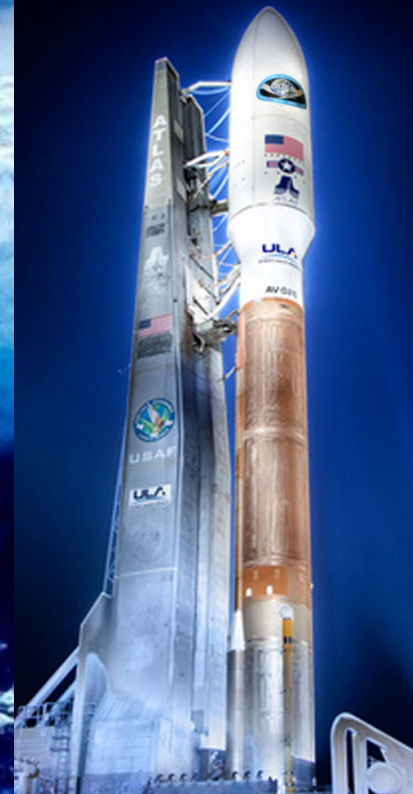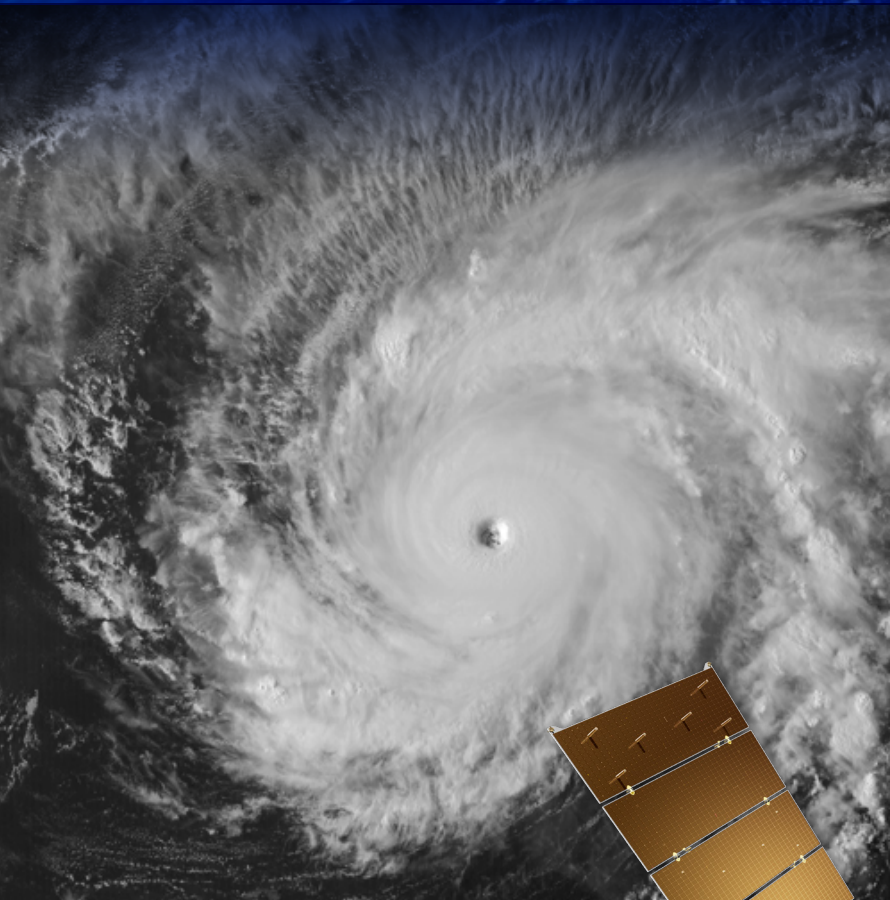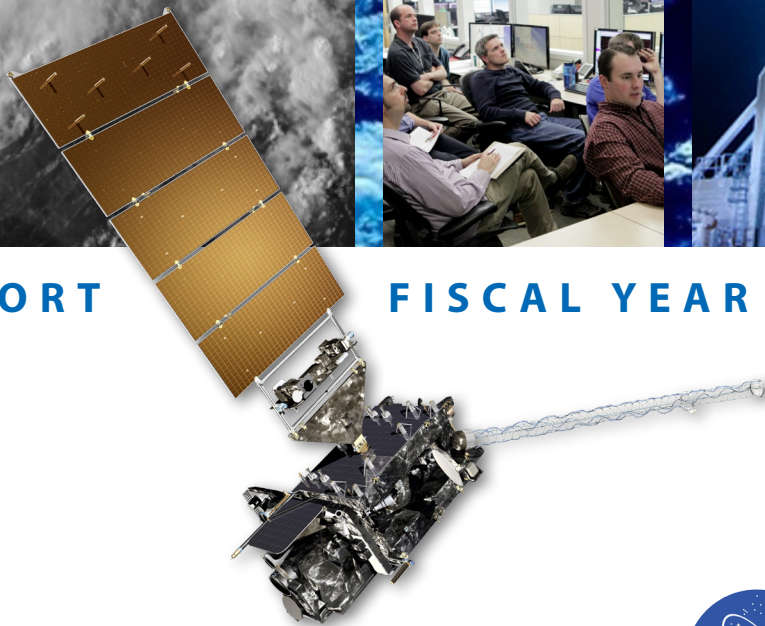# GOES-R Proving Ground

ANNUAL REPORT   **FISCAL YEAR 2015**

Proving Ground Annual Report Fiscal Year 2015

Contents

1. **Introduction and Background**

The Geostationary Operational Environmental Satellite R-Series (GOES-R) Proving Ground (PG) is a collaborative effort between the GOES-R Program Office, selected National Oceanic and Atmospheric Administration (NOAA) Cooperative Institutes, National Weather Service (NWS) forecast offices, National Centers for Environmental Prediction (NCEP), the Joint Center for Satellite Data Assimilation (JCSDA), the NASA Short-Term Prediction Research and Transition Center (SPoRT), 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 Numerical Weather Prediction (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 Advanced Weather Interactive Processing System - Version II (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.

The GOES-R Proving Ground Annual Report describes the major Proving Ground (PG) activities where the operational value of the GOES-R products and capabilities is evaluated through the use of proxy data, user feedback is collected to identify algorithm/product/service improvements, and project reports contribute to an Annual Guidance Memorandum from the Line Office representatives on the recommended priorities for future research and the transition from research to operations (R2O). All report content was obtained from demonstration reports which PG participants submitted for Fiscal Year 2015 (http://www.goes-r.gov/users/proving-ground.html).

Proving Ground Demonstrations at the NOAA Service Centers and Testbeds in FY2015 include:

A. Hazardous Weather Testbed (HWT)
B. Storm Prediction Center (SPC)
C. National Hurricane Center (NHC)
D. NOAA Aviation Weather Center (AWC)
E. The Satellite Proving Ground for Marine, Precipitation, and Satellite Analysis (OPC, WPC, TAFB)
F. High Latitude Proving Ground (AK Region)
G. NWS Operations Proving Ground (OPG)

Project alignment with agency technical and service priorities:
- Supports Weather Ready Nation
- Satellite Observing System Continuity
- Forecaster Day-1 readiness for GOES-R

2. Performance Measures for FY 2015

Relevance Metric: Number of GOES-R products evaluated and feedback documented in the Project Plans. See Table 1 below:

Table 1. GOES-R product assessments at the NOAA Testbeds

Testbeds and Proving Grounds		Transitions 2014				
Facility	Major Tests Conducted	Transitioned to Operations	Recommended for Trans. to	Advanced to Experimental Testing	Rejected for further Testing	Decision pending or deferred on
GRPG	Total: 20					
	Himawari Derived Motion Winds		1			
	Himawari Radiances		1			
	Himawari Cloud Products		1			
	Probability of Severe Model		1			
	Meso rapid scan (GOES-14 1-min proxy for ABI)	1				
	VolAsh	1				
	Nearcasting Model			1		
	Cloud Cover Layers		1			
	RGB Airmass			1		
	GOES-R RGB Nighttime Microphysics Product			1		
	Dust RGB			1		
	Hurricane Intensity Extimate (Advanced Dvorak)			1		
	Aerosol Particle Size		1			
	Ice Concentration		1			
	Ice Age/Thickness		1			
	Ice Motion		1			
	Convective Initiation			1		
	Overshooting Top Detection			1		
	Lightning Jump Algorithm			1		
	Lightning Detection- GLM gridded flash extent density			1		

3. **Quality Metric:** Sound and rigorous documentation of products to be evaluated in the Project Plan.

4. **Effectiveness and Efficiency:** User feedback documented in the Proving Ground blogs and in the Project Final Report.

5. **FY15 Milestones**
   - Tales from the Testbed webinar each week of the demonstration
   - Presentation of at least one paper at a national or international conference or workshop on the Proving Ground results.

6. **Funding / Opportunity Announcements**

Proving Ground demonstrations are supported through grants and contracts funded by the GOES-R Program Science Office via proposals for risk reduction research. Visiting scientists are also able to participate in the demonstrations via travel grants. In addition, technical interchange meetings are held

throughout the year to review the PG demonstration projects which include a major All-Hands meeting of participants during Satellite Science Week and a PG All-Hands meeting.

There were no new funding opportunities in FY2015. The next Call for Proposals is planned for October 2016 for FY2017 new starts.

7. Publications

1) Chronis, T., Lawrence D. Carey, Christopher J. Schultz, Elise V. Schultz, Kristin M. Calhoun, and Steven J. Goodman, 2015: Exploring Lightning Jump Characteristics. Wea. Forecasting, 30, 23–37, doi: http://dx.doi.org/10.1175/WAF-D-14-00064.1

2) Schmit, T. J., Steven J. Goodman, Mathew M. Gunshor, Justin Sieglaff, Andrew K. Heidinger, A. Scott Bachmeier, Scott S. Lindstrom, Amanda Terborg, Joleen Feltz, Kaba Bah, Scott Rudlosky, Daniel T. Lindsey, Robert M. Rabin, Christopher C. Schmidt, 2015: "Rapid Refresh Information of Significant Events: Preparing Users for the Next Generation of Geostationary Operational Satellites," Bulletin of the American Meteorological Society, Vol. 96, Issue 4 (April 2015) pp. 561-576, doi: http://dx.doi.org/10.1175/BAMS-D-13-00210.1

3) Gravelle, Chad M., John R. Mecikalski, William E. Line, Kristopher M. Bedka, Ralph A. Petersen, Justin M. Sieglaff, Geoffrey T. Stano, and Steven J. Goodman, 2015: Demonstration of a GOES-R Satellite Convective Toolkit to "Bridge the Gap" Between Severe Weather Watches and Warnings: An Example from the 20 May 2013 Moore, OK Tornado Outbreak, Bulletin of the American Meteorological Society, doi: http://dx.doi.org/10.1175/BAMS-D-14-00054.1, in press (available on line).

8. Proving Ground Demonstrations at the NOAA Service Centers and Testbeds in FY2015 include:

A: NOAA Hazardous Weather Testbed (HWT)

Milestones and Status:

Demonstration Duration: May 4th, 2015 - June 12th, 2015

Participants:
- 25 National Weather Service (NWS) Weather Forecast Office (WFO) Forecasters
- 5 Broadcast Meteorologists
- National Severe Storms Laboratory (NSSL)
- Storm Prediction Center (SPC)

Discussion:
GOES-R proxy products, capabilities, and algorithms were demonstrated in a real-time simulated short-term forecast and warning environment using AWIPS-II. Training modules in the form of a 10-30 minute Articulate Power Point presentation for each demonstration product were sent to and completed by all participants prior to their arrival at the HWT in Norman, OK. Product feedback from the evaluation was abundant and came in a number of forms, including daily surveys, weekly surveys, daily debriefs, weekly debriefs, over 500 blog posts, informal conversations in the HWT and the weekly "Tales from the Testbed" webinars. Typical feedback included: suggestions for improving the algorithms, ideas for making the displays more effective for information transfer to forecasters, best practices for product use, and situations in which the tools worked well and not so well.

Significant Outcomes:
Participants appreciated the full-CONUS view provided by the Legacy Atmospheric Profile (LAP) thermodynamic fields, and found them to be most useful for assessing overall trends and tracking gradients in atmospheric moisture and stability. Throughout the experiment, the GOES-R Convective Initiation (CI) product was an effective tool for drawing forecaster attention to areas where deep convection was becoming more probable.

Participants found that the ProbSevere model improved their situational awareness during severe weather operations by successfully highlighting the most threatening storms in the near-term, sometimes influencing their warning decisions.

The Super Rapid Scan Operations for GOES-R (SRSOR) 1-min imagery from GOES-14 was coveted by all users as they successfully and creatively incorporated it into their convective warning process, emphasizing specific processes and features made clearer by the very high temporal resolution satellite data. An automated Overshooting Top Detection (OTD) product and 10-min updating winds product both derived from the SRSOR data were also available to forecasters.

The Pseudo Geostationary Lightning Mapper (PGLM) total lightning data and Lightning Jump algorithm both proved valuable for the real-time detection of rapid updraft fluctuations that often preceded the occurrence of severe weather at the surface.

B. NOAA Storm Prediction Center (SPC)

Milestones and Status:

Demonstration Duration: Year Round 2015

Participants:
- Storm Prediction Center (SPC)

Discussion:
Satellite-based products currently available to forecasters for evaluation in the SPC operational NAWIPS system include: Cloud Top Cooling (CTC), Overshooting Top Detection (OTD), NearCast Model forecasts and analyses, Lightning Threat Forecast Algorithm (LFA) for NWP, Atmospheric Motion Vectors (AMVs), GOES Sounder RGB Airmass, synthetic satellite imagery from NSSL-WRF and NAMNEST NWP models, and GOES-14 Super Rapid Scan Operations for GOES-R (SRSOR) 1-min imagery (when available). One-on-one training is provided to the SPC forecaster by the satellite liaison. Feedback is given to the satellite liaison through verbal and email communication, and survey completion.

Significant Outcomes:
Both the Cloud Top Cooling and Overshooting Top Detection products continue to be utilized by forecasters as non-obtrusive overlays on their visible or infrared satellite imagery displays. The Cloud Top Cooling product provides them with an indication of where convective development is first occurring, separating the strongest updrafts from weaker ones. The Overshooting Top Detection product helps forecasters to monitor the health of mature convective systems by allowing them to more easily track significant trends in strong convective updrafts. Forecasters have viewed the NearCast Model fields when monitoring thermodynamic environmental trends as it highlights locations where convective development and maintenance are becoming more/less likely. These products have been mentioned in various SPC forecast products during the period.

GOES-14 came out of storage and collected SRSOR 1-min data during the periods of 18 May 2015 – 11 June 2015 and 10 August 2015 – 21 August 2015. As with past SRSOR experiments, the 1-min visible and infrared window channel imagery was made available in the SPC operational NAWIPS system and used extensively by SPC forecasters when available over convectively active regions. These campaigns help to prepare SPC forecasters for the very high temporal resolution satellite imagery that will be available in the GOES-R era. Forecasters referenced the SRSOR in various forecast products, and mentioned that the imagery has increased lead-time to the issuance of convective watches and mesoscale discussions on several occasions.

The AMVs provide an additional source of observation-based upper-level wind data, while the Sounder Airmass product helps to prepare forecasters for the increased RGB capabilities that will be available with the ABI. The synthetic satellite imagery provides an alternative method for analyzing model data, and the Lightning Threat Forecast Algorithm (LFA) for NWP enhances forecaster situational awareness to where lightning activity is expected in the model forecast.

C. National Hurricane Center (NHC)

Milestones and Status:

Demonstration Duration: August 1st, 2014 - November 30th, 2014

Participants:
- NHC Hurricane Specialist Unit (HSU)
- Tropical Analysis and Forecast Branch (TAFB) forecasters

Discussion:
During this time 14 prototype GOES-R Proving Ground products and 1 JPSS product were demonstrated and valuable forecaster experience and feedback were obtained. Three of these products were new to the NOAA Satellite PG at the NHC in 2014, including the GOES-R DEBRA Dust Product, the GOES-R RGB Nighttime Microphysics, and a GOES-R lightning density product. The 2014 Atlantic hurricane season was relatively inactive and was dominated by short-lived hurricanes that recurved east of the U.S. coast. The eastern North Pacific hurricane season, however, was extremely active and provided several opportunities for evaluations of Proving Ground products, especially those available in both basins.

Significant Outcomes:
During this time 14 prototype GOES-R Proving Ground products and 1 JPSS product were demonstrated and valuable forecaster experience and feedback were obtained. Three of these products were new to the NOAA Satellite PG at the NHC in 2014, including the GOES-R DEBRA Dust Product, the GOES-R RGB Nighttime Microphysics, and a GOES-R lightning density product. The 2014 Atlantic hurricane season was relatively inactive and was dominated by short-lived hurricanes that recurved east of the U.S. coast. The eastern North Pacific hurricane season, however, was extremely active and provided several opportunities for evaluations of Proving Ground products, especially those available in both basins.

The primary results from the 2014 Proving Ground include the following: 1) Several demonstration products have been utilized for several years and will probably be part of the initial GOES-R product set for NHC (Hurricane Intensity Estimate, Air Mass and Dust RGB products, some version of a natural color product, and the Saharan Air Layer image combination product); 2) The GOES-R Advanced Baseline Imager (ABI) Super Rapid Scan Operations (SRSO) imagery will be most useful for disorganized systems, especially around sunrise; 3) The GOES-R Geostationary Lightning Mapper (GLM) lightning density product complements the ground-based flash location data currently available in N-AWIPS; 4) Separate

versions of the lightning-based rapid intensification index will likely be needed for the east Pacific and Atlantic basins due to differences in the storm sizes in those basins; 5) Efforts should be made to obtain the low-latency VIIRS imagery, especially the Day-Night Band, becoming available from direct readout stations being deployed in Miami and Puerto Rico; 6) There may be value in modification of the standard EUMETSAT GOES-R RGB recipes for tropical applications, as indicated by comparing the standard version of the Dust Product to a version developed by CIRA tuned to delineating dust from non-dust, and de-emphasizing other features. 2 2. Introduction The purpose of the NOAA Satellite Proving Ground (PG) at the National Hurricane Center (NHC) is to provide NHC forecasters with an advance look at tropical cyclone-related satellite products for evaluation and feedback during the most active period of the Hurricane season (August 1 – November 30).

D. NOAA Aviation Weather Center (AWC)

Milestones and Status:

Demonstration Duration: February 1st, 2015 – September 1st, 2015

Participants:
   a.   Aviation Weather Center Proving Ground, Kansas City, MO
   b.   Air Traffic Control Systems Command Center, Warrenton, VA
   c.   Center Weather Service Units

Discussion:
The structure of the 2015 demonstration remained based around the AWC's operational desks as in years past. These include World Area Forecast (WAF) and Tropical desks on the international operations branch (IOB), and the Convective SIGMET (CSIG), the Area Forecast (FA) desks, as well as the National Aviation Meteorologist (NAM) desk on the domestic operations branch (DOB). However, there were also several notable changes and transitions to AWC operations, including 1) the automation of the Collaborative Convective Forecast Product and the subsequent transition to the Collaborative Aviation Weather Statement (CAWS) desk, 2) the introduction of utilizing the Global Forecast Editor (GFE) on the Advanced Weather Interactive Weather Processing System (AWIPS-2) for the creation of cloud visibility grids as a replacement for the current text Area Forecasts, and 3) the exploration of graphical based forecasts for the Tropical desk, also as a replacement for the 3 current text Area Forecasts.

Significant Outcomes:
The 2015 demonstration at the Aviation Weather Center (AWC) in Kansas City, MO, took place from 1 February – 1 September 2015, its purpose two-fold: (1) it provided a pre-operational environment in which to test and evaluate new GOES-R/JPSS proxy products, and (2) it also aided in familiarizing forecasters with the capabilities of our next generation GOES/JPSS satellite series. While the AWC was once again fully staffed in 2015, forecaster training for the transition of the Collaborative Aviation Weather Statement (CAWS) to operations resulted in the cancellation of the 2015 Winter Experiment. To accommodate, the 2015 evaluation was again divided into two long-term evaluations with a two-week long intensive Summer Experiment also included.

Lessons Learned that are relevant to future projects:

Like in 2014, feedback for the 2015 demonstration period was received via in-depth discussions and blog posts. Some survey questions were provided via Survey Monkey during the Summer Experiment, but were kept as very broad 'which products did you use and how?' or 'any comments on the GOES-R products?' type questions. This was done due to the nature of the participants within the AWT. Unlike

the Hazardous Weather Testbed, which is by-in-large geared towards NWS forecasters, the AWT contains airline operations personnel, FAA traffic flow managers, researchers in the aviation community, those in the general aviation community, and others, as well as forecasters. The mixed background of all of these participants makes posing very specific, scientific questions inefficient. By keeping them broad, it allows for a variety of feedback from perspectives all over the aviation community. The anticipated 2016 Winter Experiment may differ, given that the participants in previous winter experiments remained restricted to AWC and CWSU forecasters. If that is the case, some more detailed survey questions may be explored. However, overall for the long-term evaluation, in depth discussion continues to be the preferred method of feedback collection at the AWC

E. The Satellite Proving Ground for Marine, Precipitation, and Satellite Analysis (OPC, WPC, TAFB)

Milestones and Status:

Demonstration Duration:

(Winter) January 15th, 2015 – April 15th, 2015

The 2015 winter demonstration focused on re-training and applications of the Air Mass RGB products (provided by CIRA and NASA SPoRT) with an emphasis on quantifying the product using ozone retrievals from the Atmospheric Infrared Sounder (AIRS) on the Aqua satellite. The new training material was retrieved from EUMETSAT and gave more details into the single channel contributions that lead to the color schemes seen in the RGB image. The imagery proved quite useful to SAB analysts in identifying and estimating the strength of stratospheric intrusions as they related to intense cyclogenesis. The other centers made mention of the Air Mass RGB in text products to highlight the strength of individual shortwaves and potential hurricane-force wind events in the high seas (OPC). More work needs to be done on quantifying the exact color contributions and physical meaning of the colors seen in the imagery and this will be done by combining with ozone and other atmospheric retrievals in subsequent evaluations.

OPC and TAFB were introduced in the latter part of the winter phase to the Fog and Low Stratus products (provided by CIMSS), the GeoColor product (provided by CIRA), and the Night-time Microphysics RGB (provided by NASA SPoRT) to detect and monitor maritime fog events. TAFB's fog season is relatively short lasting from February into late March for the Gulf of Mexico and Southwest Atlantic. OPC's fog season starts in March and usually subsides in late June. This provided two short windows to evaluate the products at each center and the forecasters found the variety of products quite useful in confidently identifying a few fog events. TAFB liked having additional information to compare with their usual fog routines, while OPC used the product during a Coast Guard emergency to help direct the Coast Guard and a ship with an injured shipmate to a safe zone for a medevac.

(Summer) June 15th, 2015- November 30th, 2015

The summer phase of the 2015 demonstration consisted of a combination of alumni products such as the Overshooting Top Detection/Magnitude, GLD-360 Lightning Density, and the GOES-14 Super Rapid Scan Operations for GOES-R (SRSOR). A new round of GOES-R Convective Initiation training was conducted in July/August to allow forecasters an opportunity to be re-trained or trained for the first time on the product. The primary convective focus for SAB and WPC was heavy rainfall/flash flood events. The primary convective focus for OPC and TAFB was on maritime thunderstorms in terms of convective mode and possible ambient surface weather associated with those storms.

Participants:

- NWS/NCEP Ocean Prediction Center (OPC)
- Weather Prediction Center (WPC)
- NHC Tropical Analysis and Forecast Branch (TAFB)
- NESDIS Satellite Analysis Branch (SAB)

Significant Outcomes:

The GOES-R Convective Initiation product received some feedback during the demonstration, mainly from SAB and WPC. The product was used to monitor the trends of potential new convective cells associated with heavy rain events and possible flash flooding. In most cases, the product performed well and provided the analysts and forecasters with a method of monitoring the potential for training or back-building convection, especially in the Southern Plains during the spring. One popular suggestion for the future of the product is to replace the percentage probabilities with a more generic "low, probable, likely" scale.

For the third straight year, the GOES-14 SRSOR data was utilized heavily by WPC and SAB for monitoring convective trends. It was especially useful during the multi-day heavy rain and flash flooding events in the central to southern plains in late May/early June. One SAB analyst even noted that the positioning of GOES-14 was crucial in identifying new back-building convection on the western extent of an MCC over Texas, especially since GOES-13 suffered from too much parallax in that location. The added 1-minute imagery at night proved more useful this year than in previous years, but this may be attributed to the forecasters being more familiar with its availability.

The Nearcast product was demonstrated during the 2015 Flash Flood and Intense Rainfall Experiment at WPC. The satellite liaison provided a quick introductory training to the visiting forecasters and scientists, then the product was available along with a plethora of other models and products used in the forecasting of heavy rain events. The Nearcast product received a mix of positive and negative feedback, but this may have been due to the lack of training on using the product specifically for heavy rain events. With this in mind, it was decided to hold off on further evaluation for 2015 and revisit the Nearcast product in 2016.

Himawari imagery has slowly been introduced into operations thanks in part to work done by CIRA and NASA SPoRT. The first bands made available in operations were the mesoscale version of the 0.64um Visible at 2.5-min increments, the 3.9um SWIR, 6.2um upper-level water vapor, 6.9um mid-level water vapor, 7.3um low-level water vapor, 9.6um Ozone channel, and the 10.4 infrared channels all at 10-min increments. In addition, the Air Mass RGB product was made available with some additional RGBs that will be introduced further in 2016. An official data stream of Himawari imagery into N-AWIPS and AWIPS II is in the works and should be available by the end of the year.

Lessons Learned that are relevant to future projects:

The most successful part of this Proving Ground continues to be the confidence that the forecasters have gained in using and analyzing these new satellite products. For example, the RGB Air Mass product is being used routinely at all four centers and the forecasters and analysts are mentioning its use in the official forecast products. This shows that the RGB Air Mass product has earned the forecaster's and analyst's respect and the feedback is shown through those forecast products. In addition, the GOES-14 SRSORs and convective products have earned their way into the forecaster's routines and the feedback usually includes the "can we ask for more SRSOR data" or "I can't wait to see the Geostationary Lightning Mapper imagery over the oceans." This is surely a sign that the Proving Ground efforts are having a significant impact on forecast operations at OPC, SAB, TAFB, and WPC.

F. High Latitude Proving Ground

Milestones and Status:

Demonstration Duration: July, 2015 –September, 2015

Participants:
- NWS forecasters

Discussion:
The High Latitude Proving Ground project is working to improve forecasts and warnings by leveraging GOES-R investment to deliver and test NPP/JPSS data in support of operational forecasters.

Significant Outcomes:
GINA conducted its sixth and final code sprint in support of the Sandy Supplemental project. Under the leadership of Gwen Bryson, GINA and other University of Alaska staff concluded its final code sprint in support of the Sandy Supplemental project. Hardware was installed at UAF to provide a development, test, and integration sandbox for software and product development, as well as a set of hardware at NWS Sand Lake integrating with the Arctic Test Bed. GINA promoted code to operations at FCDAS and UAF supporting SNPP, AQUA, TERRA, METOP-B, NOAA 15/18/19 processing and product delivery to NWS Staff from CIMSS visited GINA July 21-23, and GINA staff visited CIMSS September 22-24. Kathy Strabala and Jordan Gerth of CIMSS in Madison, Wisconsin visited GINA in July. Specific projects worked on included implementation of CSPP code at GINA with a special emphasis on ensuring that the expanded suite of imagery delivered by GINA to NWS Alaska could be optimized in the AWIPS2 environment. Jay Cable and Carl Dierking of GINA visited CIMSS in Madison to coordinate on CSPP upgrades and other recent development efforts beneficial to NWS in Alaska.

G. NWS Operations Proving Ground (OPG)

Milestones and Status:

Demonstration Duration: February, 2015 – April, 2015

Participants:
- NWS Weather Forecast Offices (WFO) and four CONUS NWS Regional Offices
- WFO Eastern Region (4 forecasters)
- WFO Central Region (5 forecasters)
- WFO Southern Region (2 forecasters)
- WFO Western Region(6 forecasters)

Discussion:
Between February and April of 2015, the National Weather Service (NWS) Operations Proving Ground (OPG) hosted and facilitated an Operational Impact Evaluation (OIE) focused on the usefulness of 1-min satellite imagery for NWS operations in the Geostationary Operational Environmental Satellite (GOES)-R Series era. The overarching goal of the evaluation was to provide quantitative and qualitative guidance to NWS senior leadership, including the regional NWS Scientific Services Division Chiefs, on how satellite imagery with a refresh rate of 1 minute impacts NWS forecaster decision making.

Significant Outcomes:
In total, seventeen NWS forecasters completed eight simulations that were developed using imagery from the 2013 and 2014 GOES-14 Super Rapid Scan Operations for GOES-R (SRSOR). Six additional

forecasters participated in a follow-up assessment using live 2015 SRSOR imagery. During the OIE simulations, forecasters evaluated 1-min and 5-min satellite imagery scanning modes while completing tasks ranging from aviation forecasting and wildfire decision support services to monitoring where convective initiation would occur and integrating the imagery into the convective warning decision-making process. Each week, feedback was gathered to assess whether the satellite imagery had influence on forecaster decision making, if the satellite imagery provided forecasters with more confidence in making those decisions, to what extent they could effectively assimilate the data into operational practices, and whether forecaster workload was adversely impacted. Participating NWS forecasters overwhelming felt that 1-min satellite imagery improved their environmental analysis and increased their confidence to make effective forecast and warning decisions in a variety of simulations.

Lessons Learned that are relevant to future projects:

Many forecasters found that animating the satellite imagery while integrating it with other decision aids revealed important insight on how the atmosphere was evolving, which allowed them to anticipate and predict short-term trends. During most simulations, participants expressed that they were able to internally assimilate the imagery with ease. However, when forecasters were asked how easy the imagery was to use in convective warning operations, the feedback was mixed. Some forecasters felt that it was difficult to incorporate the satellite imagery with radar data while issuing convective warnings, while others believed that with sufficient training and experience the satellite imagery would be invaluable in warning operations. Participants unanimously agreed that in order for forecasters to understand how to accurately interpret atmospheric processes using 1-min satellite imagery, the development and delivery of timely, effective training resources is essential. Many forecasters felt these training materials need to focus on effective practices, be layered to maximize forecaster retention, and be integrated into the NWS Distance Learning Operations Course. The evaluation led to seven findings and ten recommendations that focused on preparing NWS forecasters to use high-temporal satellite imagery in the GOES-R era.