GOES-R Proving Ground Evaluation
UW/CIMMS Low Cloud and Fog Evaluation
NWS/Eastern Region

Point of Contact: Dave Radell, Eastern Region SSD

WFOs Involved: GSP, PHI

Compiled on 9/17/12 by: Dave Radell (ER SSD, david.radell@noaa.gov) with Larry Lee (GSP), Al Cope (PHI), Greg Heavener (PHI).

Introduction

As part of the national GOES-R Proving Ground efforts, two WFOs in Eastern Region have been evaluating the UW/CIMMS Low Cloud and Fog (LCF) suite of products for the period of 2/15/12 – 8/15/12. Eastern Region has an extremely active aviation forecast program, given the large amount of national and international air traffic in the Boston (BOS), New York (LGA, JFK, EWR, TEB, ISP), Philadelphia (PHL, ACY), Washington DC, (BWI, IAD, DCA) and Charlotte, NC (CLT) corridors. In addition, several experimental forecast initiatives focused on digital aviation services, for both the commercial and general aviation communities, are ongoing within the Region. Thus, aviation-related observations and short term guidance are of particular interest to Eastern Region WFOs.

WFO Greenville-Spartanburg, SC (GSP) is a regional and national leader in the research and development of new tools and techniques for gridded aviation forecasting. Their forecast challenges include low clouds and fog at CLT, and terrain-related/valley fog in all areas of their county warning area.

WFO Mt, Holly, NJ (PHI) was awarded a Research-to-Operations COMET Partner's Grant (http://www.comet.ucar.edu/outreach/details.php?id=2199) with Kean University (NJ) to examine the spatial-temporal fog environment, from development through dissipation, in a short-term operational forecast framework. Their forecast area of responsibility includes PHL, with forecast challenges ranging from degrees of fog (light to dense) which impact everything from arrival/departure rates to widespread delays, to significant advection fog episodes within their county warning area.

This evaluation report contains several items: Comments from Eastern Region Headquarters (next section); Copies of the original Provider Agreements (Appendix I); Selected references to the LCF Products from NWS Area Forecast Discussions (Appendix II); Comments on use of the LCF products in WFO operations from the SOOs at each office (through 8/15/2012; Appendix III); and the online survey completed by the forecasters, administered, collected and summarized by Chad Gravelle (UW/GOES-R Program, Appendix IV).

ERH Evaluation Overview

The UW/CIMMS Low Cloud and Fog (LCF) products were introduced to Eastern Region via a GOES-R conference call in early 2011 from NWS OST/GOES-R Proving Ground personnel. Eastern Region Scientific Services (ER SSD) advertised the experimental products to two Eastern Region WFOs (given their aviation forecasting challenges), and they expressed interest in participating in a formal evaluation. In order to coincide with the start of the PHI GOES-R COMET project award, the data needed to be pulled into ER AWIPS systems rather quickly. At the time, the LCF products had only been tested on AWIPS I workstations in AK Region, so an immediate data ingest and display challenge was encountered, given that ERH is an AWIPS II OTE site (and no longer uses AWIPS I). ERH SSD staff worked with CIMSS to update and modify the AWIPS I installation instructions for ER WFOs. After some good communication between UW/CIMSS, GSP, PHI and ERH regarding AWIPS I configurations, color tables etc., the data were flowing into AWIPS I by late January 2012, well in advance of the 15 February 2012 start date. The products used in the evaluation were Probability of IFR, Probability of MVFR, Fog Mask, Low cloud/stratus depth, and Cloud Type. See Appendix I for details.

There was not much time to offer rigorous training to forecasters on the use of the products. The availability of training at the time of product introduction appeared to be outdated and consisted mainly of a single Powerpoint presentation that did not mimic the available imagery in AWIPS. Thanks to Chad Gravelle and the GOES-R Proving ground folks, a new, updated session was made available by the end of the summer 2012, but was a bit too late for our use. VISIT sessions related to LCF interpretation were also advertised. Jordan Gerth at UW/CIMMS was very accommodating in answering our questions early on with regards to AWIPS display and product interpretation.

A few select AFD snippets of operational use of the LCF products are provided in Appendix II. The MVFR and fog depth products were mentioned most often, particularly in the Aviation and Near Term sections of the AFDs. In short, both WFOs found the MVFR product to be useful both in forecast operations and in GFE work, according to our evaluation. The full evaluation reports and the online forecaster survey are presented in Appendices III and IV, respectively.

ERH Data and Communication Concerns

Just after the LCF evaluation ended, it was discovered by WFO GSP that two of the evaluation products were discontinued as part of the AWIPS data feed. This included both the MVFR probabilities and cloud type products. The evaluation period officially ended on 8/15/12, a few days before the data were terminated. We were surprised, and quite frankly disappointed, to learn that the MVFR and cloud type products were discontinued without any prior notice. At no time were Eastern Region Headquarters, or WFOs PHI and GSP made aware these two products were going to be unplugged from the suite of low cloud/fog information sent to Eastern Region HQ. Had our input been factored in to ending the product data flow, a different decision may have been made regarding the data termination. The MVFR Probability appears to have been replaced by an LIFR Probability. These kinds of data and AWIPS configuration changes cannot be made by ERH or the WFOs without considerable work, and advance notice would have been preferred, even after the official evaluation ended. This is so AWIPS configuration documentation can be changed and tested prior to data flowing into an operational AWIPS workstation. This is particularly important if an evaluation is to be expanded to other WFOs within Eastern Region.

This underscores a larger GOES-R Proving Ground communication issue that was mentioned by ER on a recent GOES-R/SDEB call.

It is well understood understand that the GOES-R Proving Ground data are not operational and are considered "experimental". Data outages and discontinuations can and do occur, and that is to be expected. However, if the purpose of providing forecasters the data to use in operational forecasting is to get feedback on its operational utility, reasonable communication on product availability and/or termination of data must occur to all parties involved. In addition, if data are to be terminated or algorithms changed based on "forecaster feedback", isn't it in the interest of all product evaluators to be made aware of these changes, along with a scientific or programmatic justification for doing so? This kind of communication leads to more robust, scientifically sound product evaluations, not to mention an awareness (with some lead time) of product changes/discontinuation for operational forecasters.

In our opinion, significant improvement is needed within the GOES-R Proving Ground community on communication of data availability, changes to algorithm development during evaluation periods, and the results of WFO product evaluations used to make those decisions. This could be as simple as status update emails sent to product evaluators (similar to what GSD and the HRRR developers do, alerting operational folks of potential missing/corrupt data or upcoming data outages) when algorithms change or when data flow will be interrupted or discontinued.

Eastern Region is excited to be part of the Proving Ground and evaluating the next generation of satellite-derived products and algorithms. We simply emphasize the need for the data flow, algorithm changes, and evaluation feedback to be communicated to all parties as effectively as possible for the benefit of all invested.

Appendix I

WFO Evaluation Partner – and - Provider Understanding

To be considered a GOES-R Proving Ground "Evaluation Partner", please document the following:

1. WFO Name: Philadelphia/Mount Holly, NJ (PHI)
2. Provider POC: Mike Pavolonis
3. WFO POC: Al Cope (SOO) and Greg Heavener (Focal Point)
4. Training:
   a. Provider POC: Chad Gravelle and/or Jordan Gerth
   b. WFO POC: Al Cope (SOO)
5. GOES-R product or application information (for each):

. Product Name: Low Cloud/Fog (Prob IFR, Prob MVFR, Fog Mask, Low cloud/stratus depth, Cloud Type)
   a. WFO Application: Short Term Fog/Aviation operational forecasting
6. Date product(s) to be delivered to WFO: ASAP
7. Date product(s) to be integrated/tested within AWIPS (NAWIPS or AWIPS II): AWIPS I
8. Date of training: will coordinate with CIMSS
9. Resources required: n/a
10. Dates of demonstration: 6 month evaluation period after training/data ingest (2.15.12-8.15.12)
11. Final Report delivery date: 1 month after end of evaluation (9.15.12)
12. Additional Comments/Remarks:

ERH Points of contact: Josh Watson (AWIPS) and Dave Radell (evaluation)
These data are to be used for part of a COMET Award GOES-R Program grant with Kean University (NJ).

Signatures include:

MIC/SOO____

SSD Chief:____

PG Provider POC: ______________________________________

WFO Evaluation Partner – and - Provider Understanding

To be considered a GOES-R Proving Ground "Evaluation Partner", please document the following:

1. WFO Name: Greenville-Spartanburg, SC (GSP)
2. Provider POC: Mike Pavolonis
3. WFO POC: Larry Lee (SOO) and/or Mike Jackson (ITO)
4. Training:
   a. Provider POC: Chad Gravelle and/or Jordan Gerth
   b. WFO POC: Larry Lee (SOO)
5. GOES-R product or application information (for each):

. Product Name: Low Cloud/Fog (Prob IFR, Prob MVFR, Fog Mask, Low cloud/stratus depth, Cloud Type)
   a. WFO Application: Short Term Fog/Aviation operational forecasting

6. Date product(s) to be delivered to WFO: ASAP
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ERH Points of contact: Josh Watson (AWIPS) and Dave Radell (evaluation)

Signatures include:

MIC/SOO____

SSD Chief:____

PG Provider POC: ____

Appendix II

Example Area Forecast Discussion Comments

785
FXUS62 KGSP 030603
AFDGSP

AREA FORECAST DISCUSSION
NATIONAL WEATHER SERVICE GREENVILLE-SPARTANBURG SC
203 AM EDT TUE APR 3 2012

.AVIATION /06Z TUESDAY THROUGH SATURDAY/...
AT KCLT...AS THE PREVIOUS SHIFT OBSERVED...SOME OF THE MODEL GUIDANCE DEVELOPS MVFR CIGS AFTER DAYBREAK. BASED ON THE HIGHER THAN PREDICTED SFC DEWPOINTS CURRENTLY OVER THE REGION...**AND A LITTLE MVFR LOW CLOUD COVER SHOWING UP ON THE CIMSS GOES-R MVFR PROBABILITY PRODUCT**...MVFR CIGS HAVE BEEN ADDED STARTING AT 13 UTC...LASTING INTO THE EARLY AFTN. HOPEFULLY THEY WON/T COME IN ANY EARLIER THAN THAT. OTHERWISE A GENERAL ESE COMPONENT TO THE WINDS ARE EXPECTED THROUGH MID MORNING...WITH THE WINDS VEERING TO THE SOUTH BY AROUND NOON. ISOLATED TO SCT TSTMS MAY DEVELOP THIS AFTN...THOUGH THE BULK OF THE ACTIVITY SHOULD STAY OVER THE MTNS AND FOOTHILLS.

ELSEWHERE...AS MENTIONED ABOVE...DEWPOINTS ARE QUITE THIS MORNING IN THE VCNTY OF A RATHER DIFFUSE SFC COLD FRONT THAT APPEARS TO BE SOMEWHERE ALONG THE SAVANNAH RIVER VALLEY. THE NAM BRINGS IN IFR CIGS AT THE UPSTATE TAF SITES BETWEEN 09-12 UTC. THE GFS MOS IS MUCH HIGHER. HOWEVER...**AS A LITTLE MVFR CLOUD COVER HAS ALREADY SHOWED UP ON THE CIMSS GOES-R MVFR PROB PRODUCT**...IT/S EVIDENT THAT LOW CLOUD COVER IS ON THE VERGE OF BLOOMING ACROSS THE UPSTATE. THEREFORE THE NAM TREND HAS BEEN FOLLOWED WITH MVFR CIGS DEVELOPING BY 08 UTC AND IFR BY 10 UTC. A DRIER AIRMASS SHOULD RESULT IN HIGHER CIGS AT KHKY.

125
FXUS62 KGSP 020238
AFDGSP

AREA FORECAST DISCUSSION
NATIONAL WEATHER SERVICE GREENVILLE-SPARTANBURG SC
1038 PM EDT FRI JUN 1 2012

.**NEAR TERM** /THROUGH SATURDAY/...
AS OF 1035 PM FRI...THE SFC COLD FRONT HAS NOW PUSHED SOUTH OF

INTERSTATE 85...WITH DEWPOINTS NORTH OF THE BNDRY HAVEN FALLEN INTO THE 50S. THE NAM DEVELOPS UPGLIDE OVER THE COOLER/DRIER LLVL AIRMASS...RESULTING IN A CLOUD DECK THE FORMS ROUGHLY ALONG A LINE FROM SPARTANBURG TO CHARLOTTE LATER TONIGHT. THERE IS A THIN RIBBON OF WHAT LOOKS LIKE STRATO-CU SHOWING UP ON THE 11-3.9 UM SATELLITE IMAGERY IN THIS AREA ATTM. **THE CIMSS GOES-R LOW CLOUD PROBABILITY PRODUCT IS SHOWING ABOUT A 60-70 PERCENT CHANCE THAT THESE CLOUDS ARE IN THE MVFR RANGE. WHILE SKIES HAVE CLEARED NORTH AND SOUTH OF THAT AREA**. SO THERE PROBABLY WILL BE A GRADUALLY EXPANDING CLOUD DECK ALONG THIS AREA OF LLVL CONVERGENCE AND WEAK ASCENT MUCH OF THE NIGHT. SKY COVER HAS BEEN INCREASED OVERNIGHT IN THE ABOVE REFERENCED AREAS...THOUGH I/M SURE IT WILL NEED TO BE TWEAKED WITH TIME. THE REST OF THE GRIDS ARE IN GOOD SHAPE AS SHRA ACTIVITY HAS PUSHED OUT OF THE FA.

.AVIATION /15Z FRIDAY THROUGH TUESDAY/...
AT KCLT...**LATEST CIMMS GOES-R CLOUD DEPTH OVER KCLT WAS NEARLY 900 FEET. THIS SHOULD TAKE ABOUT TWO HOURS TO BURN OFF.** THE VSBY HAS RECENTLY STARTED TO DROP AS WELL WITH A TOWER VSBY OF 1/2 MILES. HOPEFULLY THIS WILL IMPROVE AFTER SUNRISE...BUT THE DOWNWARD TREND IS NOT GOOD. WILL KEEP 1400 UTC FOR BURN OFF TIME...BUT THERE IS A CHANCE THAT IFR OR BLO CONDITIONS WILL LAST LONGER THAN THIS. THE RUC BUFKIT SOUNDINGS IMPLY IFR CIGS TIL NOON.N TO NE WIND WILL CONTINUE THRU THE DAY THEN TURN SE FOR THE EVENING. EXPECT VFR CLOUDS AND LIGHT SLY WIND OVERNIGHT.

093
FXUS61 KPHI 010141
AFDPHI

AREA FORECAST DISCUSSION
NATIONAL WEATHER SERVICE MOUNT HOLLY NJ
941 PM EDT THU MAY 31 2012

.**NEAR TERM** /UNTIL 6 AM FRIDAY MORNING/...THERE WAS A SMALL FOG OR STRATUS BANK OFF OF THE DELMARVA PENINSULA TODAY THAT WAS DISSIPATING, THEN WAS MASKED BY SOME SHOWERS THAT RE-INVIGORATED IT. THE ONSHORE FLOW HAS HELPED PUSH IT TOWARD THE COAST. **TRAFFIC CAMS IN EASTERN DELAWARE ARE NOT SHOWING MUCH FOG. SOME OF THE EXPERIMENTAL SATELLITE IMAGERY DETERMINATION IS SHOWING LOW CHANCES OF IFR CONDITIONS WITHIN THAT PATCH. SO WE ARE GOING TO ASSUME ITS MORE STRATUS THAN FOG.**

175
FXUS61 KPHI 131933
AFDPHI

AREA FORECAST DISCUSSION
NATIONAL WEATHER SERVICE MOUNT HOLLY NJ
333 PM EDT WED JUN 13 2012

.**NEAR TERM** /UNTIL 6 AM THURSDAY MORNING/...
THE WRF-NMMB LOOKED BETTER THAN THE GFS WITH ITS 500MB INITIALIZATION IN THE NERN CONUS, THE GFS LOOKED BETTER IN OTHER PLACES EAST. ALSO THE GFS LOOKED SLIGHTLY BETTER AT 850MB AND 925MB. IN TERMS OF VERIFYING "WHAT IS OUT THERE", THE GFS AND CAN RGEM LOOKED SLIGHTLY BETTER THAN THE WRF-NMMB. SO THE PLAN IS TO LEAN TOWARD THE GFS THROUGH THE SHORT TERM AND MOVE THE CHANCES FASTER THROUGH OUR CWA TONIGHT. THE HRRR WAS NOT USED AS ITS WAVES OF SHOWERS REACHING INTO PA IS AND HAS NOT BEEN VERIFYING.

SHOWERS CHANCES ARE TIED TO A COMBINATION OF THE GFS, CAN RGEM AND 4KM ARW SOLUTIONS. NOT MUCH DPVA FORECAST BEYOND MIDNIGHT AND NO OTHER FORCING APPARENT. SOME COASTAL FRICTIONAL CONVERGENCE HELPING NOW ALONG THE INVERTED TROF. AS THE OFFSHORE LOW SAGS SOUTH, SO SHOULD THE GREATER CONVERGENCE/SFC TROF AND HENCE THE SOUTHWARD SAG OF POPS.

OTHERWISE EXPERIMENTAL SATELLITE IMAGERY IS SHOWING A FAIRLY LARGE SWATH OF MVFR WITH LOW PROBABILITY IFR CIGS OFFSHORE. AS THE SFC LOW SAGS SOUTHWARD, THE WINDS WILL VEER MORE TOWARD THE ONSHORE DIRECTION. WITH THE FORECAST SOUNDINGS DEVELOPING AN INVERSION, THIS SHOULD TRAP THE CLOUDS AND HELP SPREAD IT WESTWARD INTO OUR CWA. RIGHT NOW WE ARE LEANING MORE TOWARD CLOUDINESS THAN FOG. WE ARE MAKING SKY COVER MORE PESSIMISTIC TONIGHT. CONFIDENCE AS TO HOW FAR WEST THIS GETS IS NOT HIGH. BECAUSE WE ARE GOING WITH THE CLOUDIER FORECAST, WE ARE ALSO GOING WITH HIGHER STAT GUIDANCE MINIMUM TEMPERATURES.

Appendix III

Summaries and Case Examples from the Science Operations Officers

GOES-R Proving Ground Evaluation: Fog and Low Stratus
WFO Greenville-Spartanburg
Greer, SC
February – September 2012

1. Implementation

WFO Greenville-Spartanburg began receiving the following GOES-R Proving Ground products in February 2012: MVFR Probability, IFR Probability, Cloud Thickness, and Cloud Type.

The imagery was introduced to operations immediately. Initial training was gleaned from NOAA/NESDIS and NOAA/CIMSS (SSEC) documents prepared for GOES-R fog and low stratus applications in Alaska. The NOAA/ ABI document[1] for low cloud and fog provided useful information. We also gained valuable assistance from Jordan Gerth at UW-Madison (CIMSS/SSEC). Al Cope, Science and Operations Officer at WFO Philadelphia/Mount Holly, and Dr. David Radell, Eastern Region Scientific Services Division, also served as information resources. Toward the end of the evaluation period, Dr. Chad Gravelle provided a new training slideshow[2] and a link to the new "FusedFog" blog. If the new slide show had been available earlier in the evaluation period, forecasters probably would have been more comfortable incorporating GOES-R into the job stream because the examples are more relevant to our part of the country.

The available training was put to good use, and it was helpful with regard to spinning up an operational evaluation. A more focused introductory presentation, such as a webinar, discussing applications in the Lower 48 would have assisted the Science and Operations Officer in designing CWA-specific training.

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[1] Calvert, C., and M. Pavolonis, 2010: GOES-R Advanced Baseline Imager (ABI) Algorithm Theoretical Basis Document for Low Cloud and Fog (Version 1.0), NOAA/NESDIS/Center for Satellite Applications and Research, 77 pp.

[2] "Forecaster Training for the GOES-R Fog/Low Stratus (FLS) Products" by Mike Pavolonis, Corey Calvert, Scott Lindstrom, and Scott Bachmeier

2. Application to Operations

Our primary interests in applying the fog and low stratus products were directed toward our public and aviation forecasts. The WFO GSP County Warning Area is subject to periods of low stratus and dense fog.

The Piedmont and foothills of our CWA frequently experience periods of extensive fog, especially during the humid summer months when nighttime radiational cooling occurs unimpeded by wind and clouds. Low stratus can occur under the following conditions: 1) Light easterly winds promote weak upslope flow over the Carolina Piedmont and foothills, or 2) After rain the previous evening when overnight boundary layer moisture beneath an inversion is mixed enough to prevent fog formation. Charlotte-Douglas International Airport (KCLT) experiences both fog and low stratus. The impacts on aviation are important because KCLT is the sixth busiest airport in the country in terms of daily landings and takeoffs[3].

The mountain valleys in western North Carolina experience frequent dense fog. The major cities and towns in that part of the state are located in valleys, so dense fog has a significant impact on the population. Highway travel can be hampered by both low visibility and the persistence of fog. Some of the interstate highways have caution signs and flashing lights that identify locations where dense fog is common. The French Broad River valley (where the city of Asheville is situated), the Tuckasegee River valley, the Little Tennessee River valley, and the Pigeon River Gorge are particularly susceptible to low visibility caused by fog. The Asheville Regional Airport is in the French Broad valley right next to the river. Fog and low stratus can be quite disruptive to both commercial and general aviation.

3. Examples

a. Low Stratus and Fog

An example of low stratus development over a portion of the WFO GSP CWA was documented on 22 February 2012 (Appendix I). The GOES-R imagery captured the formation and northeastward extension of IFR ceilings from the WFO

[3] Personal Communication: Chip West, Meteorologist in Charge, Center Weather Service Unit, Hampton, GA.

Peachtree City CWA into extreme northeast Georgia and upstate South Carolina between 0802 UTC and 1145 UTC. The narrow band of low clouds developed northeastward over Interstate 85, and it affected three TAF sites (KAND, KGMU, and KGSP). The 1215 UTC 11µ - 3.9µ IR image showed the area that experienced low stratus corresponded closely to the GOES-R imagery signatures at approximately the same time. This example provided evidence to the forecast staff that there is value in the GOES-R fog and low stratus products. From an operational perspective, the GOES-R images can provide valuable guidance to Eastern Region forecasters who update the near term gridded forecast database at least once every three hours.

b. Recognizing Significant Model Contribution to MVFR and IFR Classification

The forecaster during the morning of 28 March 2012 used the GOES-R MVFR and IFR probabilities as guidance for the KCLT TAF and for information to coordinate with the CWSU (Appendix II). He recognized that the presence of high clouds would render the low cloud thickness product unusable. The IR imagery suggested fairly thick cirrus, and the Cloud Type product identified "cirrus" and "overlap" categories in the vicinity of Charlotte. Surface observations indicated some low clouds existed, too, especially over South Carolina. Charlotte was on the northern edge of the low clouds. The 1302 UTC probability of IFR at KCLT was approximately 25%. The probability of MVFR or lower was greater than 90%. The 1252 UTC KCLT METAR was 7SM OVC008. The forecaster stated that the GOES-R probability products did an excellent job of delineating the blanket of MVFR and lower conditions, but the specific identification of IFR was underdone. In this particular case, the shortcoming was important because of the proximity of KCLT to the low cloud field and the effect of low clouds on controlling the high volume of air traffic arriving and departing at that time of the day.[4] This situation provided a real-time opportunity to highlight the fact that numerical model input (RUC at the time) was a significant contributor to the probabilities rather than the statistical model that incorporates NWP and the satellite imagery.

[4] Any clouds below 4500 ft AGL can cause a loss of visual contact between aircraft requiring the controller to separate them, hence reducing the ability to land planes as fast as possible. Personal communication: Chip West, Meteorologist in Charge, Center Weather Service Unit, Hampton, GA.

c. Forecast Update: Dense Fog Advisory

The 14 March 2012 midnight shift near term forecaster utilized the GOES-R products (Cloud Thickness and IFR Probability) to expand a dense fog advisory into an area that was not covered by the initial issuance (Appendix III). The imagery also increased forecaster situational awareness regarding the advance of IFR conditions toward Charlotte-Douglas International Airport. Subsequent imagery – especially the Cloud Thickness - did a good job of providing indications of the portions of the fog blanket that would be the last to dissipate over northeastern South Carolina.

d. Thin Clouds Hinder GOES-R Sensitivity

During the early morning of 21 August 2012, fog produced IFR conditions at the Asheville Regional Airport (KAVL). Neither the GOES-R MVFR or IFR probability images provided an indication that low visibility existed at the terminal (Appendix IV). Close inspection of the traditional IR imagery revealed very thin clouds spreading over the Asheville area. It is surmised that the clouds were sufficient to prevent the GOES-R algorithms from performing in the optimum manner. The parallel RTMA also failed to place IFR visibilities at KAVL.

e. Dense Valley Fog in Western North Carolina

Dense early morning fog was observed in the GOES-R imagery on 24 August 2012 (Appendix V). The imagery showed the increasing probability of IFR during a period of several hours coincided with decreasing visibility at the Asheville Regional Airport. The information provided indications that IFR weather filled the valleys and probably contributed to precarious driving conditions on heavily traveled highways.

4. Assessment

Use of the experimental imagery was not uniform across the staff. Some forecasters were more eager to embrace the new products than others. The “near term” forecast desk is so busy with frequent grid updates and aviation-related coordination that the value of new guidance must be demonstrated before universal acceptance occurs. As more GOES-R PG examples are documented and new tools such as gridded versions of the imagery are improved, the real-time application of the products is certain to expand. It seems obvious that at least some of the products being tested with the current satellite technology will be greeted warmly when GOES-R becomes operational.

The MVFR and IFR probabilities and the Cloud Thickness products proved to be very good at delineating fog and stratus areas, particularly during the pre-sunrise hours when no middle and high clouds were overhead. The transition from night to day created some difficulty in interpretation because the probability values could change significantly. The GOES-R products usually provided a more definitive display of low stratus and fog than our traditional 11µ - 3.9µ fog detection method.

When the algorithm relied on model data, the MVFR and IFR depictions were only as good as the model. Forecaster confidence in using the GOES-R products was much higher when the satellite had a clear view of the low clouds and was providing essentially an observation rather than a model depiction.

Operational applications were most useful during the “near term” portion of the forecast. Cloud fields could be observed, trends could be identified, and short term extrapolations could be made. Forecasters still frequently used the traditional 11µ - 3.9µ imagery, but the GOES-R displays with color scales and pixel values that could be monitored provided more detailed information regarding low cloud and fog formation and expansion. At this point, the forecast staff is not ready to discard the legacy products, but the benefit of the GOES-R products is recognized.

The GOES-R IFR Probability and Cloud Thickness images occasionally were compared with the parallel RTMA visibility. More inspection is needed, but it appeared that the parallel RTMA sometimes placed the lowest visibilities over mountain ridges instead of in valleys where the satellite imagery displayed low cloud and fog signatures.

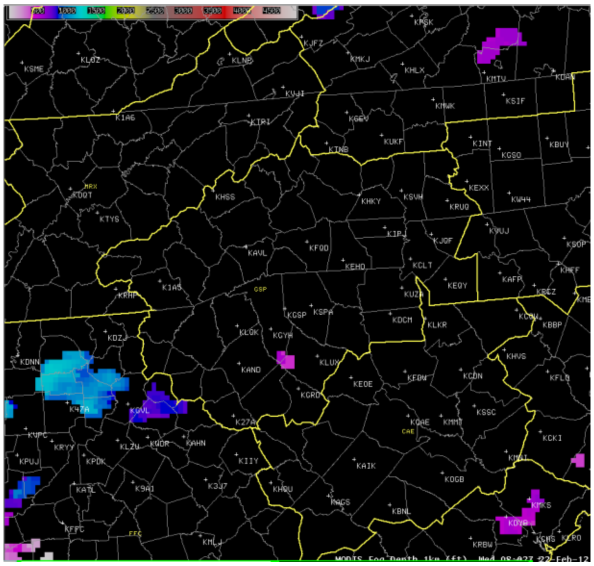
The GOES-R product developers are probably keenly aware of proposed changes in the aviation forecast program during the next several years. It is hoped that products can be developed in concert with the evolution of aviation observations and forecasts. In particular, satellite imagery – such as the array of products presently being evaluated – has the potential to greatly improve the accuracy and reliability of a national gridded ceiling database that can serve the aviation community and provide excellent initial conditions for national gridded aviation forecasts.

Harry Gerapetritis, Senior Forecaster, has led initial attempts to create IFR Probability grids in GFE. Preliminary results demonstrate that the potential exists for WFOs to employ GOES-R imagery in the near-term gridded forecast process (Appendix VI). He has also created an experimental Smart Tool that uses GOES-R IFR Probability grids to adjust the initial hour PredHgt values that are a component of the GFE TAF preparation process (Appendix VII).

We look forward to continuing our use of GOES-R fog and low stratus imagery during the cool season. Possible applications include viewing the low stratus that accompanies the demise of Appalachian cold air damming events and examining the character of low clouds during northwest flow snow events. Further refinements to populating observed gridded database fields with GOES-R products will be examined. We hope to have access to MVFR, IFR, and LIFR probability images for these experiments.

Appendix I

Stratus and Fog Development – 22 February 2012

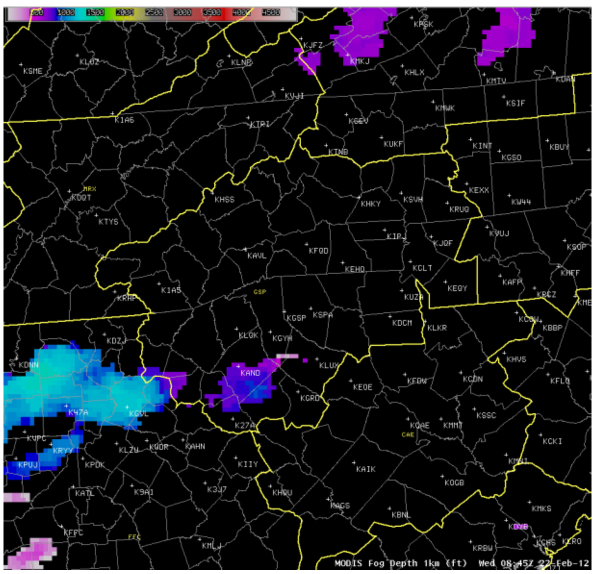


0802Z – GOES-R PG Satellite Image

GOES-East Cloud Thickness - Highest Liquid Layer

KAND… 0756Z … 10SM CLR

KGSP… 0753Z … 10SM CLR

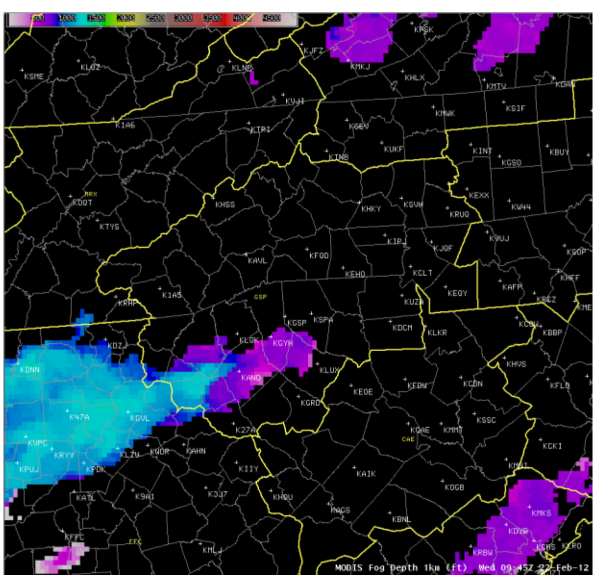


0845Z – GOES-R PG Satellite Image

GOES-East Cloud Thickness - Highest Liquid Layer

KAND… 0856Z … 6SM BR OVC003

KGSP… 0853Z … 8SM CLR

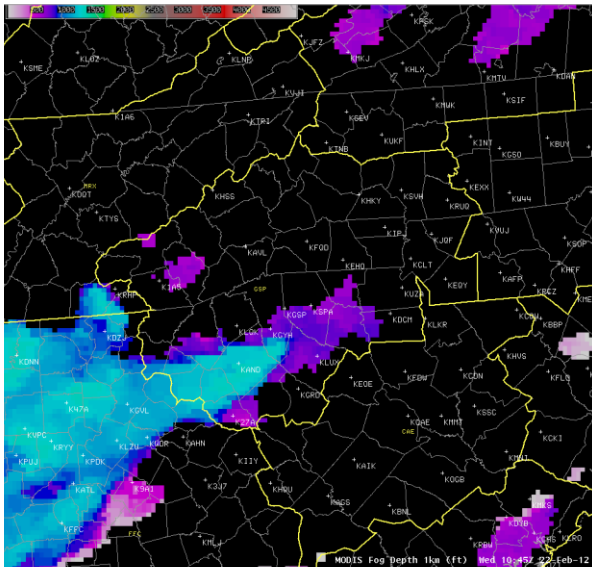


0945Z – GOES-R PG Satellite Image

GOES-East Cloud Thickness - Highest Liquid Layer

KAND… 0956Z … 2 1/2SM BR CLR

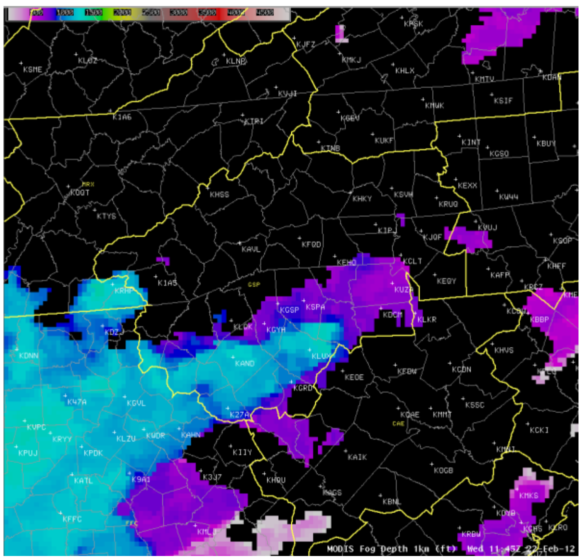
KGSP… 0953Z … 4SM BR CLR



1045Z – GOES-R PG Satellite Image
GOES-East Cloud Thickness - Highest Liquid Layer

KAND… 1056Z … 5SM BR OVC014

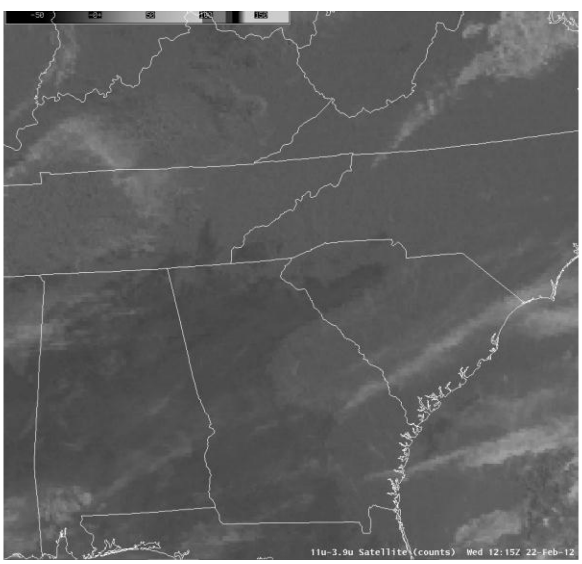
KGSP… 1053Z … 2 1/2SM BR CLR



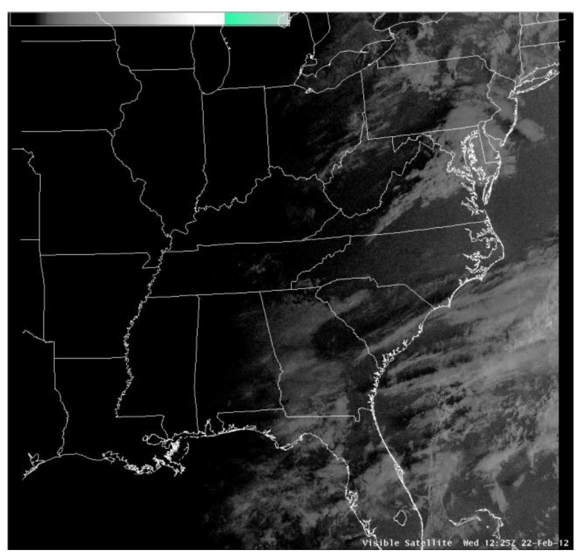
1145Z – Satellite Image
GOES-East Cloud Thickness - Highest Liquid Layer

KAND… 1156Z … 6SM BR OVC014

KGSP… 1153Z … 3SM BR FEW005
KGSP… 1213Z … 3SM BR BKN005



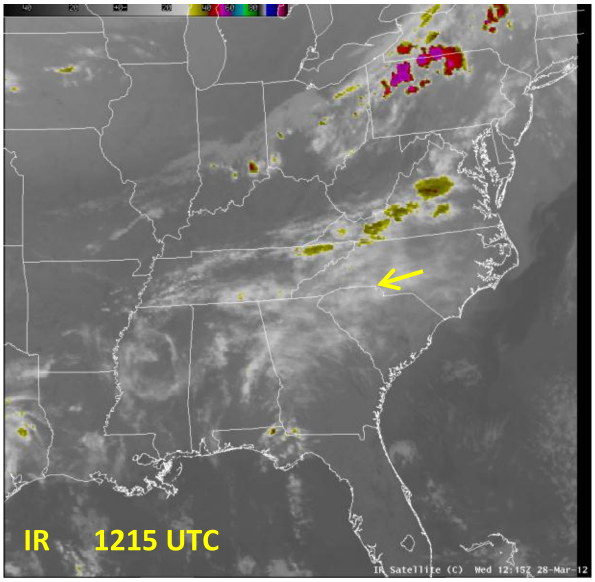
11µ - 3.9µ … 1215Z … 22 Feb 2012

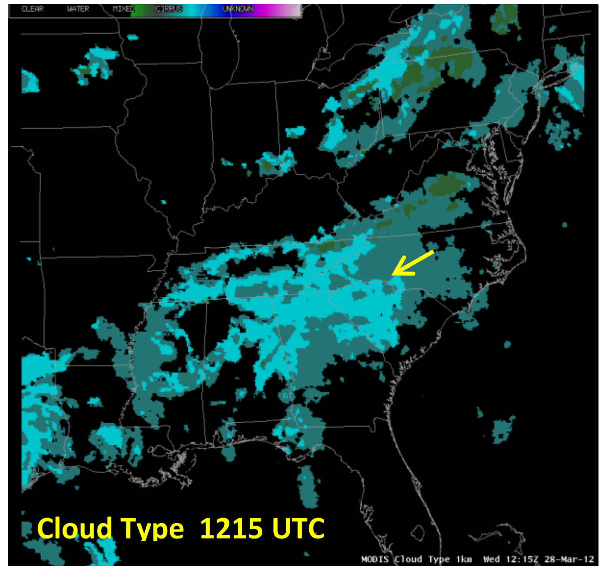


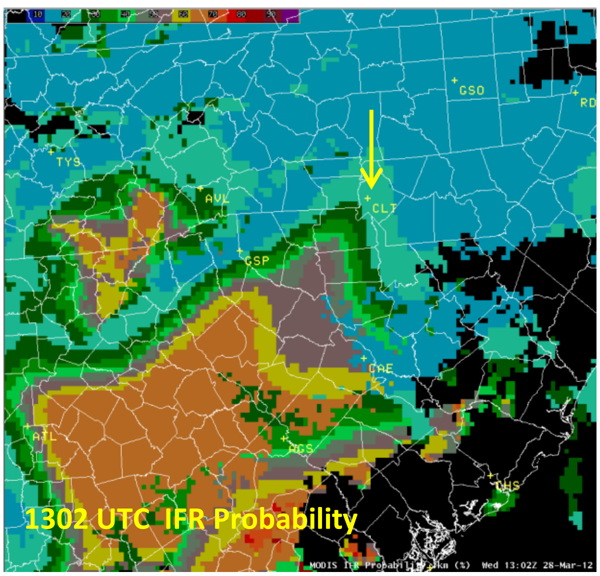
Visible … 1225Z … 22 Feb 2012

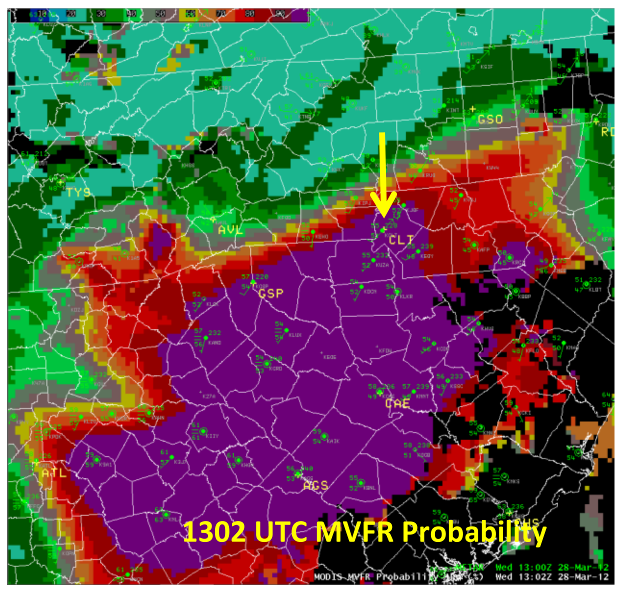
Appendix II

Model Contribution to MVFR and IFR Classification - 28 March 2012

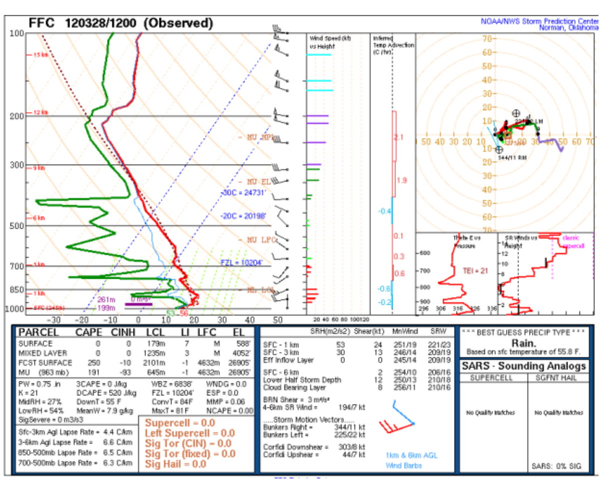




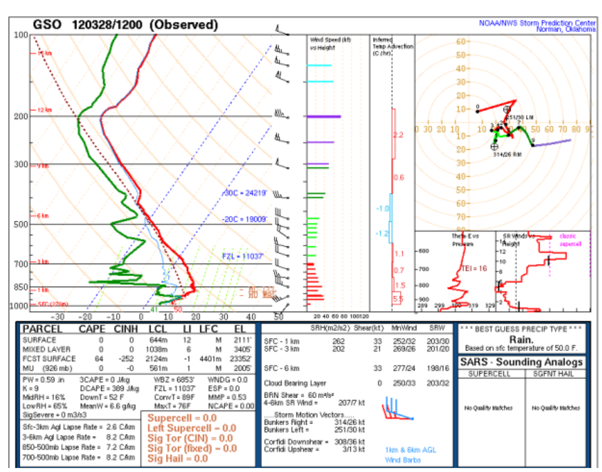




1252 UTC … CLT 7SM OVC008 (Arrows point toward CLT.)



FFC



GSO

Appendix III

Forecast Update: Dense Fog Advisory - 14 March 2012

Images prior to 1000 UTC on this date are not available. The 1002 UTC Cloud Thickness and IFR Probability images showed an extensive area of low cloudiness over South Carolina and southern North Carolina. This cloudiness had expanded from southwest to northeast during the preceding couple of hours. Monitoring the advance of the IFR conditions was extremely important because the clouds and fog spread into the KCLT terminal area. The 1200 UTC observation at KCLT included VV002 3/4SM BR.

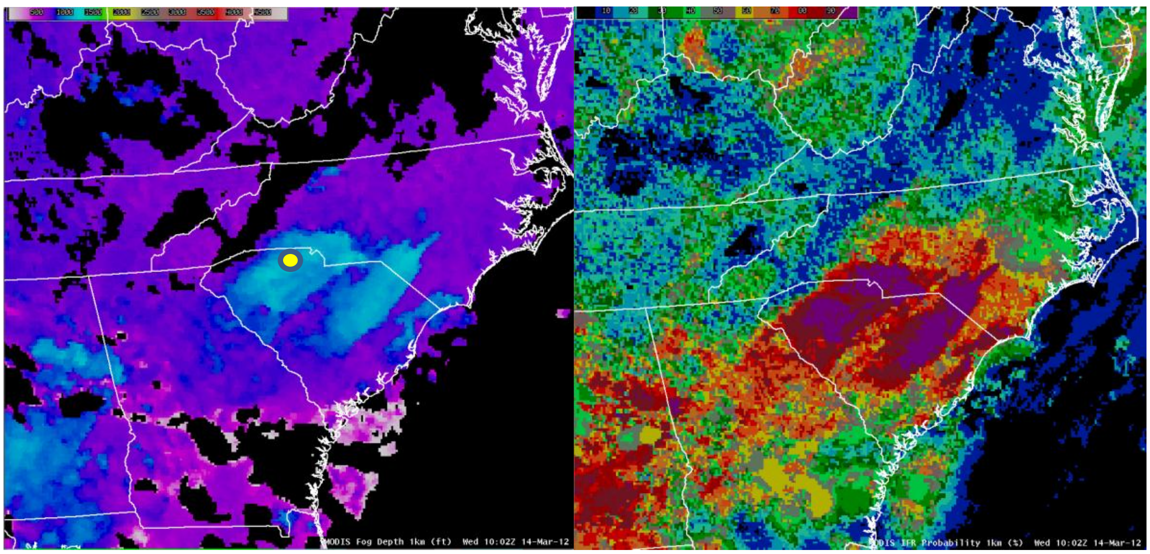


Fig. 1. 14 March 2012 1002 UTC Cloud Thickness (left) and IFR Probability (right). Approximate location of Cherokee County, South Carolina is indicated by the yellow circle.

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FXUS62 KGSP 140816
AFDGSP

AREA FORECAST DISCUSSION
NATIONAL WEATHER SERVICE GREENVILLE-SPARTANBURG SC
416 AM EDT WED MAR 14 2012

.SYNOPSIS...
HIGH PRESSURE OVER THE WESTERN CAROLINAS AND NORTHEAST GEORGIA WILL
LEAD TO WELL ABOVE NORMAL TEMPERATURES FOR AT LEAST THE NEXT WEEK.
AN UPPER LEVEL DISTURBANCE WILL CROSS THE REGION FRIDAY TO BRING
ABOUT THE BEST CHANCE OF SCATTERED THUNDERSTORMS.
OTHERWISE...ISOLATED TO SCATTERED MAINLY AFTERNOON AND EVENING
THUNDERSTORMS WILL BE POSSIBLE EACH DAY INTO EARLY NEXT WEEK.

&&

.NEAR TERM /THROUGH TONIGHT/...
-- Changed Discussion --
0830 UTC UPDATE...SATELLITE IMAGERY SUGGESTS DENSE FOG IS SPREADING
NORTHEAST INTO CHEROKEE COUNTIES IN UPSTATE SC...AND THE DENSE FOG
ADVISORY WILL BE EXPANDED INTO THAT AREA. WINDS HAVE BEEN ADJUSTED
FORM A BLEND OF THE LATEST NAM AND ADJMAV.
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Portion of WFO GSP Area Forecast Discussion issued at 0816 UTC, 14 March 2012

III-a

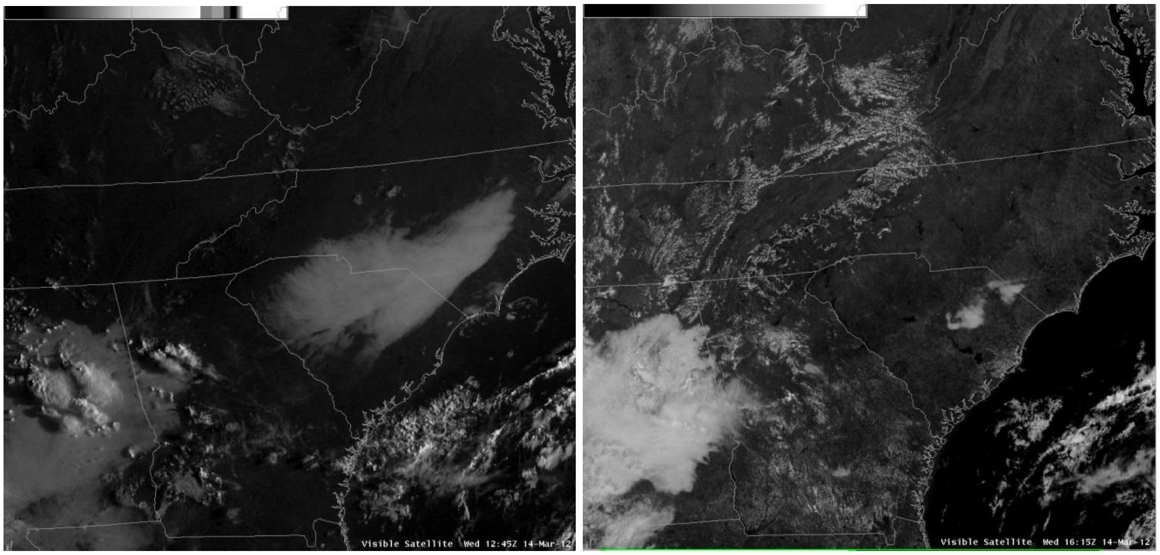


Fig. 2. Visible images at 1231 UTC (left) and 1615 UTC (right) on 14 March 2012. The last portion of the fog blanket to dissipate is near one of the thickest (approx. 1200 ft) parts of the 1102 UTC Cloud Thickness image (below).

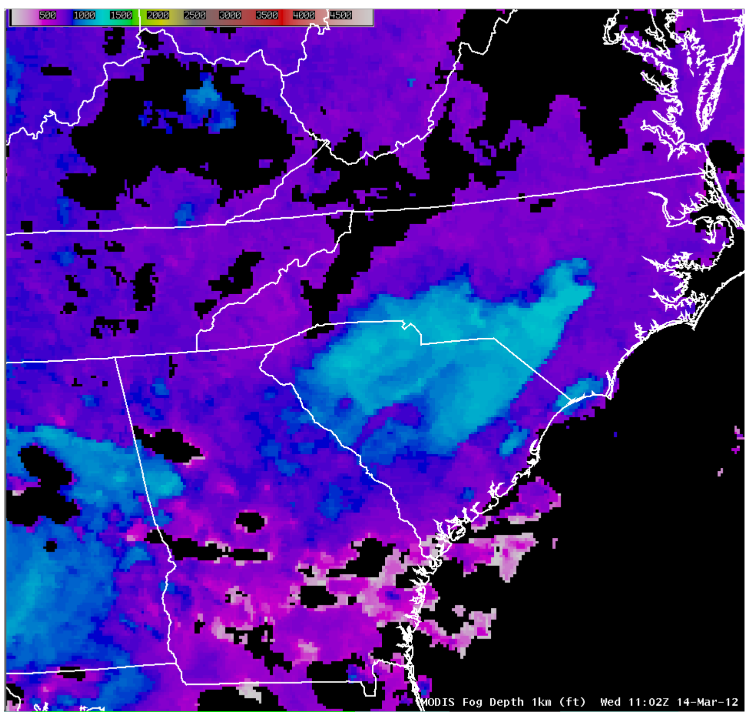


Fig. 3. 1102 UTC 14 March 2012 Cloud Thickness

Appendix IV

Thin Clouds Hinder GOES-R Sensitivity - 21 August 2012

IFR conditions caused by low visibility in fog occurred at KAVL during the early morning hours (Fig. 1).

```
SPECI KAVL 210819Z AUTO 00000KT 1 3/4SM R34/1200V2200FT BR SCT001 OVC120
     14/13 A3008 RMK AO2
SPECI KAVL 210816Z AUTO 00000KT 4SM R34/1200V3500FT BR SCT001 OVC120
     14/13 A3008 RMK AO2
SPECI KAVL 210813Z AUTO 00000KT 2SM R34/1400V3500FT BR BKN001 OVC120
     14/13 A3008 RMK AO2
METAR KAVL 210754Z AUTO 00000KT 1SM R34/2000VP6000FT BR OVC001 14/14
     A3008 RMK AO2 SLP164 T01440139
SPECI KAVL 210745Z AUTO 00000KT 1/2SM R34/1200V3000FT FG VV001 14/14
     A3008 RMK AO2
METAR KAVL 210654Z AUTO 00000KT 1/4SM R34/1000V1200FT FG VV001 14/14
     A3008 RMK AO2 SLP163 T01440144
SPECI KAVL 210622Z AUTO 00000KT 1/4SM R34/1200V1400FT FG VV002 15/14
     A3008 RMK AO2
SPECI KAVL 210614Z AUTO 00000KT 1/2SM R34/1200V2000FT FG VV002 15/14
     A3008 RMK AO2
METAR KAVL 210554Z AUTO 00000KT 1/4SM R34/1000V1400FT FG VV001 15/14
     A3008 RMK AO2 SLP163 T01500144 10189 20150 53003
```

Fig. 1. KAVL METARs on 21 August 2012 from 0554 UTC to 0819 UTC.

Neither the GOES-R MVFR or IFR probability images provided an indication that low visibility existed at the airfield. (The 11µ – 3.9µ imagery [not shown] did not have the traditional fog or low stratus signature.) The Cloud Type imagery did not detect clouds at 0600 UTC, but patches of high clouds were evident at 0800 UTC. The Cloud Thickness imagery did not display a return over the airfield at 0600 UTC when the visibility and ceiling were 1/4SM and VV001 or at 0800Z when the visibility and ceiling were 1SM and OVC001.

The parallel RTMA (parRTMA) also did not provide useful visibility guidance.
The parRTMA indicated a visibility of approximately 2 miles as compared to the observed visibility of 1/4 mile at 0600 UTCZ. The parRTMA indicated a visibility of approximately 4 miles as compared to the observed visibility of 1 mile at 0800 UTC.

Close inspection of the IR imagery, especially the animation, indicated very thin clouds streaming across western North Carolina. This was apparently enough cloudiness to diminish the effectiveness of the GOES-R algorithms. The 0600 UTC

RAP model sounding at KAVL hints that sufficient moisture for thin cirrus is near 300 mb.

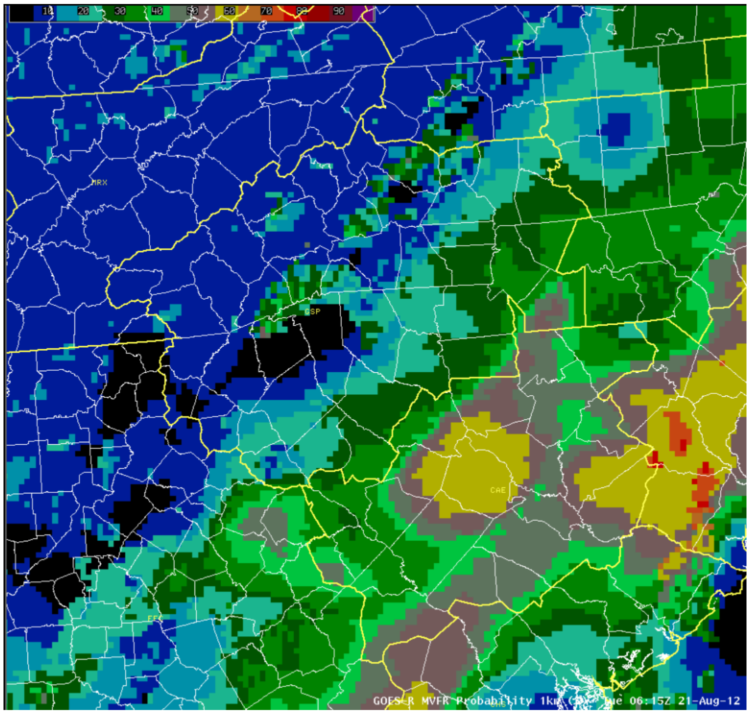


Fig. 2. 0615 UTC 21 Aug 2012 – MVFR Probability

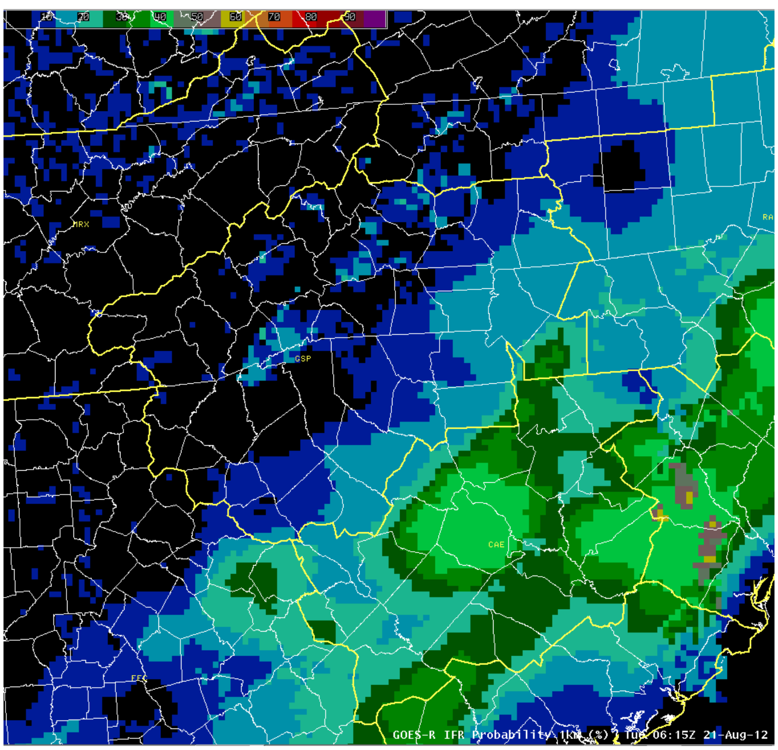


Fig. 3. 0615 UTC 21 Aug 2012 – IFR Probability

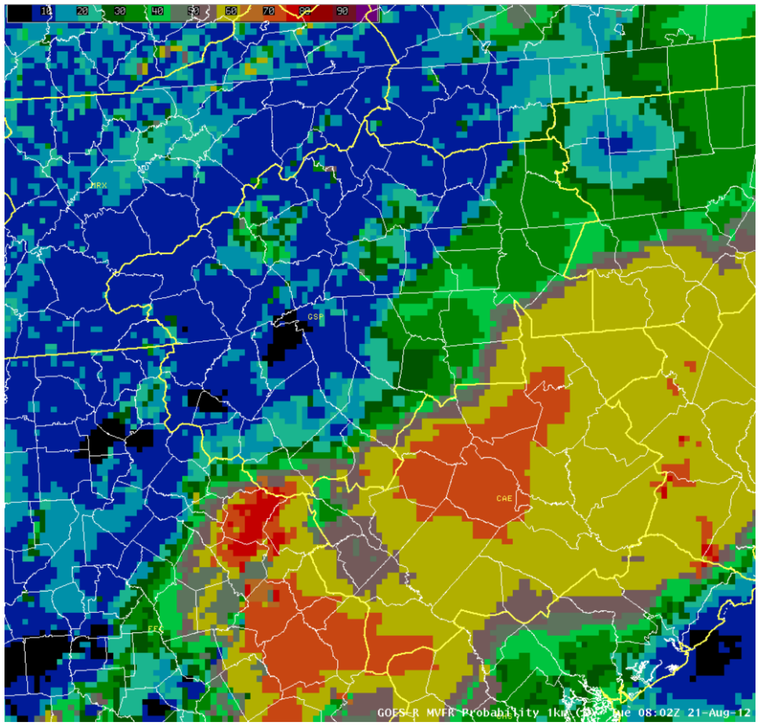


Fig. 4. 0802 UTC 21 Aug 2012 – MVFR Probability

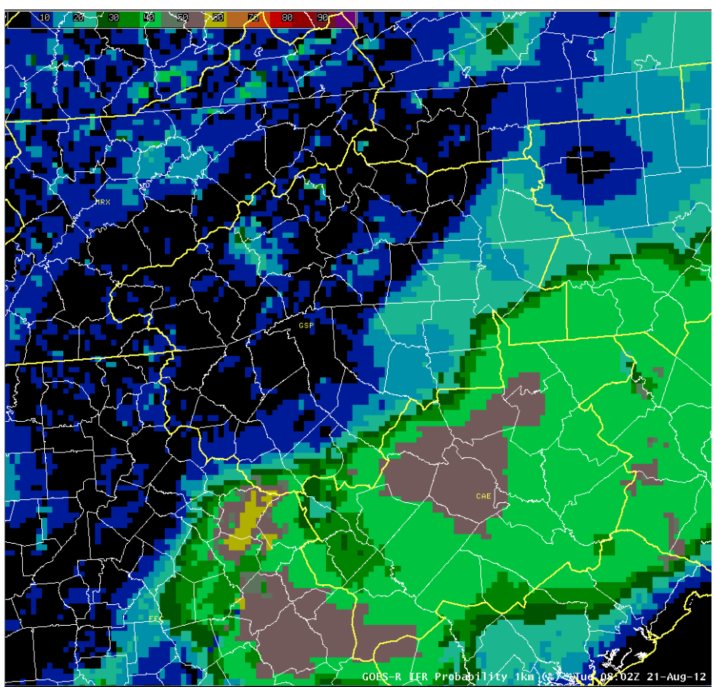


Fig. 5 0802 UTC 12 Aug 2012 – IFR Probability

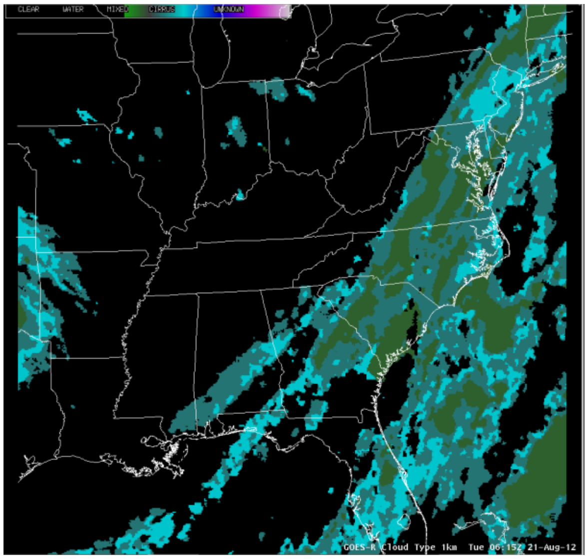


Fig. 6 0615 UTC 21 Aug 2012 – Cloud Type

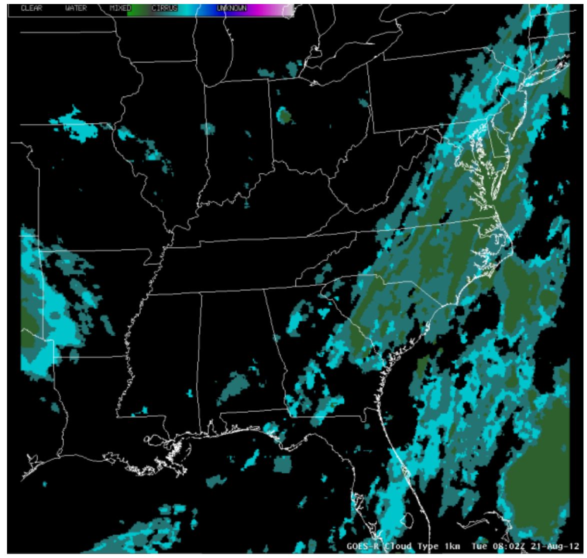


Fig. 7. 0802 UTC 21 Aug 2012 – Cloud Type

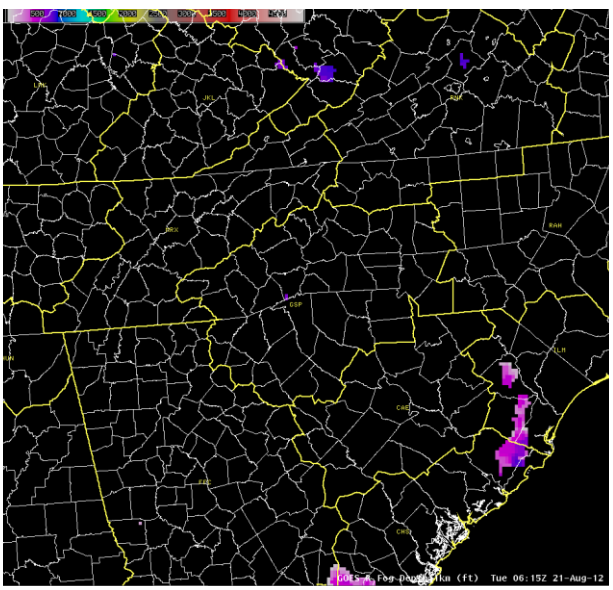


Fig. 8. 0615 UTC 21 Aug 2012 – Cloud Thickness

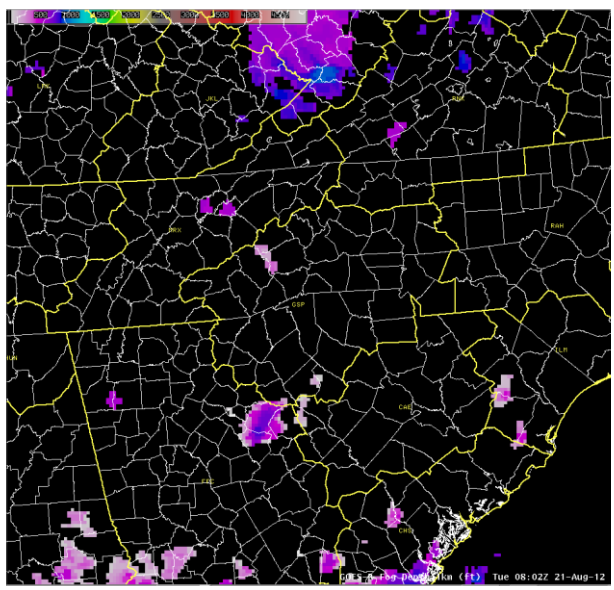
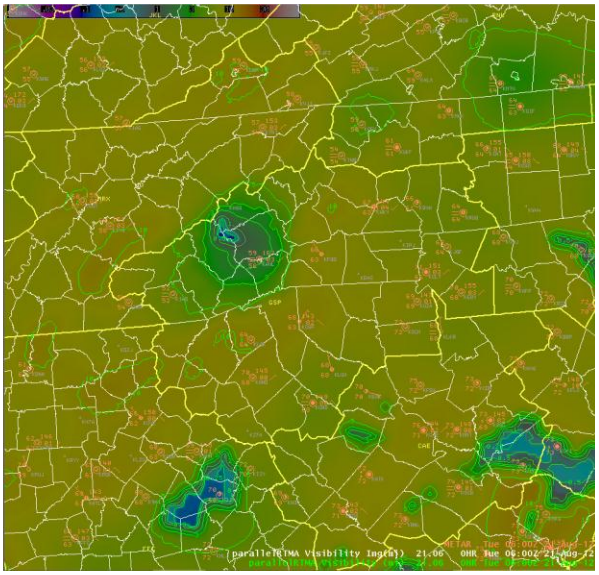


Fig. 9. 0802 UTC 21 Aug 2012 – Cloud Thickness



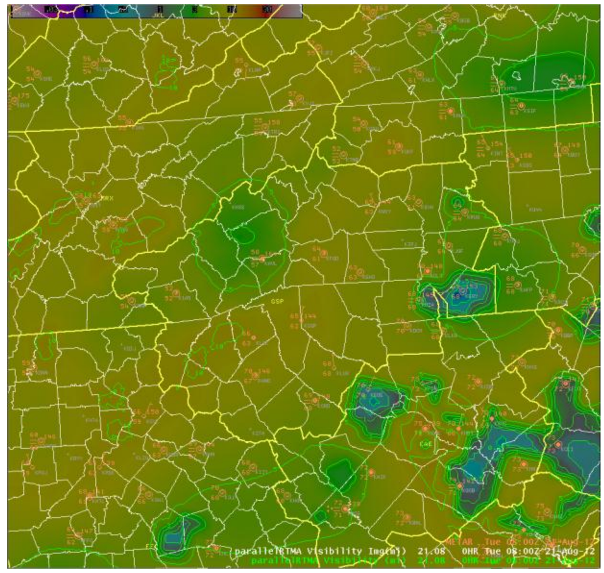
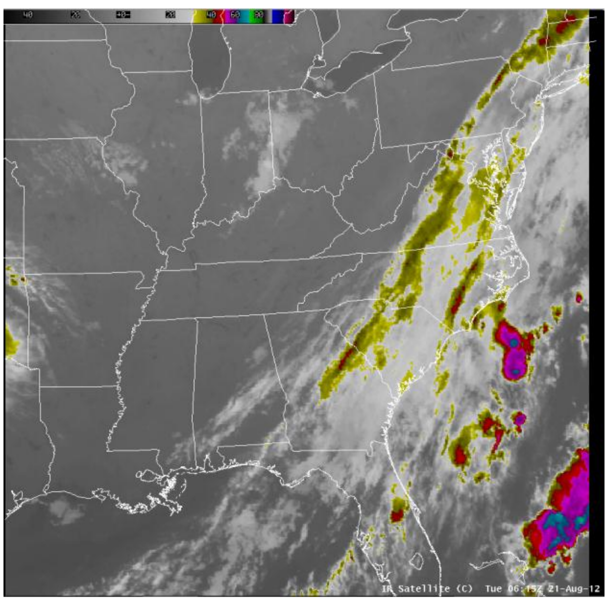


Fig. 10. 0600 UTC 21 Aug 2012 - parRTMA **Fig. 11. 0800 UTC 21 Aug 2012 - parRTMA**



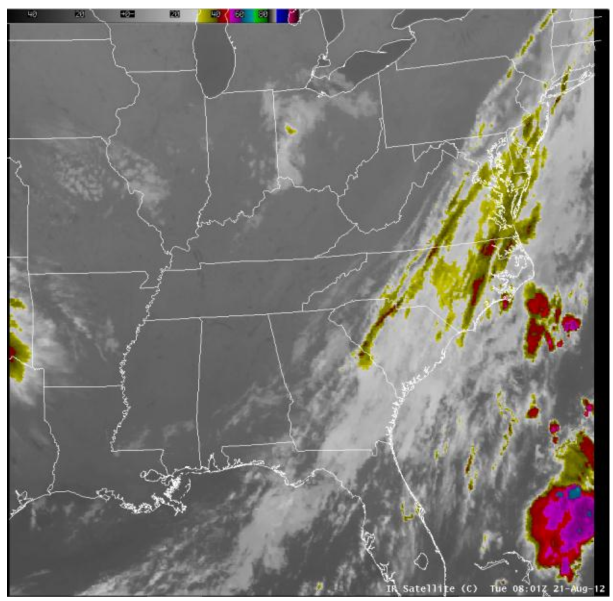


Fig. 12. 0615 UTC 21 Aug 2012 – IR **Fig. 13. 0801 UTC 21 Aug 2012 - IR**

Appendix V

24 August 2012 – Mountain Valley Fog

Dense fog formed in the mountain valleys of western North Carolina during the early morning hours on 24 August 2012 (Fig. 1).

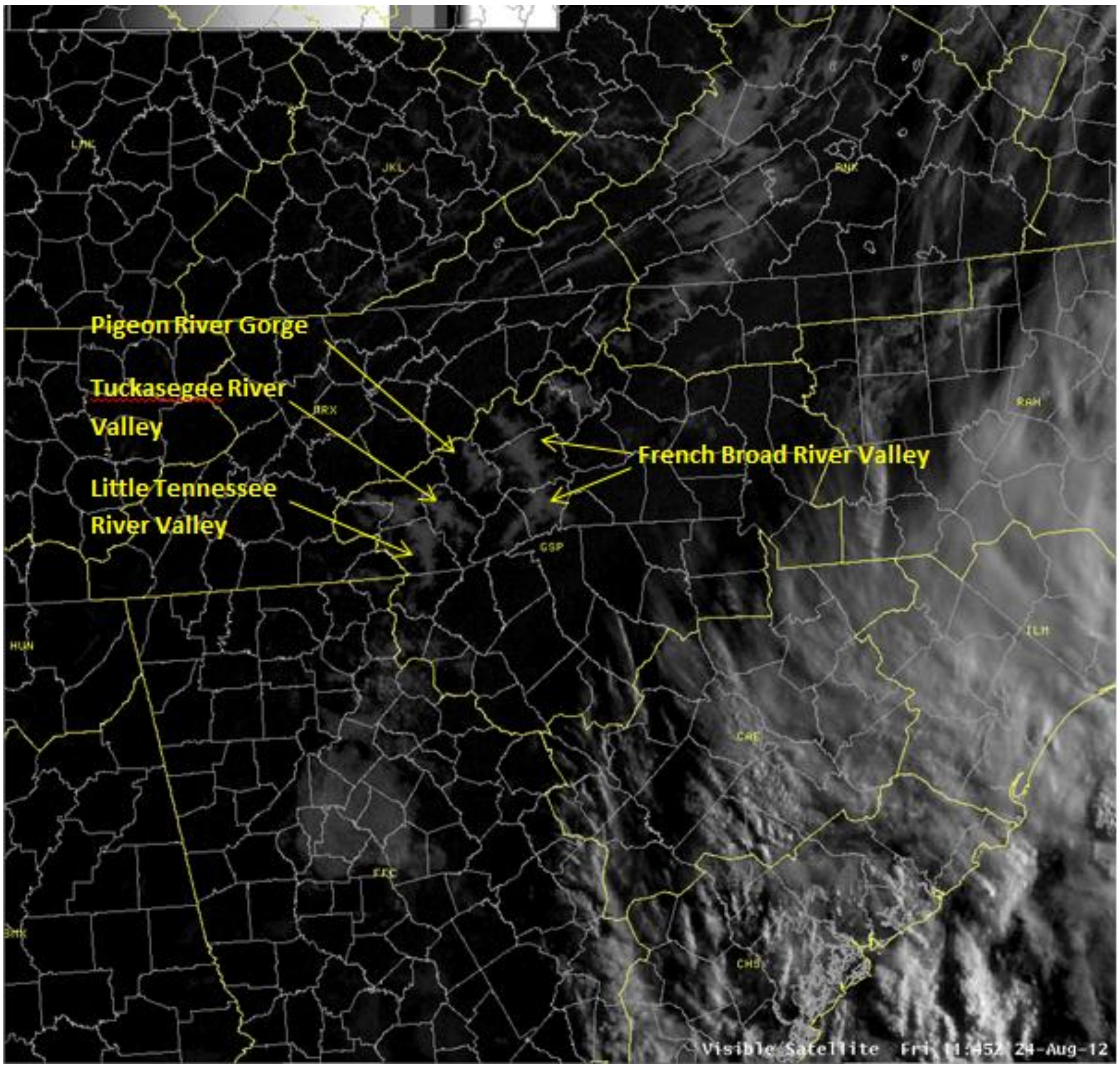


Fig. 1. Visible image 1145 UTC, 24 August 2012

The increasing IFR probability during the fog formation coincided with the lowering visibility at the Asheville Regional Airport (KAVL). As an example, refer to Figs. 2 and 3 which display the 1045 UTC and 1102 UTC, respectively, IFR probability images.

The average of the four pixels (55, 56, 60, and 61) in the vicinity of KAVL at 1045 UTC was 58. The average of the four pixels (70, 65, 75, and 65) at 1102 UTC was 69. The visibility at KAVL was 3SM BR at 1031 UTC, and it lowered to 2 1/2SM BR at 1054 UTC and to 1 1/4SM BR at 1106

V-a

UTC. The increasing IFR probability trend was noted over the course of several hours. This coincided with the lowering visibility at KAVL. One can deduce that other locations with increasing probability values also experienced lowering visibility. Not only does this information provide important aviation guidance, but it also alerts forecasters to potential public hazards such as reduced visibility on the winding, mountainous portion of Interstate 40 in the Pigeon River Gorge.

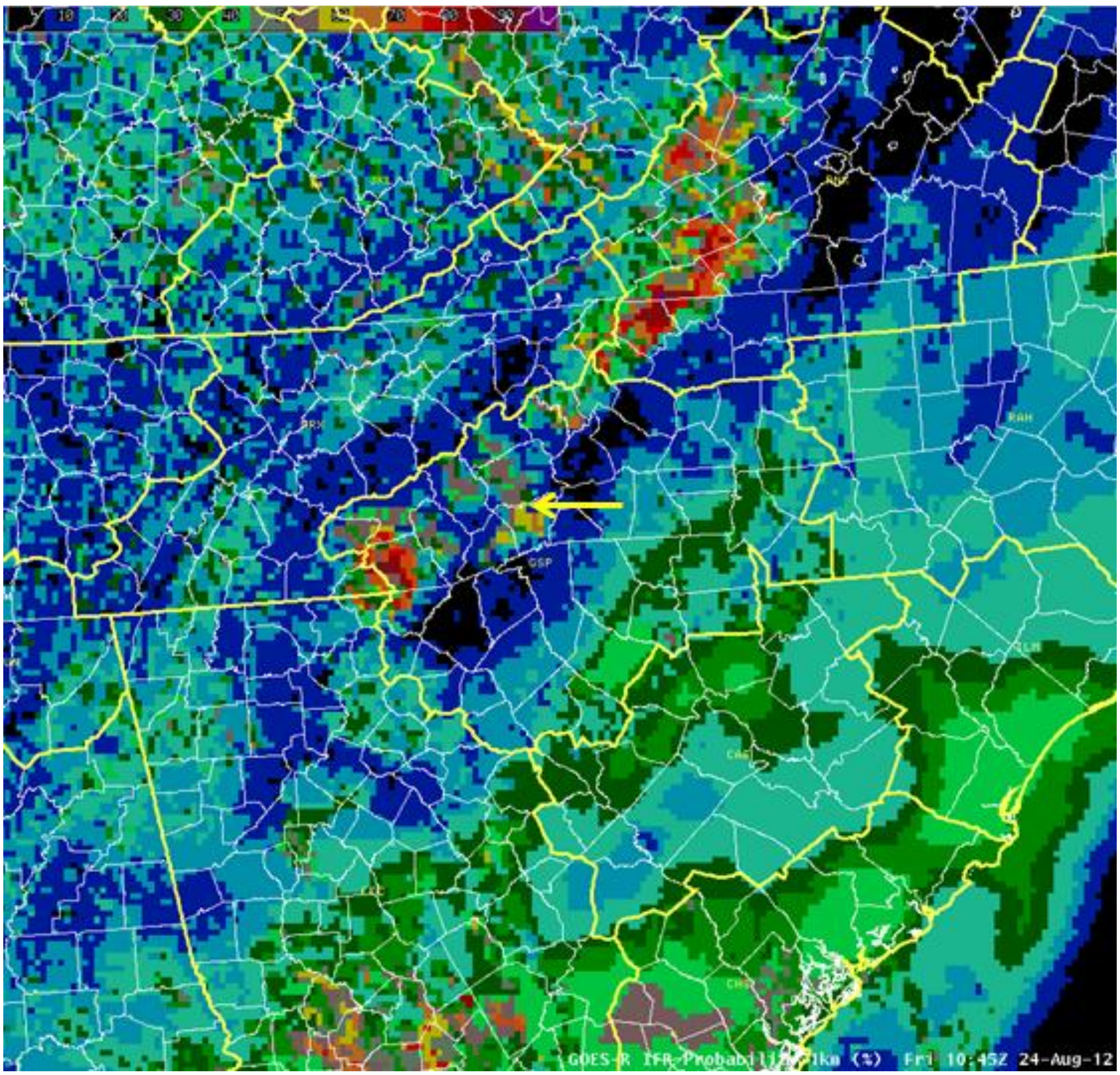


Fig. 2. IFR Probability at 1045 UTC, 24 August 2012. The Asheville Regional Airport is near the tip of the arrow.

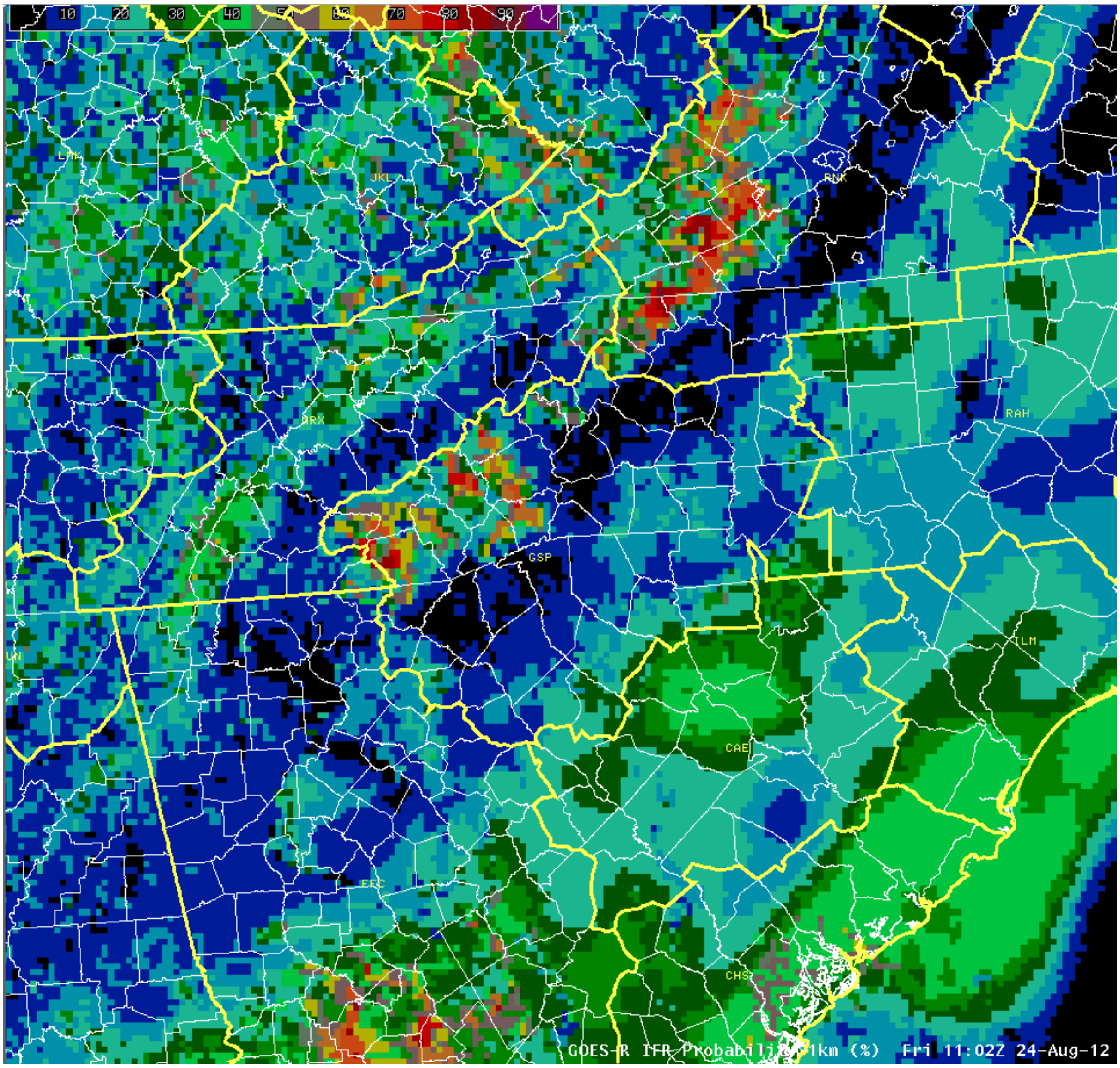


Fig. 3. IFR Probability at 1102 URC, 24 August 2012. Probability values in the mountain valleys increased since the previous image.

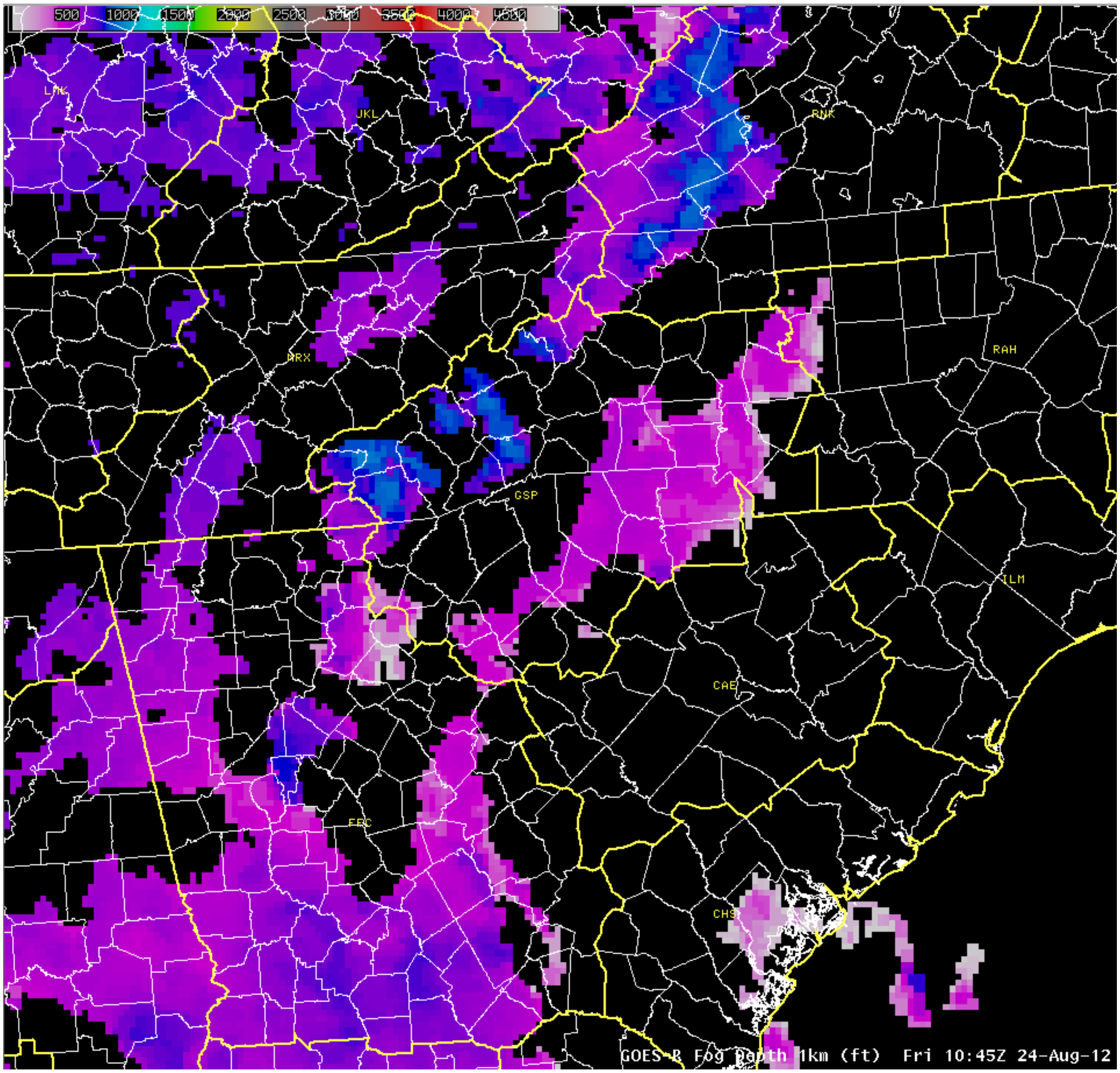


Fig. 4. Cloud Thickness at 1045 UTC, 24 August 2012. The French Broad, Tuckasegee, and Little Tennessee river valleys and the Pigeon River Gorge stand out as having relatively thick fog.

For comparison, the parallel RTMA visibility at 1000 UTC is shown (Fig. 5). The lowest visibilities were indicated to be over higher terrain instead of in the valleys where the satellite imagery detected the fog.

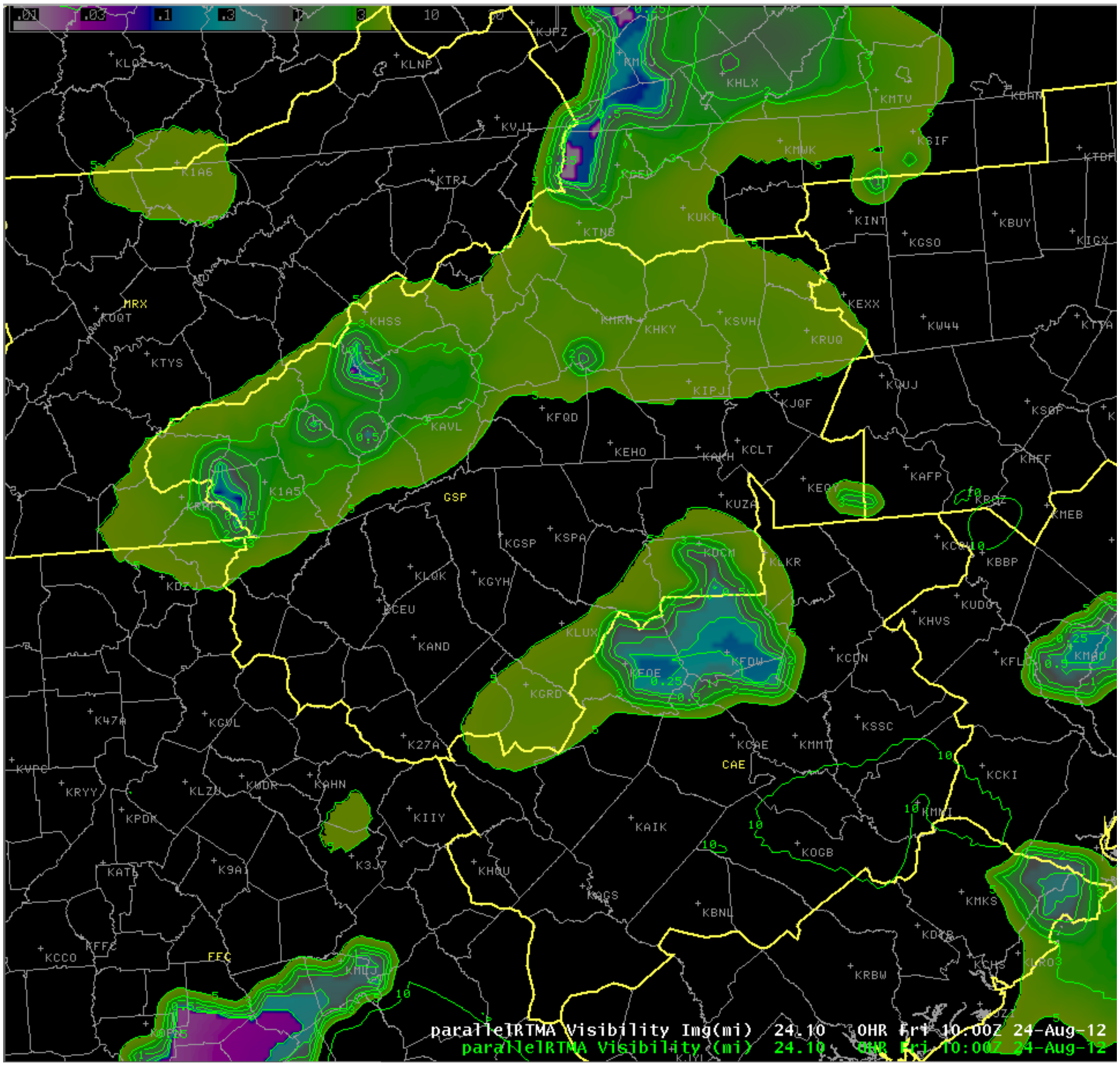


Fig. 5. Parallel RTMA visibility at 1000 UTC, 24 August 2012.

Appendix VI

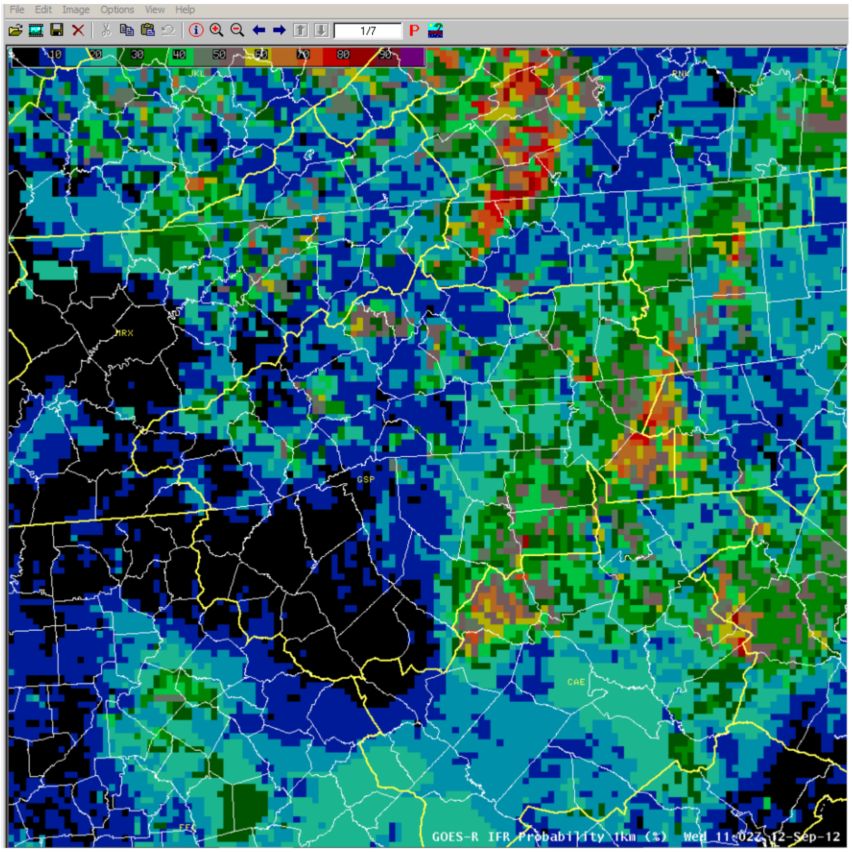


Fig. 1. D2D Display of GOES-R Probability of IFR – 1102 UTC, 12 September 2012

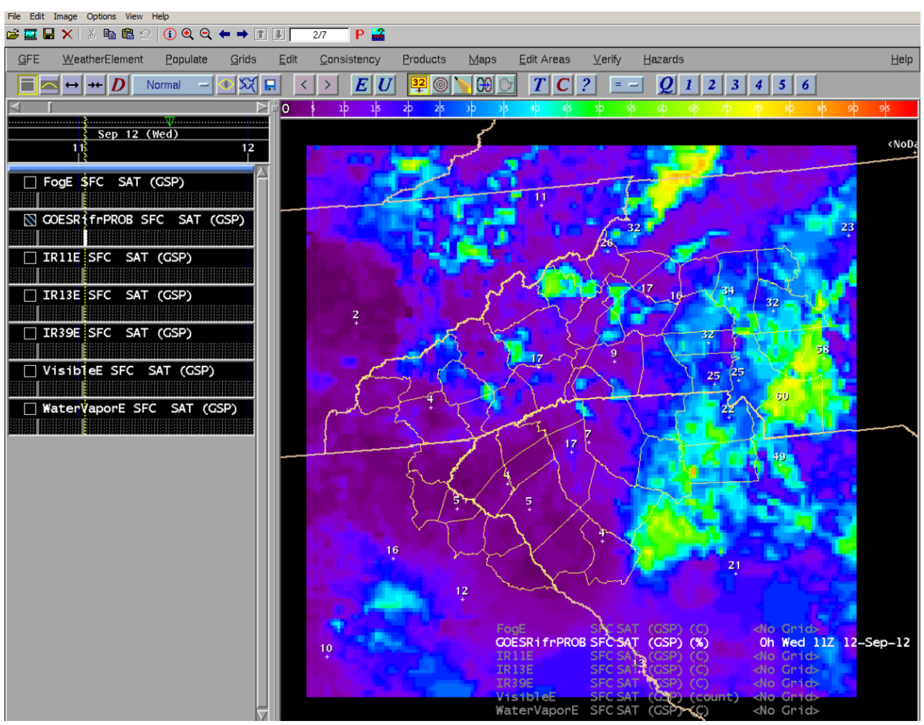


Fig. 2. GFE Display of GOES-R Probability of IFR – 1102 UTC, 12 September 2012

Instructions for WFO GSP staff regarding use of experimental Smart Tool for adjusting PredHgt grids in GFE:

The **NowAviation** Procedure (under the **Edit** menu in GFE) has been updated to allow use of the **GOES-R IFR Probability** product to adjust PredHgt values. You may recall that you can view the GOES-R proving ground products via D2D under the **Satellite -> GOES-R** menu. Now, you can also view these data in GFE via the **Satellite** menu. (See **figure 1**) If you view the data in GFE, you may wish to expand the time scale in order to more easily select the 1-minute satellite grids.

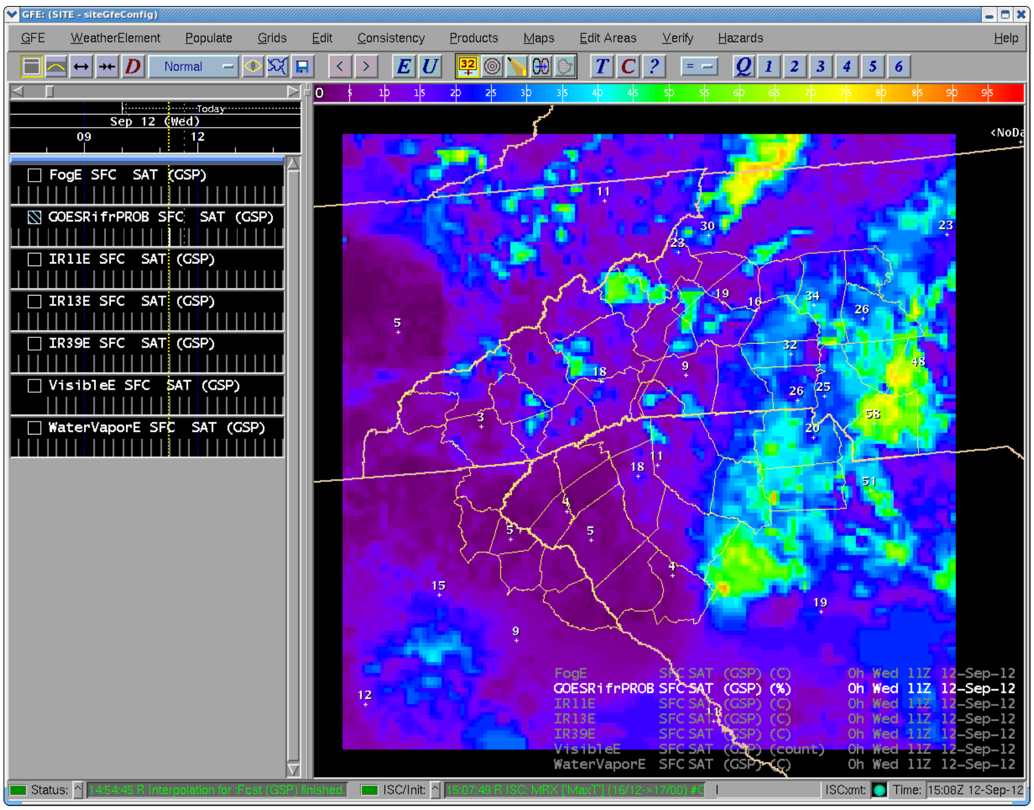


Figure 1: Satellite Weather Element Group with GOESifrPROB displayed

In the NowAviation dialog window, you can choose to use GOES-R by toggling the "**Use GOESR IFR Probabilities?**" radio option to "**Yes**." (See **figure 2**) When this option is selected, a new **GoesIfrPredHgt** smart tool will run as part of the process. After the PredHgt values are created via **ObsPredHgt** (as previously), a new user dialog window will appear to solicit the threshold for IFR probabilities. (See **figure 3**) The threshold value determines how high the probability needs to be at each point for the PredHgt grid to be lowered into the IFR range. Where the IFR probability exceeds the chosen threshold, the PredHgt will be assigned a default IFR value of **800 feet**. The only exception is that the smart tool will not touch any values that are already IFR. These values have likely come from actual observations, or were analyzed from nearby observations, and are a better estimate of the actual IFR cloud height.

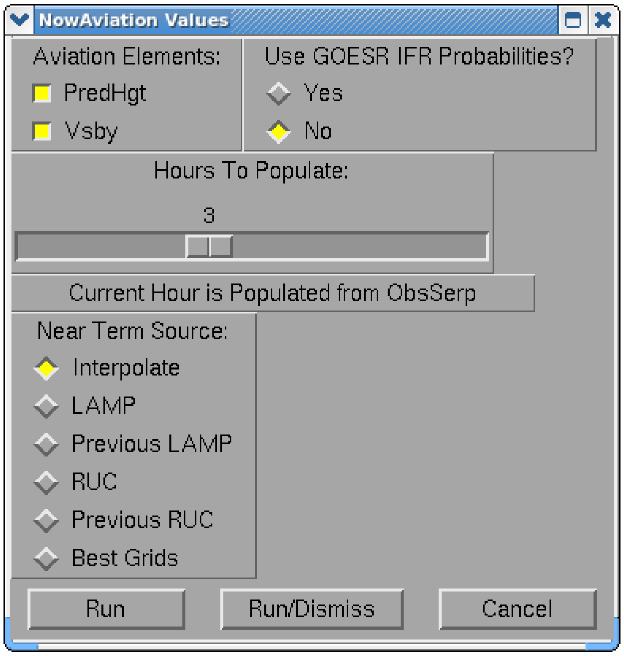


Figure 1: NowAviation Procedure

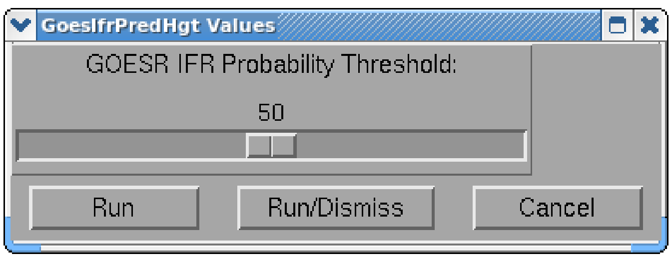


Figure 2: GoesIfrPredHgt Smart Tool

You can also run GoesIfrPredHgt independently of NowAviation on any PredHgt grid. You must have GOES-R IFR probability data available for the hour of interest. If there is no data for that hour, the procedure and tool will make no GOES-R adjustments. If there are multiple images available for that hour, the process will take an average of the available probability data. You can control how much (low threshold) or how little (high threshold) adjustment is made to the grid to get the desired outcome.

GOES-R Proving Ground Evaluation:
Fog and Low Detection Products

National Weather Service Forecast Office
Mount Holly, New Jersey

Introduction

From February through August of 2012, the National Weather Service Forecast Office at Mount Holly, New Jersey (WFO PHI), served as an Evaluation Partner for GEOstationary Cloud Algorithm Test-bed (GEOCAT) imagery. This imagery was provided by the Cooperative Institute for Meteorological Satellite Studies (CIMSS) at the University of Wisconsin-Madison Space Science and Engineering Center. The focus of the evaluation was on application to short-term public forecasts and aviation forecasts for the WFO PHI forecast area.

Four types of imagery were evaluated: Cloud Type, Cloud Depth, Probability of MVFR Conditions, and Probability of IFR Conditions. Although intended to simulate future GOES-R products, these images are derived from current operational GOES data and are available every 15 minutes, 24 hours per day. Instructions provided by CIMSS were used successfully to set up ingest, storage and display of the GEOCAT imagery on the local AWIPS system. GEOCAT imagery was included in the rotating 7-day AWIPS archive so images remained easily viewable for about a week. Also, a four-panel AWIPS "procedure" was also created to facility viewing of all four types of imagery at once.

GEOCAT imagery was introduced to the forecast staff at a fog forecasting seminar held at the office on March 14, and repeated on March 28. A brief description was given of the various types of imagery available along with some examples illustrating potential use and comparison with operational GOES imagery. During the evaluation, the SOO attempted to monitor the imagery in search of "interesting" cases to pass on to the staff. One such case on June 1 is included in the appendix. Full documentation on GEOCAT imagery was difficult to locate; a training session by experts at CIMSS would have been helpful.

No long-term archive of the GEOCAT imagery was created; however, we did identify one "intensive study period" of March 15 through the 23. During this period the WFO PHI forecast area experienced dense fog and/or low stratus every day. All GEOCAT imagery during this time was saved for further study, along with surface observations and RUC model grids. Examples from this period are included in the appendix.

GEOCAT imagery was used at times for populating near-term sky cover grids in GFE. This was done manually by some of the forecasters. Our office did not attempt to develop any "smart tools" using GEOCAT.

Evaluation

The following are some general thoughts about the operational usefulness of the GEOCAT imagery, based on our observations. Receipt of the imagery at WFO PHI proved to be quite reliable. Having the imagery update every 15 minutes is definitely a plus, especially compared to polar-obiter (e.g., MODIS) data that updates only 2 or 3 times per night. The images are available in AWIPS about 15 minutes after nominal image time.

These experimental satellite products were considered in context with many other types of data, including conventional satellite imagery, surfaced observations, radar, aircraft soundings, model analysis grids, etc. We usually have a pretty good idea of fog and stratus coverage over our area from these other data sources, especially the fairly dense network of surface reports covering our TAF sites and numerous other locations. One area where such data is lacking is over our coastal waters (NJ and DE coastline and 20 nm seaward) and over Delaware Bay. This is where the GOECAT data can be more helpful; an example is shown in Figure 1 in the Appendix. Also, additional information is more valuable at night when the higher-resolution (compared to IR) visible imagery is not available.

Perhaps the biggest limitation for any satellite-based low cloud detection system is interference from overlying layers of high- or mid-level clouds. A separate local study for the WFO PHI area has suggested that low clouds can be totally or partially obscured in this way at least 50 percent of the time. The GEOCAT algorithms seem very sensitive to the presence of even thin cirrus aloft, which are sometimes difficult to detect with conventional GOES-IR imagery.

Another limitation of the GEOCAT imagery in particular is the occurrence of a “blackout” period for a couple of hours around sunrise and sunset. During this time the Cloud Depth imagery is not available, and the IFR/MVFR probability images may also be adversely affected. The time around sunrise, in particular, is important because this is often when radiation fog becomes thickest and most widespread. Also, the Cloud Depth imagery tends to show “thinner” clouds during the daylight hours and comparatively thicker clouds at night.

Forecaster acceptance and use of the GEOCAT imagery was mixed. Some forecasters found it useful and routinely included it in their product displays on AWIPS. One forecaster found the MVFR probability product particularly helpful and was disappointed when it was removed in late August. Another forecaster provided the following input, regarding MVFR/IFR probability images on a particular midnight shift last spring:

“I found them useful with regard to the TAFs in determining whether to forecast MVFR or IFR ceilings and in trying to determine the ultimate areal extent of low clouds.”

Another forecaster commented:

"Seems to work best with marine fog, which is a big help in the spring. Not as well as with radiation fog, but given the geographic distribution, it's understandable."

Conclusion

The GOES-R Proving Ground GEOCAT imagery has proven to be useful on a number of occasions for near-term public and aviation forecasting in the WFO PHI area. It is most helpful at night, over data-sparse marine areas, and when mid- or high-cloud layers are not present to interfere with the satellite view. Under proper conditions, the GEOCAT imagery can provide significantly better depiction of fog or low-cloud coverage and development than conventional GOES imagery.

One small suggestion for product improvement: sometimes the imagery is rather noisy, especially the IFR/MVFR probabilities. Applications of a light smoother could make some of the images easier to interpret.

Some further image examples of strengths and weaknesses of the GEOCAT imagery are provide in the appendix below, along with a brief explanation in each case.

APPENDIX: EXAMPLES OF GEOCAT IMAGERY STRENGTHS AND WEAKNESSES

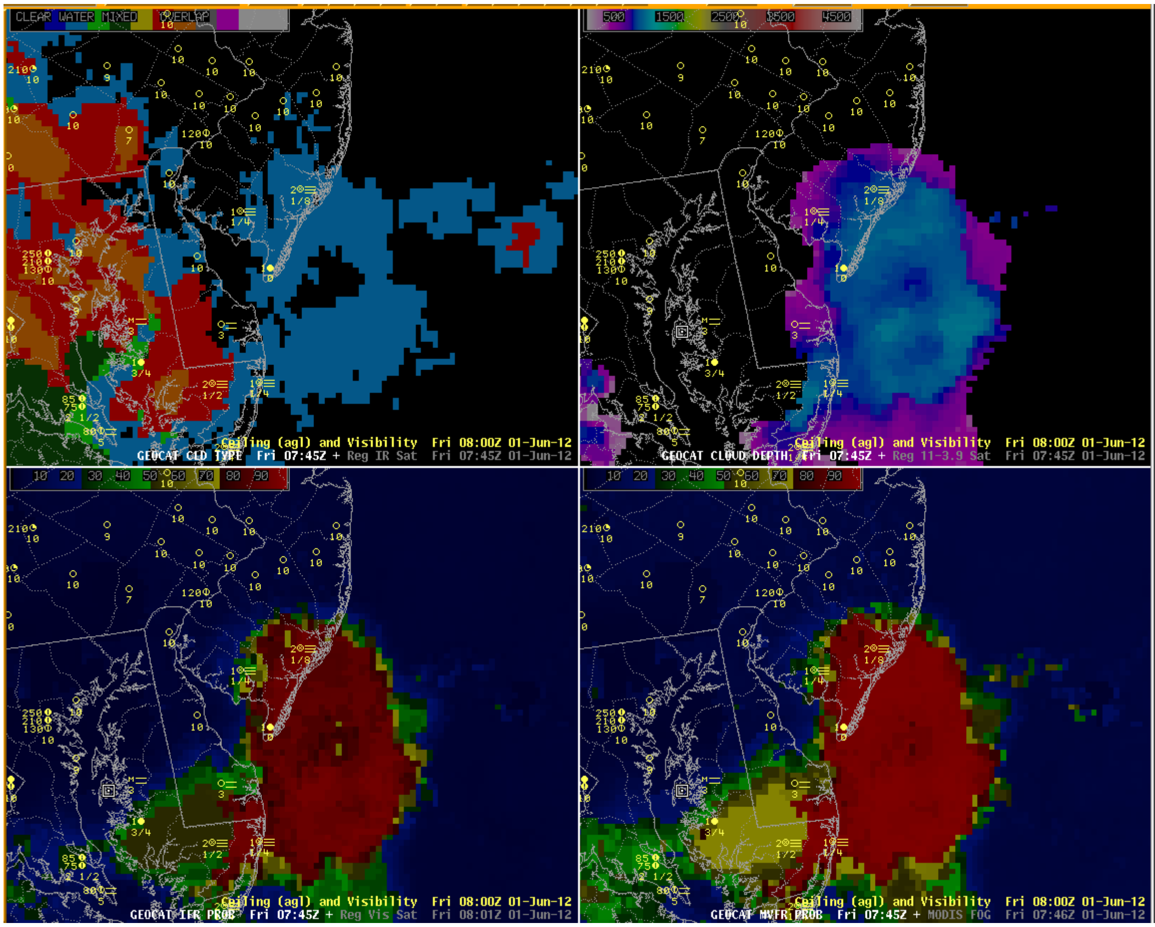


Figure 1. GEOCAT imagery from 0745 UTC on June 1, 2012. Clockwise from upper left: Cloud Type, Cloud Depth, MVFR Probability, IFR Probability. Plotted surface observations show ceiling height (hundreds of feet; left of station circle), visibility (statute miles; below circle) and observed weather (right of station circle). The imagery shows an area of dense fog and stratus developing along the coast of Delaware and southern New Jersey. It also shows the extent of fog over the adjacent coastal waters, which otherwise would be difficult to determine.

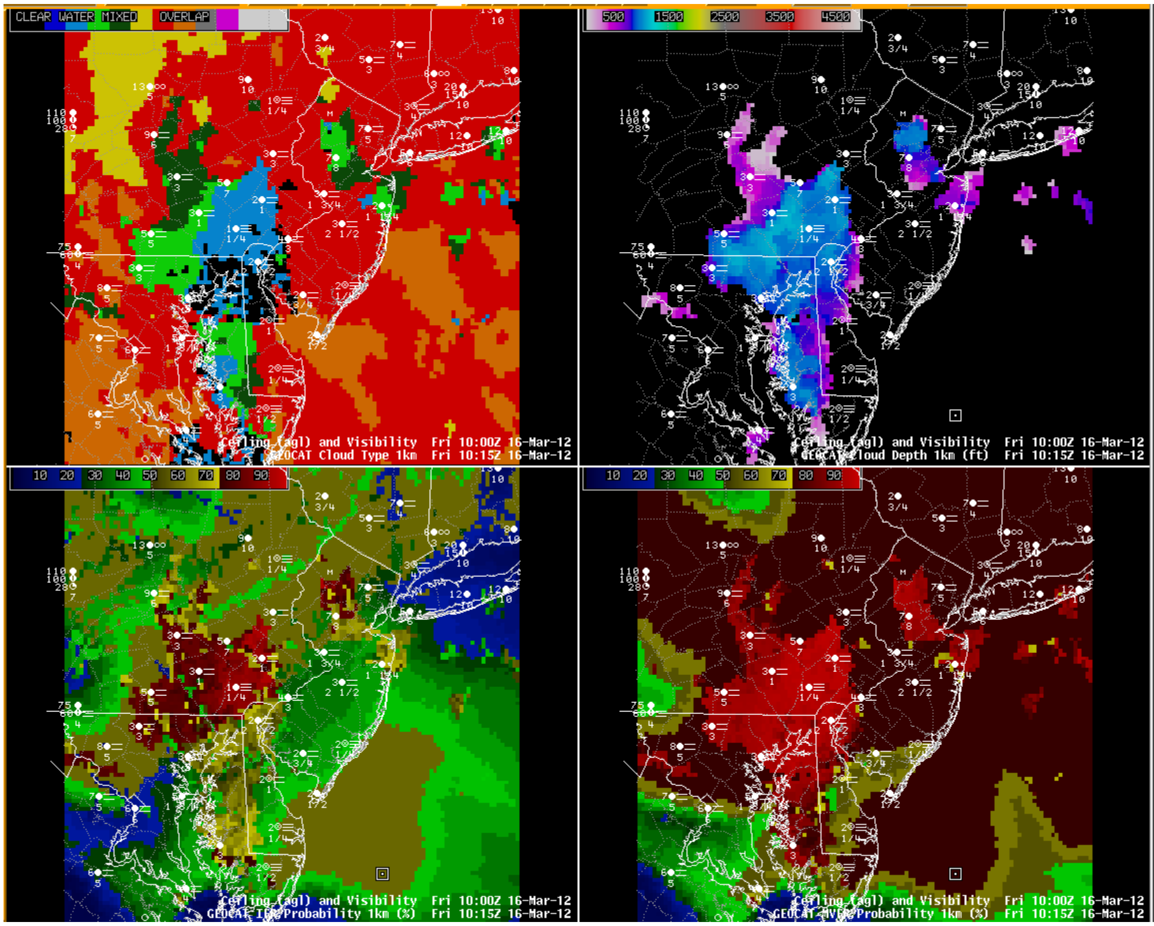


Figure 2. GEOCAT imagery from 1015 UTC on March 16, 2012. Clockwise from upper left: Cloud Type, Cloud Depth, MVFR Probability, IFR Probability. Imagery shows widespread layered clouds, but low (water) clouds are evident over southeast PA, northeast MD, and northern DE. MVFR and IFR probabilities area higher in this area, where cloud depth information is available, compared to areas with overlying higher (ice) clouds. This makes interpretation tricky, especially since the pattern of low clouds and high clouds is changing over time from image to image.

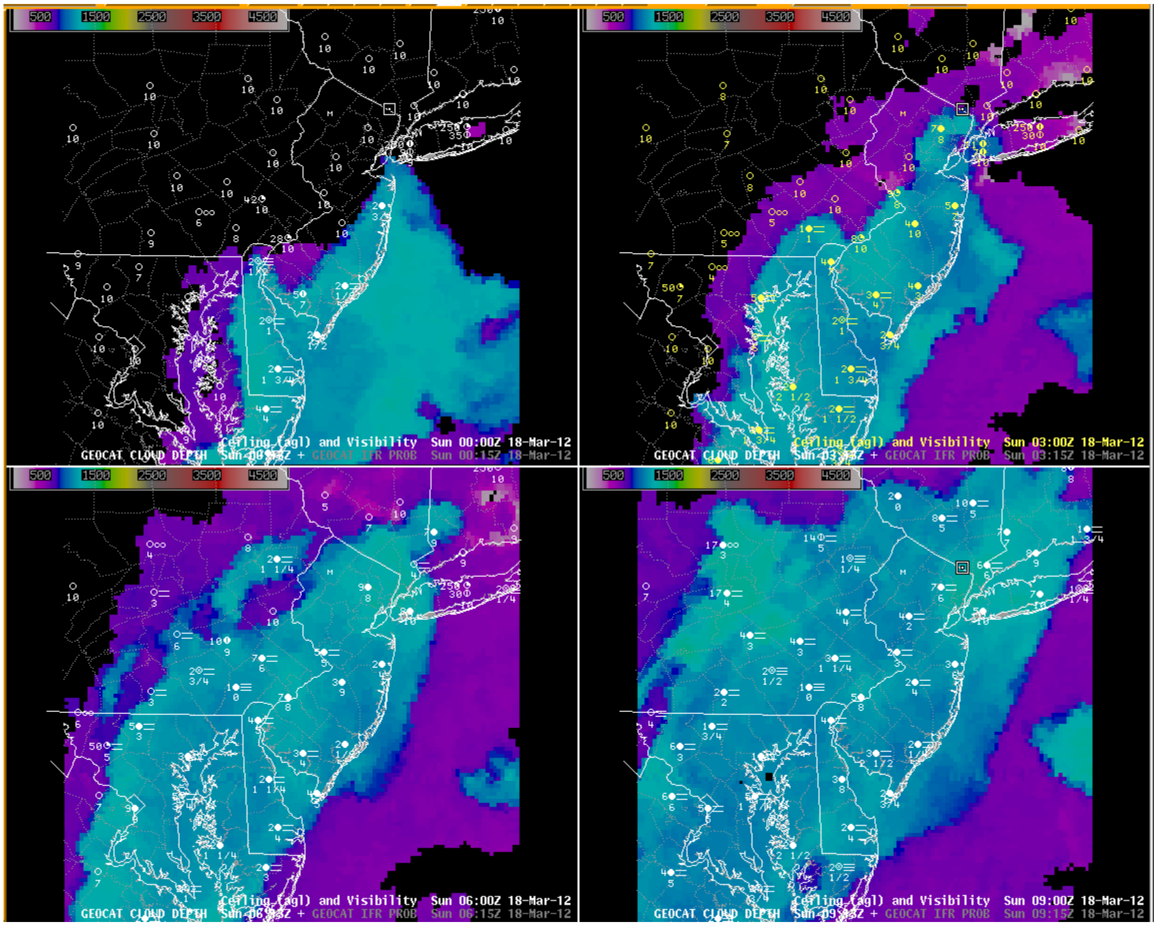


Figure 3. GEOCAT Cloud Depth imagery from March 18, 2012. Upper-left: 0015 UTC; Upper-right: 0315 UTC; Lower-left: 0615 UTC; Lower-right: 0915 UTC. In this case the imagery gave an excellent depiction of fog/stratus spreading inland from the coast overnight to eventually cover the entire forecast area. The purple "thinner" areas seem to give some indication of where the clouds area headed.

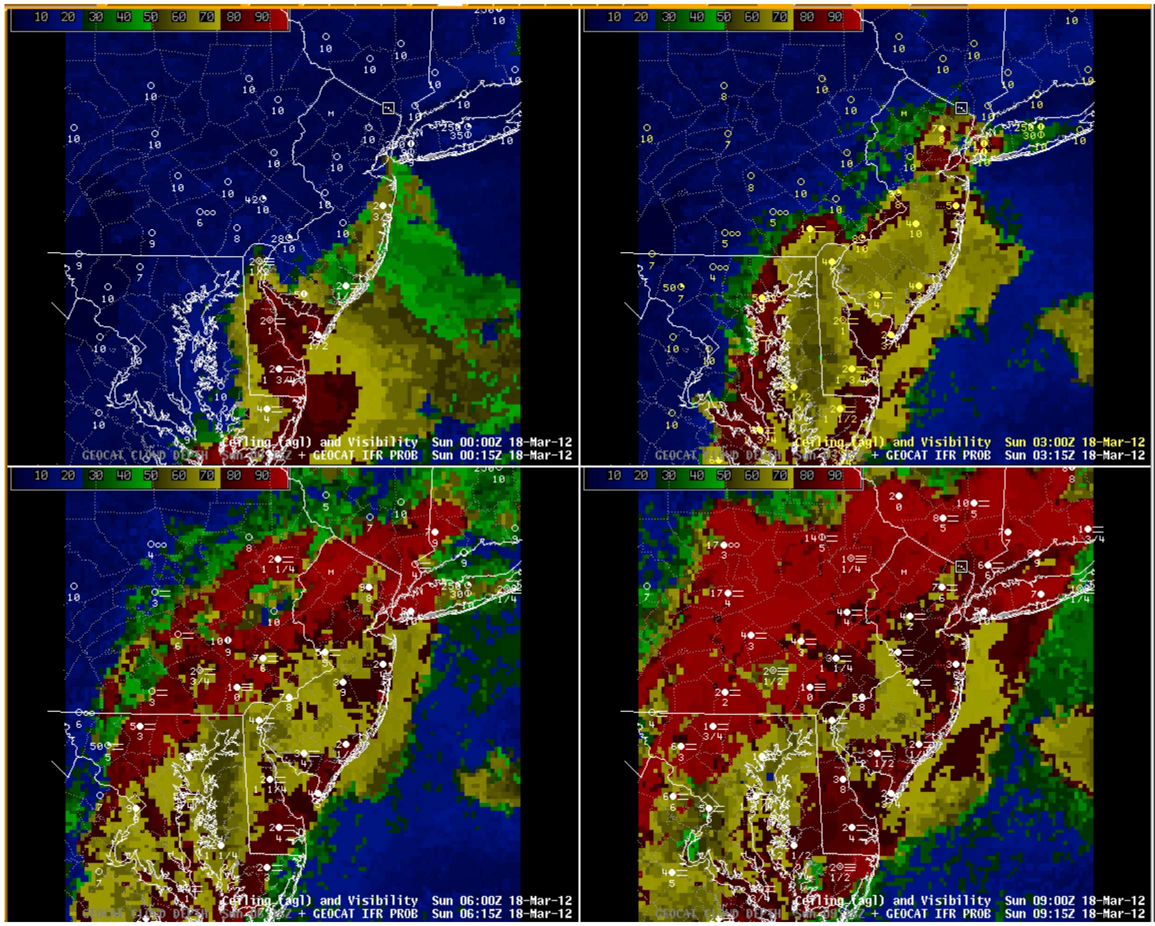


Figure 4. Same as figure 3 above, except showing GEOCAT IFR Probability images. Although IFR conditions (mainly low ceilings) are reported at all METAR sites under the cloud deck, the imagery indicates large areas of IFR probability less than 75 percent. The reason for this discrepancy is not clear.

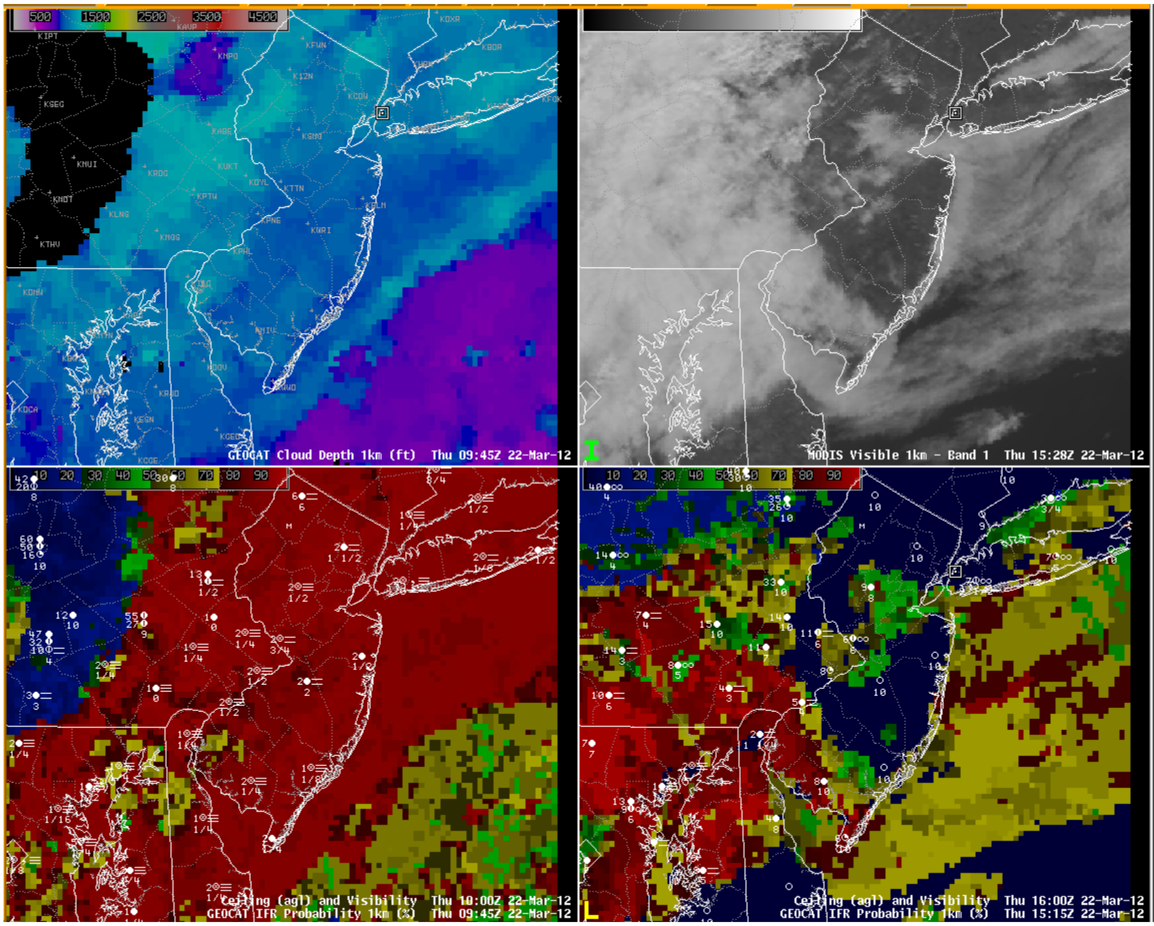


Figure 5. GEOCAT and MODIS imagery from March 22, 2012. Upper left: GEOCAT Cloud Depth at 0945 UTC; Lower left: GEOCAT IFR Probability at 0945 UTC; Upper right: MODIS Visible image at 1528 UTC; Lower right: GEOCAT IFR Probability at 1515 UTC. Corresponding surface observations are plotted over the IFR imagery. There is a slight indication in the Cloud Depth image of thinner clouds or shallower fog over New Jersey compared to eastern Pennsylvania. The later images confirm that clearing occurred sooner over New Jersey.

Appendix IV

Summaries from the Online Surveys

NWS ER GOES-R Fog and Low Cloud Survey

1. Which WFO do you forecast for?

	Response Percent	Response Count
PHI	14.3%	1
GSP	**85.7%**	**6**
	answered question	**7**
	skipped question	**0**

2. What is your current title?

	Response Percent	Response Count
Meteorological Intern	14.3%	1
Forecaster	**42.9%**	**3**
Lead Forecaster	14.3%	1
ITO	0.0%	0
WCM	0.0%	0
SOO	28.6%	2
MIC	0.0%	0
	answered question	**7**
	skipped question	**0**

3. How many years have you been a forecaster at the current WFO?

	Response Percent	Response Count
Less than 1 year	0.0%	0
1-2 years	0.0%	0
3-4 years	0.0%	0
5 or more years	**100.0%**	**7**
	answered question	**7**
	skipped question	**0**

4. During the evaluation, please rank the most common Fog / Low Cloud (FLC) problem of the day? 1 being the most common and 5 being the least common. Note: FLC "types" will be resorted as you rank.

	1	2	3	4	5	Rating Average	Response Count
Widespread Radiation Fog	**28.6% (2)**	**28.6% (2)**	**28.6% (2)**	14.3% (1)	0.0% (0)	2.29	7
Isolated Radiation Fog	**57.1% (4)**	28.6% (2)	14.3% (1)	0.0% (0)	0.0% (0)	1.57	7
Advection Fog	0.0% (0)	0.0% (0)	14.3% (1)	28.6% (2)	**57.1% (4)**	4.43	7
Mountain Obscuration	14.3% (1)	0.0% (0)	0.0% (0)	**57.1% (4)**	28.6% (2)	3.86	7
Synoptic-scale Low Stratus	0.0% (0)	**42.9% (3)**	**42.9% (3)**	0.0% (0)	14.3% (1)	2.86	7
						answered question	**7**
						skipped question	**0**

5. In general, how were the GOES-R FLC products used in the forecast process? 1 being the most used and 4 being the least used.

	1	2	3	4	Rating Average	Response Count
Current Conditions	**71.4% (5)**	28.6% (2)	0.0% (0)	0.0% (0)	1.29	7
Short-term (0-6h)	0.0% (0)	42.9% (3)	**57.1% (4)**	0.0% (0)	2.57	7
TAF	28.6% (2)	28.6% (2)	**42.9% (3)**	0.0% (0)	2.14	7
Zone Forecast	0.0% (0)	0.0% (0)	0.0% (0)	**100.0% (7)**	4.00	7
					answered question	**7**
					skipped question	**0**

6. What satellite imagery did you use to analyze the GOES-R FLC products?

	Response Percent	Response Count
GOES	**71.4%**	**5**
MODIS	0.0%	0
Both	28.6%	2
answered question		**7**
skipped question		**0**

7. Was it useful to use the MODIS FLC imagery when analyzing the products?

	Response Percent	Response Count
Extremely Useful	0.0%	0
Very Useful	0.0%	0
Somewhat Useful	**100.0%**	**2**
A Little Useful	0.0%	0
Not Useful	0.0%	0
If "Not Useful" please provide additional comments		0
answered question		**2**
skipped question		**5**

8. How did the GOES-R FLC products perform when compared to surface observations?

	Response Percent	Response Count
Very Good	0.0%	0
Good	**71.4%**	**5**
Fair	14.3%	1
Poor	14.3%	1
Very Poor	0.0%	0
Additional Comments		2
answered question		**7**
skipped question		**0**

9. Did you use both the GOES-R FLC and legacy fog (e.g., 10.35-3.9 µm band difference) products?

	Response Percent	Response Count
Yes	**85.7%**	**6**
No	14.3%	1
	answered question	**7**
	skipped question	**0**

10. How did the GOES-R FLC products perform when compared to legacy fog products?

	Response Percent	Response Count
Very Good	0.0%	0
Good	**83.3%**	**5**
Fair	16.7%	1
Poor	0.0%	0
Very Poor	0.0%	0
	Additional Comments	2
	answered question	**6**
	skipped question	**1**

11. Did you notice increases or decreases when using the GOES-R FLC probabilities?

	Response Percent	Response Count
Yes	**71.4%**	**5**
No	28.6%	2
answered question		**7**
skipped question		**0**

12. Did these probability trends give confidence for the formation or dissipation of FLC?

	Response Percent	Response Count
Very High Confidence	0.0%	0
High Confidence	**60.0%**	**3**
Average Confidence	40.0%	2
Low Confidence	0.0%	0
Very Low Confidence	0.0%	0
Additional Comments		0
answered question		**5**
skipped question		**2**

13. Did you utilize the GOES-R cloud thickness product?

	Response Percent	Response Count
Yes	**100.0%**	**7**
No	0.0%	0
answered question		**7**
skipped question		**0**

14. How useful was the GOES-R cloud thickness product?

	Response Percent	Response Count
Extremely Useful	0.0%	0
Very Useful	**57.1%**	**4**
Somewhat Useful	42.9%	3
A Little Useful	0.0%	0
Not Useful	0.0%	0
	Additional Comments	3
	answered question	**7**
	skipped question	**0**

15. Did you use the GOES-R cloud thickness product assist with estimating fog dissipation?

	Response Percent	Response Count
Yes	**57.1%**	**4**
No	42.9%	3
	answered question	**7**
	skipped question	**0**

16. How useful was the GOES-R cloud thickness product in assisting with estimating fog dissipation?

	Response Percent	Response Count
Extremely Useful	0.0%	0
Very Useful	25.0%	1
Somewhat Useful	**75.0%**	**3**
A Little Useful	0.0%	0
Not Useful	0.0%	0
	Additional Comments	3
	answered question	**4**
	skipped question	**3**

17. Did you ever mention the GOES-R FLC products in an AFD?

	Response Percent	Response Count
Yes	**57.1%**	**4**
No	42.9%	3
	Additional Comments	1
	answered question	**7**
	skipped question	**0**

18. On a scale of 1-5, overall, how useful did you find the GOES-R FLC Products?

	Response Percent	Response Count
5 Extremely Useful	0.0%	0
4	**50.0%**	**3**
3	**50.0%**	**3**
2	0.0%	0
1 Not Useful	0.0%	0
Additional Comments		1
answered question		**6**
skipped question		**1**

19. On a scale of 1-5, in the future, how likely are you to use the GOES-R FLC Products when diagnosing FLC?

	Response Percent	Response Count
5 Extremely Likely	33.3%	2
4	**50.0%**	**3**
3	16.7%	1
2	0.0%	0
1 Not Likely	0.0%	0
Additional Comments		1
answered question		**6**
skipped question		**1**

20. If there is anything else you would like to share (e.g., successes or failures) with the algorithm developers or the GOES-R Proving Ground about the GOES-R FLC products, please use the following space.

		Response Count
		2
	answered question	2
	skipped question	5

Page 6, Q8. How did the GOES-R FLC products perform when compared to surface observations?		
1	Does better with more widespread events and with thicker fog/cloud layers. I wish I could have used it more during the cool season.	Aug 17, 2012 12:45 AM
2	The few cases I was able to look at, the FLC products generally did not line up with sfc obs.	Aug 15, 2012 7:33 AM

Page 8, Q10. How did the GOES-R FLC products perform when compared to legacy fog products?		
1	This is almost a tie between "Fair" and "Good." The legacy products do a pretty good job, but sometimes it's hard to use as the contrast changes with time as the ground warms and cools. Both the GOES-R and legacy images struggle when higher clouds are in the way of viewing the surface. If the model component of the GOES-R MVFR/IFR probabilities is not accurate, that method simply doesn't work.	Aug 17, 2012 11:00 AM
2	The FLC products did not add much value, except when looking at thickness product.	Aug 15, 2012 7:34 AM

Page 12, Q14. How useful was the GOES-R cloud thickness product?		
1	This product wasn't very useful when I first started using it, but I learned how to apply it with more confidence as time went on.	Aug 17, 2012 11:02 AM
2	I was only able to use it a couple times. This is a brilliant idea and it worked well though the areas of cloud cover were rather limited in coverage.	Aug 17, 2012 12:51 AM
3	I needed more cases to make a good assessment. It did highlight a few spots which could not be discerned by the metars or legacy products.	Aug 15, 2012 7:35 AM

Page 14, Q16. How useful was the GOES-R cloud thickness product in assisting with estimating fog dissipation?		
1	The cutoff value is 700 feet. Several real time dense fog events never exceeded 600 feet. I have only applied the clould thickness process a few times.	Aug 17, 2012 2:19 AM
2	Again, I only reallly used it once for fog, but it gave me a reasonable estimate. I really like this product, however.	Aug 17, 2012 12:51 AM
3	The thickness product did seem to have some skill on highlighting areas where fog took longest to dissipate.	Aug 15, 2012 7:37 AM

Page 15, Q17. Did you ever mention the GOES-R FLC products in an AFD?

1	At least, I think I did!	Aug 17, 2012 11:03 AM

Page 16, Q18. On a scale of 1-5, overall, how useful did you find the GOES-R FLC Products?

1	If given a few more fog/stratus events, my assessment of its usefulness could go up or down.	Aug 15, 2012 7:40 AM

Page 16, Q19. On a scale of 1-5, in the future, how likely are you to use the GOES-R FLC Products when diagnosing FLC?

1	I definitely would look at the products in a future FLC event.	Aug 15, 2012 7:40 AM

Page 16, Q20. If there is anything else you would like to share (e.g., successes or failures) with the algorithm developers or the GOES-R Proving Ground about the GOES-R FLC products, please use the following space.

1	This product has a lot of potential. Acceptance of the imagery as a test operational tool might have been better if we had some initial training from the developers and subject matter experts. However, I knew this was probably not going to happen when we joined the program. The interest on the part of GOES-R folks was there, but the resources - especially time - were not. That's understandable. (The slide show that became available recently was a big help.) I tried to encourage local use of the GOES-R images, but it takes a while for new guidance to "take hold" especially in view of the fact that there are already so many other things to evaluate on busy shifts. We are still grateful for the opportunity to participate. I hope we continue to receive the imagery during the cold season. I am interested to see how the imagery behaves during low cloud events associated with the passage of East Coast cyclones and during periods of northwest flow snow in the southern Appalachians.	Aug 17, 2012 11:19 AM
2	Perhaps I need to review the documention, but I thought some of the GOES-R PG/FLC products would add value under mid-upper clouds. However, I did not find that to be the case.	Aug 15, 2012 7:40 AM