Aviation Weather Testbed – Final Evaluation

Project Title: 2014 GOES-R/JPSS Demonstration

Organization: NOAA's Aviation Weather Testbed (AWT)

Evaluator(s): Aviation Weather Center (AWC) forecasters, Central Weather Service Unit (CWSU) forecasters, Federal Aviation Administration (FAA) personnel, and general aviation personnel

Duration of Evaluation: 1 February 2014 – 1 September 2014

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1. Summary

The 2014 demonstration at the Aviation Weather Center (AWC) in Kansas City, MO, took place from 1 March – 1 September 2014, it's 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. To accommodate the staffing shortages at the AWC in 2014, the usual two-week experiments were instead divided into two long-term evaluations and a single weeklong intensive experiment period. Details of these periods can be found in Table 1 below.

**Table 1.** AWC 2014 demonstration schedule and descriptions

Evaluation Period	Description
1 March – 16 May Evaluation Period I	*Focus* - winter/early spring aviation hazards (icing, ceiling and vis, etc.) and also early season convection *Training* – one-on-one training on the forecast floor
19 May – 11 September Evaluation Period II	*Focus* – summer aviation hazards, especially convection. *Training* – one-on-one training on the forecast floor and also at the Air Traffic Control Systems Command Center (ATCSCC) in Warrenton, VA, with the National Aviation Meteorologists (NAMs)
11 – 15 August Summer Experiment	*Focus* – ceiling and visibility, with a secondary focus on convection; tropics and domestic regions with an Aviation Weather Statement emphasis *Training* – real-time training and demonstration with external participants

Participation throughout the two long-term evaluations included only AWC forecasters, while the summer experiment consisted of a wide variety of external participants from the Central Weather Service Units (CWSUs), Weather Forecast Offices (WFOs), the Alaska Aviation Weather Unit (AAWU), the Federal Aviation Administration (FAA) and other flight services companies including Lockheed Martin, FedEx, and the United Parcel Service (UPS), and research scientists from the Air Force Weather Agency (AFWA), the GOES-R program, and National Oceanic and Atmospheric Administration (NOAA) laboratories. The following report details the activities and results of the entirety of the 2014 GOES-R/JPSS demonstration.

2. Introduction

Although the logistics of the 2014 demonstration were changed, the structure remained based around the AWC's operational desks. These include World Area Forecast (WAF) and Tropical desks on the international operations branch (IOB), and the Convective SIGMET (CSIG), the Collaborative Convective Forecast Product (CCFP), and the Area Forecast (FA) desks, as well as the National Aviation Meteorologist (NAM) desk on the domestic operations branch (DOB).

The FA desks are responsible for issuing 0, 3, 6, 9, and 12-hour Graphical AIRMETs (GAIRMETs) and text forecasts every three hours as well as SIGMETs (if necessary) for hazards including ceiling and visibility, turbulence, icing, freezing level, low-level wind shear, and low ceilings. Similarly, the WAF Tropical desk also issues FAs and SIGMETs for these threats, as well as for convection (Fig. 1). Domestic FAs and GAIRMETs area utilized mainly as flight planning guides by the general aviation community. On the other hand, the Tropical FAs are an important part of helicopter operations over the Gulf of Mexico and the Caribbean.
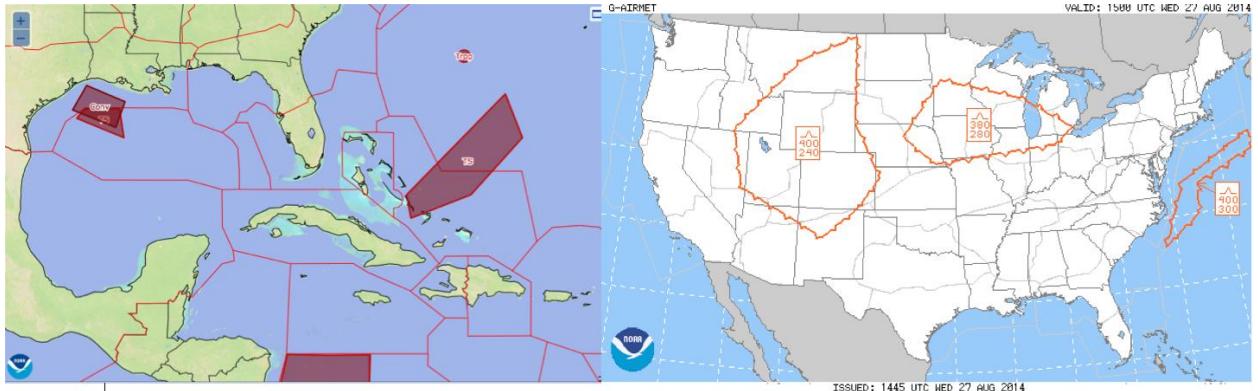
Figure 1. Tropcial domain with 1-hour international SIGMETs issued for convection (left), and a 3-hour G-AIRMET forecast for turbulence (right).

The remainder of the WAF desks are responsible for every corner of the globe and output a 12 and 24-hour forecast of convection, icing, and turbulence, as well as jets and tropopause heights (Fig. 2). Flight planners, particularly those mapping flight routes over the oceans, use this information to find the safest and most cost efficient path for international flights. On the other hand, CSIG and CCFP are domestic products, with CSIG outlooks and SIGMETs for convection issued and/or updated every hour, and 4, 6, and 8-hr CCFP forecasts of convective probability issued every 2 hours (Fig. 2).
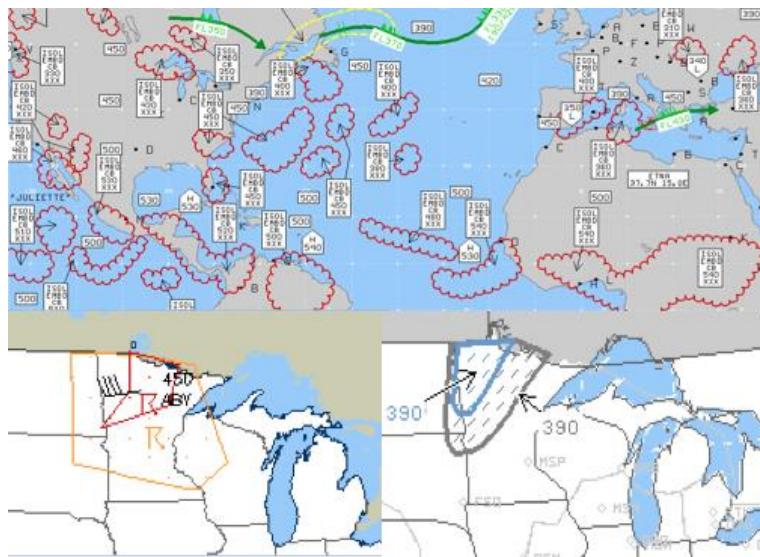
Figure 2. Global Graphics 12-hr forecast (top), CSIG outlook and SIGMETs (bottom left), and CCFP 6-hr forecast (bottom right). Red 'cotton balls' denote forecasted convection in the global graphics image. Yellow outlined boxes contain the CSIG outlook, with red boxes indicating active SIGMETs. Boxes in the CCFP forecast give convective coverage and probability as well as flight levels at which it is likely to occur.

The forecasters at the NAM desk, located in Warrenton, VA, within the FAA's Air Traffic Control Systems Command Center (ATCSCC), work with CCFP and CWSU forecasters to provide real-time weather briefings on weather hazards expected to impact aviation operations in the short term (Fig. 3). Convection, both scattered and widespread, is the primary cause of disruptions to centers and routes, with ceiling and visibility a close second. Additionally, they issue long-term forecasts for day's 1 through 7 as a broad scope of expected weather. This allows the FAA to make proper staffing decisions for upcoming shifts (Also Fig. 3). For all products, their focus typically remains on the busiest airspace and centers.
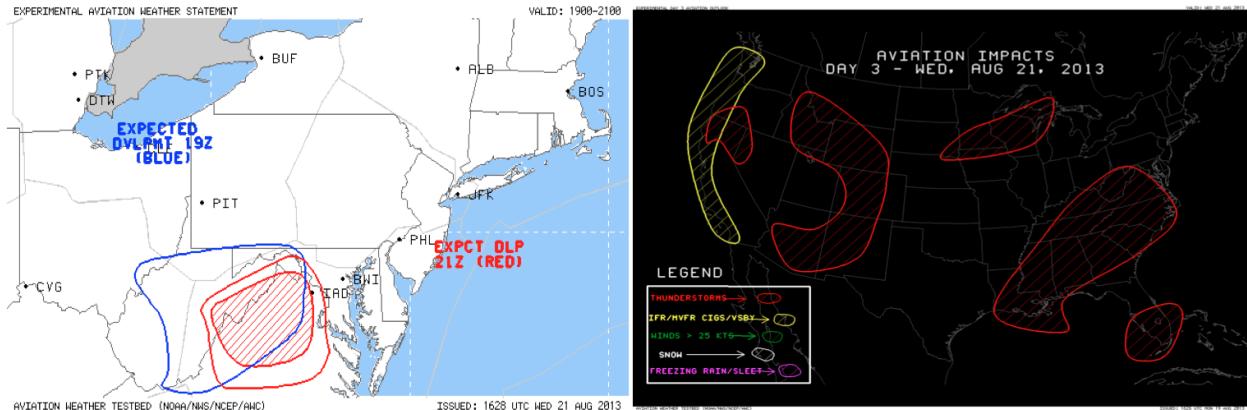
Figure 3. An example AWS (left) and Day 3 outlook. The AWS will be the future version of the CCFP, in which AWC, CWSU and NAM forecasters work together to create an outlook of hazards expected within 4 hours for traffic flow managers, while the long-term outlooks (Day 2-7) are generated by NAMs only for the FAA.

Evaluation Period 1 explored winter and early spring aviation hazards, and as such was focused mainly on the FA desks and Tropical ceiling and visibility concerns. On the other hand, the latter portion of Evaluation Period I and all of Evaluation Period II were convection-based, exploring both short and long term convective products. These evaluations took place at the CSIG, CCFP, Tropical and WAF desks in Kansas City, and with the NAMs at the ATCSCC. The broad-scale structure and one-on-one training in both long-term evaluation periods was designed to allow for flexibility around forecaster shifts and heavy workloads, while also providing ample time to hear the thoughts of as many as possible out on the operations floor.

The 2014 Summer Experiment took place in the Aviation Weather Testbed (AWT) during Evaluation Period II. This intense, one-week experiment period focused on FAA operations and requirements for ceiling and visibility (C&V) forecasts, specifically on issuing Aviation Weather Statements (AWSs) for IFR conditions. AWSs, outlooks for hazards expected to affect major terminals or enroute traffic within the next four hours, were also issued for convection as a secondary focus. Additionally, there was a long-term convective forecasting desk and a mock Tropical desk, issuing experimental graphics for both convection and C&V. On the Proving Ground side, there were also two GOES-R/JPSS support desks employed as a means for a more detailed evaluation of various products, both model and real-time, that could be used to provide additional operational situational awareness to the C&V and convective AWS desks. These desks were highly mobile, collaborating frequently with the other four desks while monitoring the onset, evolution, and cessation of ceilings and convection.

3. GOES-R/JPSS Products Evaluated

A number of products were evaluated during the 2014 demonstration and are listed below in Table 2. These products were chosen based on AWC needs and applicability for the time of year. Providers were the University of Wisconsin's Cooperative Institute for Meteorological Satellite Studies (CIMSS), the Cooperative Institute for Research in the Atmosphere (CIRA), and NASA's Short-term Prediction Research and Transition Center (SPoRT). Baseline products, those products that are implemented as part of the GOES-R initial continuity operational product set, and Future Capabilities products, those that offer new capabilities made possible by ABI, were utilized in the experiment.

Synthetic model-derived decision aids used to show the capabilities of baseline cloud and moisture imagery included the NSSL-WRF and NAM Nest Simulated Satellite forecasts. Other baseline products included the Pseudo Geostationary Lightning Mapper (PGLM) and the ACHA Cloud Height Algorithms. Future Capabilities products included the Fog and Low Stratus and GeoColor imagery, and also

encompassed those products within the 'Convective Toolkit'; i.e. Cloud-top Cooling and Overshooting Top Detection, and the GOES-R Convective Initiation. Super Rapid Scan 1-minute imagery from GOES-14 was used to showcase the ABI 1-min rapid refresh mesoscale capability. Additionally, a 1-9 hour Nearcasting model was included as the only Risk Reduction product.

A number of VIIRS products from JPSS were also evaluated to a lesser extent. Specifically, the Day/Night band and the Nighttime Microphysics product were evaluated. Additionally, the dust products were evaluated when an event arose.

Table 2. GOES-R/JPSS products demonstrated within the 2014 Demonstration

GOES-R Demonstrated Product	Category
Aircraft Flight Icing Threat	Future Capability
ACHA Cloud Height Algorithms	Baseline
Convective Initiation	Future Capability
Cloud Top Cooling/Overshooting Top Detection	Future Capability
Fog and Low Stratus	Future Capability
GeoColor imagery	Future Capability
Nearcasting Model	Risk Reduction
Pseudo Geostationary Lightning Mapper	Baseline
GOES-14 Super Rapid Scan imagery	Baseline
Simulated Cloud and Moisture imagery	Baseline
JPSS Demonstrated Products	**Category**
VIIRS Day/Night band imagery	Baseline
VIIRS/MODIS Nighttime Microphysics	Future Capability
VIIRS/MODIS Dust products	Future Capability
Category Definitions: **Baseline Products** - GOES-R products providing the initial operational implementation **Future Capabilities Products** - New capability made possible by ABI **Risk Reduction** – Research initiatives to develop new or enhanced GOES-R applications and explore possibilities for improving current products	

3.1 **Aircraft Flight Icing Threat** – University of Wisconsin Cooperative Institute of Meteorological Satellite Studies (UW-CIMSS) and NASA's Langley Research Center (LaRC)

The Flight Icing Threat (FIT) integrates various cloud properties from the GOES-R baseline DCOMP algorithm to generate a probability and intensity of icing conditions. It is composed of three components including (1) an icing mask available day and night which discriminates regions of possible icing, (2) an icing probability, estimated during the daytime only, and (3) a two-category intensity index which is also derived during the daytime only. While it is difficult to validate a product such as this given the lack of icing PIREPs and other methods of ice measurement, it has been shown to have skill in identifying areas of more significant icing conditions.

This product was introduced to AWC forecasters during the 2013 Winter Experiment and was further evaluated during Evaluation Period I of the 2014 GOES-R/JPSS Demonstration. Since 2013, the product has undergone several improvements, including a projection change and minor adjustments to the color curve. Forecasters noted that these improvements have made the product much more aesthetically pleasing, and subsequently, easier to interpret. Figure 4 shows a comparison of both versions.
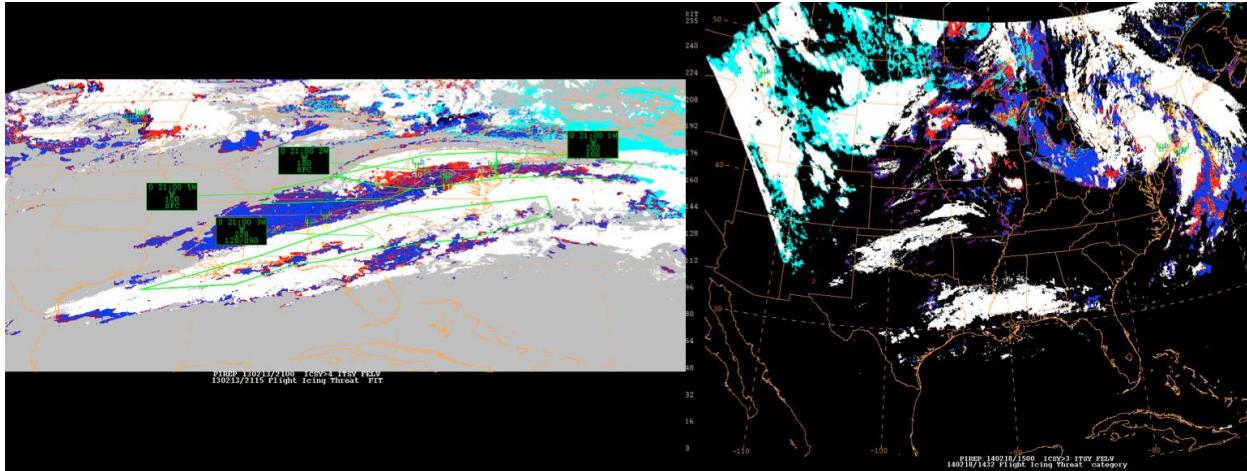
Figure 4. The old version of the FIT (left) compared to the new version with the improved projection and color curve (right).

In general, the FIT has been used a situational awareness tool for the issuance of icing AIRMETS, providing forecasters an at-a-glance overview of cloud layers that may contain moderate or greater icing. However, as the icing intensity is only available during the day, forecasters found little use of the product at night, when only a 'yes/no' mask is available. Furthermore, the current inputs only allow for icing intensity solutions to be available given that there are no higher ice clouds obscuring the lower layers. In the case of larger scale synoptic systems, where large areas of high ice clouds often do exist, the product is also found to be of little use.

During the 2013 evaluation, NASA LaRC added additional inputs to a very similar algorithm, which dramatically increased the solutions in the presence of higher clouds. Additionally, it allowed the estimation of the base and top of the icing layer. AWC forecasters viewed this algorithm and noted that the addition of those inputs to the GOES-R FIT made the product much more useful. They believe that if these inputs could be combined with the GOES-R DCOMP version of the algorithm (perhaps in a collaborative effort between CIMSS and LaRC), it would provide a much more robust and useable version of the FIT.

3.2   ACHA Cloud Height Algorithms - University of Wisconsin Cooperative Institute of Meteorological Satellite Studies (UW-CIMSS)

The Algorithm Working Group's Cloud Height Algorithms (ACHA), including the Cloud Top Height, Cloud Top Temperature, and Cloud Emissivity products, were provided to the AWC in 2012. Cloud Top Heights saw the most use, and as a result of forecaster feedback over the past two years, a Cloud Top Altitude product was developed for the 2014 demonstration. This product provides cloud tops in feet instead of meters, as feet (or flight levels) are the common unit in aviation forecasting. Additionally, the domain of this product not only included the CONUS, but also hemispheric and global. This extension was designed to supplement the IOB branch of AWC operations, where large data void areas across the globe result in forecasters becoming completely reliant on satellite imagery to issue their products. The cloud altitudes were evaluated within the Summer Experiment on a CONUS and international scale.

AWC, CWSU, and WFO aviation focal points alike showed an immediate interest in the cloud altitudes, as cloud bases and cloud heights are required variables for the issuance of the vast majority of aviation related forecast products. During the experiment, they were particularly interested in the product for convection forecasting. In aviation operations it is imperative that traffic flow managers know exactly where tops are and how high. Ideally, traffic is directed over thunderstorms as long as possible. Once

aircraft began to shoot gaps and divert around thunderstorms, fuel costs and delays begin to increase significantly. With an accurate and real-time analysis of tops, these effects can be minimized. It was in this way that the cloud altitudes were explored.

Previously, the generic color curve of the cloud altitudes was split into two separate versions. One version highlights low clouds (< FL180) while the other highlights high cloud tops (> FL180), the threshold based on the National Airspace System (NAS) classifications (Fig. 5). This allows forecasters to utilize the imagery for ceiling and visibility purposes, as well as convection forecasting. However, during the experiment a third version was developed. This version highlights tops of FL300 and above (also Fig. 5), following the generic NAS rule of thumb that once tops are above FL300, planes can no longer safely fly above them.
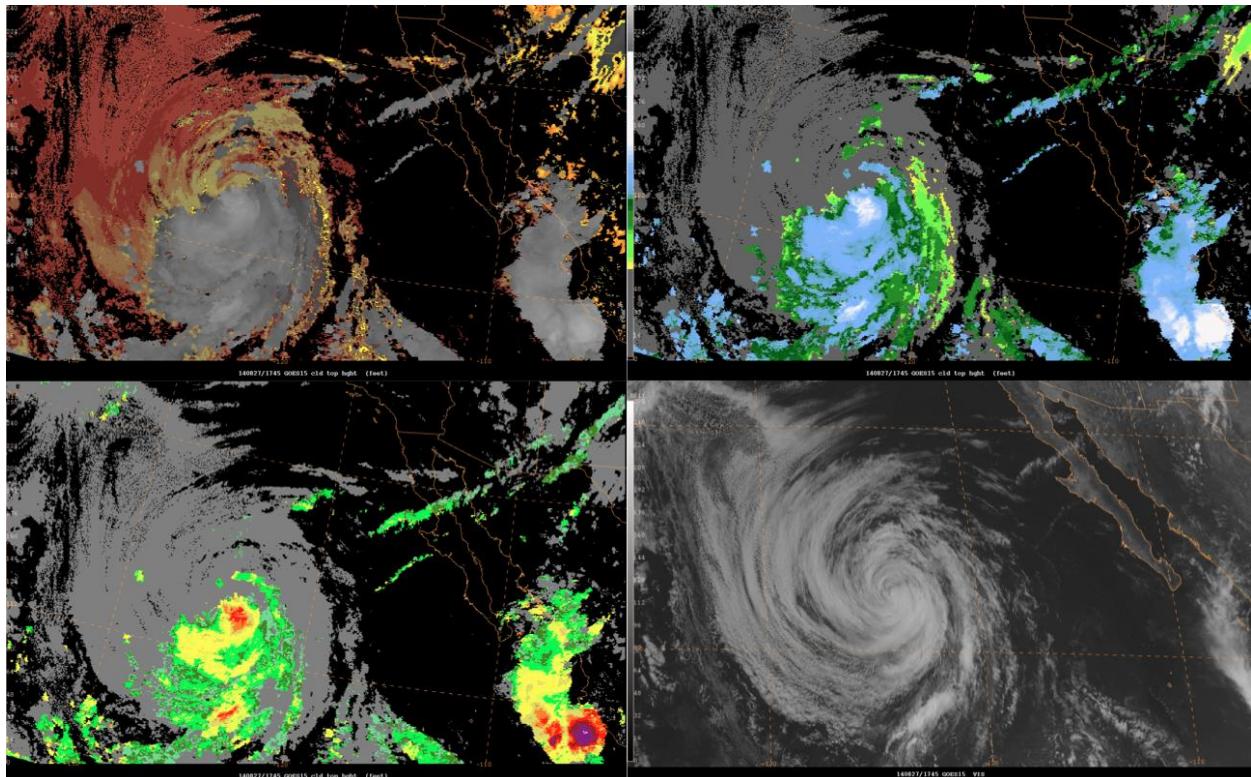
Figure 5. 20140827 1745 UTC cloud altitudes in Hurricane Marie below FL180 (top left), above FL180 (top right), and above FL300 (bottom left), with visible imagery from GW (bottom right).

Figure 6 below shows an example from the experiment in which the third version was utilized in real-time 'mock' traffic flow operations. On this particular afternoon the typical low-topped, summertime convection was expected to begin popping in the Northeast. Around 1700 UTC the first echoes could be seen on radar, and by 1745 UTC the cloud altitude product was showing one top in eastern PA that had a top of ~FL420. As a comparison, echo tops during the same time indicated heights of ~FL400. In general, a cloud top will almost always be higher than the top of the radar echo, and in this case the cloud altitudes proved to provide an accurate estimate of tops. In other instances with widespread scattered convection of this nature, CWSU and CSIG forecasters in particular noted that the cloud altitudes would be a valuable tool in their operations for convection, not only providing additional information on the tops of clouds, but also porosity, or if there are holes in convective coverage.
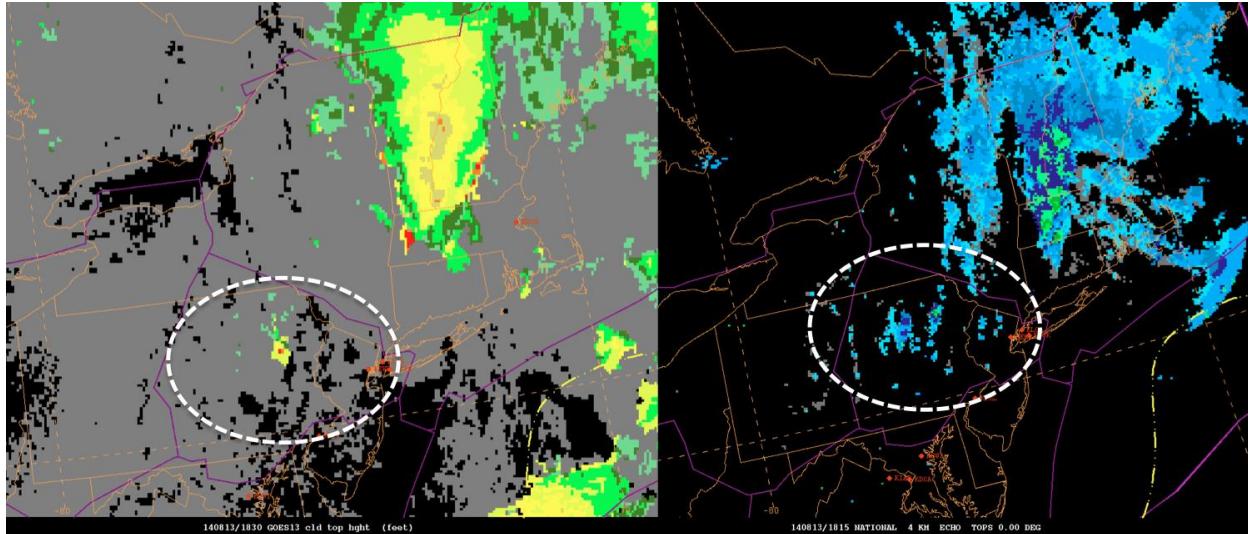
Figure 6. 20140813 1745 Cloud Altitudes (left) and radar Echo Tops (right). Note the red pixels in the altitude, indicating tops of ~FL440, while the greens in the Echo Tops for the region indicated ~FL400.

Forecasters also noted the potential use in low cloud situations. However, more exploration is needed here to determine the value of a low cloud top when aviation forecasters are really looking for the ceiling, or the base of the low cloud. To this end, forecasters used the cloud thickness piece of the GOES-R Fog and Low Stratus algorithm. Comparing the top of the clouds to the thickness of the layer allowed them a rough estimate of ceiling height. However, this estimate only worked in areas where no higher cloud layers were present, and was mostly explored for the SFO terminal area.

To a lesser extent, the cloud altitudes were explored from an international perspective. The IOB branch of AWC operations is perhaps one of the more challenging set of desks to work and as mentioned above, is almost completely reliant upon satellite imagery in some locations. At the Tropical desk in AWC operations the cloud altitudes provides additional important information on convective tops, as well as areas of low clouds in radar sparse regions. On the other hand, those at the global graphics are issuing 12 and 24-hour forecasts of tops and bases of threats like convection and icing, and as such the altitudes become an important verification tool, as well as an initial look at conditions that may impact a different area in the future.

As mentioned above, the cloud altitudes are a new piece of the ACHA algorithms developed for aviation purposes and was pulled into the AWC in early spring of 2014. Since then, a handful of both WFO and CWSU offices have show interest in getting the product into their AWIPS systems. Additionally, AWC forecasters have shown an interest in continued evaluation, particularly for international and C&V purpose.

3.3   Convective Toolkit
3.3.1 GOES-R Convective Initiation – University of Alabama in Huntsville and NASA's Short-term Prediction Research and Transition Center

The GOES-R Convection Initiation, introduced into AWC operations nearly a year ago, continues to be evaluated for use in aviation operations. In the 2014 demonstration, it was examined in Evaluation Period II and during the Summer Experiment. The focus of the evaluation shifted from familiarization with the display of the product, to the integration of the product into aviation operations. To this end, it was examined in all aspects of convection forecasting, locally with the CSIG and CCFP desk, and off site with the NAMs at the Command Center and various CWSUs who were in attendance at the experiment.

The Convective SIGMET is focused on any convection that reaches at least 30dBZ intensity. As the GOES-R CI is a probabilistic 0-2 hour forecast of convection that will initiate to >30dBZ, the product was noted to be potentially useful in the outlook portion of their forecast. However, the fast-paced nature of this particular desk, especially on active convection days, has these forecasters going into triage mode once convection begins developing. At this point, they no longer care about what's going to happen in the short term as their focus has shifted entirely to ongoing activity.

On the other hand, CCFP is focused on the longer term. Currently the FAA requirements have them issuing forecasts beginning at 4-hours out. This is a bit of a stretch for the GOES-R CI product, and as such it has been determined that the algorithm would be of little use at this particular desk. However, it is important to note that the FAA is working towards the transition of CCFP into the Aviation Weather Statement (AWS). The AWS would potentially cover not only longer-term concerns, but focus heavily on the 4-hour time period as well. The GOES-R CI product has been evaluated with respect to the AWS in past experiments and could potentially have some value here.

The GOES-R CI was also evaluated by the NAMs and the CWSUs, both of which would be involved in the issuance of the AWS, and both of which currently provide short-term forecasts for traffic flow purposes. Figure 7 below shows an example of using the GOES-R CI product in this manner during the Summer Experiment. In this case, a fairly strong low-pressure system was pushing into the Eastern U.S. with a cold front expected to set off convection along the East Coast. Around 1715 UTC, the GOES-R CI product began to show probabilities of CI just over 50% along two axes near the front. Several GOES scans later, convection began to form.
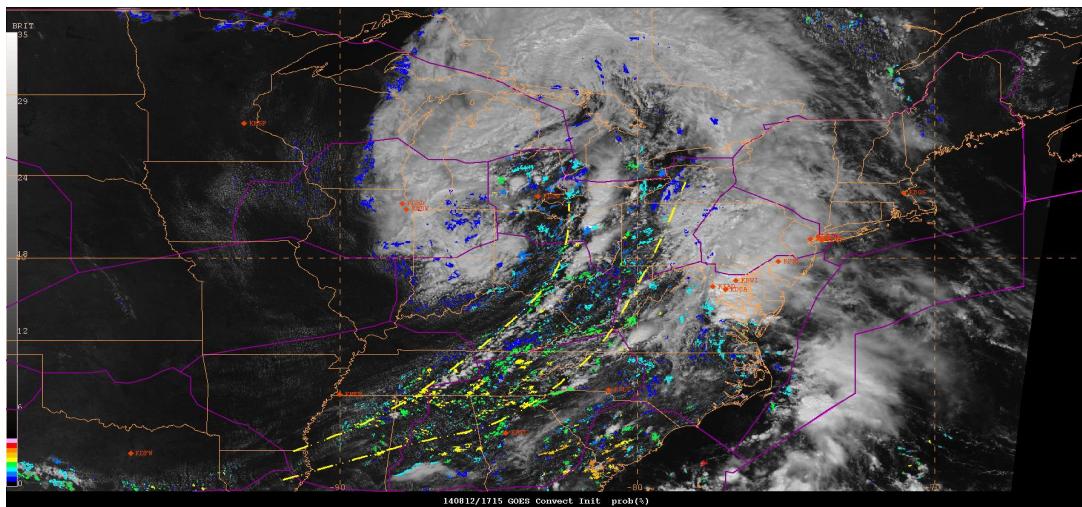
Figure 7. 20140812 1715 GOES-R CI and visible imagery. Note the yellow signals, indication 50% probabilities of initiation.

For the most part this convection was fairly slow-growing and low-topped. This behavior of the convective storms corresponds with the GOES-R CI, as probabilities never really made it above 50%. In the 0-2-hour time period, did this 50% instill additional confidence in the forecasters looking at this case? No, not on its own. The GOES-R CI was designed to identify CI in clear-sky and mostly clear scenes (under thin cirrus clouds), toward forecasting the development of new convective cores that achieve greater than 30dBZ intensity for robust convective cores in areas of clear skies. As has been noted in previous reports, aviation forecasters care about any convection over 30dBZ intensity. So how exactly can they get the most use out of this algorithm?

In this case, forecasters were able to use the Nearcasting Model in tandem with the GOES-R CI. The yellow dashed lines in the images above indicated areas where the Nearcast had previously been showing some weak instability. This, along with experience in forecasting in this region during the late summer, increased confidence in the fact that the nature of the convection would be weaker and low-topped. So, when forecasters began to see those 50% probabilities lining up in generally the same area, they didn't ignore them as they may have otherwise. Instead, they monitored the area.

In summary, both CWSU and NAM forecasters agreed that the CI product does show value. However, it is a challenge to adapt an algorithm designed for robust convection to aviation forecasting. For example, the CI product has been shown to do extremely well with robust cores that fire along the dryline in the Plains. While it certainly is helpful for an aviation forecaster to know that these cores will be strong, the abundance of open airspace in this region allows airplanes plenty of room to maneuver. However, in the case of developing low-topped cells over the New York TRACON (traffic control), where every little bit of airspace is vital, signals from the CI product, as expected, probably wouldn't reach above 50% and might not result in convective storm initiation. This was noted several times during the experiment, and while storms didn't necessarily fire off of those weaker signals, it did provide additional confidence in the type of convection to expect when those signals occurred consistently over a number of scans.

Forecasters would like to continue to evaluate this product towards this end. They would like to determine: 1) if areas of consistent marginal signals (i.e. ~50%) by-in-large result in low-topped and weaker cores, and 2) how much extra confidence this would provide when used with other tools like the Nearcast.

3.3.2 Cloud-Top Cooling – University of Wisconsin's Cooperative Institute for Meteorological Satellite Studies

The University of Wisconsin's Cloud-Top Cooling (CTC) Algorithm was designed to provide a satellite-based tool for diagnosing convective cloud growth. Using IR brightness temperatures and AWG cloud phase information, the algorithm (Sieglaff et al. 2011) identifies immature convective clouds that are growing vertically, and hence cooling (K/15 minutes). Additionally, the UW-CTC utilizes GOES visible optical depth retrievals (Sieglaff et al. 2014), which enables detection of growing convection beneath areas of thin cirrus clouds during daytime and allows for better detection of the strongest cooling rates with developing convection. It has been evaluated at the AWC for the past several years, and like the CI, the focused shifted to integration into operations. In the 2014 demonstration it was evaluated at CSIG, CCFP, and also by the NAMs and CWSUs.

While the GOES-R CI tends to lose its value at the CSIG desk once convection has begun, the Cloud Top Cooling remains a useful at-a-glance too1. Not only is it simple and easy to interpret, but it also provides forecasters with something to quickly key in on in the fast-paced nature of their operations. It can also be used in tandem with radar to provide further confidence in the issued CSIG area. This is especially important over busy terminals.

As previously mentioned, CCFP is a longer term forecast in its current state, but forecasters at this desk tend to have the CTC product at hand as a means of verification. Additionally, once the CCFP transitions to the AWS, the short-term (within 4 hours) will become the focus of the forecast, potentially making the CTC a very valuable situational awareness tool. One such case occurred during the summer experiment and is outlined below in Figure 8. In this case, the CTC signals east of the New York TRACON prompted the issuance of an (experimental) AWS.
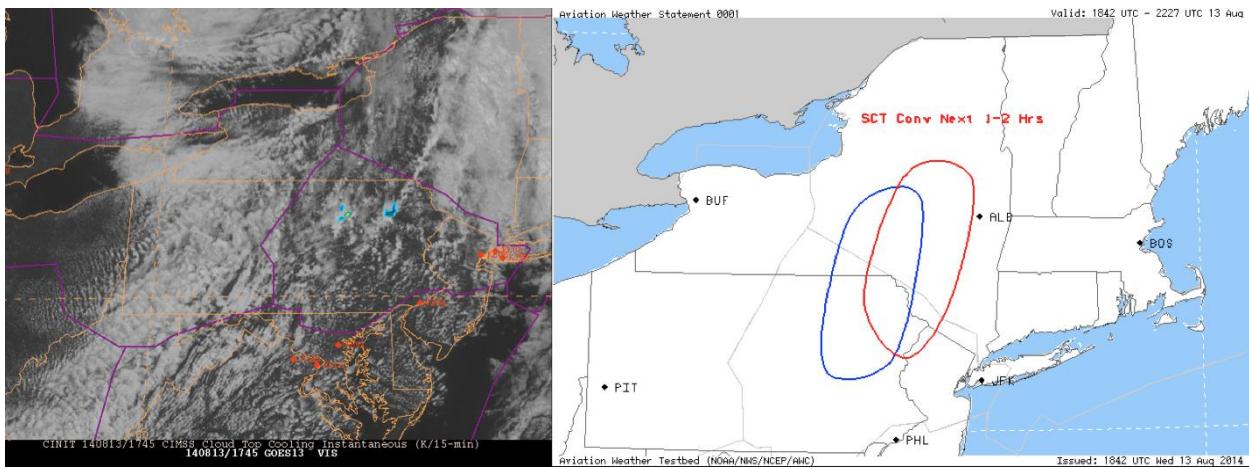
Figure 8. 20140813 1745 UTC Cloud Top Cooling and subsequently issued 1845 UTC Aviation Weather Statement

Like the CI, the CTC is designed to best identify robust cores, and while forecasters did find use in this tool, it was once again a challenge to adapt it to an aviation perspective. In the case shown above, signals were fairly weak, but some low-topped convection did initiate and not all of it resulted in a CTC signal. Similar to the CI, forecasters questioned whether the presence of weak signals could improve confidence in the forecast of weak, scattered convection, and if this would provide any economic benefit, particularly in the Northeast corridor where even this type of convective setup can have a significant impact on aviation operations.

3.3.3 Overshooting Top Detection – NASA's Langley Research Center

The Overshooting Top Detection (OTD) algorithm (Bedka et al. 2010) was designed as a means to identify anomalously cold groups of cloud pixels within an anvil cloud that are associated with overshooting tops, and subsequently, very strong updrafts. It contains not only a simple binary yes/no detection but also a magnitude of the overshooting tops. This year, the OTD magnitude product was evaluated for use by the NAMs in FAA traffic flow operations over the CONUS where near-continuous NEXRAD coverage is present.

The majority of forecast products issued by the NAMs at the FAA's Command Center are completed before 1500 UTC with the purpose of identifying problem areas for the remainder of the day. Traffic flow managers then use this information to outline the necessary traffic flow programs for the day, including potential diverts, delays, or ground stops. By the time there are overshooting top signals occurring, these programs are generally already in effect. Additionally, while the OTD magnitude can be used to differentiate between weaker and stronger tops, the general rule of thumb, as mentioned previously, is for pilots to begin diverting around storms once they reach FL300, typically well below the average height of an overshooting top. As such, the OTD algorithm was found to be of little use to the NAMs in forecasting for FAA traffic flow operations over the CONUS. Separate evaluations will be done in future demonstrations for offshore traffic flow operations, where the OTD product has previously proven to be useful in areas where there is no radar coverage.

However, it does have value in the validation of products, specifically of the CCFP product. The CCFP product was designed based on FAA requirements and as with every human issued product, can be inaccurate at times. As such, the FAA as well as FAA customers like the airlines conduct a validation after each day, looking at the weather that actually occurred and the accuracy of the forecast, and subsequently the programs issued. The OTD has been useful in this validation application.

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In one particular high impact case, highlighted in Figure 9, a large squall line was expected to develop and extend over much of the central U.S as it progressed east. As this was expected to impact all east and westbound traffic, an accurate forecast was imperative. After the event occurred, a recap was put together including the CCFP forecast, flight tracks, and radar. Additionally, the OTD was overlaid upon visible imagery.
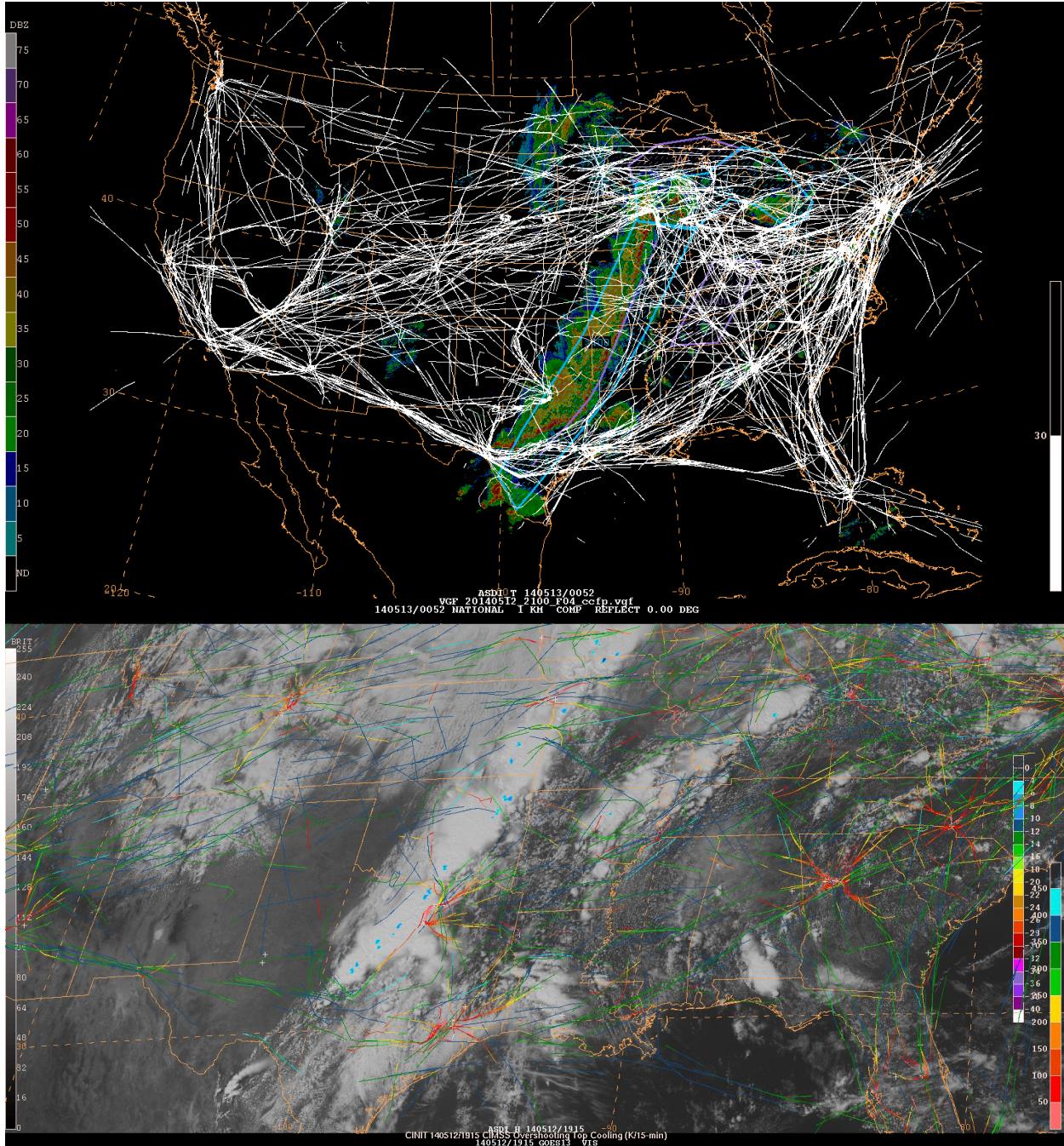
Figure 9. 20140512 2100 UTC CCFP forecast, radar imagery, and flight tracks (top) and visible imagery with overshooting tops and flight tracks (bottom)

The CCFP forecast called for a line of storms with tops of FL400 and above by 2100 UTC, which the presence of multiple OTD signals at 1915 UTC validated. While overshooting tops are generally fairly

easy to pick out in visible imagery when zoomed, the signals from the OTD product provided an easy, at-a-glance confirmation of the forecast over a broad geographic region.

It is likely that the OTD will continue to be used in this manner, as a validation tool for convective weather forecasts. Additionally, exploration will also continue into applications of the OTD in offshore flight routing where radar coverage is sparse. In particular, forecasters at the Tropical desk have shown interest in utilizing the OTD for the routing of helicopter operations in the Gulf of Mexico. Helicopters generally remain at a much lower altitude than commercial airlines, and if caught in bad weather generally try to set down if possible. However, when flying over the Gulf for oil-rig operations, there is no land to set down upon. As such, knowing exactly where and how severe the convection is becomes imperative.

3.4   Lightning Detection
3.4.1 Pseudo Geostationary Lightning Mapper (PGLM) – NASA's Short Term
Prediction Research and Transition Center

In an effort to create a proxy dataset to represent total lightning data from the Geostationary Lightning Mapper (GLM; Goodman et al. 2013), the Lightning Mapper Array (LMA) networks were utilized as a pseudo-GLM (PGLM) product. The PGLM is generated from seven LMA networks: Northern Colorado, New Mexico Tech, West Texas, Oklahoma (central and southwest), Houston, TX, Northern Alabama, and Washington DC. Before being translated into an AREA file and ingested into N-AWIPS, VHF data from these networks are sorted into flashes and the number of flashes are counted in each 8x8 km grid box. This creates the PGLM flash extent density and is given at a resolution to match the expected GOES-R GLM resolution. In Evaluation Period II, the PGLM was evaluated for use by the NAMs in FAA traffic flow operations.

After last year's evaluations and forecaster feedback, it was intended that the AREA version of the PGLM be reformatted as a grid file. This would allow the product to be overlaid on visible or radar imagery as an additional tool for convection forecasting. However, because of a number of delays, the new format was not completed in time for the 2014 demonstrations at the AWC. Additionally, due to some maintenance issues and upgrades with various networks, there was some instability with the data in those networks. As such, the PGLM was not evaluated until the end of Evaluation Period II, and in FAA operations only.

Diverting an aircraft around a storm requires extra fuel and depending on the size and areal coverage of storms, it can require a significant amount. This need for extra fuel has to be taken into account at whichever terminal an aircraft originates from. For longer flights, it's necessary to make that decision well ahead of any impending weather, which often causes a headache all on its own. Adding extra fuel also makes an aircraft much heavier, subsequently resulting in fuel being burned at a faster rate. However, taking the chance and not adding fuel and running into convection that results in an unplanned divert into a different terminal would be even more costly than simply adding extra fuel.

Because of this, traffic flow managers attempt to prevent diverts until absolutely necessary. Typically, it is only when they start seeing lightning in the echoes that they will begin to consider changing traffic patterns en route, and it is for this reason that the NAMs believe the PGLM will be of great use. With both intra-cloud (IC) and cloud-to-ground (CG), they will be able to identify lightning activity much more accurately, particularly in the vicinity of Gulf of Mexico and Atlantic flight routes where there may only be intra-cloud lightning. While traffic flow managers would not necessarily begin diverting traffic right away, it would potentially provide them with more lead-time to reroute traffic more efficiently later in the event.

3.5   Fog and Low Stratus - University of Wisconsin's Cooperative Institute for Meteorological Satellite Studies

The GOES-R Fog and Low Stratus, a fused product using both satellite and model data to produce a probability of Instrument Flight Rule conditions, has been a part of the Aviation Weather Testbed since 2012. It continues to be one of the most commonly used products at the AWC. Locally, forecasters in the domestic branch keep the analysis handy when issuing C&V Area Forecasts and G-AIRMETs. The analysis provides great situational awareness and in certain situations can be used to identify when fog may be dissipating or expanding.

However, it is by far the most useful in FAA operations at the ATCSCC. The AWC's NAMs utilize this product often to provide TFMs a real-time update of ceiling conditions across the country, particularly at busy terminals. One example of this took place in late December of 2013 in Colorado (Figure 10). Early in the morning of the 29rd, Eagle County Airport in Colorado was placed into a ground stop due to low ceilings. At 1800 UTC, the FLS was continuing to indicate a high probability of IFR directly over the airport. However, at 1830 UTC, the probability dropped to zero. After noting this, the NAM on duty notified the TFMs, who subsequently cancelled the ground stop. By 1900 UTC, skies over the airport were completely cleared. Ending the ground stop early saved both money and customer time. Since then the FLS has been used in many similar cases and has become a regular part of NAM operations.

Figure 10. 20131229 1800 UTC FLS probs and sky cam (left), and 1830 UTC FLS probs and 1900 UTC sky cam (right).

Forecasters would like to keep this product in operations and also focus more on LIFR probabilities. Additionally, it is possible that an Aviation Weather Statement for C&V will be developed. During the Summer Experiment this was explored and the FLS was found to be a valuable tool here as well. It was requested that evaluation to this end be continued in future experiments.

Furthermore, forecasters would like to look more closely at a comparison of the MVFR, IFR, and LIFR probabilities to observed flight conditions, ceilings and visibilities. To this end, a qualitative view of the product has been designed as a web tool (Figure 11). Twenty of the major terminals that deal with ceiling issues on a regular basis have been input into the tool, with analysis of the past 24-hours available at 3-hour intervals.
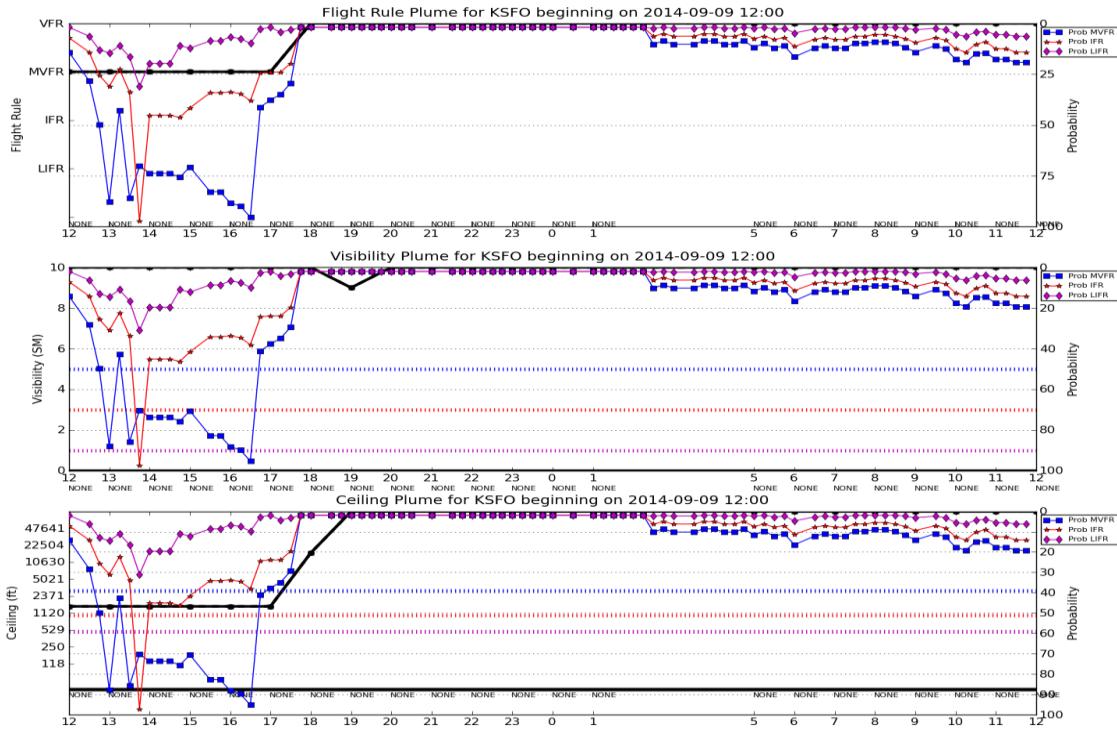
Figure 11. GOES-R MVFR/IFR/LIFR (blue, red, and pink respectively) vs. observed flight rule, visiblity, and ceiling (black solid line) for SFO.

In the Summer Experiment, this assessment was exploratory for the most part. Forecasters were able to get a feel for the data and begin to identify when the FLS did or did not perform well as compared to observations. Eventually, the goal is to also use this information as a verification tool for various C&V models currently running at the AWC.

3.6   **Geocolor Imagery** - The Cooperative Institute for Research in the Atmosphere

The GeoColor imagery was introduced to the AWC early this summer and represents some of the potential for GEO/LEO image combination that will be available in the GOES-R era. Not only does it provide a seamless transition between day and night, it also adds features like a natural color background, low clouds highlighted in pink during the day, and city lights at night. The product has been available for some time in AWIPS, but was generated in an N-AWIPS friendly format for the AWC and demonstrated during the Summer Experiment.

One case in which it was utilized occurred on August 12th. IFR and LIFR conditions stretched across a large portion of the Eastern U.S., while a smaller area centered over CLT. Despite the observed LIFR and IFR conditions in that region, the corresponding IFR and LIFR probabilities from the FLS were fairly low (Figure 12)

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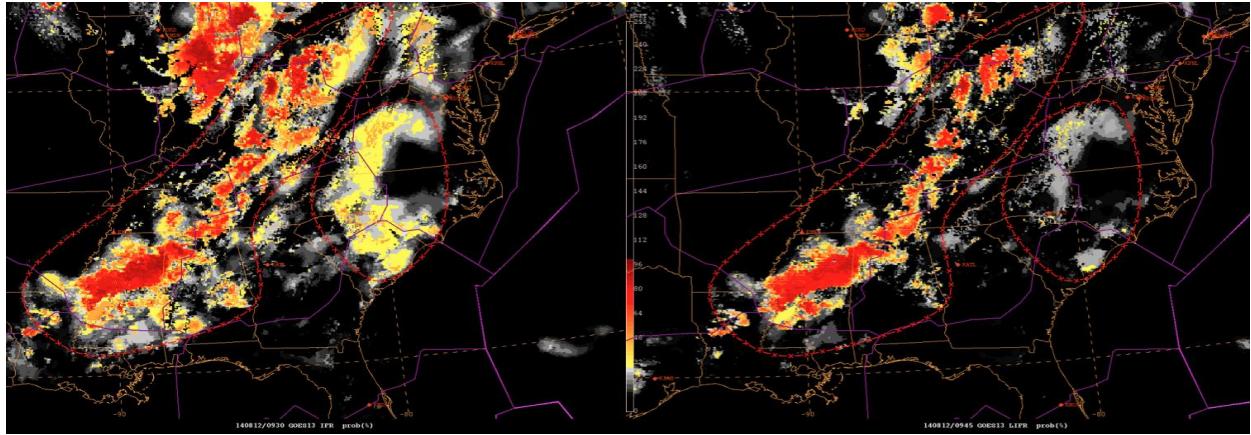
Figure 12. 20140812 0945 UTC IFR (left) and LIFR (right) probabilities from the FLS. Note the much lower probabilites surrounding CLT.

Note how smooth both the IFR and LIFR probabilities seem over CLT. This suggests that only model parameters were contributing to the FLS output. The GeoColor Imagery at the same time, shown in Figure 13 below, explains why this happened.
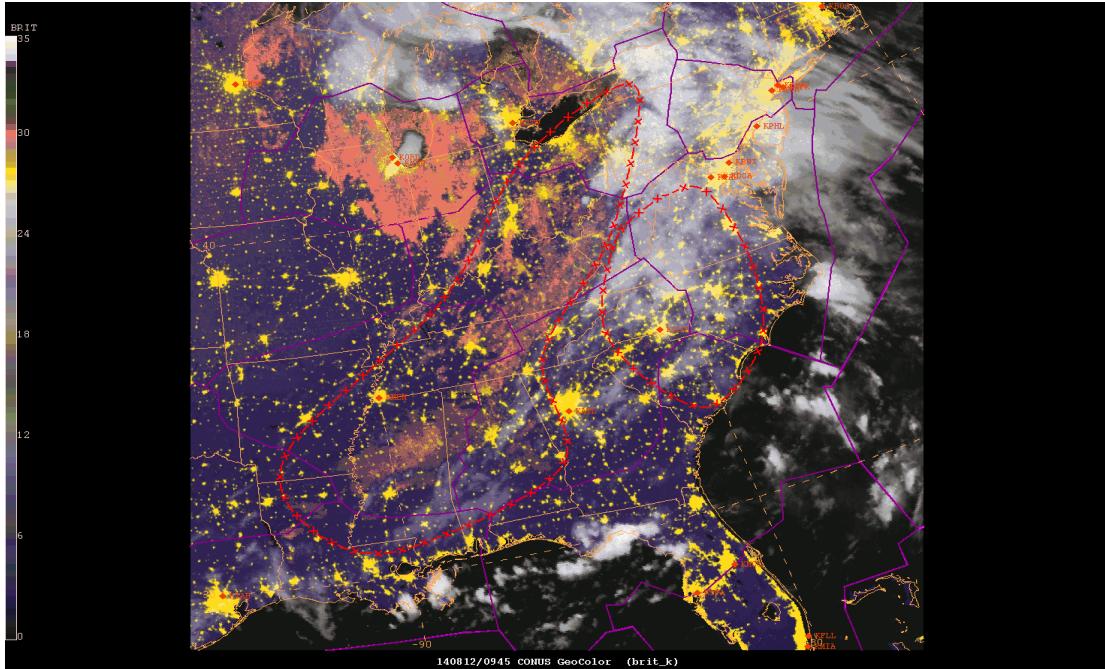

Figure 13. 20140812 0945 GeoColor. Pinks indicate low clouds or stratus, while whites indicate higher clouds.

The pink areas along the Appalachians were associated with the western area of observed LIFR and higher LIFR and IFR probabilities. However, the eastern area over CLT corresponded to an area of high clouds. This higher cloud layer subsequently prevented any satellite data from being assimilated into the probability product. The GeoColor was able to provide context in the case.

It was also noted to provide valuable context when using the Nearcasting model. On more than one occasion, large chunks were missing from the Nearcast due to existing cloud cover. Using the GeoColor as an underlay provided the context needed to see 1) the cause of the missing data and 2) compare the missing areas with earlier forecast areas of instability. Figure 14 below provides an example of this.
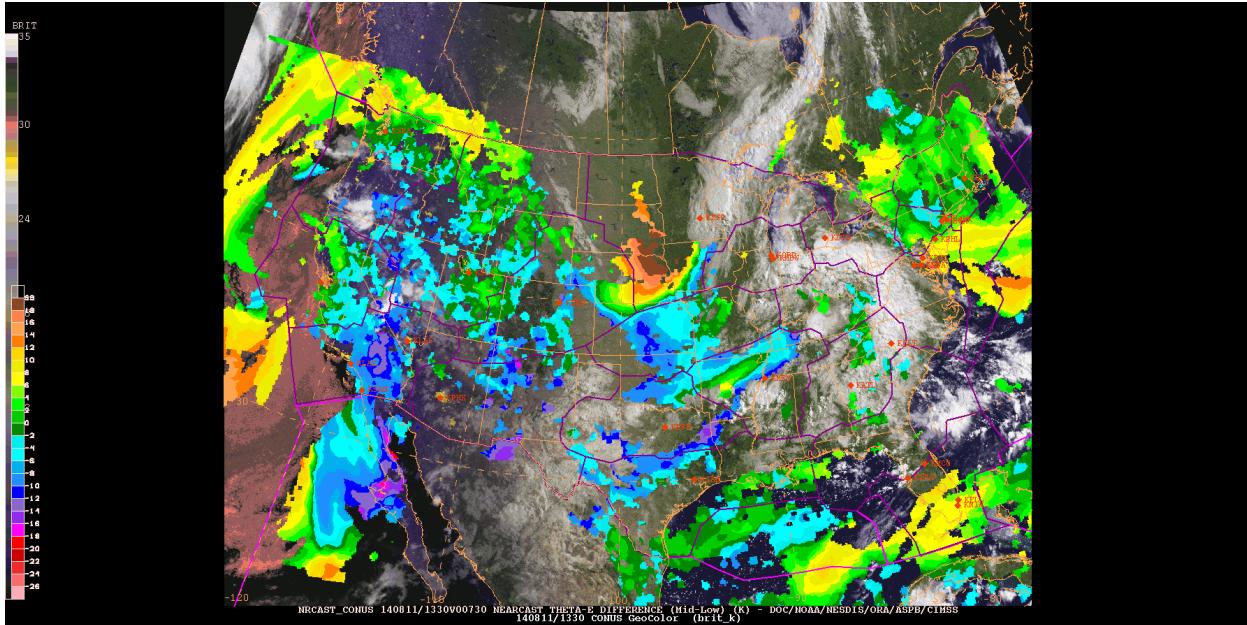
Figure 14. 20140811 1330 UTC Nearcast theta-e difference from the 0600 UTC run.

Aside from providing context, the GeoColor also provided an aesthetically pleasing full CONUS view, which was very helpful for the broad scale nature of many aviation operations. In fact, this product was used multiple times as an overview during the lunchtime brown bag seminars that were given during the experiment.

Overall, forecasters were very positive about the product thus far and would like to continue to evaluate it for aviation applications.

3.7   **The Nearcast Model** - University of Wisconsin's Cooperative Institute for Meteorological Satellite Studies

The NearCast Model, provided by UW-CIMSS, integrates the hourly full-resolution (10-12 km) information from the 18-channel GOES sounder. Using a Lagrangian approach in which multi-layer moisture information is transported forward in time using dynamically accelerating winds initialized with GFS modeled wind and height fields, this 'model' generates 1-9 hour 'NearCasts' of atmospheric stability and moisture indices. These nearcasts were designed to fill the 1-9 hour information gap that exists between longer-range (beyond 12 hours) numerical forecasts and observation-based nowcasts, and to enhance current NWP forecasts by successfully capturing characteristics (gradients, maxima, and minima) observed by GOES satellites that will define the development of convective instability (or stability). The Lagrangian approach allows for this information to be provided several hours in advance, even after subsequent IR satellite observations have become cloud contaminated.

Within the NearCast suite are a number of products, each based on a particular parameter typically used in forecasting atmospheric instability (or stability) and moisture availability. In previous years the layers and layer differences were evaluated but for the 2014 demonstration, only the theta-E difference was examined, specifically for FAA operations forecasting. Additionally, a full CONUS view of these parameters was made available for the Summer Experiment. As mentioned in the introduction, CCFP forecasters along with the NAMs and the CWSUs work together to provide traffic flow managers the most accurate convection forecast possible. This year, these forecasters looked at the potential for improving this forecast using the full CONUS NearCast.

On the first day of the experiment, the group working on the 'mock' convective AWS expected convection in the Southeast associated with a fairly strong low centered over MI. Early in the morning the NearCast showed two distinct axes of instability through the region, denoted by the yellow dashed lines in Figure 15 below.
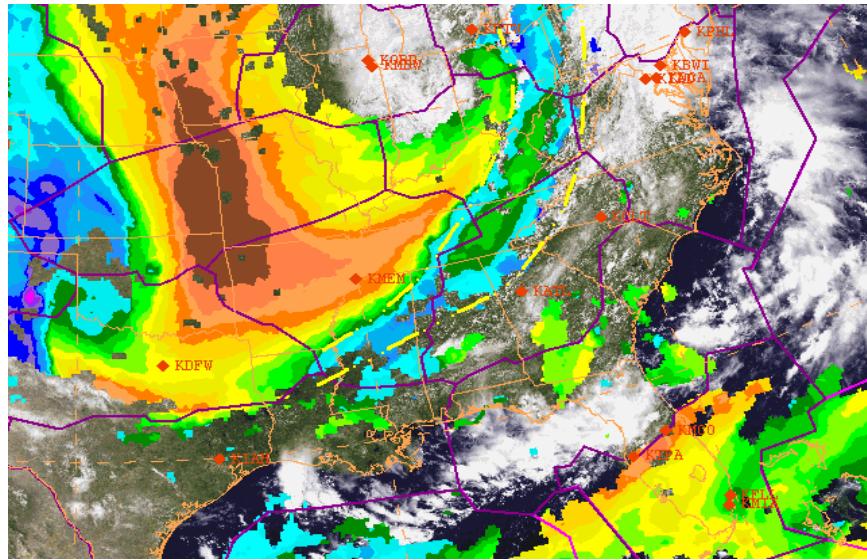

Figure 15. 20140812 1715 UTC Nearcast theta-e difference from the 0800 UTC run.

The instability values in both areas weren't particularly impressive but still enough for forecasters to conclude that 1) convection was possible once the front worked its way into the regions and 2) any convection that did develop would likely be non-severe and low-topped. The GeoColor imagery underneath shows some of the weak convection that began to initiate by 1715 UTC.

The CWSU forecasters were particularly pleased with this product. While they noted that the concept of the NearCast required a bit of a learning curve, they liked the fact that the color bar made it very easy to interpret, in this case the dry air associated with the trough sinking into the middle of the country as compared to the higher instabilities associated with the obvious frontal features of the low. All of the CWSU offices in attendance requested the weblink for the imagery as it is not currently available in their AWIPS.

During the experiment the NearCast was also examined for use in the tropics, where a wide variety of helicopter operations, along with FAA flight routes, make it important to have an accurate forecast of convection. The forecasters at this desk began by examining the theta-E difference over the Gulf of Mexico and Caribbean, but realized this was of little use to them in the tropical environment. The theta-E difference pinpoints instability caused by upper-level dry air moving over lower-level moisture. However, tropical convection forms when there is an abundance of moisture through the entire column. For this reason, the Tropical desk looked at the NearCast precipitable water fields instead (Figure 16 below).
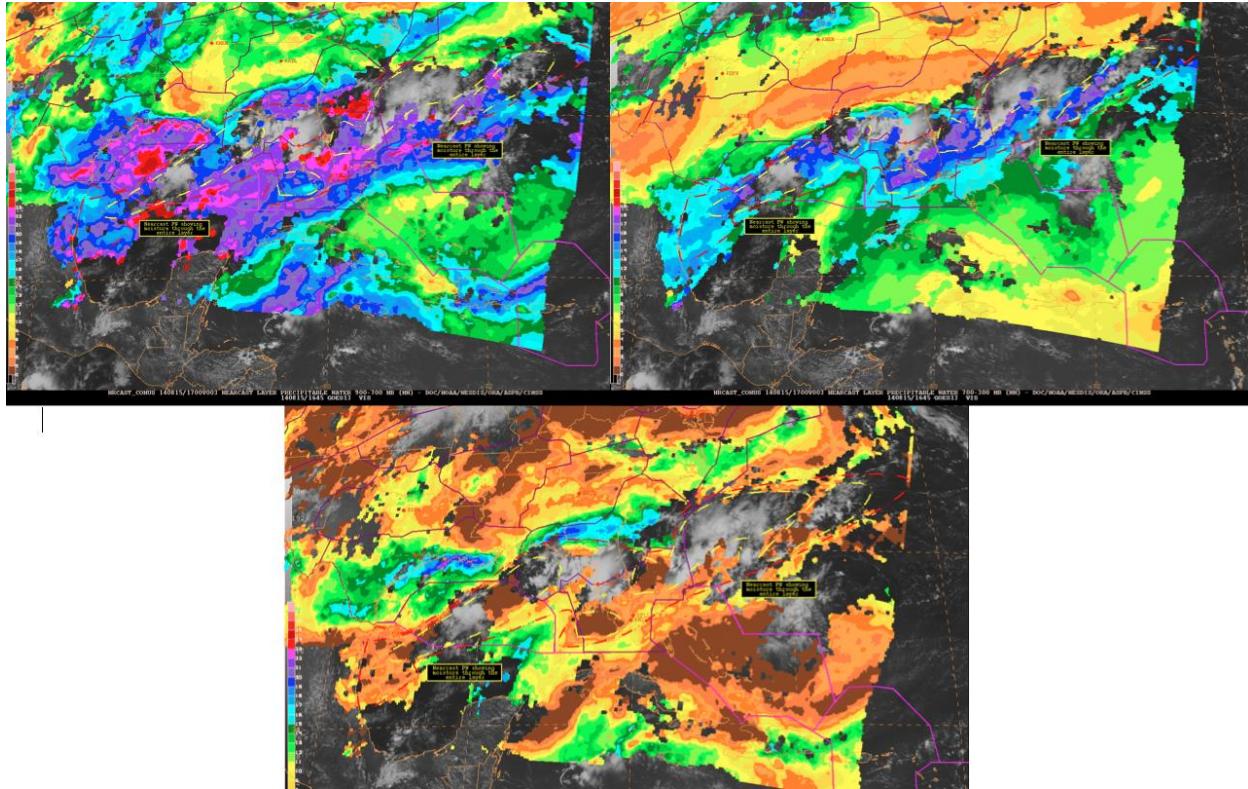
Figure 16. 20140815 1400 UTC 3-hour Nearcast of precipitable water in the low levels (top left) and upper-levels (top right), as well as the precipitable water difference (bottom). Areas of zero difference and high moisture values in both levels are indicated by the dashed yellow lines.

By comparing where there were areas of zero difference to areas of higher moisture in both layers, they were able to pinpoint several locations where moisture extended all the way through the atmosphere. As noted from the GeoColor underlay, these areas did correspond to convective activity.

The NearCast theta-E parameter is currently available in AWC operations, and both the NAM and CWSU forecasters would like to continue to evaluate it. Specifically, they would like to explore whether the values and/or areas of instability can be in any way related to the porosity of convection. Forecasting porosity, or how filled in an area or line of convection becomes, is one aspect that models struggle with the most and any additional tools to this end would be valuable. Also, after the feedback from the Tropical desk, forecasters would like to continue to explore the preciptable water fields.

3.8 GOES-R 14 Super Rapid Scan 1-minute Imagery - University of Wisconsin's Cooperative Institute for Meteorological Satellite Studies

Two periods of 1-minute Super Rapid Scan imagery (SRSOR) occurred during the 2014 demonstration, the first in May and then second in August. This data was made available in AWC operations via an LDM feed from SSEC. In previous years, the goal of the GOES-14 rapid scan experiments was to familiarize forecasters with the rapid temporal refresh expected with GOES-R ABI and how it benefits operations. This continues to be important, but this year's focus was on how rapid the temporal refresh should be. Given the ability of N-AWIPS to manually choose a refresh rate, forecasters specifically explored if the benefits of 1-minute imagery outweigh a 2 or even 5-minute refresh. In other words, 1-minute imagery is very, very aesthetically pleasing, but is it really necessary? Could we improve forecasts just as well using

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2 or 5-minute imagery? Below in Figure 17 is a sample image from an examination of 1-minute imagery during the Summer Experiment.
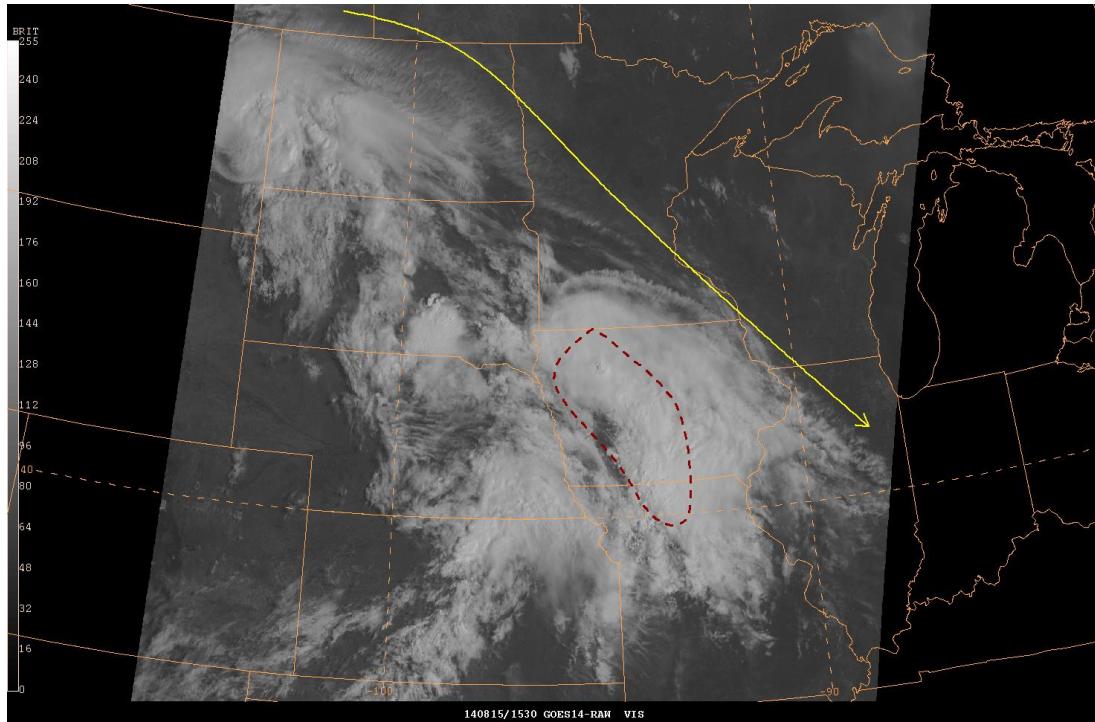
Figure 17. 20140815 1530 UTC SRSOR 1-minute visible imagery.

In this particular instance forecasters were examining an area of convection over IA (red dashed line) and an area of transverse waves across the upper Midwest (yellow arrow). An AWS was issued for the area of convection and forecasters monitored the 1-minute imagery to determine when tops might begin to drop, and also if any additional developing waves, and subsequently areas of turbulence, could be identified. At the same time, forecasters were also viewing 5-minute imagery. No derived products from the imagery were investigated.

After several hours, the consensus of both AWC and CWSU forecasters was that there really wasn't a noticeable benefit to having the 1-minute over the 5-minute imagery. By in large, the majority of aviation products are issued on a broad scale, even for the CWSUs. Additionally, with such large areas of responsibility the details of 1-minute imagery are lost in the rapid pace of issuing products. For these reasons, 5-minute imagery would likely suffice.

Perhaps the only part of aviation operations that isn't always broad scale is in terminal traffic flow. While the NAMs are monitoring all terminals, if there is weather around a specific terminal causing variations in mesoscale flow, they will take a closer look. Changing mesoscale flow patterns can cause a change of operations (i.e. runways) at a terminal and in some cases, compression issues (i.e. stronger winds above with lighter winds below, causing traffic compression on arrival). Though it hasn't been explored in detail, 1-minute imagery may be useful in these situations. More information and SRSOR can be found at http://cimss.ssec.wisc.edu/goes/srsor2014/GOES-14_SRSOR.html

3.9   Simulated Cloud and Moisture Imagery - University of Wisconsin Cooperative Institute of Meteorological Satellite Studies (UW-CIMSS) and the Cooperative Institute for Research in the Atmosphere (CIRA)

Various forecast fields are collected from the 00 UTC run of both the NSSL-WRF and the NAM Nest, including pressure, temperature, water vapor, heights, canopy temperature, cloud water, cloud ice, snow, graupel, and rain, all of which are processed as inputs for a radiative transfer model. Synthetic radiances and brightness temperatures are generated through this model and displayed as simulated satellite imagery meant to represent the capabilities of the Advanced Baseline Imagery (ABI) on GOES-R. The focus of the 2014 demonstration was on the visible channel (band1; 0.65 μm), low through mid/high-level water vapor levels (bands 8 – 10; 6.19, 6.95, and 7.34 μm), the clean infrared channel (band 14; 10.35 μm), and the simulated band difference for fog (band 14 – 3; 10.35 μm – 3.65 μm).

One of the areas in which Area Forecasters are challenged is in the issuance of G-AIRMETs for turbulence. Currently, forecast procedures have them using parameters like the Ellrod-Knox Index, Divergence Tendency, and Richardson Number. As a supplement to these values, the simulated WV imagery has been used as an underlay (Figure 18).
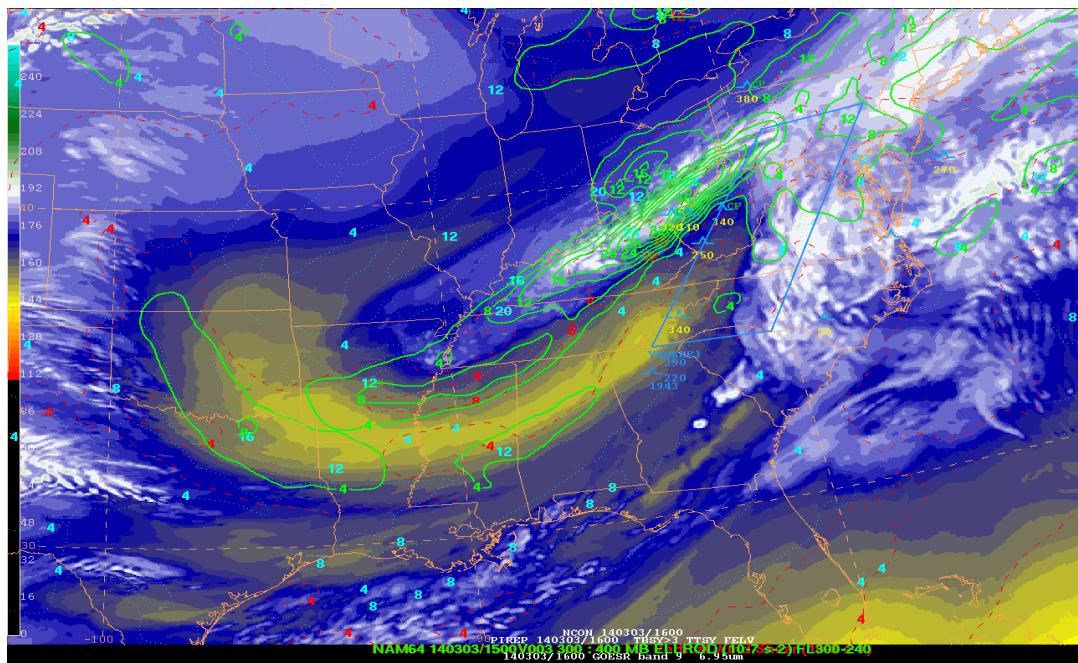

Figure 18. 20140303 1600 UTC simulated WV with 1600 UTC forecast of Ellrod Index values, and a turbulence SIGMET issued through 1900 UTC. Note the bullseye of higher Ellrod values near the shear zone of the jet in the simulated imagery.

Note the area of higher Ellrod values (green contours) that corresponds fairly well to the location of the shear zone in the jet. A SIGMET for turbulence was eventually issued due to reported severe turbulence in the area. In this particular case, the simulated imagery provided additional confidence in the turbulence forecast.

Simulated imagery was also used, not only by G-AIRMET forecasters but also NAM and CWSU forecasters for ceiling and visibility purposes. Along with the simulated band difference that highlights low, liquid water clouds, the 2014 demonstration also featured the simulated visible imagery. Forecasters explored utilizing these two products in tandem to provide more accurate information on the fog

dissipation. Figure 19 below highlights a case in which forecasters were interested in predicting if and when the stratus deck would move onshore and affect SFO.
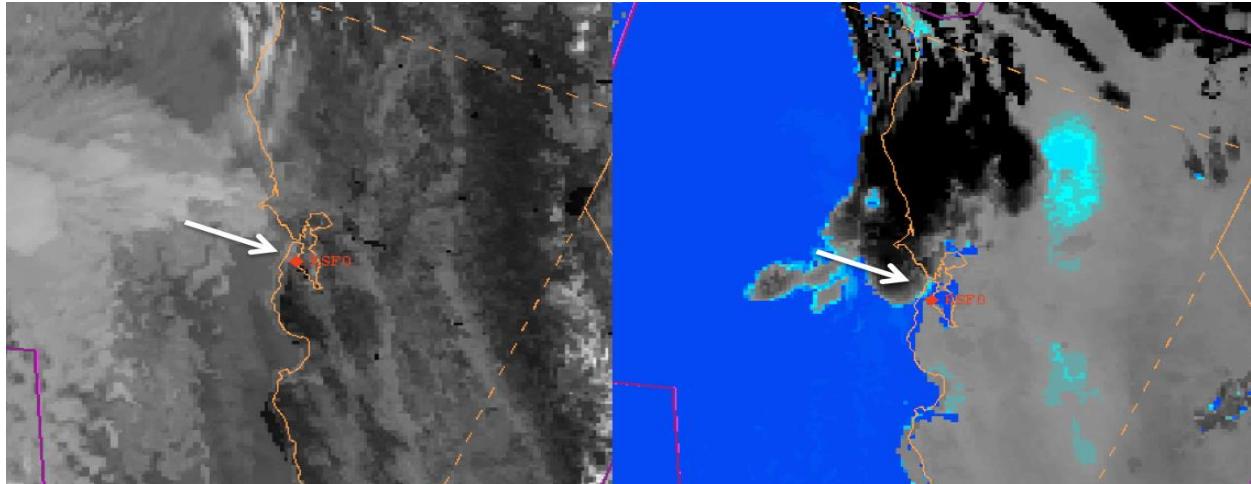
Figure 19. 20140811 1200 UTC simulated visible imagery (left) and simulated band difference for fog (right). The white arrow indicates where both products were beginning to indicate clearing by 1200 UTC.

In this case, both products showed low clouds affecting only the very tip of the San Francisco Bay, indicating the SFO would maintain MVFR conditions throughout the morning. Actual visibility observations corresponded well with this forecast, remaining at 7 miles or more. Again, the simulated imagery was able to provide additional confidence

NAM and CWSU forecasters take advantage of this imagery for convection forecasting purposes as well. During the summer experiment it was noted that it is beneficial, not only as a first glance at what will occur later in the day, but also as an easy way to determine how the model may be performing. One good example of the latter occurred on the morning of August 25th (Figure 20).
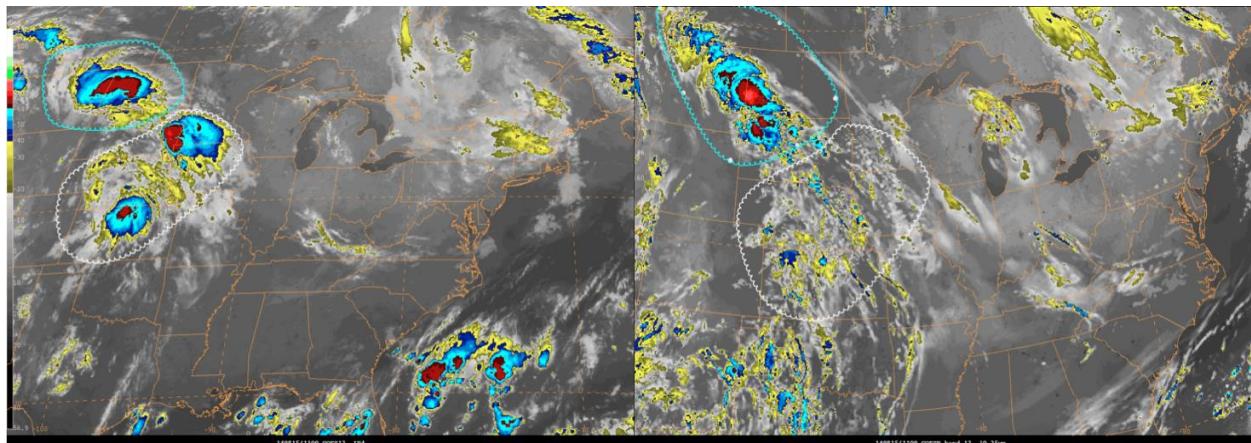
Figure 20. 20140815 1100 UTC IR imagery (left) and simulated satellite imagery (right). Three distinct MCSs were occurring in the central U.S. on this morning, but the modeled IR only forecast one.

Three separate, very distinct MCSs were moving through the central U.S. However, the 1100 UTC modeled IR imagery only forecast one. Given that this was fairly early in the run, it was a good indication that the remainder of the run would likely be inaccurate in that area of the country as well.

While the simulated imagery clearly was shown to be a beneficial forecast tool by a vast majority of the desks at the AWC, it is important to recall that the original purpose of the simulated imagery was to familiarize forecasters with the baseline capabilities of the ABI. For this reason AWC forecasters would like to continue to evaluate the simulated imagery, but shift their focus to further explore the potential capabilities of each new band. For example, exploring the benefit of having three water vapor channels in forecasting for various levels of turbulence. Though this concept was explored to some extent this year, forecasters would like more evaluation done to this end during the next demonstration period.

3.10   VIIRS Imagery - University of Wisconsin Cooperative Institute of Meteorological Satellite Studies (UW-CIMSS), the Cooperative Institute for Research in the Atmosphere (CIRA), and NASA's Short Term Prediction Research and Transition Center

As one of two, world area forecast centers, the AWC is responsible for forecasting over the entire globe, and as such utilizes polar satellites as well as geostationary satellites. VIIRS imagery, specifically the Day/Night Band and the Nighttime Microphysics RGB, have been made available to forecasters in N-AWIPS. Additionally, several Dust RGBs have also been made available to forecasters via web quick looks as well as in N-AWIPS.

One of the challenges of polar imagery is the domain. Currently polar imagery (NOAA-15, 18, and 19) is stitched into a series of global mosaic imagery utilized by those in the International Operations Branch (IOB). The eventual goal is for the VIIRS imagery to be assimilated into these mosaics, however what is currently being received via the testbed is limited to the CONUS domain. Also, the latency and spatial discontinuity of polar imagery does somewhat limit it's use in an operational setting.

That said, it has still been beneficial for forecasters to take a look at the imagery, as it provides a first glance into the potential capabilities of higher resolution satellite imagery, such as will be available with the launch of GOES-R. For example, the Tropical desk examined the Nighttime Microphysics RGB for the issuance of Gulf FA's, as it aided in the discrimination of various cloud layers, and the Day/Night band was explored for the same FA at night. Also, the Dust RGBs were utilized as a validation tool for the issuance of a blowing dust SIGMET (by far one of the most challenging products to issue) at the Central FA desk.

Shown in Figure 21 below is a comparison of the VIIRS True Color and the VIIRS dust enhancement. While the dust is barely visible in the true color imagery, it is clearly enhanced in pink in the dust imagery. Given the delay of the imagery, AWC forecasters could not use it for the issuance of a dust SIGMET in this case, but as mentioned above, were able to use it to validate the area of the SIGMET.
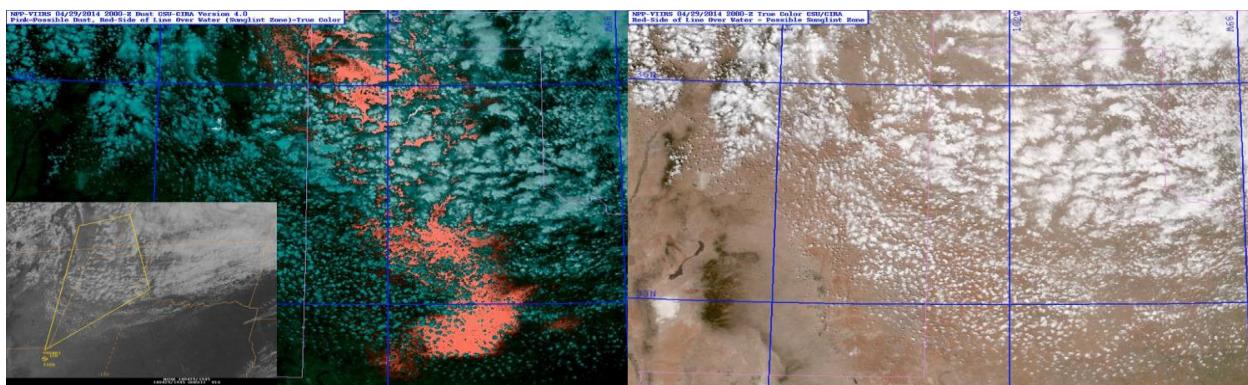
Figure 21. 20140429 2000 UTC VIIRS True Color (right) and dust enhancement (left), and the issued blowing dust SIGMET (bottom left). Dust enhancement images courtesy of Steve Miller, CIRA.

A similar dust RGB (one created by EUMETSAT for use with SEVIRI) was explored in which dust is highlighted in pink and other clouds layers are assigned various other reds and oranges. This tool also did well in highlighting dust in this case. However, the forecaster on shift using these tools suffered from color blindness, and the pink-red contrast of the EUMETSAT dust RGB colors made it difficult to identify the area of dust; whereas, the dust enhancement shown above was designed with color-blindness in mind. Additionally, for the purposes of blowing dust SIGMETS, forecasters are only looking to identify the blowing dust. While the EUMETSAT RGB does provide beneficial information on other cloud layers, forecasters preferred the single-feature enhancement. When this type of imagery becomes available at a higher temporal resolution it will be of huge benefit to aviation forecasters.

Again, polar imagery is difficult to evaluate in real time operations when trying to determine if it provides any value in improving forecasts. However, like the simulated imagery, it can be used to provide some insight into the baseline capabilities of the GOES-R ABI. In the future, forecasters would like to explore these (dust and nighttime microphysics) and other potential capabilities for use in aviation operations.

4. Summary and Conclusions

The Aviation Weather Center has a wide variety of forecast concerns for very distinct groups of customers including general aviation, commercial airlines and the FAA, and also helicopter operations. The 2014 GOES-R/JPSS demonstration was designed, in part, by these forecasters, and structured so that the focus was on integrating the chosen next generation satellite tools into the above-mentioned operations. It was separated into two long-term evaluations, Evaluation Period I and II, and concluded with a one-week, intensive experiment.

Unlike in previous years, no formal training seminars were conducted during the 2014 demonstration due to staffing shortages.. Instead training was conducted via one-on-one verbal discussion with forecasters out on various shifts. To supplement this one-on-one discussion, forecasters also had one page 'quick guides' for each product available in various forms (several electronic training folders and a hard copy binder in operations), as well as '2-minute case studies'. These cases are based on operational examples from the AWC and designed to be readable in the short periods of time between product issuances. This allowed for flexibility around forecaster shifts and heavy workloads, while also providing ample time to hear the thoughts of as many as possible out on the operations floor. In the future, forecasters have suggested providing audio for the '2-minute case studies' by using the AWC's Camtasia software, resulting in a short, recorded presentation similar to the articulate formats currently used for other GOES-R training modules. Additionally, with the new staffing hires at the AWC, it is expected that formal training sessions may become a possibility again for next year's demonstration. However, forecasters suggested keeping the current training design and using the formal training seminars as an additional supplement.

Feedback for the 2014 demonstration period was received via in-depth discussion with forecasters and blog posts. Survey questions were omitted based on a handful of initial meetings with forecasters during the planning stages of the demonstration. In general, it was noted that forecasters need exposure to a product being used in their real-time operations, especially if it is fairly new. Unless someone is out on the operations floor, encouraging them to take a look at a specific product (like a satellite tool), they won't often take time to pull it up, let alone answer a survey question. Admittedly it is a slow process, but once a few forecasters begin looking at a product regularly, that information begins to spread through the rest of the operations floor. As a product becomes more widely used and is discussed more frequently, the resulting feedback becomes much more detailed and constructive.

The Flight Icing Threat received perhaps the most constructive criticism. Though there was a dramatic improvement in appearance after a change of projection and color bar, and it was noted in previous years that it has the potential to be a valuable icing analysis, forecasters concluded that in its current form it is of little use. They recommend that the version of the algorithm that utilizes the GOES-R DCOMP inputs be somehow integrated with the version provided by NASA LaRC in the 2013 Winter Experiment, hence adding solutions for icing in areas with higher clouds. Additionally, they suggest working on a way to provide solutions for icing intensity at night, as only a binary yes/no is currently available.

Following feedback from last year's experiments, the ACHA cloud altitude product was developed and evaluated during the 2014 demonstration period. This product was very well received, especially by CWSU and NAM forecasters who are involved in forecasting for traffic flow operations. With three separate color scales, the product can be tuned to fog and low ceiling forecasts, as well as convection forecasting. The product was also available on a global scale for the WAFC desks, providing valuable information in otherwise data sparse areas. Given the high interest, the SPSRB process has already begun to add the cloud altitudes as a baseline product with the other ACHA algorithms. The Fog and Low Stratus product is similarly working down this path, and continues to be widely used in NAM operations.

Given that the Convective Toolkit products (including the GOES-R Convective Initiation, Cloud Top Cooling, and Overshooting Top Detection) have been in the AWT for a number of years, the 2014 demonstration of these algorithms focused on integration. Forecasters (CCFP, NAM, and CWSU) again saw the potential use of both the CI and the CTC, however given the nature of the algorithms to detect robust convection they also noted that it was difficult to adapt these algorithms to aviation operations, particularly for weaker, low-topped convection that can cause major traffic flow problems in the Northeast. They would like to continue to evaluate these products, focusing on those weaker events to further determine if the products are as beneficial as additional decision support tools, or if they are better served as inputs to an algorithm like CWIS. Overshooting tops, on the other hand, were determined to be of little use in traffic flow operations over the CONUS, though have been noted to be a good validation tool for various AWC issued products. Additionally, there is some potential use of the product in forecasting for convection for helicopter operations over the Gulf.

The Nearcast model continues to draw the interest of forecasters, its fields providing valuable information on both the likelihood of convective initiation and the behavior of ongoing convection in the 1-9 hour period. In particular, it provided a means to identify the potential for weaker, low-topped convection as well as more robust convection. Additionally, the new extended CONUS domain of the product provided valuable information for tropical forecasters. While there is still no clear path to operations for this product, it is recommended that further discussion of this matter be considered.

A product that was not as heavily evaluated in the 2014 demonstrations was the PGLM. With the delay of the grid version, and some inconsistencies with the networks, it was difficult to find good times and/or events to evaluate. However, forecasters still strongly believe that the GLM will provide valuable information for aviation forecasting, particularly for traffic flow management purposes and over oceans. No other lightning datasets (i.e. the GLD and ENI) were evaluated this year, although some did briefly view the HRRR lightning threat algorithm. While it provided some interesting information, it was difficult to determine a route in which to integrate the product into operations.

There were two instances in which GOES-14 was taken out of storage for SRSOR 1-minute experiments. This imagery is meant to emulate the expected temporal resolution of GOES-R and as per usual, was a popular tool among forecasters. However, this year forecasters took a closer look, comparing 1 to 5-minute data in an effort to determine which latency would be most plausible for aviation forecasting. In general, the latter was suggested, though forecasters will continue to evaluate this in the future. Events were compiled by the AWC's SOO and will be explored at a later date.

Another tool meant to emulate GEO/LEO integration capabilities was the GeoColor imagery, a new display developed by CIRA. Forecasters responded well to the aesthetically pleasing nature and CONUS scale of the display and found it to be a valuable context for other products such as the Nearcasting Model and the Fog and Low Stratus. They will continue to explore this product for further uses in aviation operations. Additionally, it is expected that new, extended Atlantic and Pacific domains will be available in the near future.

Perhaps one of the most popular tools among forecasters is the simulated imagery. This imagery was again noted as a valuable forecast tool for icing, turbulence, ceiling and visibility, and convection, and is used frequently by AWC and NAM forecasters, and also by a number of CWSU forecasters. These forecasters would like to continue to have this imagery as forecast tool, but believe it is important that it also be explored as a way in which to familiarize them with the capabilities of the ABI. This was pursued somewhat by turbulence forecasters viewing the three water vapor channels, and will be likely be more of a focus in upcoming evaluations.

Lastly, several VIIRS products were evaluated throughout the 2014 demonstration period. Given the global forecast responsibilities at the AWC, high latitude polar imagery is continuously utilized in the local generation of the global mosaics used in operations. Currently the VIIRS imagery that the AWC has access to is either CONUS or Alaska centric. For this reason, forecasters found it of little use for real-time forecasting. However, they were able to use it as a means to explore future capability displays, such as the dust enhancement and the nighttime microphysics, both potential possibilities with the GOES-R ABI.

Overall, feedback from the forecasters was very constructive, and by in large positive. Perhaps one of the biggest requests related to all of these products was the availability to the CWSU forecasters. Given the constant collaboration between the AWC and CWSUs for FAA operations, it is vital that both groups have access to the same satellite tools. This is somewhat difficult given the N-AWIPS at the AWC vs. the AWIPS-1 display at the CWSU's, and continuous bandwidth issues experienced by the CWSUs. This matter will be pursued within the next several months. Furthermore, additional meetings are in the works to provide the FAA research team with various GOES-R tools for eventual integration into their weather display systems.

More detailed feedback and case examples from the 2014 Demonstration can be found on the GOES-R Proving Ground AWT blog at:
http://goesrawt.blogspot.com/

General information about the 2014 Summer Experiment, all included datasets, the testbed blog, training material, etc., can be found at the AWT testbed home page:
http://testbed.aviationweather.gov/page/public?name=2014_Summer_Experiment

Details on the baseline algorithms and optional future capabilities can be found at:
http://www.goes-r.gov/resources/docs.html

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