WORLD METEOROLOGICAL ORGANIZATION
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ET-SUP-8/Doc. 10.2
(31.III.2014)
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COMMISSION FOR BASIC SYSTEMS
OPEN PROGRAMME AREA GROUP ON INTEGRATED OBSERVING SYSTEMS

EXPERT TEAM ON SATELLITE UTILIZATION AND PRODUCTS

ITEM: 10.2

EIGTH SESSION

GENEVA, SWITZERLAND, 14 -17 APRIL 2014

Original: ENGLISH

# PREPARING USERS FOR NEW SATELLITES: GOES-R Proving Ground

*(Submitted by Anthony Mostek NOAA/NWS)*

**Summary and Purpose of Document**

This document reports on the latest plans, developments and activities of GOES-R Proving Ground program.

This report is provided in response to request for information in support of ET-SUP-8 meeting.

## ACTION PROPOSED

The eighth session is invited to:

(a) Take note of the rapid progress of NOAA GOES-R Proving Ground and the many activities regarding user readiness and product evaluation in preparation for launch late in 2015 or early 2016.

(b) Expert Team is asked to consider developing plans to establish Proving Grounds in preparation for other satellites.

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**Appendices**: A. Map of PG GOES-R Proving Ground Partners

B. GOES-R Proving Ground FY13 Annual Report

# DISCUSSION: GOES-R Proving Ground

## 1. Introduction

In preparation for the launch of the GOES-R series, NOAA conducted several user Conferences beginning in 2000. A major user request was to establish a Proving Ground dedicated to user readiness for GOES-R to include product assessment, training and feedback between developers and users (Research-to-Operations – R2O). The GOES-R Proving Ground (PG) was established in 2008 with dedicated funding to support a small team of scientists working with product development, training and evaluation programs. From this small beginning, the GOES-R PG grew quickly to encompass many NOAA product development and operational offices across the United States (See map Appendix A). This report attempts to provide the current status of GOES-R PG, summary of recent reports and plans for the next year (2014).

## 2. GOES-R Proving Ground – Status and Plans

Much the following GOES-R Proving Ground description is a summary of information found on the website at: http://www.goes-r.gov/users/proving-ground.html. The Expert Team is advised to spend time going through the GOES-R PG website to stay updated on the latest status, plans and activities.

The Proving Ground is a collaborative effort between the GOES-R Program Office, NOAA Cooperative Institutes, a NASA center, NWS Weather Forecast Offices, NCEP National Centers, and NOAA Test Beds. The Proving Ground is a project in which simulated GOES-R products are tested and evaluated before the GOES-R satellite is launched. The simulated GOES-R products are generated using combinations of currently available GOES data, along with higher resolution data provided by instruments on polar-orbiting satellites such as MODIS on NASA's Aqua and Terra satellites, NOAA SNPP, and numerical model synthetic satellite data.

The Proving Ground was established to realize the benefits of the GOES-R system as soon as the satellites are launched and operational. GOES-R marks the first major technological advances in NOAA geostationary observations since 1994. The advances include improvements upon existing data such as increased spatial, temporal, and spectral resolutions for Earth monitoring and improved space weather observations and initiation of new operational observations from lightning mapper.

Many GOES-R products will be aimed at monitoring severe weather to help forecasters issue timely, more accurate severe weather warnings. To create the most useful severe weather monitoring tools, the GOES-R Proving Ground works with the Experimental Forecast Program and the Experimental Warning Program of the NOAA Hazardous Weather Test Bed. By utilizing experimental GOES-R products in the HWT, forecasters can help determine their utility in monitoring and forecasting severe convective weather.

The GOES-R Proving Ground program facilitates research-to-operations (R2O) with the principal focus on the forecaster to help users prepare for the GOES-R observations, to get real-world experience by leveraging existing resources, and to evaluate product enhancements.

The GOES-R Proving Ground engages the National Weather Service (NWS), other agencies, and other operational offices in pre-launch demonstrations of selected GOES-R products with the objective of preparing for the transfer from research to operations (R2O) by:

- Utilizing current systems (satellite, terrestrial, or model/synthetic) to emulate GOES-R observations;
- Infusing GOES-R-like products and techniques into NWS and other NOAA operations;
- Locating satellite liaisons at key operational offices to interact between developers and users
- Engaging in a continuous feedback loop between developers and users and managers.

Key steps of the Proving Ground process are: training forecasters to use new products, identifying different utilities of each product, identifying weaknesses or errors with each product, and user-feedback for enhancing or developing new products done within an integrated multi-sensor and multi-model forecast and warning operations.

**3. Proving Ground Report from 2013**

Key outcomes and product assessment highlights of the PG activities in 2013 are provided below. For access to the complete PG 2013 report, please go to:
http://www.goes-r.gov/users/docs/PG_annual_report_2013.pdf

In 2013 (and couple events in 2012), PG activities were conducted at the following locations:

- Hazardous Weather Testbed (HWT) in Oklahoma
- National Hurricane Center (based on 2012 report) in Miami, Florida
- Aviation Weather Center in Kansas City , Missouri
- High Latitude and Arctic Testbed in Alaska
- Air Quality in Maryland?
- NWS Central Region FLS Evaluation in several Midwest Offices
- Alaska and San Juan Puerto Rico Quantitative Precipitation Estimation (QPE)

1. Fog and Low Stratus (FLS) products are scheduled to be deployed on NOAA systems and will be delivered to NWS users via the Satellite Broadcast Network (SBN), NCEP Central Operations (NCO) backbone, Direct Broadcast, and possibly AWIPS Data Distribution Service (DDS) as an alternative.
2. The RGB Dust product is now used routinely by TAFB (Tropical Analysis Forecast Branch) forecasters as input to the Tropical Weather Discussion product. It was especially useful for helping to diagnose the atmospheric stability in the early stage of Tropical Storm Florence.
3. Simulated Satellite Forecasts are available in Aviation Weather Center (AWC) operations (experimental) since July 2013. GOES-R Convective Initiation (CI) were transitioned into AWC operations (experimental) later in 2013. The Cloud Top Cooling (CTC) product was transitioned into AWC operations (experimental) in the fall of 2012. The Pseudo Geostationary Lightning Mapper (PGLM) transition into AWC operations (experimental) was done late in 2013. Additionally, as part of the Fog and Low Stratus suite, the Cloud Top Phase is available in AWC (experimental) operations.
4. The RGB product suite is available in Ocean Prediction Center (OPC) and Weather Prediction Center operations (experimental).
5. The SRSOR 1-minute imagery, from the spare satellite GOES-14, was available in August 2013, allowing for forecaster evaluation during the AWC Summer Demonstration and the NHC Demonstration. This imagery was meant to emulate the expected temporal resolution of GOES-R and was popular among forecasters, particularly for the excellent situational awareness provided in areas of rapid convective development.

**4. Lessons Learned Relevant to Future Projects:**

In the HWT spring experiment, with the exception of the RGB Airmass imagery, forecasters found the training material appropriate and informative. One suggestion to improve and further solidify these training efforts is the inclusion of quick guides for each product. There were several provided by various project investigators this year, all of which were very beneficial for forecasters to use as a reference if they found themselves needing further clarification during activities.

**5. Methods to Foster Collaborations between Research, Operations and External Stakeholders**

Planned initiatives to foster collaborations between research and operations/applications and external stakeholders are the visiting scientist program, bringing forecasters and product developers to the Hazardous Weather Testbed, monthly science seminars, bi-annual forecaster forums, and broadcaster participation in workshops and future proving ground demonstrations. These methods help to fulfill the goal of aligning the Proving Ground with the NOAA Weather Ready Nation (WRN) initiative.

The Air Quality Proving Ground relies on a seamless interaction between NOAA and state and federal

air quality forecasters who work for other agencies. The Proving Ground workshops demonstrated significant external interest in GOES-R and the promise of the new ABI.

**6. Effectiveness of PG in terms of Timeliness, Cost Savings, Cost Sharing, and Low Overhead.**

Efficiency is achieved through virtual technical interchange meetings while resources are used most effectively through partnerships with our Proving Ground partners and NOAA Testbed facilities. Utilizing forecasters who are on-site, and at nearby offices, to participate in demonstrations is an effective way to reduce costs. Users receive product training during regularly scheduled shifts which results in no additional costs.

**7. Leveraged resources from broader community**

Leveraged resources are provided by NASA SPoRT, NOAA Cooperative Institute infrastructure, and NOAA Testbeds. Resources from JPSS program provide additional support for some satellite liaisons and the Air Quality Proving Ground activities.

**8. Proving Ground Plans for 2014**

Preliminary Outline for the HWT Spring Experiment (May/June) along with Experimental Warning Program (EWP) is as follows:

- Uses a simulated warning operations environment with direct Benefit to WFO forecasters
- Includes upgrades with AWIPS 2
- GOES-R PG is a significant component

The 2014 experiment will focus on the following:

- University of Alabama Huntsville (UA) Convective Iinitiation (CI)
- Total Lightning (proxy GOES Lightning Mapper - pGLM)
- University of Wisconsin (UW) Severe Probabilities
- NearCast
- SPoRT tracking tool

To help prepare users and forecsters for the HWT experiment, a new Weather Event Simulator (WES) training case for EWP is being developed.

A critical component of HWT (and other NOAA testbeds) is the formal evaluation conducted during and upon conclusion of the experiment. This feedback is crucial to continued improvement in the products, training and overall user readiness preparations for GOES-R.

**9. Conclusion**

In preparation for the launch of the GOES-R series, NOAA established a Proving Ground dedicated to user readiness for GOES-R to include product assessment, training and feedback between developers and users (Research-to-Operations – R2O). The GOES-R PG has grown rapidly and participates in several experiments through NOAA's existing Testbeds. The Expert Team is asked to review the status, plans and results of the Proving Ground and consider initiating additional programs through Space Programme Virtual Laboratory to prepare for other new satellites.

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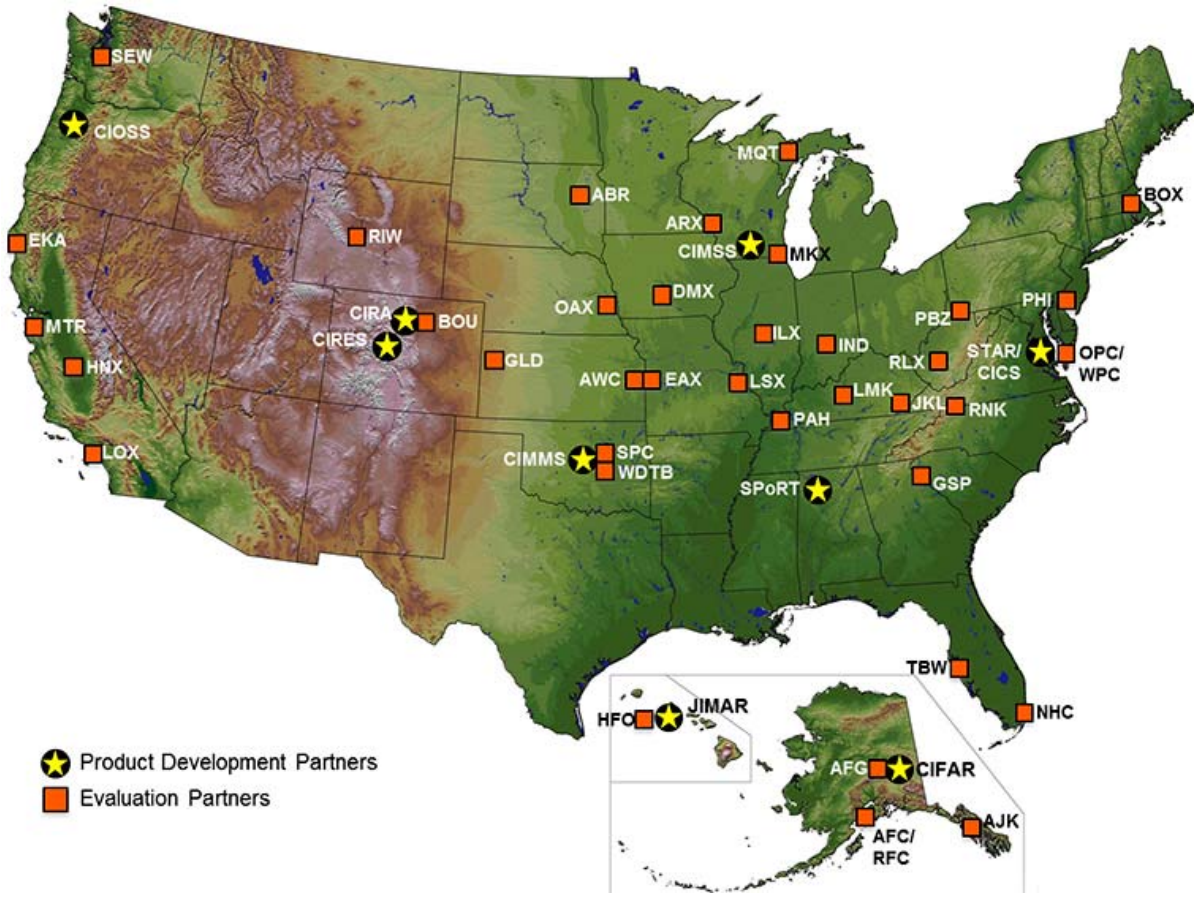
## Appendix A: NOAA GOES-R Proving Ground Partners

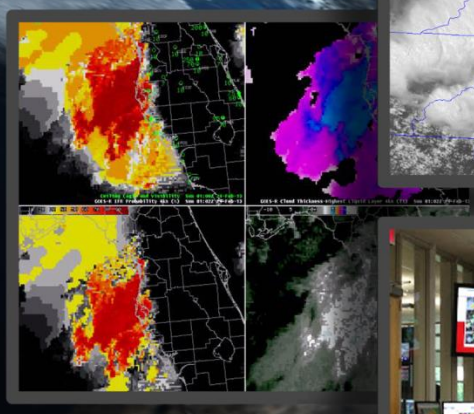


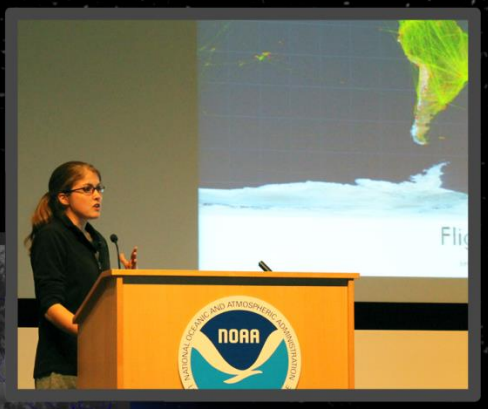
## Appendix B. GOES-R Proving Ground FY13 Annual Report (Attached)

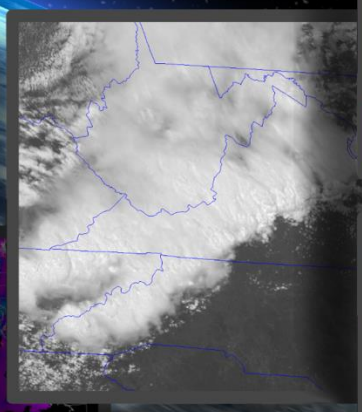
# GOES-R Proving Ground

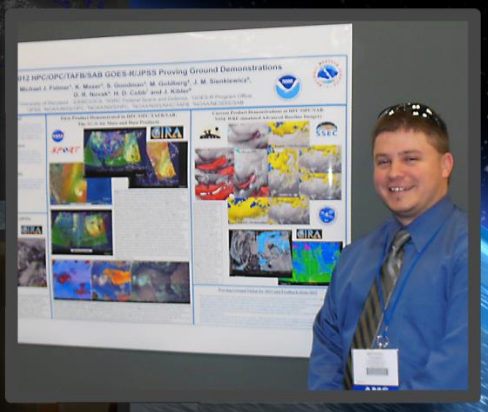
## FY13 Annual Report

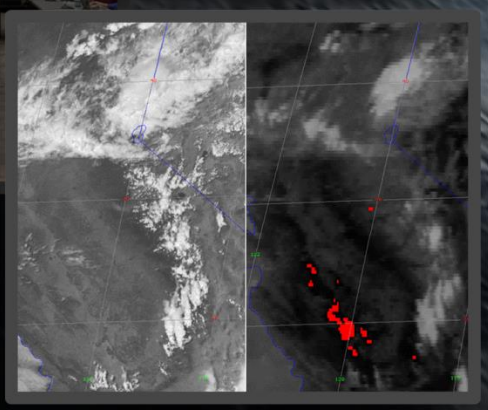
November 15, 2013









CONNECTING RESEARCH AND OPERATIONS
GOES-R
PROVING GROUND

# GOES-R Proving Ground FY13 Annual Report[1]

## Contents



[1] Cover page images, clockwise from left: 1) The forecasters at KTBW (WFO Tampa Bay, FL) used the GOES-R FLS products to brief the U.S. Coast Guard (USCG) during a fog event in the NE Gulf of Mexico in early February 2013. 2) In June, GOES-14 was placed into SRSO after acting as a backup to GOES-13 when it experienced an anomaly. During a severe weather event on June 13, GOES-14 captured one-minute visible imagery of a severe bow echo. 3) Amanda Terborg (Aviation Weather Center) provides an update on aviation forecasting and satellite applications at the AWC at the NOAA Satellite Conference in April. 4) GOES-R Satellite Liaison Michael Folmer with his poster, "The 2012 HPC/OPC/TAFB/SAB GOES-R/JPSS Proving Ground Demonstrations" at the 93rd Annual AMS Meeting in Austin in January. 5) Dave Schneider of the United States Geological Survey (USGS) gives a tour of the Alaska Volcano Observatory in Fairbanks during the GOES-R/JPSS OCONUS Proving Ground Technical Interchange Meeting in June. 6) GOES-14 visible (left) and Infrared (right) Super Rapid Scan Operations (SRSO) one-minute imagery of the Yosemite Rim fire on August 27, 2013. 7) The 2013 NOAA Satellite Science Week meeting was held as a "virtual" meeting, run from the Cooperative Program for Operational Meteorology, Education, and Training (COMET) in Boulder, CO. Attendees dialed in from all over the U.S. and from locations in South America and Europe. 8) Forecasters test GOES-R products at the Hazardous Weather Testbed (HWT) during the 2013 Spring Experiment.

## 1. Introduction and Background

The GOES-R Proving Ground (PG) is a collaborative effort between the GOES-R Program Office, selected NOAA Cooperative Institutes, NWS forecast offices, NCEP National Centers, the Joint Center for Satellite Data Assimilation, the NASA Short-Term Prediction Research and Transition Center, and NOAA testbeds where proxy and simulated GOES-R products are tested and evaluated in an operational environment before the GOES-R launch. The objective of the PG is to bridge the gap between research and operations by ensuring that there is two-way communication between product developers and the user communities. The intended outcome is that users will be ready for optimal use of GOES-R products on day-1 of operations.

The next generation GOES will continue providing valuable data to support high impact weather warnings as well as key inputs for global and regional NWP models. The large volume of GOES-R data will present new challenges and opportunities that require more intelligent integration of information derived from blended satellite products (e.g., geostationary and polar satellite observations), multi-dimensional classification of severe storm potential by combining satellite, radar, in-situ data and models, and new ways of visualizing GOES-R data within the AWIPS-II forecaster workstation. Algorithm developers at NESDIS, NASA SPoRT, and the NOAA cooperative institutes are already creating JAVA-based satellite application plug-ins for AWIPS-II, which will quickly accelerate the transition from research to operations at NWS.

This report will describe the PG activities leading to an evaluation of the operational value of the proxy GOES-R products and user feedback for future improvements. All report content was obtained from reports and PG participants.

## 2. Proving Ground Demonstrations

- **a.** Hazardous Weather Testbed (HWT) Spring Experiment (7 May 2013 – 24 May 2013). Participants included 18 NWS forecasters and 9 visiting scientists.
- **b.** National Hurricane Center (NHC) Tropical Cyclone Demonstration (1 August 2012 – 30 November 2012) Participants included forecasters from NHC and scientists from NESDIS STAR, CIRA, CIMSS, and SPoRT.
- **c.** Aviation Weather Center (AWC) Winter Experiment (11 February 2013 - 22 February 2013) and Summer Experiment (12 August 2013 – 23 August 2013). Participants included AWC and Weather Forecast Office (WFO) forecasters, external visitors from: the Federal Aviation Administration, Lockheed Martin, the National Transportation Safety Board, NCAR, NASA Langley Research Center, United Parcel Service, and research scientists from the Air Force Weather Agency, the GOES-R program, Earth Networks, NOAA laboratories, and a number of universities.
- **d.** WPC/ OPC/ SAB demonstrations (1/1/12 – 4/30/12) (ongoing: focus on precipitation and ocean applications). Participants include forecasters at WPC, OPC, and SAB.
- **e.** High Latitude and Arctic Testbed (ongoing: focus on snow/ fog and low stratus/ volcanic ash/ and aviation applications). Participants include NWS Alaska Region, Alaska Pacific River Forecast Center, CIMSS, SPoRT, and UAF.
- **f.** Air Quality (ongoing: focus on aerosol product development and applications). Activities led by scientists from UMBC and NESDIS STAR; participants include Pennsylvania

State University Meteorology Departments as well as federal, state, and local air quality forecasters, modelers, and analysts.

**g.** Pacific Region OCONUS Demonstration (ongoing: focus on tropical cyclones/ heavy rainfall/ and aviation applications) Participants include NWS forecasters and scientists from the University of Hawaii.

**h.** NWS Central Region Fog and Low Stratus Evaluation (1 August 2012 – 31 December 2012). Participants included NWS forecasters at Des Moines, IA; Pleasant Hill, MO; Indianapolis, IN; Jackson, KY; Louisville, KY; St. Louis, MO; Marquette, MI; Riverton, WY.

**i.** Alaska and Puerto Rico GOES-R QPE Assessment (15 July 2013 – 15 September 2013). Participants included NWS forecasters at Juneau, AK; Anchorage, AK; Fairbanks, AK; San Juan, Puerto Rico; Alaska Pacific River Forecast Center.

## 3. Funding / Opportunity Announcements

The Proving Ground demonstrations are supported through grants and contracts funded by the GOES-R Program Science Office via proposals for risk reduction research as well as visiting scientist travel grants to participate in the demonstrations. Technical interchange meetings are held throughout the year to review the PG demonstration projects with a major virtual All-Hands meeting of participants during Satellite Science Week.

## 4. Significant Outcomes and Product Assessment Highlights

1. The Fog and Low Stratus products are currently scheduled to be operationalized on OSPO ESPC systems and will be delivered to NWS users via the Satellite Broadcast Network (SBN), NCEP Central Operations (NCO) backbone, Direct Broadcast, and possibly AWIPS Data Distribution Service (DDS) as an alternative.
2. The RGB Dust product is now used routinely by TAFB (Tropical Analysis Forcaste branch) forecasters as input to their Tropical Weather Discussion product. It was especially useful for helping to diagnose the atmospheric stability in the early stage of Tropical Storm Florence. TAFB is considering developing a new graphical public product to depict areas of dust.
3. Simulated Satellite Forecasts as of July 2013 are available in AWC operations (experimental). GOES-R Convective Initiation (CI) will be transitioned into AWC operations (experimental) later this fall. The Cloud Top Cooling (CTC) product was transitioned into AWC operations (experimental) in the fall of 2012 and the use of the product has continued to gradually increase within the past year. The Pseudo Geostationary Lightning Mapper (PGLM) transition into AWC operations (experimental) is expected by the end of September 2013. SRSO (Super Rapid Scan Operations), whenever GOES-14 is activated, is made available to AWC operations for display in N-AWIPS. Additionally, as part of the Fog and Low Stratus suite, the Cloud Top Phase is available in AWC (experimental) operations.
4. The RGB product is in OPC, WPC, SAB operations (experimental).
5. The SRSOR 1-minute imagery, from the spare satellite GOES-14, was reactivated for the latter part of the month of August, allowing for forecaster evaluation during the AWC Summer Demonstration (2013) and the NHC Demonstration (2012). This imagery was meant to emulate the expected temporal resolution of GOES-R and was popular among

forecasters, particularly for the excellent situational awareness it provides via the additional detail in areas of rapid convective development.

**Additional product assessments will be found in the individual Proving Ground and Testbed reports at http://www.goes-r.gov/users/pg-activities-01.html**

## 5. Proving Ground Activities that Worked Well

### *5.1 Hazardous Weather Testbed 2013*

a. Based on 2012 feedback, the most significant change to this year's HWT experiment was the effort to stimulate interactions among diverse user groups within the HWT and the broader weather communities. Most notable was the collaboration between Experimental Warning Program (EWP) warning activities and Experimental Forecast Program (EFP) forecasting activities. Each afternoon, participants from the EWP joined those from the EFP for a collaborative discussion regarding current and expected hazardous convection. Such discussions strengthened the relationship between the two programs and maximized the Operations-to-Research feedback received from forecasters. While more cross-participation is planned for future years, the interactions between the EFP and EWP this year helped develop an end-to-end forecast generation/discussion, from outlook to mesoscale discussion, watch, and warning.
b. The Spring Experiment, though slightly smaller and shorter than in previous years to due budget restrictions, proved very beneficial. Despite only having 18 NWS forecasters in attendance, there were still 108 real-time blog posts, 3 weekly webinars, and the post-event surveys.
c. Forecasters were pleased with the GOES-R product training, with most preferring to receive the training material prior to their arrival at the HWT. This not only gave them a chance to familiarize themselves with the products before using them in a simulated operational environment, but it also allowed for shorter spin-up time during their first experimental shift.
d. In post event surveys, participants were asked how comfortable they felt with each product and if they believed the products would have an impact on their WFO operations. Roughly 70% indicated they would use the Simulated Satellite imagery, most of which indicated they would utilize it most in the pre-storm period. Similarly, about 78% indicated the benefit of having the NearCast data available within the 1 to 3 hour forecast period, while 67% also reported that it was useful in the 3 to 6 hour period. 53% reported at least some to large impact of the CI product during the experiment, roughly 70% used and were comfortable with the CTC, and nearly 80% found the pGLM useful. Lastly, only 40% reported that they would be comfortable using the RGB Airmass product in operations. This low percentage is likely due to the less intuitive nature of the product and the lack of in-depth training materials.

### *5.2 National Hurricane Center 2012*

a. The availability of GOES-14 provided numerous opportunities to obtain SRSOR imagery. GOES-14 was made available to the PG and science teams during its out-of-storage testing and made it possible to obtain 28 images per half hour. The SRSOR data have greater utility for monitoring changes in convective activity, especially for storms such as Hurricane Isaac when it was in the central Gulf of Mexico, where the inner core circulation is the formative stage. TAFB forecasters found the SRSOR data useful for their tropical weather discussions,

and helped document convection within tropical waves. Hurricane Specialist Unit (HSU) and TAFB forecasters indicated that the full value of the SRSOR data will realized when it is fully exploited in atmospheric motion vector algorithms and then assimilated into hurricane forecast models. This work is underway through support by the GOES-R program office and the Hurricane Forecast Improvement Project (HFIP).

b. The RGB Air Mass product continues to be one of the most highly utilized PG products. RGBs offer additional situational awareness for forecasters above and beyond the standard product algorithms. The HSU forecasters found it useful for analyzing the moisture structure in Subtropical Storm Beryl, identification of dry air wrapping around Hurricane Gordon and monitoring the evolution of a trough upstream of that cyclone. The product was also useful for identifying air mass boundaries and interaction with upper level potential vorticity anomalies during Nadine. More experience is still needed to understand the behavior of the product in some cases, and tuning might be needed to better represent tropical cyclone applications. For example, the evolution of the product for Hurricane Gordon when it reached the subtropics was complicated, with the product indicating dry air in regions where there was still likely moist air in the low levels. There may also be some ambiguity between regions of stratospheric air and lofted dust.
c. The availability of the Saharan Air Layer and Pseudo Natural Color Imagery products in N-AWIPS format this year increased their utility.

### *5.3 Aviation Weather Center 2013*

*5.3.1Winter Experiment*

a. The first annual Winter Weather Experiment, though designed as a smaller scale demonstration, proved to be beneficial to the GOES-R Research to Operation (R to O) effort at the Aviation Weather Center. Forecasters appreciated the chance to explore new satellite tools and also those previously evaluated within the Summer Experiment, from a winter season perspective. Given the limited time to view new datasets during a regular shift, they were also eager to provide a more in-depth evaluation.
b. While all of the products were well received, the Simulated Satellite Forecasts were by far the most popular amongst participants and consistently were praised with very positive feedback. In fact, many forecasters requested use of this data during their shifts and it is anticipated that these Baseline products will be at the top of the list for implementation.
c. Unlike the 2012 AWC Summer Experiment, which consisted of four desks constructed around various new forecasting tools (i.e. high-resolution verification, GOES-R, etc.), the 2013 demonstration consisted of four ‘mock’ operational desks including a World Area Forecast (WAF) Global Graphics (GG) desk, a Convective SIGMET (CSIG) desk, a Collaborative Convective Forecast Product (CCFP) desk, and a National Aviation Meteorologist (NAM) desk.

*5.3.2 Summer Experiment*

a. Using the success of the 2013 Winter Experiment structure as a basis, it was redesigned to account for desks currently found on the AWC operations floor. This, as well as the inclusion of a Situational Awareness desk, provided participants a chance to explore and evaluate the products in an operational-like setting and proved to be very beneficial to the GOES-R Research to Operations effort at the Aviation Weather Center.

b. The Simulated Satellite Forecasts continues to be a very popular forecast tool, particularly now that it has been transitioned into AWC operations and forecasters have been using it more frequently in their day to day procedures. However, the Nearcasting model has also drawn the interest of forecasters, its fields providing valuable information on both the likelihood of convection initiation and the behavior of ongoing convection in the 1-9 hour period.
c. The improvements made to the GOES-R CI over the past year, including the generation of the new fused version and the change of formats to increase the loading speed, showed a great amount of potential as a forecast tool in the 0-2 hour period, but also was often used in tandem with the CTC to increase confidence in convective behavior, from growth to maturity and cessation. This was particularly important at the CSIG and NAM desks, as both are responsibility for convection forecasting during this time period.
d. The PGLM saw perhaps the most improvement of any product, featuring a new color bar as well network status bars and the addition of data from a number of new Lightning Mapping Array (LMA) networks. Forecasters were very pleased to see this new display, especially when monitoring the rapid development and intensification of convection; however the limited domains of the LMAs inhibited frequent use of the product.
e. Overall forecasters were very pleased with the SRSOR1-minute imagery and look forward to seeing it in operations on a permanent basis come the launch of GOES-R. This imagery, whenever GOES-14 is activated, is made available to AWC operations for display in N-AWIPS.
f. Following the discussion at the Winter Experiment, one-page fact sheets were made available to participants in the Summer Experiment, providing a brief summary and example of the various GOES-R datasets. Having a strong base knowledge of these tools allowed for a higher degree of confidence in interpretation of each product and subsequently a more in-depth evaluation.

### *5.4 High Latitude and Arctic Testbed 2013*

a. Two versions of the Fog and Low Stratus (FLS) product are available on AWIPS at the NWS in Alaska: a version derived from GOES West and a version derived from MODIS. Some "false positive" noise signals over Alaska's interior in the GOES-derived version of the FLS product have been detected and are attributed to a stray light issue with the GOES satellite. Ways to mitigate this issue are being assessed. The MODIS-derived FLS has proven to have much less of a problem with such "false positive" signals in Alaska.
b. Data from MODIS, functioning as a proxy for the GOES-R ABI, are being used by the River Forecast Center (RFC) in Anchorage as an input to their hydrologic models during spring break-up. The MODIS data help the RFC determine which areas have become snow-free and which areas still have snow that can melt and flush additional water into the river system. In the future, Alaska Fire Service may be interested in using this GOES-R approach to assess the retreat of snow cover (and thus the onset of the potential fire season) with more temporal and spatial precision than they have been able to use in the past.
c. WFO Anchorage's Ice Desk continues to use MODIS imagery to assess ice cover. This also includes discriminating between ice and clouds, something the MODIS false-color imagery does very well.
d. With regard to volcanic ash, MODIS imagery has been used not only when volcanoes erupt, but even in cases of "re-suspension" when winds pick up ash from historic eruptions.

### *5.5 Air Quality 2013*

a. Results from the three air quality demonstrations have concluded with a system that provides a framework for other operational products including MODIS and VIIRS. To that end, the JPSS team has requested (including leveraged funding) that the Air Quality Proving Ground be expanded to cover JPSS aerosol products for training of the user community in those results, as well as GOES-R future products.
b. NESDIS STAR has developed a capability to simulate aerosol optical depth using a combination of the Weather Research and Forecasting (WRF) Community Multi-scale Air Quality Model (CMAQ) (a prognostic model which forecasts aerosol concentration fields), the Community Radiative Transfer Model (CRTM that translates aerosol concentration and radiative effects to predict on-orbit radiances that GOES-R will see) and the ABI aerosol processing system (to display the GOES-R operational aerosol products). This system is correctly classified as an OSSE (observational system simulation experiment) and allows "flying" the spacecraft before launch. These results have been used in training of the Air Quality Users Group.
c. In March 2013, 45 participants attended the third user training workshop (federal, state and local air quality forecasters) held at the University of Maryland Baltimore County campus. Attendees examined test cases of GOES-R simulations and provided feedback on the display system that will be available after launch. Results of the workshops have fine-tuned user requirements to the point that a web-based delivery module (similar to that currently operational for the GOES Aerosol and Smoke Product (GASP), MODIS and VIIRS imagers) is now ready for deployment after GOES-R launch.

### *5.6 NWS Central Region FLS Evaluation 2012*

a. The majority of forecasters thought the GOES-R FLS products were successful at providing probabilistic guidance of exceeding flight-rule thresholds and would use the products again in operations.
b. The majority of forecasters thought that the GOES-R FLS products performed well when compared to surface observations (69%) and the legacy channel difference product (71%).
c. The probabilistic products provided confidence to the majority of users that FLS was present during an unobstructed view to the liquid water clouds as well as when high clouds were present.
d. Forecasters suggested, at least currently, that the GOES-R FLS products should be used in combination with more traditional FLS detection tools.
e. The WFO POCs (points-of-contact) suggested that additional research should be completed on how the Fog Depth product can be used to diagnose the dissipation time for the liquid cloud layer.
f. The WFO POCs thought the product training was more than adequate for the evaluation, but thought some forecasters did not understand the basics of probabilistic guidance.
g. The majority of forecasters (67%) used the Simulated Satellite Forecasts to update their short-term forecasts.
h. The Simulated Satellite Forecasts were included in 19 NWS Area Forecast Discussions.
i. Almost half of forecasters thought the Simulated Satellite Forecasts were extremely or very useful and 86 percent were either extremely or very likely to use the products again.

j. Despite model limitations and errors in the forecasts, results from the Simulated Satellite Forecast evaluation show there is a need for this type of information when producing short-term forecasts.

***5.7 Alaska/San Juan Quantitative Precipitation Estimation (QPE) 2013***

a. Participants most often found GOES-R QPE somewhat useful over data-deprived regions, such as mountainous terrain or over oceans, trending toward more favorable responses at the end of the two-month evaluation period. For events in which GOES-R QPE would consistently under-estimate the rainfall rate, participants could account for the bias and found the product useful despite the under-estimate.
b. Participants were also asked to compare GOES-R QPE to other rainfall estimates. In most events, regardless of precipitation type (e.g. Terrain-Influenced, Atmospheric River, Convective, etc.) or accumulation product used, the forecasters responded that GOES-R QPE underestimated precipitation and typically QPE was found to be less than or equal to half of other precipitation point observations. The most commonly cited reason for this under-estimate in San Juan, as diagnosed by forecasters and the algorithm team from analysis of case studies collected during the evaluation, was likely the temporal and spatial resolution of the product on current GOES.

**6. Lessons learned that are relevant to future projects and/or agency priorities:**

In the HWT spring experiment, with the exception of the RGB Airmass imagery, forecasters found the training material appropriate and informative. One suggestion to improve and further solidify these training efforts is the inclusion of quick guides for each product. There were several provided by various project investigators this year, all of which were very beneficial for forecasters to use as a reference if they found themselves needing further clarification during activities.

**7. Methods to foster collaborations between research and operations/ applications and external stakeholders**

Planned initiatives to foster collaborations between research and operations/applications and external stakeholders are the visiting scientist program, bringing forecasters and product developers to the Hazardous Weather Testbed, monthly science seminars, bi-annual forecaster forums, and broadcaster participation in workshops and future proving ground demonstrations. These methods help to fulfill the goal of aligning the Proving Ground with the NOAA Weather Ready Nation initiative.

The Air Quality Proving Ground relies on a seamless interaction between NOAA and state and federal air quality forecasters who work for other agencies. The Proving Ground workshops have demonstrated significant external interest in GOES-R and the promise of the new ABI and can be used for other NOAA sensors as well. These results will be expanded to include YouTube videos and demonstrations at AMS and AGU in the NOAA booth to reach an even wider audience in the air quality community.

**8. Project alignment with agency technical and service priorities**

The alignment with NWS and NOAA service priorities is coordinated through the Office of Science and Technology and the NWS Operational Advisory Team (NOAT), comprised of the Region Scientific Services Division chiefs and a representative from NCEP.

**9. Balance of PG portfolio (incremental evolutionary ideas vs larger revolutionary ideas)**

The PG portfolio priorities in order are user readiness for the at-launch baseline products, followed by the new products and applications made possible by the advanced capabilities of the GOES-R instruments. The revolutionary advancements will come from the development of fused products and decision aids that will be possible with enterprise processing systems and early integration into AWIPS-II.

**10. Demonstrations of consistent practices with guidelines**

Guidelines for PG demonstrations are developed by the Science and Demonstration Executive Board in coordination with the NOAT and satellite liaisons.

**11. Efficiency and effectiveness of PG in terms of timeliness, cost savings, cost sharing, re-use and/or low overhead.**

Efficiency is achieved through regular virtual technical interchange meetings while resources are used most effectively through partnerships with our Proving Ground partners and NOAA Testbed facility managers. Utilizing forecasters who are already on-site, and at nearby offices, to participate in demonstrations is an effective way to reduce costs in the Proving Ground. They receive product training during regularly scheduled shifts which has no additional cost to the program.

**12. Leveraged resources from broader community**

Leveraged resources are provided by NASA SPoRT, Cooperative Institute infrastructure, and NOAA Testbeds. Resources from JPSS have provided additional support for select satellite liaisons and the Air Quality Proving Ground activities.

**Appendix A: 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.

Cintineo, R., J. A. Otkin, F. Kong, and M. Xue, 2013: Evaluating the accuracy of planetary boundary layer and cloud microphysical parameterization schemes in a convection permitting ensemble using synthetic GOES-13 satellite observations. Accepted for publication in Mon. Wea. Rev.

DeMaria, M., J.A. Knaff, M.J. Brennan, D. Brown, R.D. Knabb, R.T. DeMaria, A.B. Schumacher, C.A. Lauer, D.P. Roberts, C.R. Sampson, P. Santos, D. Sharp, K.A. Winters, 2013: Improvements to the Operational Tropical Cyclone Wind Speed Probability Model. *Weather and Forecasting*. 586–602. doi: 10.1175/WAF-D-12-00116.1

Ding, S., P. Yang, B. A. Baum, A. Heidinger, and T. Greenwald, 2013: Development of a GOES-R Advanced Baseline Imager solar channel radiance simulator for ice clouds. *J. Appl. Meteor. Climatol*., 52 (4), 872–888, doi: 10.1175/JAMC-D-12-0180.1

Goni, G. J, J.A. Knaff, I-I. Lin, 2013: [The Tropics] Tropical Cyclone Heat Content [in "State of the Climate in 2012"]. *Bull. Amer. Meteor. Soc*., 94 (8), S99-S100.

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.

Grasso L.D, D.W. Hillger, C. Schaaf, Z. Wang, R.L. Brummer, and R. DeMaria, 2013: Use of MODIS 16 Day Albedos in Generating GOES-R Advanced Baseline Imager (ABI) Imagery. *J. Appl. Remote Sens*., 7 (1), 073584; doi: 10.1117/1.JRS.7.073584

Hillger, D.W., T. Kopp, T. Lee, D.T. Lindsey, C. Seaman, S.D. Miller, J. Solbrig, S.Q. Kidder, S. Bachmeier, T. Jasmin, and T. Rink, 2013: First Light Imagery from Suomi NPP VIIRS. *Bull. Amer. Meteor. Soc*., 94 (7), 1019-1029, doi:10.1175/BAMS-D-12-00097.1

Jedlovec, G., 2013: Transitioning research satellite data to the operational weather community: The SPoRT Paradigm. *Geoscience and Remote Sensing Magazine (*March, L. Bruzzone, editor), **1**, No. 1, , Institute of Electrical and Electronics Engineers, Inc., New York, pages 62-66.

Knaff, J.A., M. DeMaria, C.R. Sampson, J.E. Peak, J. Cummings, W.H. Schubert, 2013: Upper oceanic energy response to tropical cyclone passage. *J. Climate*, 26, 2631–2650. doi: 10.1175/JCLI-D-12-00038.1

Knapp, K.R., J.A. Knaff, C.R. Sampson, G. Riggio, and A. Schnapp, 2013: A pressure-based

analysis of the historical western North Pacific tropical cyclone intensity record. *Mon. Wea. Rev.*,141, 2611–2631. doi: 10.1175/MWR-D-12-00323.1

Li, X., J.A. Zhang, X. Yang, G. Pichel, M. DeMaria, D. Long, and Z. Li, 2013: Tropical cyclone morphology from spaceborne synthetic aperture radar. *Bull. Amer. Meteor. Soc*., 94, 215-230

Lin, I-I, G.J. Goni, J.A. Knaff, C. Forbes, M.M. Ali, 2013: Tropical cyclone heat potential for tropical cyclone intensity forecasting and its impact on storm surge. *Nat. Hazards*. 66, 1481-1500. doi:10.1007/s11069-012-0214-5

Lindsey, D.T., T.J. Schmit, W.M. MacKenzie, Jr., C. P. Jewett, M.M. Gunshor, L.D. Grasso, 2012: 10.35 μm: atmospheric window on the GOES-R Advanced Baseline Imager with less moisture attenuation. *J. Appl. Remote Sens*., 6 (1), 12, doi: 10.1117/1.JRS.6.063598

Molthan, A. and G. Jedlovec, 2013: Satellite Observations Monitor Outages from Superstorm Sandy, *Eos*, Vol. 94, No. 5, 29 January 2013.

Noh, Y. J., C. J. Seaman, T. H. Vonder Haar, and G. Liu, 2013: In situ aircraft measurements of water content profiles in various midlatitude mixed-phase clouds. *J. Appl. Meteor. Climatol*., 52, D110202, doi:10.1175/JAMC-D-11-0202.1

Pavolonis, M. J., A. K. Heidinger, and J. Sieglaff, 2013: Automated retrievals of volcanic ash and dust cloud properties from upwelling infrared measurements. *J. Geophys Res.,* 118, doi:10.1002/jgrd.50173

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*., doi:10.1175/BAMS-D-12-00080.

Setvak, M., K. Bedka, D.T. Lindsey, A. Sokol, Z. Charvat, J. Stastka, P.K. Wang, 2013: A-Train observations of deep convective storm tops. *Atmos. Research*, 123, 229-248. doi: 10.1016/j.atmosres.2012.06.020

Sharma, N., M.M. Ali, J.A. Knaff, and P. Chand, 2013: A soft-computing cyclone intensity prediction scheme for the Western North Pacific Ocean. *Atmos. Sci. Lett*., 14,187–192. doi: 10.1002/asl2.438

Sitkowski, M., J.P. Kossin, C.M. Rozoff, and J.A. Knaff, 2012: Hurricane eyewall replacement cycle thermodynamics and the relict inner eyewall circulation. *Mon. Wea. Rev.*, 140, 4035–4045. doi: 10.1175/MWR-D-11-00349.1

Zavodsky, B. T., J. L. Case, C. B. Blankenship, W. L. Crosson, K. D. White, 2013: Application of next-generation satellite data to a high-resolution, real-time land surface model, *Earthzine*, J. Kart, editor, Institute of Electrical and Electronics Engineers [Available online at http://www.earthzine.org/2013/04/10/application-of-next-generation-satellite data-to-a-high-resolution-real-time-land-surface-model/.]

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.*, 1 (7), 71-83

Zhang, H., R. M. Hoff, S. Kondragunta, I. Laszlo, and A. Lyapustin, 2013. Aerosol optical depth (AOD) retrieval using simultaneous GOES-East and GOES-West reflected radiances over the western United States. *Atmos. Meas. Tech.* 6, 471-486. doi:10.5194/amt-6-471-2013

## Appendix B: Conference/Meeting Presentations

**Jim Gurka and Steve Goodman gave oral presentations on the GOES-R Proving Ground at the following conferences/meetings:**
2013 AMS Annual Meeting, Austin, TX, January 7-10.
2013 NOAA Virtual Satellite Science Week, March 18-22.
2013 NOAA Satellite Conference, College Park, MD, April 8-12.
2013 OCONUS Proving Ground Meeting, Fairbanks and Anchorage, AK, June 17-21.

**Satellite Liaisons gave oral presentations on GOES-R Proving Ground activities at the following conferences/meetings:**
2013 AMS Annual Meeting, Austin, TX, January 7-10.
2013 Interdepartmental Hurricane Conference, College Park, MD, March 5-7.
2013 NOAA Virtual Satellite Science Week, March 18-22.
2013 NOAA Satellite Conference, College Park, MD, April 8-12.
2013 OCONUS Proving Ground Meeting, Fairbanks and Anchorage, AK, June 17-21.
2013 Annual National Weather Association meeting, Charleston, SC, October 12-17.

**Air Quality presentations:**

Hai Zhang, H., R. M. Hoff, S. Kondragunta, I. Laszlo, A. Lyapustin, Aerosol Optical Depth (AOD) Retrieval using GOES-East and GOES-West Reflected Radiances over the Western United States, Paper A23J-05, American Geophysical Union Fall Meeting, San Francisco, CA , December 3-7, 2012.

2013 Air Quality Workshop Presentations:
http://alg.umbc.edu/aqpg/2013_workshop_agenda.htm

**SPoRT conference presentations**:

Berndt, E., B. Zavodsky, and G. Jedlovec, 2013: Impact of the Assimilation of Hyperspectral Infrared Retrieved Profiles on Advanced Weather and Research Model Simulations of a Non-Convective Wind Event. 38th NWA Annual Meeting, Charleston, SC.

Berndt, E., Zavodsky, B., Molthan, A. Molthan, and G. Jedlovec, 2013: The Use of Red Green Blue Air Mass Imagery to Investigate the Role of Stratospheric Air in a Non-Convective Wind Event. 38th NWA Annual Meeting, Charleston, SC.

Blankenship, C., B. Zavodsky, G. Jedlovec, and G. Wick, 2013: Impact of AIRS Thermodynamic Profiles on Precipitation Forecasts for Atmospheric River Cases Affecting the Western of the United States. AMS Annual Meeting, January 6-10, 2013, Austin, Texas.

Case, J. L., S. V. Kumar, R. J. Kuligowski, and C. Langston, 2013: Comparison of Four Precipitation Forcing Datasets in Land Information System simulations over the Continental U.S. Hydrology Conference, AMS Annual Meeting, January 6-10, 2013, Austin, Texas

Jedlovec, G. J., 2013: SPoRT: Transitioning NASA and NOAA Experimental Data to the Operational Weather Community. Preprints, Third Conference on Research to Operations, AMS Annual Meeting, January 6-10, 2013, Austin, Texas.

Molthan, A. L., K. K. Fuell, F. LaFontaine, K. McGrath, and M. Smith, 2013: Current and Future Applications of Multispectral (RGB) Satellite Imagery for Weather Analysis and Forecasting Applications. AMS Annual Meeting, January 6-10, 2013, Austin, Texas.

Smith, M., K. McGrath, and J. Burks, 2013: AWIPS II Application Development, a SPoRT Perspective. AMS Annual Meeting, January 6-10, 2013, Austin, Texas.

Stano, G. T., B. C. Carcione, K. D. White, and C. J. Schultz, 2013: Low Topped Convection and Total Lightning Observations from North Alabama. Sixth Lightning Conference, AMS Annual Meeting, January 6-10, 2013, Austin, Texas

Stano, G. T., J. A. Sparks, S. J. Weiss, and C. W. Siewert, 2013: Fusing Total Lightning Data with Aviation Weather Center and Storm Prediction Center Operations during the GOES-R Visiting Scientist Program. 9th Future Satellites Symposium, AMS Annual Meeting, January 6-10, 2013, Austin, Texas

White, K. D., and J. L. Case, 2013: The Utility of the Real-Time NASA Land Information System Data for Drought Monitoring Applications. Hydrology Conference, AMS Annual Meeting, January 6-10, 2013, Austin, Texas.

White, K. D., G. Stano, and B. Carcione, 2013: Utility of North Alabama Lightning Mapping Array Data and Implementation Strategies in AWIPS II, 38th NWA Annual Meeting, Charleston, SC.

White, K. D., G. T. Stano, and B. Carcione, 2013: An Investigation of North Alabama Lightning Mapping Array Data and Usage in the Real-time Operation Warning Environment During the March 2, 2012 Severe Weather Outbreak in Northern Alabama. Sixth Lightning Conference, AMS Annual Meeting, January 6-10, 2013, Austin, Texas.

**CIRA Conference Presentations:**

2013 AMS Annual Meeting, Austin, TX, January 7-10.

2013 Hazardous Weather Workshop, Norman, OK, February 6-7.
2013 Eastern Region Virtual Satellite Workshop, February 26.
2013 Interdepartmental Hurricane Conference, College Park, MD, March 5-7.
2013 EPDT/AWIPS II workshop with SPoRT, March 12-14.
2013 NOAA Virtual Satellite Science Week, March 18-22.
2013 NOAA Satellite Conference, College Park, MD, April 8-12.
Grasso, L., 2013: SPC Spring Experiment, Norman, OK, May 6-10.
2013 OCONUS Proving Ground Meeting, Fairbanks and Anchorage, AK, June 17-21.
DeMaria, M., 2013: Honolulu WFO, July 8-11.
2013 CoRP Symposium, Madison, WI, July 23-24.
Szoke, E., 2013: Aviation Weather Center Testbed, Kansas City, MO, August 12-16.
2013 EUMETSAT/AMS Satellite Conference, Vienna, Austria, September 16-20.
2013 AWIPS II EPDT code spring working session, Huntsville, AL, September 23-27.
2013 Boulder WFO Winter Weather Workshop, September 30 and October 2.
2013 Annual National Weather Association meeting, Charleston, SC, October 12-17.

**CIMSS Conference Presentations can be found at the following website**:
http://library.ssec.wisc.edu/research_Resources/bibliographies/goesr#2013
(Listed under "Gray Literature")

**Posters:**
Use of GOES-R Imagery in the Detection of Volcanic Ash and the Production of Aviation Warning in Alaska – Tom Heinrichs, GINA, N. Eckstein, and E. Stevens, Fairbanks, AK (presented at NSC Apr. 2013)

Verification of the GOES-R Fog and Low Stratus Products in Central California – Chad Gravelle Central Region - Chad M Gravelle, CIMSS/SSEC/University of Wisconsin-Madison, NWS Operations Proving Ground, Kansas City, MO (Presented at NWA Oct. 2013)

An Overview of the Tampa Bay, FL High-Impact Sea Fog and Low Stratus Event on 23-24 February 2013 – Chad M Gravelle, CIMSS/SSEC/University of Wisconsin-Madison, NWS Operations Proving Ground, Kansas City, MO (Presented at NWA Oct. 2013)

Improving the Depiction of Moisture Transport in short-range Forecasts of the Pre-Convective Environment - William Line, University of Oklahoma - CIMMS and NOAA/NWS/Storm Prediction Center, Norman, OK and R. Petersen (presented by Petersen at EUMETSAT Sept. 2013)

Satellite Observed Signatures Associated with Moderate to Severe Turbulence Events – Amanda Terborg, CIMSS/SSEC/University of Wisconsin-Madison, AWC Kansas City, MO, and K. Bedka (presented at NSC Apr. 2013)