

Transitioning the GOES-R Fog and Low Stratus Products from Research To Operations Through the NWS Operations Proving Ground

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- **Collaborative effort between the following:**
 - GOES-R Program Office
 - National Oceanic and Atmospheric Administration (NOAA) Cooperative Institutes
 - NASA SPoRT
 - NOAA Testbeds
 - National Weather Service (NWS) Forecast Offices
 - National Centers for Environmental Prediction (NCEP)
- **User community is prepared for GOES-R imagery and data that has improved spectral resolution, spatial resolution, and temporal flash rate.**
- **Emphasis on the R20-O2R process**
- **Demonstration products provide forecasters the opportunity to:**
 - become trained
 - identify weaknesses and errors
 - identify different utilities



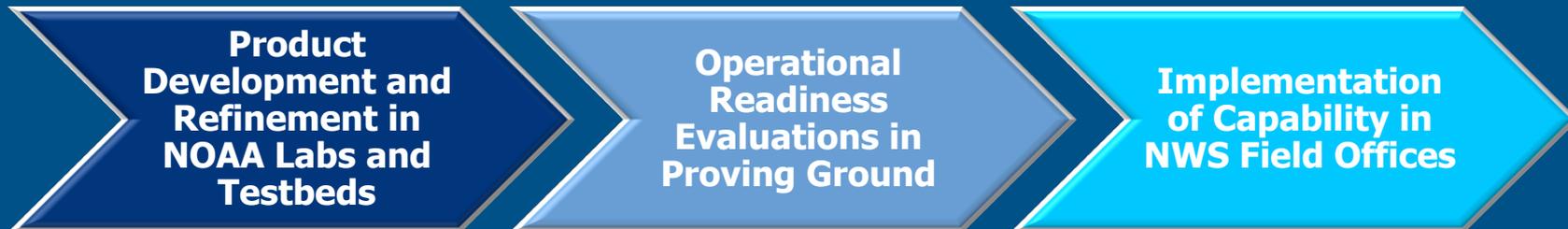


NWS Operations Proving Ground

- **Vision...prepare today's NWS forecaster to support tomorrow's Weather Ready Nation by building capacity for superior impact-based decision support services.**
- **Mission...to advance the processes and skill sets needed to generate, deliver, and communicate weather information by evaluating end-to-end service delivery in a realistic operational setting.**
- **A Distinctive Niche**
 - **O2R-R20 Arm of the OPG: Validate Operational Readiness in Operational Setting**
 - **Services Arm of the OPG: "DSS Testbed"**



"One" avenue to complete this mission...



...loosely based on DOE Technology Readiness Levels (TRL)

What is Fog and Low Stratus?

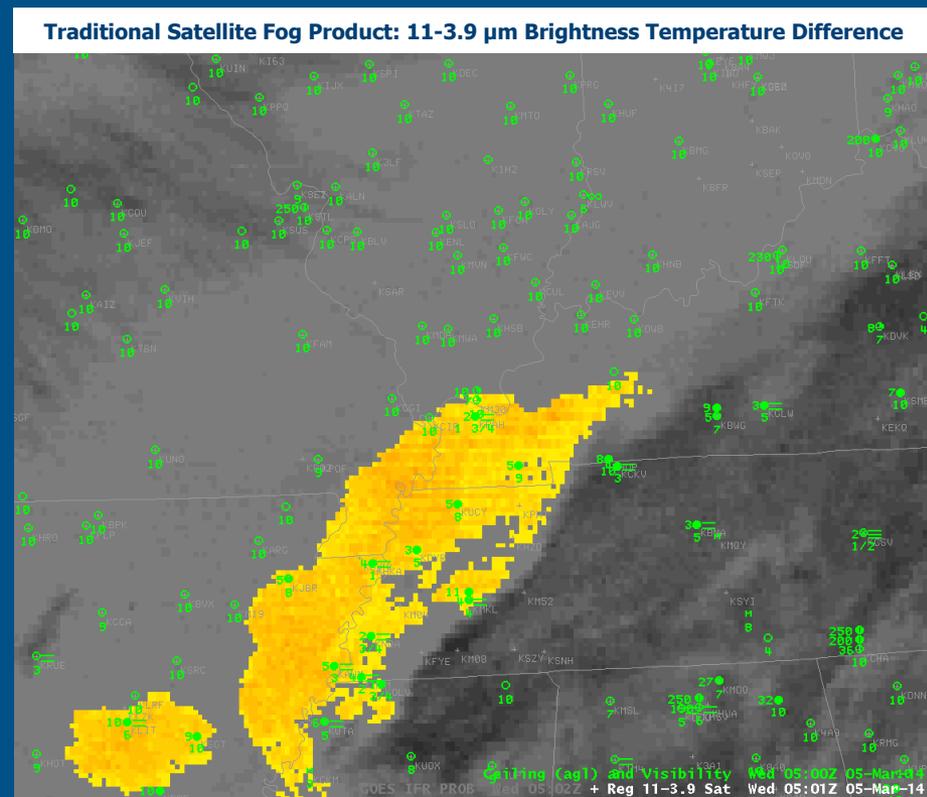
- **What is Fog?**
 - stratus cloud that has a cloud base at (or close) to the surface
 - reduction in surface visibility to less than 1 km (5/8 statute mile)
- **Weather transportation hazard that nearly every NWS forecaster addresses...**
 - Weather Forecast Offices
 - Aviation Weather Center
 - Alaska Aviation Weather Unit
 - Ocean Prediction Center
 - Storm Prediction Center

- **The GOES-R Fog/Low Stratus (FLS) detection products provide the probability of the following conditions occurring...**

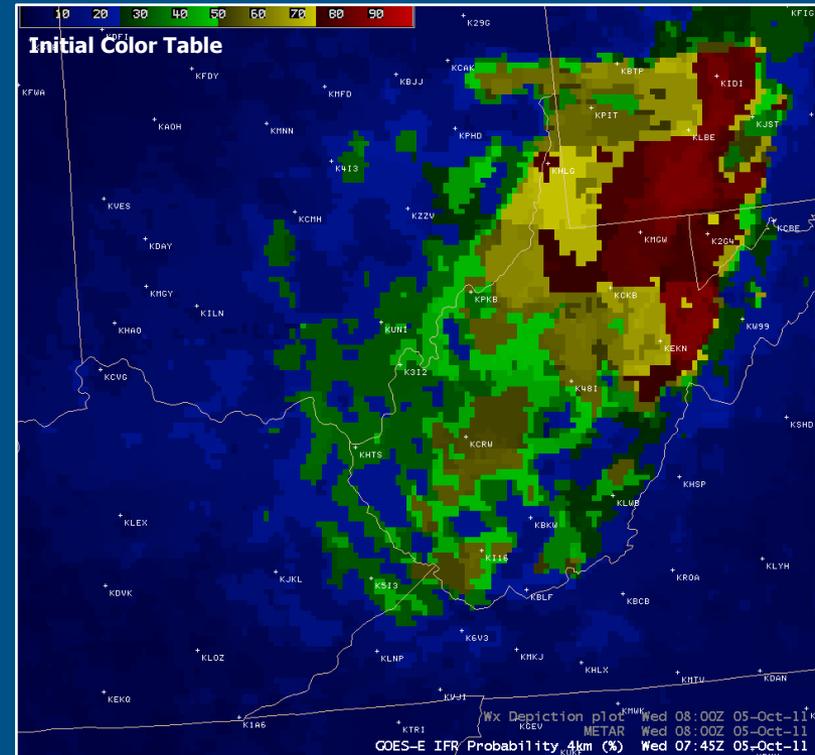
Marginal Visual Flight Rules (MVFR):
ceiling 1000-3000 ft and/or vis 3-5 mi

Instrument Flight Rules (IFR):
ceiling 500-1000 ft and/or vis 1-3 mi

Low Instrument Flight Rules (LIFR):
ceiling < 500 ft and/or vis < 1 mi

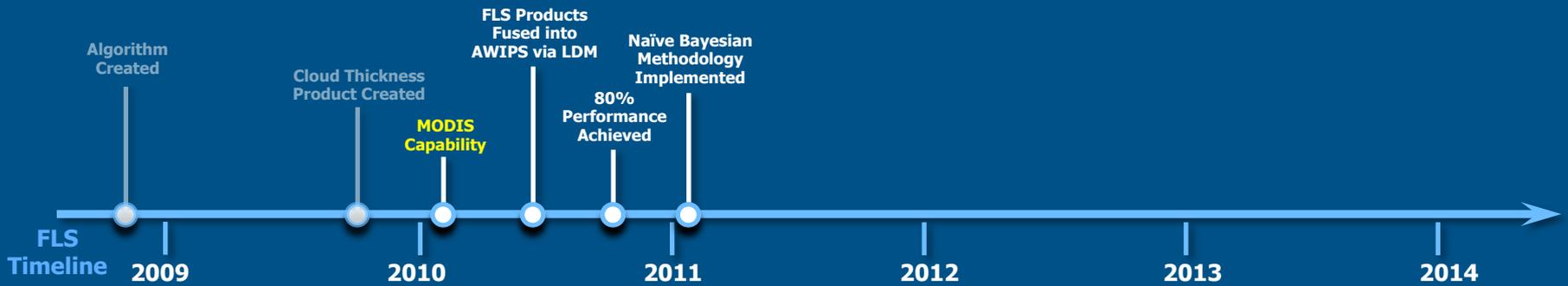
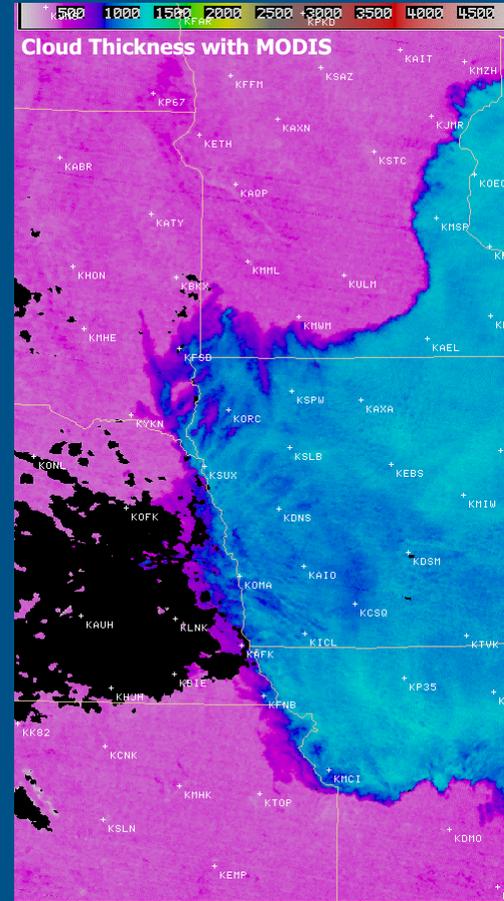
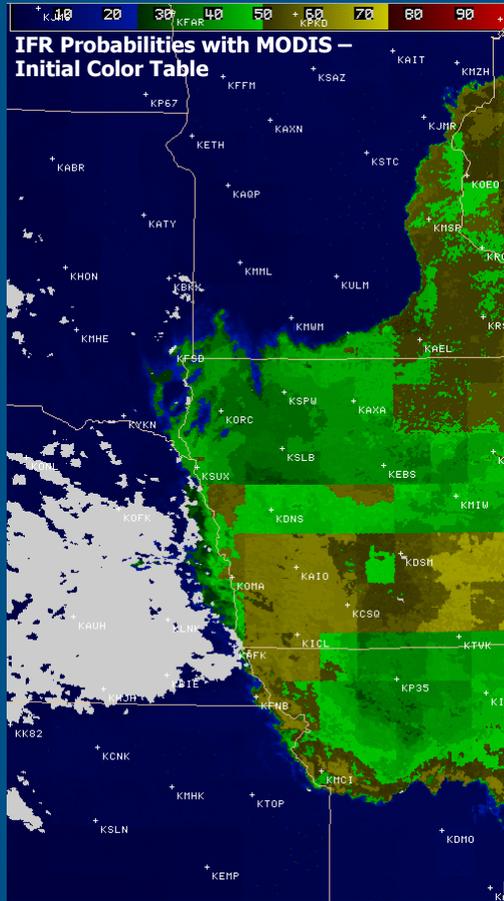


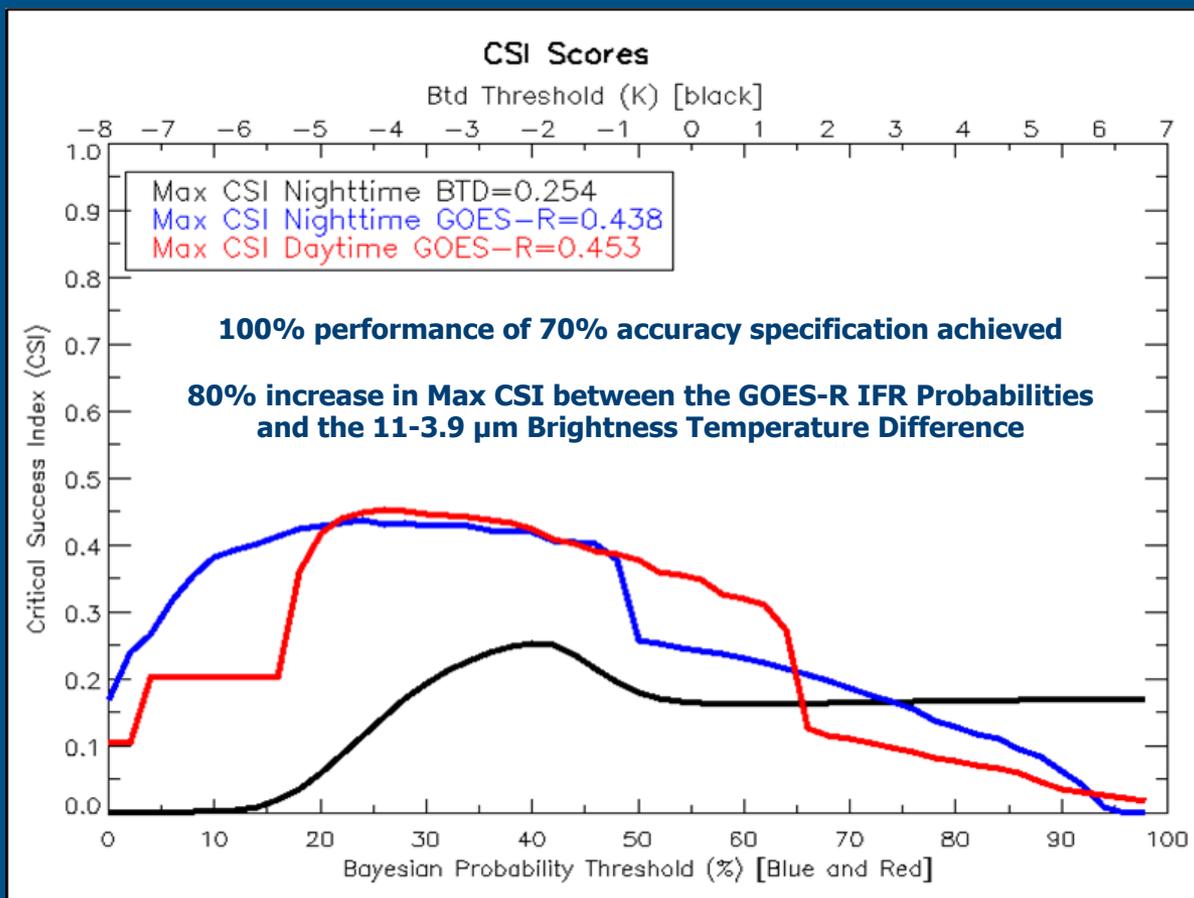
- The GOES-R FLS probability products use a naïve Bayesian model to merge/fuse the following data sources:
 - satellite
 - NWP model (sfc T and T/q profiles)
 - daily SST
 - static ancillary data
- The fused approach allows weaknesses in the individual predictors to be mitigated.
- Quantitative information on cloud ceilings and/or surface visibility.
- 2.5 years from scientific concept to useful real-time product.



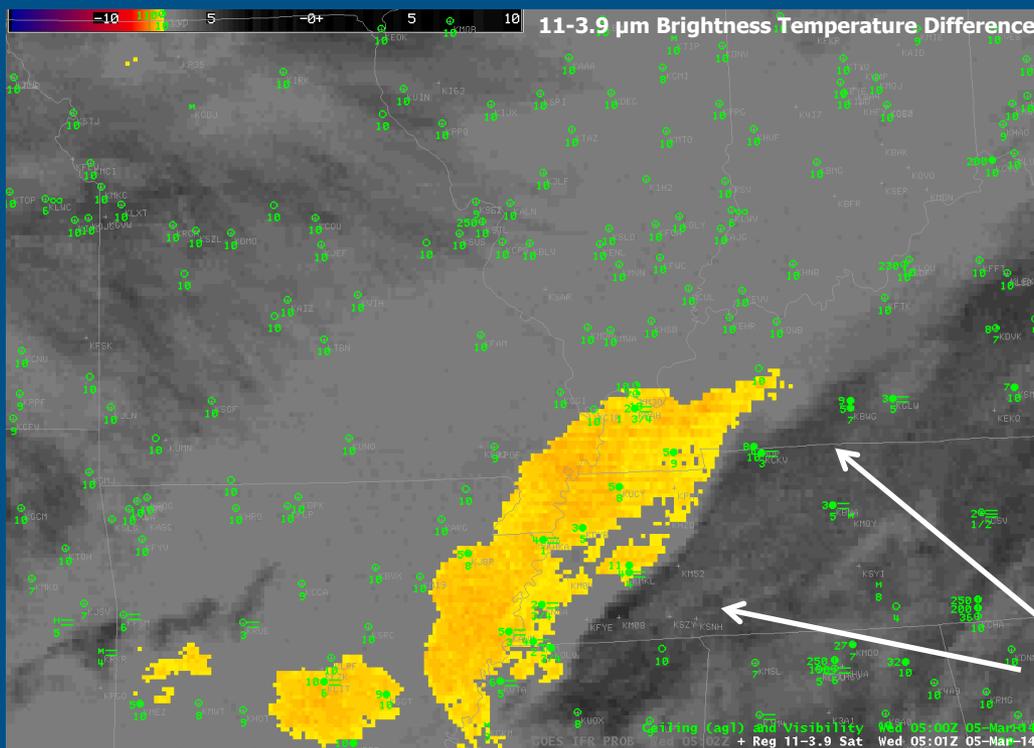


FLS Algorithm Development

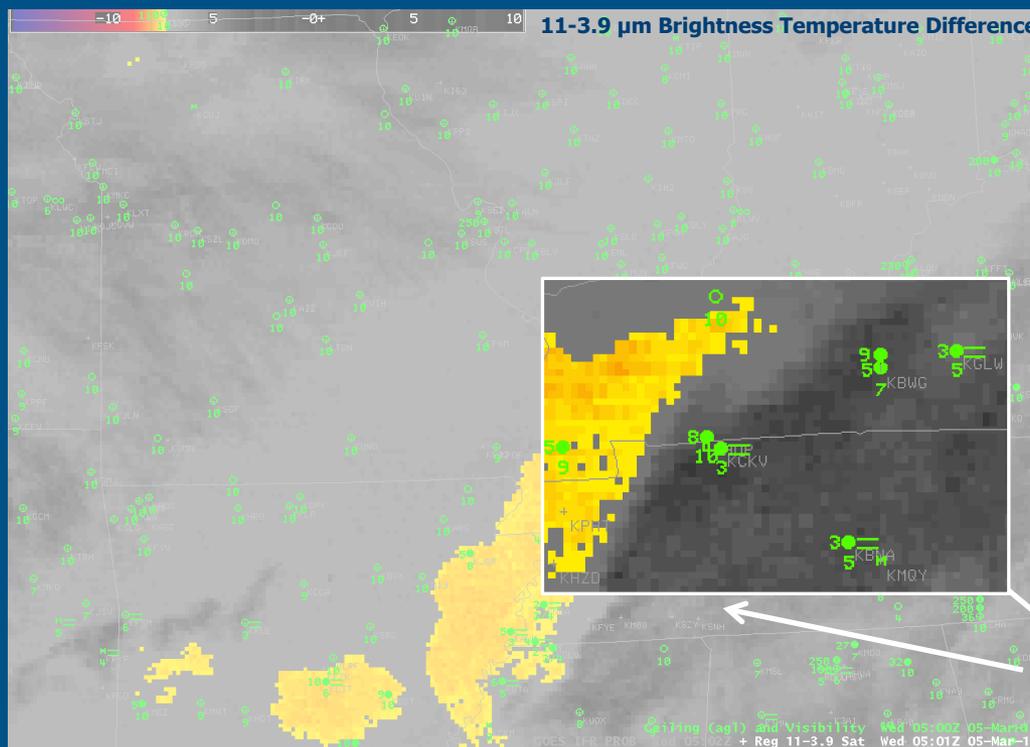




- Feedback from initial GOES-R FLS product evaluations with Alaska Region and Milwaukee, WI WFOs led to some of the algorithm improvements.



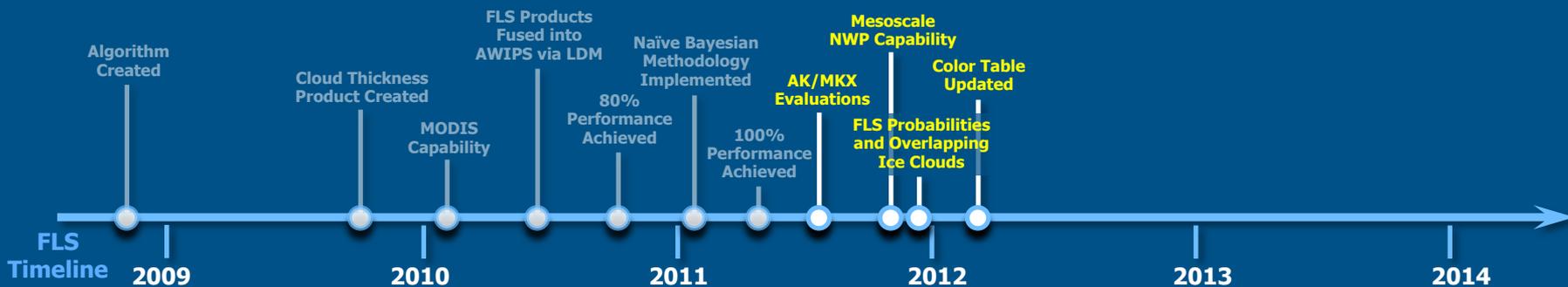
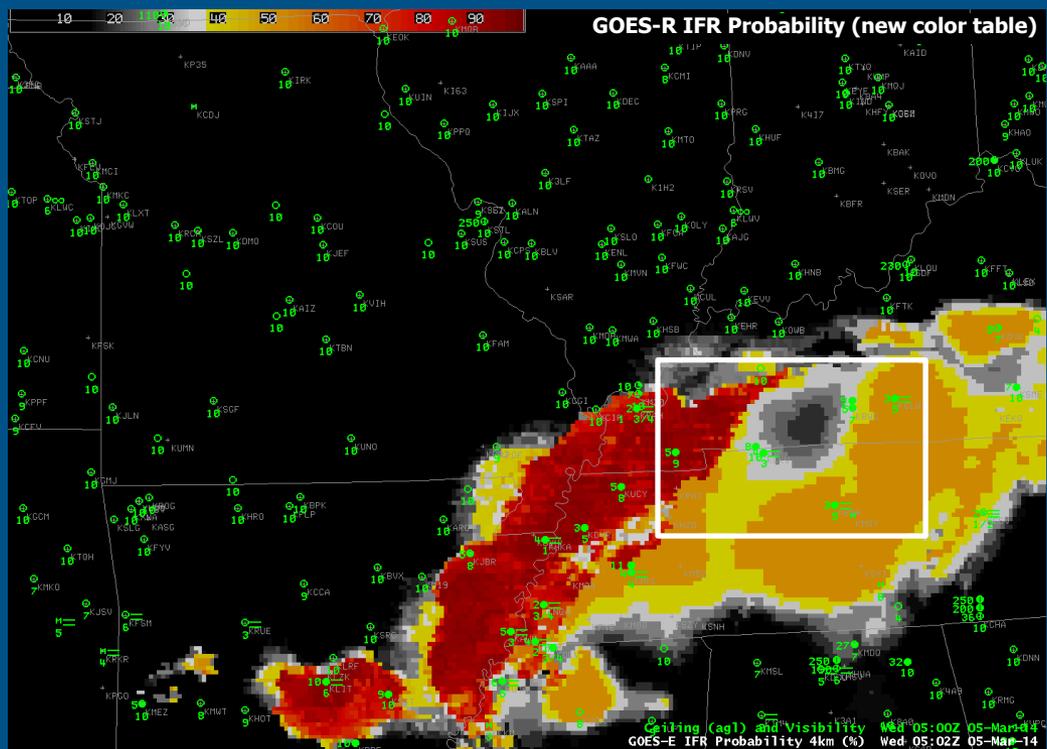
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Upper-Level Cirrus Clouds



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GOES-R FLS Training Significantly Upgraded

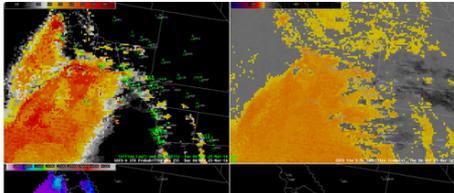
- With the algorithm enhancements, the training material was significantly updated by the product developer.
 - Specific product cases/examples for each NWS Region and NCEP Center
 - VISIT module was added to the NWS Learning Center
- GOES-R Fog Blog
 - First Post: 11 July 2012
 - About 1-3 posts per week
 - Identifies interesting events
 - SOOs notified within region of interest
 - Just-In-Time Training
 - Average of 5000 visits a month
 - Top 2 visitors: .gov and usna.edu

GOES-R Fog Product Examples
 Fog detection fusing GOES, Terra/Aqua or Suomi/NPP Satellite data with Model output

HOME

Fog vs. Stratus over southern California

Brightness temperature difference fields over the Pacific Ocean offshore of southern California showed a solid field of clouds overnight. How can this information about the top of the cloud be used to predict where low clouds and fog (IFR conditions) might exist? If you blend the satellite predictors with predictors from the Rapid Refresh model, you have information about the presence of clouds (the satellite predictors) and about the likelihood of saturation in the lowest kilometer of the model atmosphere. Consider the example below from 0400 UTC on 25 March 2014.



RECENT POSTS

- [Fog vs. Stratus over southern California](#)
- [Stratus vs. Fog in the upper Midwest](#)
- [Low clouds and Fog along the West Coast](#)
- [Identifying regions of fog under cirrus](#)
- [Fog over northeast Florida and coastal Georgia and South Carolina](#)

RECENT COMMENTS

ARCHIVES

- [March 2014](#)
- [February 2014](#)





Operations Proving Ground – NWS Central Region Evaluation

- **Evaluation: 1 August – 31 December 2012**
- **Participating Central Region Offices: DMX, EAX, IND, JKL, LMK, LSX, MQT, RIW**
- **“Back Door” delivery of the products via the Central Region LDM.**
- **Training session was given to the WFOs via GoToMeeting by the FLS product developer, Mike Pavolonis.**
- **Feedback on the products was provided through:**
 - **Forecaster Surveys**
 - **Area Forecast Discussions**
 - **SOO**
 - **Facebook Posts**
 - **Informal Emails**





Operations Proving Ground – NWS Central Region Evaluation

“FLS products identified the areas better than the legacy visible/fog imagery, but felt IFR/LIFR probabilities were too low considering the areal coverage and uniformity of LIFR conditions, likely due to high clouds moving across the state.”

“Mostly good, although the IFR/LIFR probabilities were very low at times when vsbys were M1/4.”

“On this morning, the GOES-R datasets gave increased confidence that fog/low clouds were developing near KSAW, despite having high clouds initially over the site.”

“A good additional tool. I'm sure our interpretive skill will improve as we use it more.”

“We are becoming increasingly confident of using this information for TAFs, etc. and it gives us confirmation of what we normally think should be going on.”

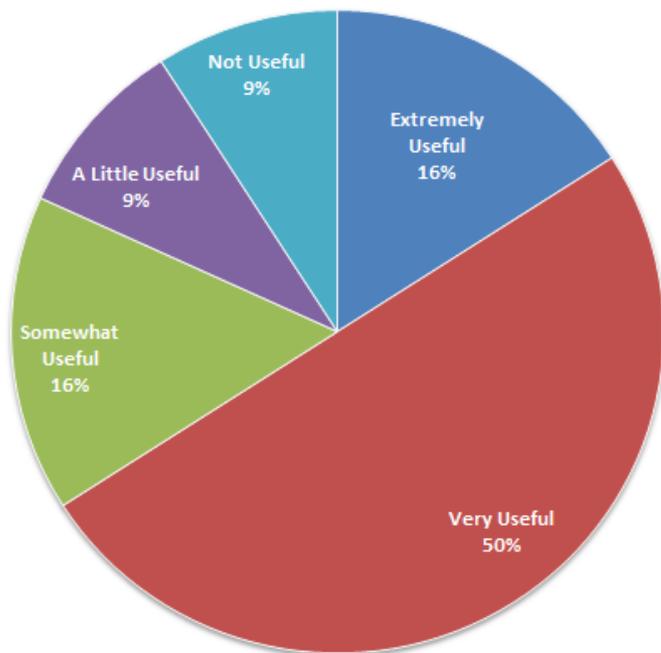




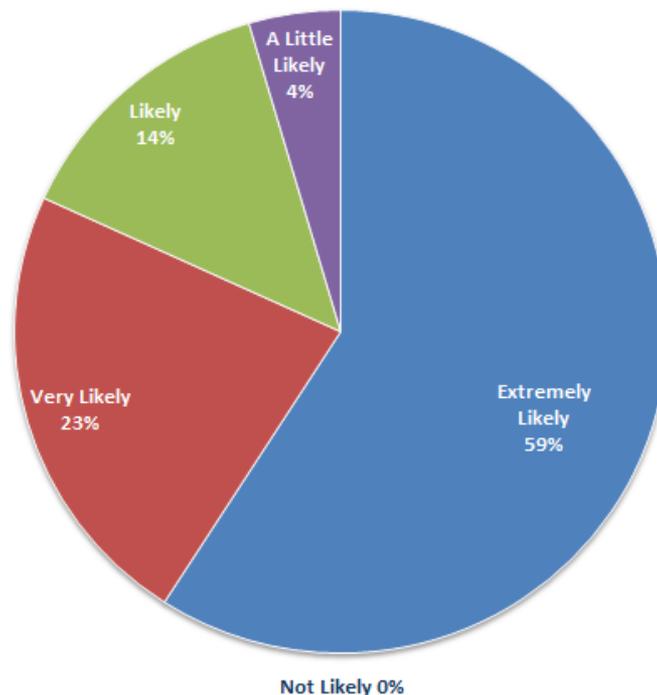
Operations Proving Ground – NWS Central Region Evaluation

Overall, how useful did you find the GOES-R FLS Products?

n=45



How likely are you to use the GOES-R FLS Products again when diagnosing FLS?



Operations Proving Ground – TBW Pilot Project Evaluation

- **NWS Tampa Bay Pilot Project has objectives to collaborate with core partners and develop smoke/fog visibility forecasts.**
- **Assisted the NWS Tampa Bay Pilot Project in satisfying their objective of... "Evaluating the GOES-R Fog and Low Stratus Products in coordination with the GOES-R Proving Ground".**
- **Evaluation: 1 November 2012 – 1 May 2013**
- **Tampa Bay's Ports:**
 - Tampa (largest port in FL, 16th largest in U.S., 3 cruise terminals)
 - St. Petersburg
 - Manatee



- **High-Impact Sea Fog Event: 23-24 February 2013**
- **NWS Conference call occurred the early evening of 23 February between:**
 - NWS Tampa Bay
 - U.S. Coast Guard
 - Tampa Bay Harbor Pilots
 - Vessel Traffic Safety Board
- **Traffic into the Tampa Bay Channel will be held until tomorrow 1300 UTC or until conditions approve.**
- **10+ vessels will be anchored until the fog lifts. Ships with priority are: 1 NH3 ship and 3 Cruise ships**



Operations Proving Ground – TBW Pilot Project Evaluation

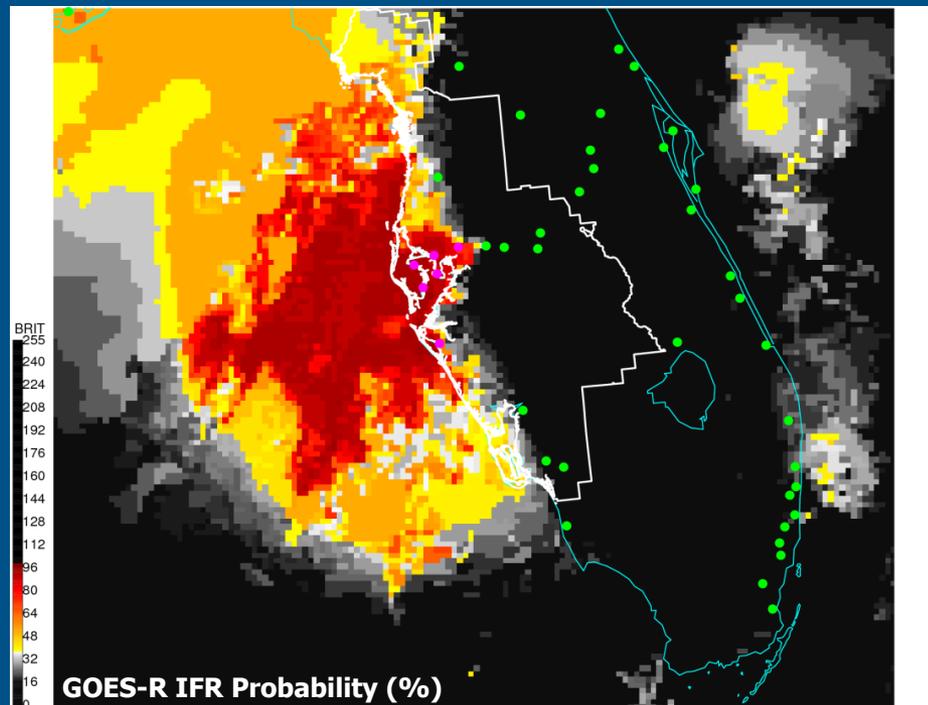
**FXUS62 KTBW 240153
AFDTBW**

**AREA FORECAST DISCUSSION
NATIONAL WEATHER SERVICE TAMPA BAY RUSKIN FL
853 PM EST SAT FEB 23 2013**

.UPDATE...MAIN ISSUE OVERNIGHT WILL BE THE LOW CLOUDS AND FOG...ESPECIALLY THE SEA FOG WHICH IS MOVING IN ALONG THE COAST. GOES-R IFR PROBABILITIES SHOW HIGHEST CONCENTRATION/MOST LIKELY AREAS OF FOG TO BE OVER THE GULF BETWEEN HERNANDO COUNTY AND MANATEE COUNTY. SURFACE OBSERVATIONS AND REPORTS FROM THE COAST GUARD AND TAMPA BAY PILOTS CONFIRM THAT DENSE FOG /VISIBILITY 1 MILE OR LESS OVER THE GULF WATERS/ IS OCCURRING OVER THE BAY AND EVEN EGMONT KEY...BUT VISIBILITIES HAVE REMAINED ABOVE DENSE FOG CRITERIA / ONE QUARTER MILE / OVER LAND.

A LINE OF SHOWERS WITH A FEW THUNDERSTORMS IS ADVANCING TOWARD LEVY COUNTY SHOULD GET THERE BETWEEN 930 AND 10 PM...THEN CONTINUE SLOWLY SOUTHEAST THROUGH CITRUS AND PERHAPS HERNANDO COUNTY BY SUNRISE. MOST OF THE STORMS HAVE WEAKENED FROM EARLIER...BUT ONE OR TWO STILL SHOW SIGNIFICANT LIGHTNING ACTIVITY. WILL LEAVE THE SLIGHT CHANCE OF THUNDER IN THE FORECAST OVERNIGHT THERE.

VERY FEW CHANGES WERE MADE BEYOND THE OVERNIGHT PERIOD.



**At the end of the conference call, USCG Commander Omar told the forecasters at TBW:
“Great weather information and thank you for providing us support on the call.”**





Operations Proving Ground – NWS West Coast Evaluation

- **Evaluation: 1 May – 1 September 2013**
- **Participating Western Region Offices: SEW, EKA, LOX, MTR**
- **Assess FLS product output during warm-season along West Coast (June Gloom).**
- **Feedback on the products provided through:**
 - **Forecaster Surveys**
 - **Area Forecast Discussions**
 - **SOO**
 - **Conference Calls**
 - **Facebook Posts**
 - **Informal Emails**

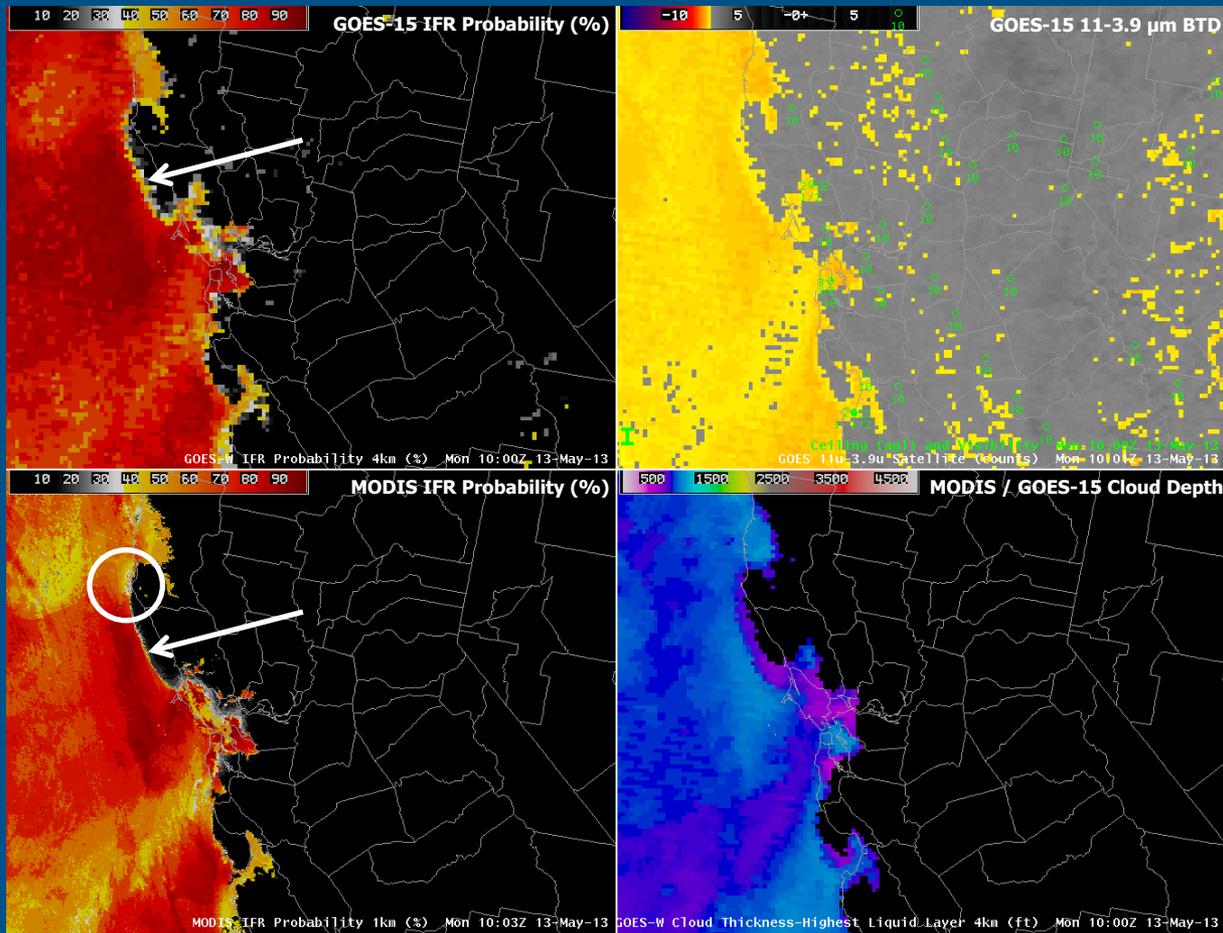


- **Evaluation Wrap-Up Conference Call Takeaways:**
 - **Product verification presented in training is important for new products.**
 - **Forecasters are routinely using the products to assess the presence of flight rule conditions: "...it is now integrated into our operations."**
 - **4km resolution is a challenge with ocean-land elevation differences and airports along the coast.**
 - **It was noticed that model errors/biases can influence probabilities... especially over ocean.**



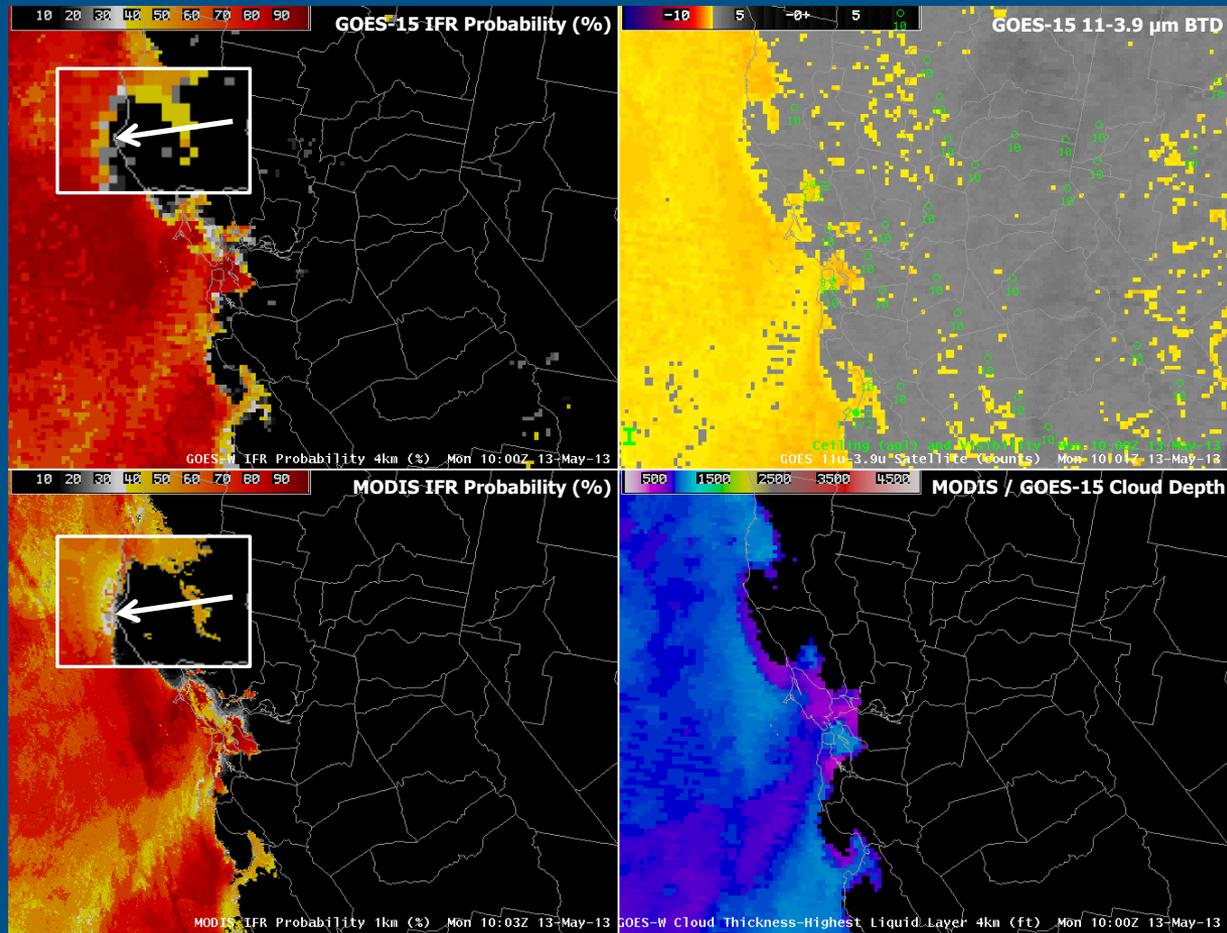


Operations Proving Ground – NWS West Coast Evaluation





Operations Proving Ground – NWS West Coast Evaluation





Current Summary of NWS Using GOES-R FLS

- **WFOs Using FLS Products: 30**
 - Eastern Region: 8 (BOX, BTV, CHS, CTP, GSP, OKX, PBZ, PHI)
 - Central Region: 10 (DMX, EAX, IND, JKL, LMK, LSX, MKX, MQT, OAX, RIW)
 - Southern Region: 3 (JAX, MOB, TBW)
 - Western Region: 6 (EKA, HNX, LOX, MTR, PIH, SEW)
 - Alaska Region: 3 (AFC, AFG, AJK)
- **NCEP Centers Using FLS Products: 4**
 - Storm Prediction Center
 - Aviation Weather Center
 - Ocean Prediction Center
 - Tropical Analysis & Forecast Branch (beginning May 2014)
- **Area Forecast Discussion References since March 2012: 111**





Transition to NESDIS Operations Commences

- Transition to NESDIS Operations and integration into AWIPS-II operational build.
- Satellite Product and Services Review Board reviewed/approved and Product System Development and Implementation funded FLS Products for the NESDIS Enterprise.
- “Front Door” delivery of the products into AWIPS II sites via the SBN.
- Data flow implementation is currently under development.
- Tentative Dates:
 - October 2015: Pre-operational
 - April 2016: Operational



- **Product naming/branding is very important due to multiple product lines.**
- **SME involvement in the training process is very important.**
- **Operational needs are regionally dependent...the training material should contain region specific examples that are current.**
- **Reliable and efficient product generation and distribution can occur outside of NESDIS operations.**
- **“Back Door” delivery of the products via the LDM limits WFO participation in evaluations.**
- **Forecasters’ understanding of probabilistic products.**



- Generate GOES-R FLS products using VIIRS
- Hybrid approach by merging LEO and GEO capabilities (i.e., use high spatial resolution VIIRS FLS probability as a priori probability in GOES classifier)
- Reduce differences between daytime and nighttime results
- Incorporate morphometric characterization of landforms into classifier (this should allow for more accurate and detailed depiction of smaller scale valley fog and local variability in cloud base)
- Develop 1 - 3 hour prognostic IFR and LIFR probability products
- Develop fog formation alerting capability
- Integrate results with GPS applications





Questions or Comments?



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