. During the 2012 Experimental Warning Program, surveys indicated that a large majority of forecasters (about 80%) want the ability to view total lightning data in their offices. Of the PGLM products surveyed by forecasters, flash extent density has been the best received and deemed as the most useful to operations. The maximum flash density product garnered less interest, but forecasters appeared to prefer it for lightning safety. In particular, forecasters have been very impressed by the ability to provide lead time on the first cloud-to-ground strike using the PGLM. The primary request by forecasters during evaluations has been a real-time, time-series display of total lightning, which has led to the development of the AWIPS II trending tool. Forecasters have also requested an intra-cloud to cloud-to-ground ratio product. The SPoRT team will likely be able to extend the tracking tool to accomplish this goal in AWIPS II. At the AWC Summer Experiment, there were generally few cases for evaluation, but in one event the PGLM showed that air traffic was being routed into a region of greater lightning activity than what radar alone had suggested (They were routing air traffic to an apparent gap between storms, but that is where the lightning maximum was actually located.).

SPoRT is currently working with satellite champions to further evaluate the PGLM at the AWC and SPC, and is actively establishing additional collaborations to bring in more networks for the PGLM. SPoRT is also developing a project with WFO Morristown, TN to evaluate the PGLM with the Chattanooga/Hamilton County Emergency Management to see how future GLM information can aid emergency managers.

WindSat

At the request of the NWS Office of Science and Technology in the fall of 2010, SPoRT began transitioning an enhanced ocean surface wind vector dataset derived by NRL from the WindSat radiometer on the Coriolis satellite to select NWS WFOs. In keeping with the SPoRT paradigm, training materials were developed and provided, while the data were made available for import into the AWIPS environment. As a part of the transitioning process and in order to gain valuable feedback from end-users, SPoRT conducted a comprehensive evaluation of this new WindSat dataset with NWS WFOs in Monterey and Eureka, CA and Medford, OR from 9–31 August 2012. The August timeframe for the evaluation was chosen because of the climatological higher frequency of northerly-flow wind events that are important for their forecast operations. The primary goal of this evaluation was to assess the overall relevancy and usefulness of WindSat data in the real-time operational environment, given the limitations of polar-orbiting data and imagery. Since the Coriolis satellite is a polar orbiter, WindSat data are generally available once or twice daily over a given location (~0300 and ~1500 UTC off the U.S. West Coast), and occur in swaths approximately 1000 km in width. Per input from the Science and Operations Officers at these offices, WindSat ocean surface wind vectors were generally considered useful if the swath fell somewhere within 300 nm (~555 km) of the coast, although observations closer to the coast were desired. In addition to the spatial and temporal limitations, data availability and timeliness were also limited by access to satellite downlink. Because of this limitation, download and dissemination to NWS WFOs often did not occur for three or more hours after the satellite pass, making the data useful primarily in a retrospective manner.

SPoRT staff sought the expertise of the Science and Operations Officers to determine the content and questions most relevant to the goals of the survey, and to encourage survey input and use of WindSat data by their respective staff members. By the end of the month, 72 evaluations had been submitted by the three WFOs, of which 20 consisted of northerly-flow wind cases. Wind direction was further grouped according to near-shore and off-shore flow, with northerly flow comprising 41%, and 74% of events with data availability, respectively. While WindSat data were not available (i.e., outside of the desired range, downlink was too late, missing data, etc.) 27 times, or 38% of completed surveys during the evaluation period, 44 surveys (61%) counted data availability, with 32 of these (44%) occurring during the 1500 UTC satellite pass time (Figure 18). Per comments from survey respondents, most issues regarding the relevance and usefulness of WindSat observations involved data latency. Survey respondents overwhelmingly expressed high confidence in WindSat derived wind speeds during all wind-speed regimes, while no respondents indicated low confidence (Figure 19).

MODIS and VIIRS RGB Imagery

The MODIS RGB suite (consisting of air mass, dust and night-time microphysics products, along with associated training materials and AWIPS-ingest instructions) were sent to collaborative NWS offices in early April 2012. These products have been made available to

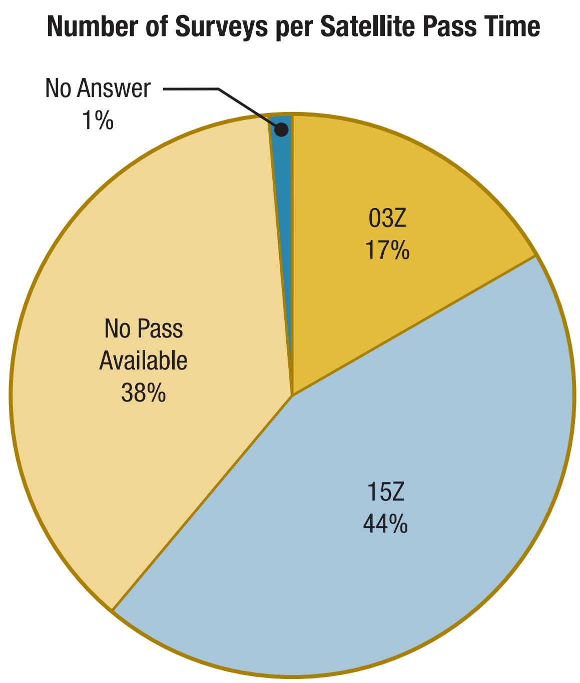
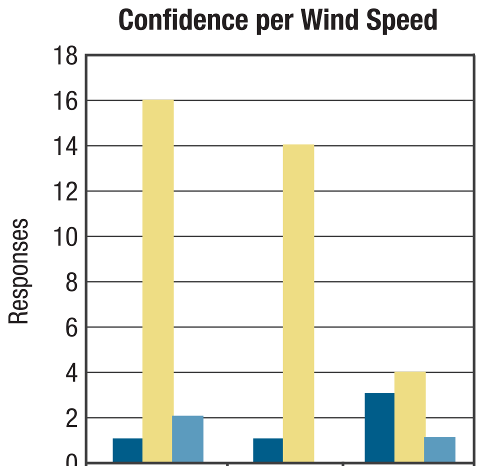


Figure 18. Number of surveys per satellite pass time during the WindSat evaluation.



	Light	Moderate	Strong
Low	0	0	0
Medium	1	1	3
High	16	14	4
No Answer	2	0	1

Figure 19. Survey responses for confidence in wind speed, based on wind speed regime (light, moderate, strong).

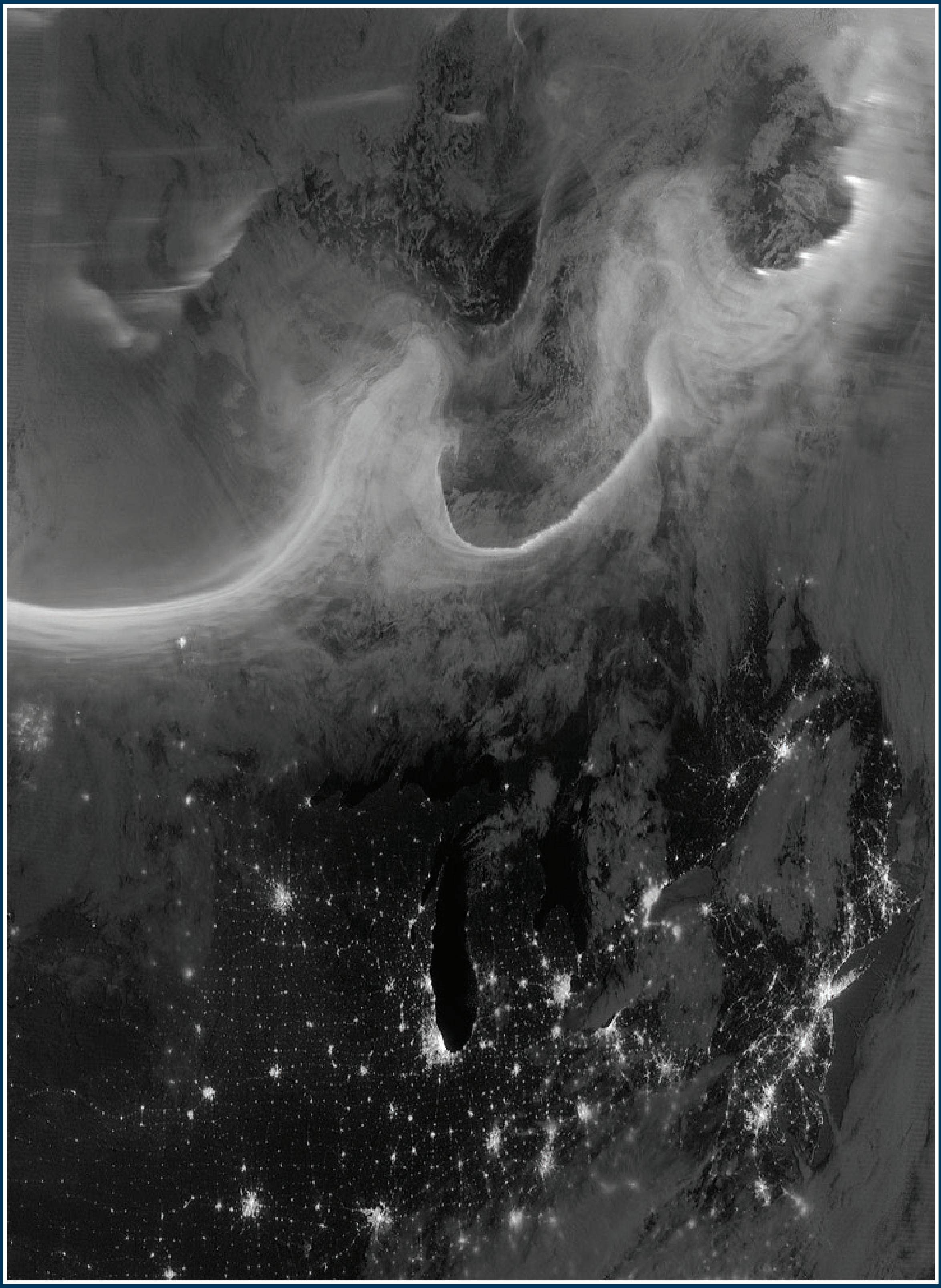
National-Center forecasters at the WPC, OPC, and SAB since 2011. While a more formal assessment of these products has not yet been conducted, discussions with various end-users and blog posts have allowed for informal assessments to date. Since the delivery of these products, 23 posts about their use have been made to the Wide World of SPoRT blog, all occurring during 2012. These posts range from the use of the air mass RGB to detect PV anomalies and strengthening storms in the upper atmosphere, to the detection of dust plumes in the Southwest and Great Plains with the dust RGB, to the superior detection of fog in the narrow valleys of the southern Appalachians using the night-time microphysics RGB. One of these posts, which covered an usual dust event that stretched from the central High Plains into the Tennessee Valley garnered the most views (over 3,000) of any SPoRT blog post to date. Importantly, this post highlighted the use of the RGB dust product in differentiating between airborne dust and the Earth's surface, which can be more difficult to distinguish with conventional imagery.

In addition to the MODIS derived products, SPoRT has been generating a similar suite of RGB products from VIIRS aboard the Suomi-NPP satellite. These RGB products consist of night-time microphysics, dust, DNB, true color, and false color. SPoRT is also generating an air mass RGB using a combination of data from the VIIRS and CrIS instruments, and making these initially available via the SPoRT web page. SPoRT has combined the various VIIRS and MODIS RGB imagery into single products (e.g., MODIS-VIIRS night-time microphysics RGB) without requiring AWIPS menu or configuration changes by NWS collaborative partners. However, in striving for consistency, efficiency of product transition, and to address potential bandwidth issues, SPoRT is creating and working with collaborative partners on a voluntary basis to implement AWIPS I menu and configuration changes. The ultimate goal is to have all SPoRT collaborative partners with common AWIPS menu configurations. SPoRT has also made the array of MODIS and VIIRS products available on the SPoRT web page and in gif and KMZ formats via an ftp server to facilitate ease of use by partners without AWIPS I (i.e., partners with AWIPS II and/or N-AWIPS platforms).

In Fall 2012, SPoRT conducted an informal evaluation of the RGB night-time microphysics product with the Huntsville, Morristown, Nashville, and Raleigh NWS WFOs. With the advent of AWIPS II on the horizon, some offices had been reluctant to make menu and internal configuration changes necessary to port these new products into their existing AWIPS I platforms. So, SPoRT created a web page with high-resolution images of the night-time microphysics RGB product focused on the proper Southeast CONUS domain. The primary purpose of this informal evaluation was to introduce operational users to multi-spectral RGB imagery and to determine its effectiveness in differentiating fog from other cloud features. SPoRT conducted many one-on-one survey discussions with co-located Huntsville forecasters (nine different individuals). Users stated that the RGB imagery did provide a greater amount of information over standard fog monitoring products/imagery. Feedback indicated that the frequency of the imagery limited its usefulness as an operational tool and that users need additional training to better associate color combinations with physical cloud types and features. However, e-mails and blog posts from these inland offices showed heightened interest in the night-time microphysics RGB imagery with an application example shared by the Raleigh NWS office (Figure 9). This imagery helped forecasters determine the extent of similar cloud features (including fog) and delineate between fog and other cloud types. Future plans involve a similar assessment with coastal WFO partners when fog is more prevalent in their areas.

6

Information Technology



Aurora Borealis as detected by the Day-Night Band sensor aboard the Suomi-NPP satellite.

In the recent years leading up to 2012, SPoRT relied on a combination of desktop Linux machines, an in-house Linux cluster, and some external resources from the National Center for Climate Simulation (NCCS) Discover cluster at Goddard Space Flight Center to handle product generation, modeling applications, and DSS development activities. However, in 2011, as SPoRT expanded collaborations with partners outside of NWS Southern Region, the need for diverse, multifunctional, and fast computational resources became increasingly apparent.

Updates to Internal Computational Resources

In 2011, SPoRT began using two desktop supercomputing resources called Weather in a Box (WiB; see Figure 20) to enhance SPoRT's modeling capabilities. With these new systems, SPoRT developed a new computational use paradigm in which one machine is tasked with generating real-time modeling products to support NWS partners, while the other machine is tasked with conducting research to develop new products (or enhance existing ones) without interrupting or reducing the computational speed of the operational products. To ease transition of research capabilities to an operational configuration, the two desktop clusters retain parallel versions of operating systems, software, and system management so that it is inherently easy to move processing from one machine to the other. In addition, a large Redundant Array of Inexpensive Disks (RAID) system was connected to the WiB systems for archiving modeling results and storing data needed for the various modeling projects that require extended model spin-ups. The RAID can be accessed from both WiB systems, making transition of products easier.

At the onset of 2012, SPoRT began the process of procuring a suite of rack-mounted, high-powered production machines to replace the multi-tasked computers that were being used for both product generation and development of DSS capabilities. The goal of these new machines was to match the operational and research paradigm developed using the WiB systems to have computers that are dedicated to a specific task. To this end, SPoRT purchased six new Linux machines. Three of these machines are tasked with production of SPoRT's operational products, one of these machines is tasked with research and development of new products, and two of these machines are tasked with visualization and development of software to aid in transitioning satellite data into the end-users' DSS. In an effort to better integrate SPoRT products into the operational forecasting environment, SPoRT worked with NWS Southern Region to obtain access to the standard AWIPS data stream that each WFO obtains from the Satellite Broadcasting Network. This data is obtained via a split in the network at the NWS Huntsville WFO and disseminated to select visualization machines using a dedicated server. With the data feed from the NWS and dedicated servers to display and integrate products, SPoRT now has the capacity to emulate more completely the forecaster data environment without relying on additional NWS intervention.

Figure 20. Weather in a Box (WiB) desktop supercomputers employed by SPoRT for modeling and data assimilation research and operational products.

Use of External Computational Resources

In addition to in-house computational resources, new computational resources are continuously sought to 1) further collaborations, and 2) enable additional processing capabilities. SPoRT has been an active participant in code testing and implementation of NWP models using NASA cloud computing resources, such as the NASA Ames Code I Private Cloud computing environment. In collaboration with NASA SERVIR (refer to https://www.servirglobal.net), the execution of the EMS model using cloud computing resources has been successfully demonstrated for generating near-real-time numerical forecasts over Central America (Molthan et al. 2012). SPoRT continues to pursue avenues for product development and data dissemination via the cloud, including use of private-sector cloud resources. Researchers have also used supercomputing resources from the NCCS to enhance its modeling and data-assimilation capabilities. The NCCS Discover cluster continues to be utilized for modeling research activities related to LIS and the NASA Unified-WRF modeling systems. More recently, the NCCS Joint Center in a Big Box has been accessed for data-assimilation research. The use of the Joint Center in a Big Box enhanced collaborations between the JCSDA and SPoRT and allowed for more rigorous and computationally-intensive research that would not otherwise be possible. Conversations have begun with the Army to discuss mutual projects that would enable access to supercomputing resources on Redstone Arsenal. Projects associated with this resource will be pursued to a greater extent in 2013 and beyond.

Visualization and Collaboration Laboratory (VCL)

The use of new data and products to address particular forecast issues or problems is first evaluated in a testbed environment before transition to operations. This testbed consists of non-operational configurations of the end-user environment including computer systems and software and access to the various data streams used in the forecast environment. SPoRT uses a laboratory environment equipped with computers running AWIPS, N-AWIPS, and AWIPS II applications with access to real-time data streams to develop and test solutions to forecast problems using various research data sets. This lab is also used for end-user training (both face-to-face and remote), meetings and program briefings.

SPoRT functions have outgrown the current facility; therefore, SPoRT is developing a new 1200 square foot visualization and collaboration laboratory to support these needs. The new laboratory will contain advanced workstations running a variety of end-user software including AWIPS II, state-of-the-art videowalls (using Scalable Adaptive Graphics Environment [SAGE] and other visualization software) for product development and demonstrations, advanced audio-visual and teleconferencing capabilities, and “operation” center capabilities to ingest and display unique satellite imagery in support of new disaster response activities.

7

Disaster Response

View looking west at the Cullman, AL EF-4 tornado from 27 April 2011, as it passed near Baileyton, AL.
Image copyright Eugene W. McCaul, Jr. Used with permission.

ROSES Tornado Damage Track Project

In 2012, the SPoRT team was awarded additional funding through the NASA Applied Sciences Program to extend the 2011 work that provided high-resolution MODIS and ASTER detection of tornado damage tracks resulting from the 27 April 2011 violent tornado outbreak across the southeastern United States. In a one-year feasibility study, the project is advancing the use of NASA, NOAA, and commercial satellite data sets by incorporating them within the Damage Assessment Toolkit (DAT) developed by NOAA/NWS. The DAT is a comprehensive toolkit that incorporates mobile devices and GIS capabilities, where a meteorologist involved in a storm survey can take geotagged photos with a handheld device such as a smartphone, note the estimated degree of damage and other eyewitness accounts, and accumulate the data to obtain a broader view of the damage prior to categorizing the event. SPoRT envisions that the inclusion of high-resolution satellite data will provide a confirmation of the damage from space, helping to ensure that the total track length is matched to ground observations, and so that satellite observations can supplement the ground survey in places where surveys are restricted due to limited access or staff availability. If funded for additional years, the proposed activity will assist the NWS with establishing longer-term access to satellite data sets of interest and facilitate other applications of satellite data to damage estimation from other hazards such as strong winds, hail, flooding, and wildfires.

Hurricane Sandy Support

In late October 2012, widespread strong winds, torrential rain, coastal flooding, and inland blizzard conditions from Hurricane (a.k.a., "Superstorm") Sandy contributed to widespread power outages throughout the northeastern United States. Superstorm Sandy was unique due to the unusual sharp left turn in the track as it approached the Middle-Atlantic coastline from the south-east, and how it interacted with an intense mid-latitude cold-core trough which rapidly transitioned Sandy into an extratropical cyclone prior to landfall. The interaction with the cold trough resulted in prodigious snowfalls up to 34 in (86 cm) from the Smoky Mountains of North Carolina and Tennessee to southern Pennsylvania, particularly for so early in the Fall.

Approximately one year prior to Sandy, the NASA/NOAA Suomi-NPP satellite was launched, providing continuity for several measurements previously obtained from other NASA, NOAA, and Defense Meteorological Satellite Program systems. The VIIRS instrument aboard Suomi-NPP provides high-resolution visible, near-infrared, and infrared imaging and includes of a low-light sensor (DNB). The DNB provides 750-m resolution visible imagery during nighttime periods by sensing emission from city lights, wildfires, and other human activity, or by moonlight reflected off clouds or the land surface. As a result, DNB imagery can be helpful in monitoring power outages that result from natural disasters or downed infrastructure. This capability will be extended in the future with the planned launch of the JPSS series of satellites. In the meantime, products from Suomi-NPP and VIIRS are provided to the community through organizations such as CIMSS, CIRA, and SPoRT.

In response to Sandy, SPoRT provided DNB imagery and an experimental, false color "blackout composite". Since city lights are typically brighter than moonlight reflected from cloud and surface features, they are prominent in DNB imagery. Image enhancement techniques help to separate urban cores from highways and rural areas. Comparisons of pre- and post-event imagery draw the eyes to places where lights have disappeared, helping to identify possible outages. SPoRT's experimental blackout composite of pre-storm and post-event imagery also helped to identify missing lights in a single image on 1 November (Figure 21a). The composite was generated by assigning pixel red and green intensities to DNB imagery obtained in nearly clear sky conditions from 31 August 2012. Blue intensities for each pixel were assigned to the reflectance for each image captured following the landfall of Superstorm Sandy. In the composite, lights occurring before and after the storm appear as shades of light blue to white, while power-outage areas appear as yellow. Recovery can be monitored (Figure 21b) as pixels transition from yellows (outage) to light blues and white (restored).

Through collaboration with NASA's Applied Sciences Disasters Program, these composites were provided to the United States Geological Survey's Hazards Data Distribution System, where they were then distributed to the Department of Defense (DoD) Joint Task Force-Civil Support (JTFCS). The DoD's JTFCS used the daily reflectance imagery and experimental blackout composite to help identify regions of power outages for the purposes of staging generators as

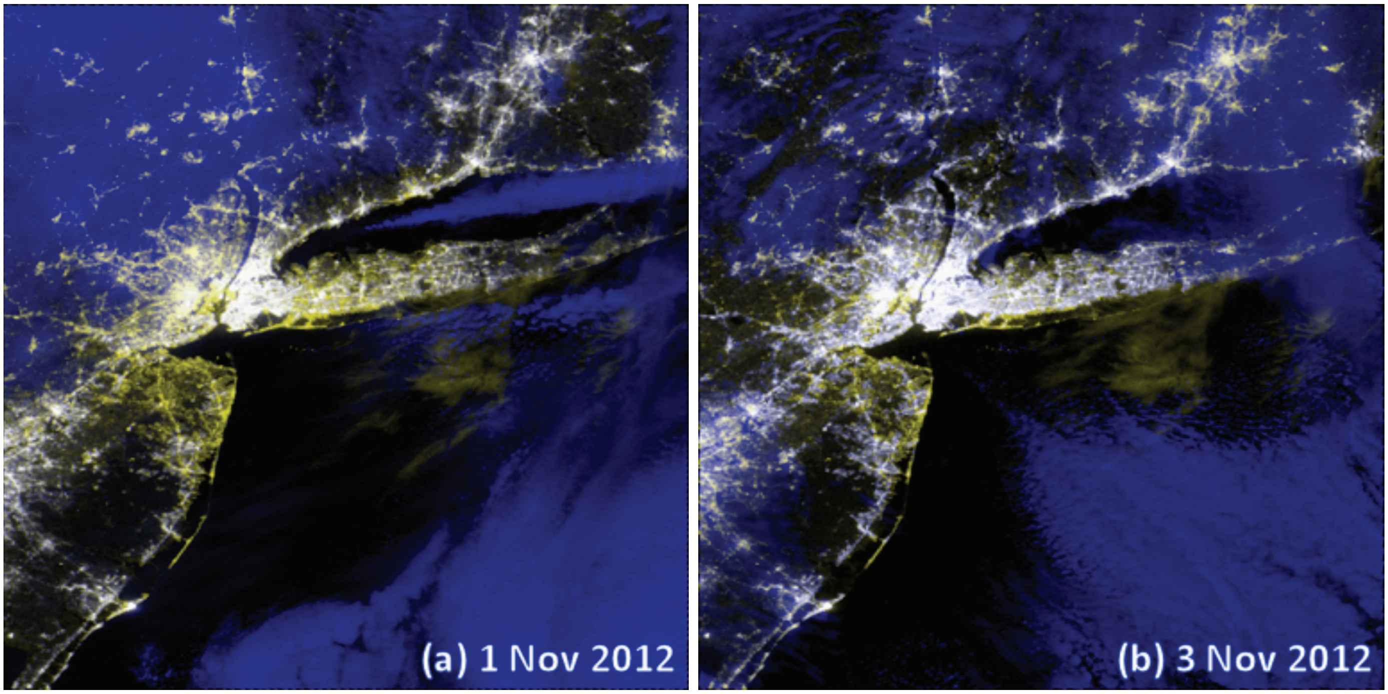


Figure 21. SPoRT experimental false-color blackout composite, combining pre-event (31 August 2012) and post-event VIIRS day-night band imagery from (a) 1 November, and (b) 3 November. Areas of yellow pixels in Lower Manhattan, Long Island, and New Jersey correspond to widespread outages in (a). Previously yellow areas in portions of Manhattan, Long Island, and New Jersey indicate power recovery as they are restored to white shades in (b), while more significant outages continue in New Jersey.

part of their role in supporting recovery. In addition, composites were provided to the Federal Emergency Management Agency's GIS portal for colocation with other accumulated data sets. This event provides a great example of the capabilities of the VIIRS day-night band and possible interagency collaborations for applying satellite data in response to major disasters. The SPoRT Center plans to continue collaborations with CIMSS, CIRA, and NASA's Applied Sciences Disasters Program to improve upon these products and their dissemination to end-users within NOAA, the National Weather Service, and other federal agencies.

In addition to the support for monitoring the widespread power outages, SPoRT team members and collaborating partners also regularly contributed to the Wide World of SPoRT blog. A wide variety of SPoRT products useful in assessing various aspects of Superstorm Sandy were highlighted in blog posts from the incipient phase to damage assessments and post-storm analysis. A list of blog posts corresponding to this event is provided at the right.

- Folmer, (10/24/2012, reposted via GOES-R and JPSS National Centers Perspective blog): “What to do with Sandy?, parts I, II, and III”; post highlighting GOES sounder RGB products and VIIRS imagery.
  http://nasasport.wordpress com/2012/10/24/4930/,
  http://nasasport.wordpress.com/2012/10/25/4931/, and
  http://nasasport.wordpress.com/2012/10/26/4941/.

- Jedlovec (10/27): VIIRS images of Sandy, and SPoRT’s first Suomi-NPP air mass RGB image derived from VIIRS data supplemented with the water vapor and ozone channels on CrIS.
  http://nasasport.wordpress.com/2012/10/27/viirs-images-of-sandy-1027/, and
  http://nasasport.wordpress.com/2012/10/27/air-mass-rgb-product-derived-from-cris-and-viirsdata-on-suomi-npp/.

- Zavodsky (10/29): Summary of SPoRT suite of multi-spectral satellite products in support of forecasting for Hurricane Sandy.
  http://nasasport.wordpress.com/2012/10/29/sport-multispectral-imagery-products-available-for-download/.

- Zavodsky (10/30): Comparison between new VIIRS-CrIS and legacy MODIS air mass RGB images of Hurricane Sandy.
  http://nasasport.wordpress.com/2012/10/30/comparison-of-air-mass-rgbs-for-extratropical-cyclone-sandy/.

- White (10/30): Sandy observations in the context of VIIRS DNB RGB imagery and SPoRT SST composites.
  http://nasasport.wordpress.com/2012/10/30/sport-datasets-and-observations-of-sandy/.

- Molthan (11/1) and Jedlovec (11/2): Blog posts highlighting the power outages in the Northeastern U.S.
  http://nasasport.wordpress.com/2012/11/01/viirs-day-night-band-comparisons-of-northeastern-city-lights/, and
  http://nasasport.wordpress.com/2012/11/02/viirs-dnb-difference-images-pinpoint-hurricane-sandy-damaged-regions-still-without-power/.

- White (11/2), Highlighting the Appalachian snowfall from Sandy using MODIS false color imagery.
  http://nasasport.wordpress.com/2012/11/02/now-for-something-different-a-look-at-southern-appalachian-snows/.

- Folmer (11/7, reposted via National Centers Perspective blog): Sequence of GOES sounder RGB products overlaid with WPC map analyses.
  http://nasasport.wordpress.com/2012/11/07/5091/.

- Jedlovec (11/7): ASTER data used to monitor Hurricane Sandy damage areas.
  http://nasasport.wordpress.com/2012/11/07/aster-data-monitors-hurricane-sandy-damage/.

- Jedlovec/Molthan (12/6): SPoRT disaster applications presented on NASA Hyperwall at American Geophysical Union annual meeting.
  http://nasasport.wordpress.com/2012/12/06/sport-disaster-applications-presented-at-nasa-hyperwall-at-agu/.

8

Metrics for Success


Significant Dry Air Intrusion Today
Special Weather Briefing
Denver
Albuquerque
MOIST
DRY
HOT
The MODIS Red-Green-Blue imagery uses an enhanced color curve developed by EUMETSAT that allows forecasters to better examine the moisture and temperature characteristics of synoptic and mesoscale weather patterns.
Storm chances will focus over far western and northern NM where better moisture exists.
Color Contributions
DRY UPPER LEVELS
MOIST / WARM
MOIST / COLD
MODIS RGB Air Mass Product*
*Product made available by NASA SPoRT: http://weather.msfc.nasa.gov/sport/
*EUMETSAT: http://www.eumetsat.int/Home/index.htm

The success of the SPoRT's transition to operations activities is measured in a number of ways; with peer-reviewed publications, transitional successes, community recognition, and end-user satisfaction. While the transition of a variety of new products and research capabilities to the end-user community is an important metric, the impact of the product and the satisfaction of the end-user with the NASA and NOAA research capabilities is equally important for both products transitioned and tools developed and provided to carry-out successful transitions. Feedback on the success of these transitions is obtained through user surveys and documented in assessment studies and reports. Community recognition of SPoRT as an important partner to help facilitate other transitions is equally important. Recognition of SPoRT as "the place to go" for help in the transition of unique NASA products to operational weather community demonstrates the success of the program. Additionally, newly developed transitional activities undertaken by other agencies utilizing the SPoRT paradigm, capabilities, or information are an additional measure of project success. Peer-reviewed publications on the new research and transitional capabilities and techniques used to develop them are a key metric to document the success of the project. The publication rate may depend on the changing emphasis of the project; from time-to-time, more emphasis is put on transition rather than research. Publication of transitional results and assessments are also appropriate although not always in peer-reviewed forums.

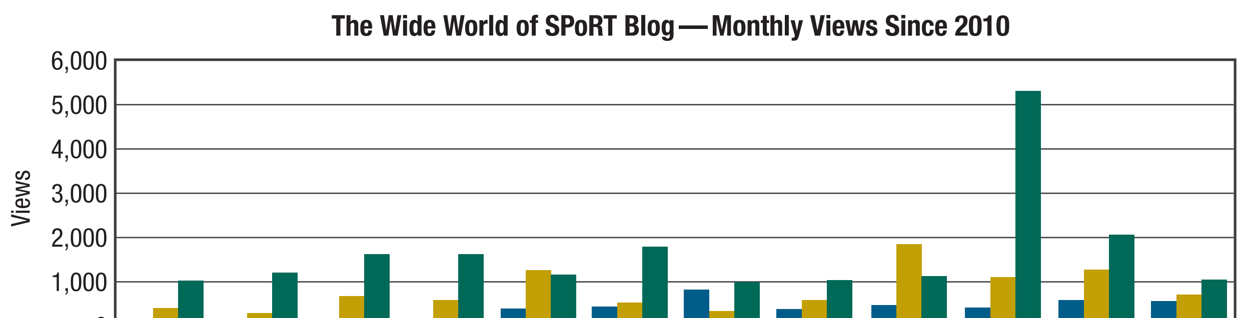
Web and Blog Posts

SPoRT continues to support the web site and blog. In the past year, a number of significant sections have been added to the Web site including:

- GOES-R Proving Ground Activities,
- JPSS Proving Ground Activities,
- Disaster Response Activities,
- Transitioned Products,
- A system for monitoring the health of real-time ingested data files, and
- Real-time VIIRS and Passive Microwave imagery.

One of the more significant advancements to the SPoRT web site has been the development of an interface to dynamically view high-resolution tiled satellite imagery products. An example of this showcases the analysis products SPoRT generated to support disaster relief efforts in the wake of Superstorm Sandy (http://weather.msfc.nasa.gov/sport/disasters/201210_sandy/maps/).

The Wide World of SPoRT blog (http://nasasport.wordpress.com/) experienced a marked increase in activity in 2012. During the year, 81 new posts were made to the blog, growing the total archive to 284 posts. There were 273 images uploaded supporting these posts, which is about 5 images per week. The blog had nearly 20,000 views in 2012, far eclipsing the total views of 9,600 in 2011 and 4,000 in 2010 (Figure 22). The most popular post, detailing a significant dust event that



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2010	2	4	45	60	387	435	821	393	468	415	584	559
2011	397	298	685	590	1,255	521	346	581	1,848	1,095	1,269	704
2012	1,024	1,200	1,618	1,626	1,154	1,789	979	1,307	1,128	5,313	2,052	1,047

Figure 22. Summary of monthly views of the Wide World of SPoRT blog since 2010.

stretched across the Great Plains into the Tennessee Valley in late October, garnered over 3,000 views in nearly one day, the most ever by a post in the SPoRT blog. Other popular posts during the year involved the use of new RGB imagery at NWS forecast offices and National Centers. Some of these were among the most popular posts of the year. Specifically, the use of new VIIRS DNB to detect large scale urban power loss in along the NE coast following the passage of Superstorm Sandy, and to indicate strong convection and thunderstorm activity at night over the mid-Mississippi Valley one night in early June. Other popular posts involved the use of air mass RGB products by National Centers (OPC, WPC) to detect upper-atmospheric anomalies. The SPoRT blog also welcomed several new user accounts during the past year, including accounts for the Miami and Raleigh NWS offices.

Journal Publications and Conference Proceedings

Peer-reviewed publications continues to be an important metric to determine successful research and transitions. Ten articles have been published or accepted into peer-reviewed journals, as listed in Appendix D. SPoRT also had a strong presence at conferences, symposia, and science meetings in order to stay abreast on the latest science, and to communicate successes to the science and operational communities. In 2012, SPoRT participated in the American Meteorological Society's annual meeting in New Orleans, LA, the 26th Conference on Severe Local Storms in Nashville, TN, the 13th WRF model Users' Workshop in Boulder, CO, and the National Weather Association annual meeting in Madison, WI. A summary of all presentations, posters, and abstracts during 2012 are included in Appendix D.

9

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Appendix A. SPoRT Work Groups and Participating Team Members

The members of each SPoRT Work Group are listed in Table A1 below. In many instances, the same representative appears in more than one Work Group to foster cross-collaboration between groups.

Table A1. List of SPoRT Work Groups and participating team members in each group.

Work Group	Participating Team Members
SPoRT Leadership Team	Dr. Gary Jedlovec (NASA MSFC, SPoRT PI), lead Mr. Kevin Fuell (UAH) Dr. Andrew Molthan (NASA MSFC) Mr. Matt Smith (UAH) Dr. Geoffrey Stano (ENSCO, Inc.) Mr. Bradley Zavodsky (NASA MSFC)
Modeling and Data Assimilation	Mr. Bradley Zavodsky (NASA MSFC), lead Dr. Emily Berndt (NASA Post-doctoral scientist) Dr. Clay Blankenship (USRA) Mr. Jonathan Case (ENSCO, Inc.) Dr. Shih-Hung Chou (NASA MSFC; retired in June) Ms. Jayanthi Srikishen (USRA)
Product Development/Maintenance	Dr. Geoffrey Stano (ENSCO, Inc.), lead Dr. Bob Atkinson (USRA) Dr. Emily Berndt (NASA Post-doctoral scientist) Mr. Kevin Fuell (UAH) Mr. Frank LaFontaine (Raytheon) Ms. Anita LeRoy (UAH) Mr. Kevin McGrath (Jacobs) Dr. Andrew Molthan (NASA MSFC) Mr. Matt Smith (UAH) Mr. Kristopher White (NWS HUN/NASA MSFC)
Decision Support Systems	Mr. Matt Smith (UAH), lead Mr. Jason Burks (NASA MSFC) Mr. Kevin McGrath (Jacobs)
Transition, Training, and Assessments	Mr. Kevin Fuell (UAH), lead Mr. Jonathan Case (ENSCO, Inc.) Mr. Frank LaFontaine (Raytheon) Ms. Anita LeRoy (UAH) Mr. Matt Smith (UAH) Dr. Geoffrey Stano (ENSCO, Inc.) Mr. Kristopher White (NWS HUN/NASA MSFC)
Information Technology	Mr. Bradley Zavodsky (NASA MSFC), lead Mr. David Cross (NSSTC IT Support) Ms. Rita Edwards (NSSTC IT Support) Mr. Kevin McGrath (Jacobs) Ms. Jayanthi Srikishen (USRA)

Appendix B. Complete List of SPoRT Products

SPoRT continues to maintain its core suite of MODIS satellite products and model initialization fields for use by its operational end-users. The product list has grown substantially this past year with the inclusion of additional products from Suomi-NPP. Table B1 summarizes the suite of SPoRT products, details on the products, and the forecast challenge(s) that each product helps to address.

Table B1. SPoRT product suite provided to end-users.

Instrument/Product	Forecast Problem (Domains)
MODIS (Terra and Aqua)	**(CONUS, Alaska)**
Imagery (visible, 3.9, 6.7, 11 μm)	Improved situational awareness
Suite of RGB products (true, false color snow, air mass, night & day-time microphysics, dust)	Cloud structure, visibility obstructions, snow-cover extent
Fog / low cloud (11-3.9 μm)	Improved situational awareness
NDVI / Green Vegetation Fraction (GVF)	Improved NWP model initialization and forecasts
AIRS (Aqua)	**(CONUS)**
Carbon monoxide, ozone imagery	Fires, air quality, storm dynamics
Total Lightning Data (ground-based)	**(North AL, DC, Central FL, OK, West TX, CO, Langmuir)**
Source / flash density	Severe weather, lightning safety
Combined Instrument Products	**(Northern Hemisphere – Atlantic & Pacific basins)**
Multi-sensor SST / Great Lakes LST / ice mask composite	Coastal processes, lake-effect precipitation;
Improved NWP model initialization and forecasts	
CIRA Blended TPW / Layered PW	Moisture mapping, atmospheric rivers, precipitation
HMS/FIRMS fire/burn area	Smoke, reduced visibility, localized flooding
GOES	**(GOES-East)**
Sounder air mass RGB	Storm dynamics, improved situational awareness
GOES-R Proxy Products	
Pseudo GLM product suite	Severe weather, lightning safety (total lightning nests)
POES-GOES hybrid imagery (visible, 3.9, 6.7, 11μm)	Improved situational awareness (CONUS, Alaska)
POES-GOES Hybrid RGB suite	Improved situational awareness (CONUS, Alaska)
NESDIS Quantitative Precipitation Estimates	Precipitation mapping (CONUS, Alaska)
GOES-R Convective Initiation (CI) algorithm	CI, precipitation mapping (GOES-East & West)
JPSS Proxy Products (Suomi-NPP)	**(CONUS, Alaska)**
VIIRS imagery (visible, 3.9, 11 μm)	Improved situational awareness
Suite of VIIRS RGB products (true color, air mass (w/CrIS), night & day-time microphysics, dust)	Cloud structure, visibility obstructions,
Storm dynamics	
VIIRS DNB (low light) – radiance, reflectance, RGB	Improved situational awareness
SEVIRI	**(Atlantic basin)**
RGB products (air mass, dust, Saharan Air Layer)	Tropical storm forecasting, storm dynamics
Passive Microwave	**(Atlantic & Pacific basins)**
TMI (TRMM) 37(V/H), 85(V/H), composite	Precipitation monitoring, storm dynamics
SSMI/S 37(V/H), 85(V/H), 91(V)	Precipitation monitoring, storm dynamics
SSMI/S RGBs – 37/85, 37PCT	Precipitation monitoring, storm dynamics
MISCELLANEOUS	
Land Information System (LIS) – soil moisture	CI, drought/flood monitoring; Improved NWP model initialization and forecasts (SE CONUS)
WindSat – Ocean Surface Wind Vectors (OSWV)	Improved situational awareness over oceans (global)

Appendix C. Product Suites at SPoRT Collaborating Partners

The tables below summarize the SPoRT product suites that are developed and disseminated to the collaborating entities listed. The information pertains to the collaborating product development partners (Table C1), National Center evaluation partners (Table C2), and NWS Regional Headquarters (Table C3), according to the map given in Figure 3.

Table C1. List of Product Development Partners and the suite of products provided to SPoRT.

Product Development Partner	Product Suite Provided
CIRA – Cooperative Institute for Research in the Atmosphere	Blended TPW, Layered PW, GOES Sounder air mass
NOAA/NESDIS – National Environmental Satellite, Data, and Information Service	GOES data, Meteosat SEVIRI NESDIS QPE, Snowfall rate
NRL – Naval Research Laboratory	Passive microwave, WindSat
UAF/GINA – University of Alaska - Fairbanks/Geographic Information Network of Alaska	MODIS data, VIIRS data
UW/CIMSS – University of Wisconsin - Madison/Cooperative Institute for Meteorological Satellite Studies	MODIS data, VIIRS data

Table C2. List of National Center Evaluation Partners and the suite of products obtained from SPoRT.

National Center Evaluation Partner	Product Suite Obtained
AWC – Aviation Weather Center	GOES-R CI, PGLM
HWT/SPC/NSSL – Hazardous Weather Testbed/Storm Prediction Center/National Severe Storms Laboratory	GOES Sounder air mass, GOES-R CI, PGLM, WRF Lightning Forecast Algorithm
NHC – National Hurricane Center	Passive Microwave, RGBs
OPC/WPC/SAB – Ocean Prediction Center, Hydro-meteorological Prediction Center, Satellite Analysis Branch	AIRS Ozone, MODIS, Passive Microwave, RGBs, VIIRS

Table C2. List of NWS Evaluation Regions and the suite of products obtained from SPoRT.

NWS Evaluation Region	Product Suite Obtained
Alaska Region Headquarters	NESDIS QPE, SPoRT Hybrids, SPoRT SST, WindSat
Central Region Headquarters	RGBs, Total Lightning
Eastern Region Headquarters	MODIS, RGBs, SPoRT Hybrids, SPoRT SST, VIIRS data
Pacific Region Headquarters	NESDIS QPE, SPoRT SST
Southern Region Headquarters	CIRA Blended TPW, GOES-R CI, LIS, MODIS, MODIS vegetation, RGBs, SPoRT Hybrids, SPoRT SST, Total Lightning, VIIRS
Western Region Headquarters	CIRA Layered PW, MODIS, NESDIS QPE, RGBs, SPoRT SST, VIIRS, WindSat

Appendix D. SPoRT Publications and Presentations in 2012

Peer-reviewed journal publications:

Case, J.L., F.J. LaFontaine, J.R. Bell, G.J. Jedlovec, S.V. Kumar, and C.D. Peters-Lidard, 2013: A real-time MODIS vegetation product for land surface and numerical weather prediction models. IEEE Trans. Geosci. Remote Sens., In Press.

Goodman, S.J., R.J. Blakeslee, W.J. Koshak, D. Mach, J. Bailey, D. Buechler, L. Carey, C. Schultz, M. Bateman, E. McCaul Jr., G. Stano, 2013: The GOES-R Geostationary Lightning Mapper (GLM). Atmos. Res., 125-126, 34-49.

Goodman, S.J., J. Gurka, M. DeMaria, T.J. Schmit, A. Mostek, G. Jedlovec, C. Siewert, W. Feltz, J. Gerth, R. Brummer, S. Miller, B. Reed, and R.R. Reynolds, 2012: The GOES-R Proving Ground: Accelerating User Readiness for the Next-Generation Geostationary Environmental Satellite System. Bull. Amer. Meteor. Soc., 93, 1029 -1040.

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Ralph, M., J. Intrieri, D. Andrea, Jr., R. Atlas, S. Boukabara, D. Bright, P. Davidson, B. Entwistle, J. Gaynor, S. Goodman, J. Gwo-Jiing, A. Harless, J. Huang, G. Jedlovec, J. Kain, S. Koch, B. Kuo, J. Levit, S.T. Murillo, L.P. Riishojgaard, T. Schneider, R. Schneider, T. Smith, and S. Weiss, 2013: The Emergence of the Weather-focused Testbeds Linking Research and Forecasting Operations. Bull. Amer. Met. Soc., In Press, doi:10.1175/BAMS-D-12-00080.

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Zavodsky, B.T., S.-H. Chou, and G.J. Jedlovec, 2012: Improved regional analyses and heavy precipitation forecasts with assimilation of atmospheric infrared sounder retrieved thermodynamic profiles. IEEE Trans. Geosci. Remote Sens., 50, 4243-4251.

Zavodsky, B.T., A.L. Molthan, and M.J. Folmer, 2013: Multispectral imagery for detecting stratospheric air intrusions associated with mid-latitude cyclones. J. Operational Meteor., In Press.

Conferences, Symposia, Workshops, Newsletters and Meetings:

Bell, J.R., J.L. Case, F.J. LaFontaine, and S.V. Kumar, 2012: Evaluating the Impacts of NASA/SPoRT Daily Greenness Vegetation Fraction on Land Surface Model and Numerical Weather Forecasts. Preprints, 16th Symp. on Integrated Observing and Assimilation Systems for the Atmosphere, Oceans, and Land Surface, New Orleans, LA, Amer. Meteor. Soc., P247. [Available online at http://ams.confex.com/ams/92Annual/webprogram/Manuscript/Paper200664/Bell_etal_2012AMS_16IOAS-AOLS_P247_Final.pdf]

Beven J., M Brennan, H. Cobb, M. DeMaria, J. Knaff, C. Velden, J. Dunion, G. Jedlovec, and K. Fuell, 2012: The 2011 GOES-R Proving Ground at the National Hurricane Center. 66th Interdepartmental Hurricane Conference, Charleston, SC, NOAA/NWS.

Carcione, B., J. Burks, K.D. White, M. Smith, and K. McGrath, 2012: Incorporating NASA SPoRT and Other Alternative Data Sets into an Operational AWIPS II Environment. Preprints, National Weather Association 37th Annual Meeting Session P.2, Madison, WI, Natl. Wea. Assoc., P2.54.

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Fuell, K.K., G. Jedlovec, A. Molthan, and G.T. Stano, 2012a: NASA/SPoRT's GOES-R activities in support of product development, management, and training. Session Geostationary Satellite Data Generation II. San Francisco, CA, Amer. Geophys. Union.

Fuell K.K., A. LeRoy, G. Jedlovec, A. Molthan, and M. Smith, 2012b: NASA/SPoRT products for the GOES-R Proving Ground. 37th National Weather Association Annual Meeting, Madison, WI, Natl. Wea. Assoc., P1.61.

Fuell, K.K. and A.L. Molthan, 2012a: Transition and evaluation of RGB imagery to WFOs and National Centers by NASA SPoRT. NOAA Satellite Science Week, Kansas City, MO, NOAA.

Fuell K.K., and A. Molthan, 2012b: RGB imagery applications within U.S. National Weather Service. EUMETSAT Workshop on RGB Satellite Products, Seeheim, Germany, WMO.

Fuell K.K., A. Molthan, G. Jedlovec, K. McGrath, and M. Smith, 2012c: RGB Imagery Transition to WFOs for AWIPS I and AWIPS II. NOAA Satellite Science Week, Kansas City, MO, NOAA.

Fuell, K.K., M. Smith, and G.J. Jedlovec, 2012d: Early transition and use of NPP/VIIRS and GOES-R ABI and GLM products by NWS forecast offices. Eighth Symp. on Future Operational Environmental Satellite Systems, New Orleans, LA, Amer. Meteor. Soc., 5.4.

Goodman, S.J., R.J. Blakeslee, W.J. Koshak, D.M. Mach, J.C. Bailey, D.E. Buechler, L.D. Carey, C.J. Schultz, M.G. Bateman, E. McCaul Jr., and G.T. Stano, 2012: The GOES-R Geostationary Lightning Mapper (GLM). Lightning and Atmospheric Electricity in Thunderstorms I. San Francisco, CA, Amer. Geophys. Union, AE11A-01.

Harrison, K.,D. Morton, B. Zavodsky, and S. Chou, 2012: Assessment of data assimilation with the prototype High Resolution Rapid Refresh for Alaska (HRRRAK). 2012 Alaska Weather Symposium, Fairbanks, AK.

Jedlovec, G., M. Demaria, and T. Schmit, 2012: RGB activities for the GOES-R Proving Ground. NOAA Satellite Science Week, Kansas City, MO, NOAA.

Jedlovec, G.J., A.L. Molthan, K. White, J. Burks, K. Stellman, and M. Smith, 2012: Use of remote sensing data to enhance NWS Storm Damage Toolkit. Session IN035: Near Real-time Data Uses for Earth Science and Space Weather Applications, San Francisco, CA, Amer. Geophys. Union.

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Medlin, J.M., L. Wood, B.T. Zavodsky, J.L. Case, and A.L. Molthan, 2012: Preliminary results of a U.S. Deep South warm season deep convective initiation modeling experiment using NASA SPoRT initialization datasets for operational National Weather Service local model runs. Preprints, 26th Conf. on Severe Local Storms, Nashville, TN, Amer. Meteor. Soc., P121. [Available online at https://ams.confex.com/ams/26SLS/webprogram/Paper210503.html]

Molthan, A.L., J. Case, J. Venner, M.J. Moreno-Madrinan, and F. Delgado, 2012: Development of a high resolution weather forecast model for Mesoamerica using the NASA Nebula Cloud Computing Environment. Session IN43C: Impact of High-Performance Computing Trends on Earth and Space Science Posters, San Francisco, CA, Amer. Geophys. Union.

Molthan, A.L., K.K. Fuell, J. Knaff, and T. Lee, 2012: Current usage and future prospects of multispectral (RGB) satellite imagery in support of NWS Forecast Offices and National Centers. 37th National Weather Association Annual Meeting, Madison, WI, Natl. Wea. Assoc., P1.18.

Molthan, A.L., K.K. Fuell, H.K. Oswald, and J.A. Knaff, 2012: Development of RGB Composite Imagery for Operational Weather Forecasting Applications. Eighth Annual Symposium on Future Operational Environmental Satellite Systems, New Orleans, LA, Amer. Meteor. Soc., P301.

Schultz, C.J., L.D. Carey, E.V. Schultz, W.A. Peterson, P.N. Gatlin, K.R. Knupp, A.L. Molthan, G.J. Jedlovec, B. Carcione, C.B. Darden, and C.C. Crowe, 2012: Dual-polarimetric radar-based tornado debris signatures and paths associated with tornadoes over northern Alabama during the historic outbreak of 27 April 2011. Special Symp. on Tornado Disasters of 2011, New Orleans, LA, Amer. Meteor. Soc., J2.2.

Schultz, E.V., G.T. Stano, L.D. Carey, and W.A. Petersen, 2012: Radar applications for nowcasting lightning cessation. 37th National Weather Association Annual Meeting, Madison, WI, Natl. Wea. Assoc., A3.2.

Smith, M. R., K. K. Fuell, A. L. Molthan, and G. J. Jedlovec, 2012: Transition of Suomi National Polar-Orbiting Partnership (S-NPP) data products for operational weather forecasting applications. Session A54F: Space-Based, Operational Global Earth Observations from NPP and JPSS III, San Francisco, CA, Amer. Geophys. Union.

Smith, M., K. McGrath, J. Burks, and B. Carcione, 2012: Application programming in AWIPS II. 18th Conf. on Satellite Meteorology, Oceanography and Climatology, New Orleans, LA, Amer. Meteor. Soc., TJ21.4.

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White, K.D., G.T. Stano, and B. Carcione, 2012: The Use of the North Alabama Lightning Mapping Array in the Real-time Operational Warning Environment during the March 2nd, 2012 Severe Weather Outbreak in Northern Alabama. 37th National Weather Association Annual Meeting, Madison, WI, Natl. Wea. Assoc., P1.25.

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Wood, L., J.M. Medlin, B.T. Zavodsky, J. Case, and A. Molthan, 2012: Preliminary results of a U.S. Deep South modeling experiment using NASA SPoRT initialization datasets for operational National Weather Service local model runs. 37th National Weather Association Annual Meeting, Madison, WI, Natl. Wea. Assoc., P1.58.

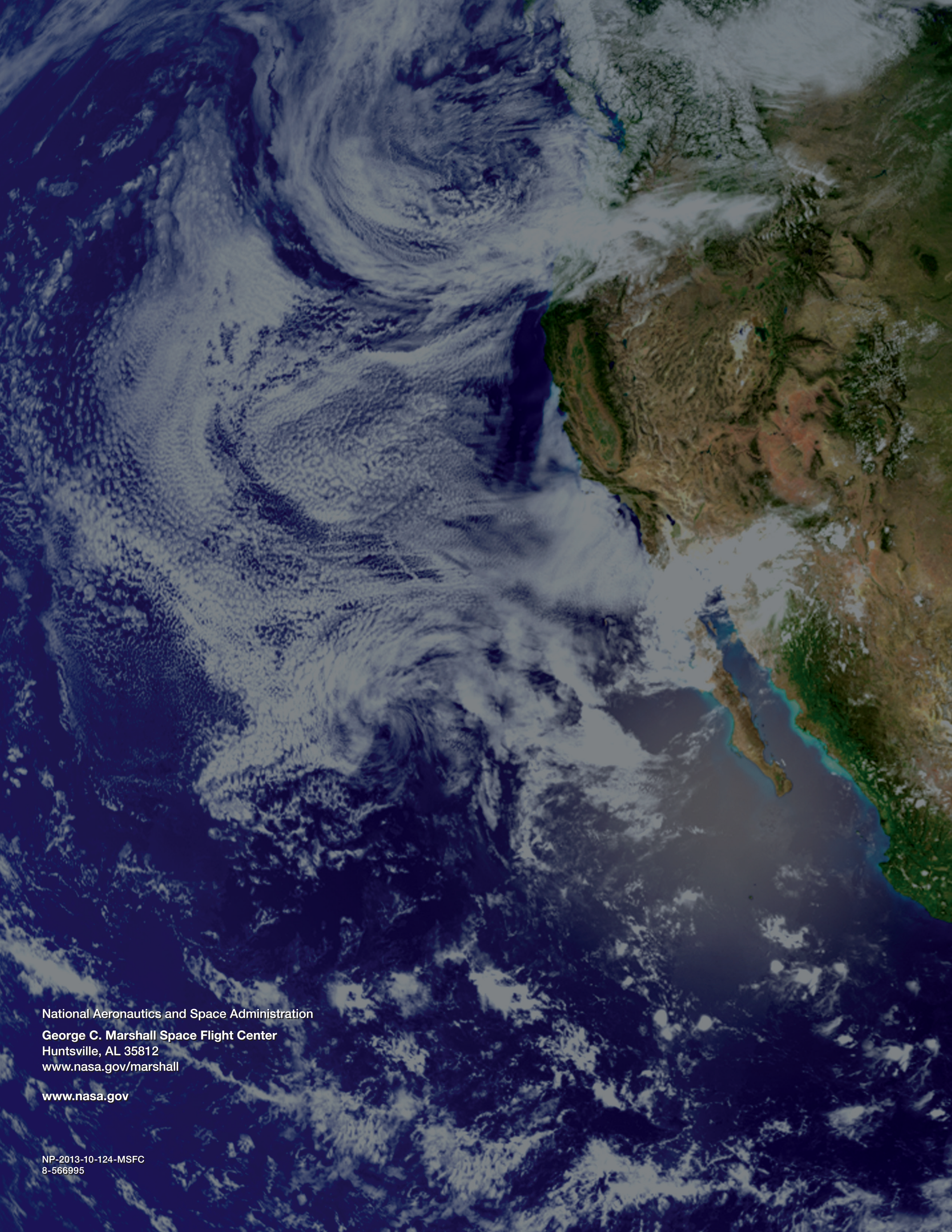
Zavodsky, B.T., J.L. Case, D.M. Kozlowski, and A.L. Molthan, 2012a: The SPoRT-WRF: Evaluating the impact of NASA datasets on convective forecasts. Preprints, 16th Symp. on Integrated Observing and Assimilation Systems for Atmosphere, Oceans, and Land Surface (IOAS-AOLS), New Orleans, LA, Amer. Meteor. Soc., 15.3. [Available online at: https://ams.confex.com/ams/92Annual/webprogram/Paper200585.html]

Zavodsky, B.T., S-H. Chou, and G.J. Jedlovec, 2012b: Improved impact of Atmospheric Infrared Sounder (AIRS) radiance assimilation in numerical weather prediction. 18th Conf. on Satellite Meteorology, Oceanography and Climate, New Orleans, LA, Amer. Meteor. Soc., P161.

Appendix E. Acronyms and Abbreviations

ABI	Advanced Baseline Imager
AIRS	Atmospheric InfraRed Sounder
AMSR-E	Advanced Microwave Scanning Radiometer for EOS
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
AWIPS	Advanced Weather Interactive Processing System
AWIPS II	next generation AWIPS
CI	Convective Initiation
CIMSS	Cooperative Institute for Meteorological Satellite Studies
CIRA	Cooperative Institute for Research in the Atmosphere
CONUS	Conterminous United States
CrIS	Cross-track Infrared Sounder
DNB	Day-Night Band
DoD	Department of Defense
DSS	Decision Support System
EMC	Environmental Modeling Center
EMS	Environmental Modeling System
EOS	Earth Observing System
EPDT	Experiment Products Development Team
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
FED	Flash Extent Density
FID	Flash Initiation Density
GFS	Global Forecast System
GLERL	Great Lakes Environmental Research Laboratory
GLM	Geostationary Lightning Mapper
GLSEA2	Great Lakes Surface Environmental Analysis
GLST	Great Lakes Surface Temperature
GOES	Geostationary Operational Environmental Satellite
GPM	Global Precipitation Measurement
GSI	Gridpoint Statistical Interpolator
GVF	Green Vegetation Fraction
HMT	HydroMeteorology Testbed
HQ	Headquarters
HWT	Hazardous Weather Testbed
IGBP	International Geosphere Biosphere Programme
IR	Infrared
JCSDA	Joint Center for Satellite Data Assimilation
JPSS	Joint Polar Satellite System
JTFCS	Joint Task Force-Civil Support
KML	Keyhole Markup Language
KMZ	Zipped KML files
LIS	Land Information System
LMA	Lightning Mapping Array
LPW	Layered Precipitable Water
LSM	Land Surface Model
MFD	Maximum Flash Density
MODIS	Moderate Resolution Imaging Spectroradiometer
NASA	National Aeronautics and Space Administration
N-AWIPS	National Centers-AWIPS
NCCS	National Center for Climate Simulation
NCEP	National Centers for Environmental Prediction
NDVI	Normalized Difference Vegetation Index
NESDIS	National Environmental Satellite Data and Information Service
NHC	NCEP National Hurricane Center
NOAA	National Oceanic and Atmospheric Administration
NSSL	National Severe Storms Laboratory
NWP	Numerical Weather Prediction
NWS	National Weather Service
OCONUS	Outside the CONUS
OPC	NCEP Ocean Prediction Center
PG	Proving Ground
PGLM	Pseudo Geostationary Lightning Mapper
POES	Polar Orbiting Environmental Satellite
PV	Potential Vorticity
PW	Precipitable Water
QPE	Quantitative Precipitation Estimate
REMSS	Remote Sensing Systems
RGB	Red-Green-Blue
ROSES	Research Opportunities in Space and Earth Sciences
SAB	Satellite Analysis Branch
SAC	Science Advisory Committee
SEVIRI	Spinning Enhanced Visible and IR Imager
SMAP	Soil Moisture Active Passive
SPC	NCEP Storm Prediction Center
SPoRT	Short-term Prediction Research and Transition
SSMI	Special Sensor Microwave Imager
SST	Sea Surface Temperature
Suomi-NPP	Suomi-National Polar-orbiting Partnership
TIM	Technical Interchange Meeting
TMS	Tile Map Service
TPW	Total Precipitable Water
TRMM	Tropical Rainfall Measuring Mission

UAH	University of Alabama in Huntsville
VIIRS	Visible Infrared Imaging Radiometer Suite
WFO	Weather Forecast Office
WiB	Weather in a Box
WPC	Weather Prediction Center
WRF	Weather Research and Forecasting



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