The GOES-R/JPSS Approach for Identifying Hazardous Low Clouds: Overview and Operational Impacts

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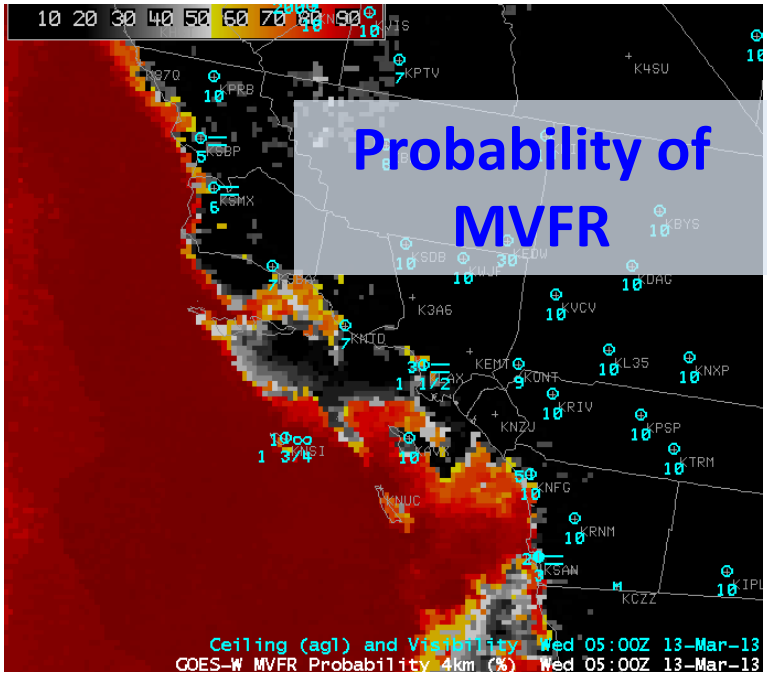
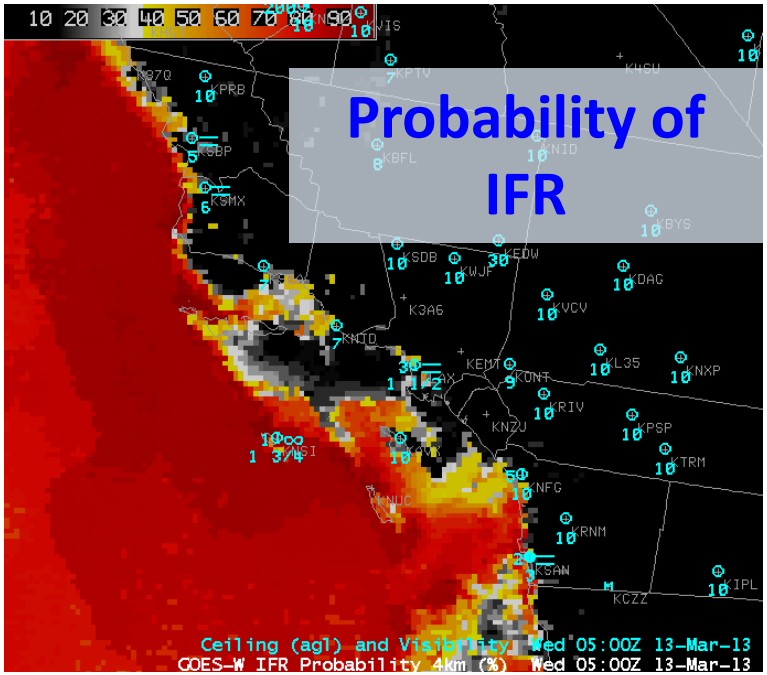
What is Fog/Low Stratus (FLS)?

- **FLS = Fog/low stratus**
- **There is no widely accepted definition of fog/low stratus so the GOES-R definition of FLS was based off aviation flight rules**
- ***The primary goal of the GOES-R fog/low cloud detection algorithm is to identify IFR, or lower, conditions.***

- **VFR - Visual flight rules**
  ceiling > 3000 ft and vis > 5 mi
- **MVFR - Marginal visual flight rules**
  1000 ft < ceiling < 3000 ft or 3 mi < vis < 5 mi
- ***IFR - Instrument flight rules***
  ***500 ft < ceiling < 1000 ft* or 1 mi < vis < 3 mi**
- ***LIFR - Low instrument flight rules***
  ceiling < 500 ft or vis < 1 mi


Probability of MVFR
10 20 30 40 50 60 70 80 90
Ceiling (agl) and Visibility Wed 05:00Z 13-Mar-13
GOES-W MVFR Probability 4km (%) Wed 05:00Z 13-Mar-13


Probability of IFR
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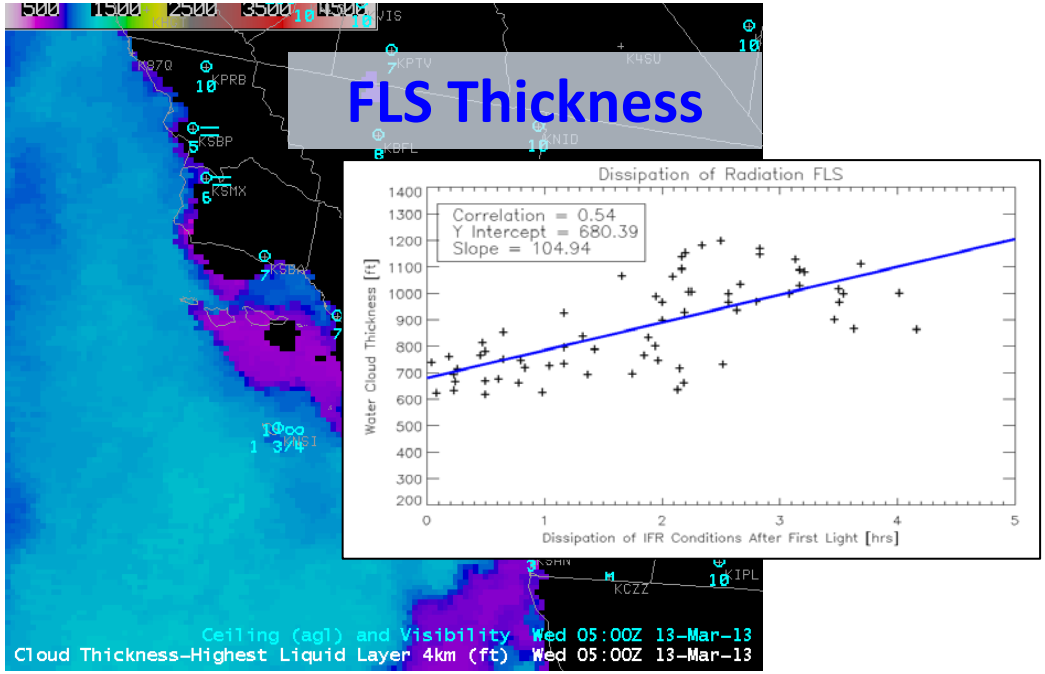
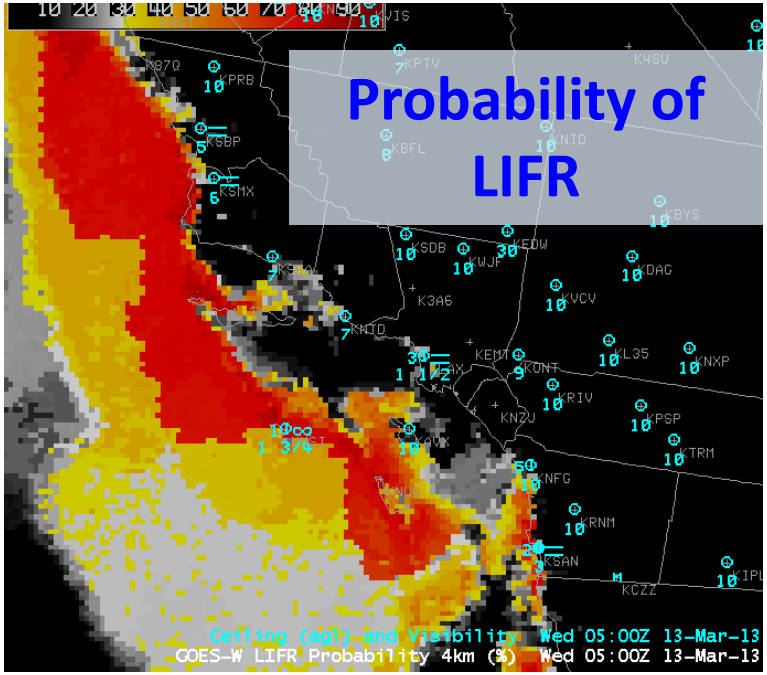
Ceiling (agl) and Visibility Wed 05:00Z 13-Mar-13
GOES-W IFR Probability 4km (%) Wed 05:00Z 13-Mar-13


FLS Thickness
Dissipation of Radiation FLS
Correlation = 0.54
Y Intercept = 680.39
Slope = 104.94
Water Cloud Thickness [ft]
Dissipation of IFR Conditions After First Light [hrs]
Ceiling (agl) and Visibility Wed 05:00Z 13-Mar-13
Cloud Thickness-Highest Liquid Layer 4km (ft) Wed 05:00Z 13-Mar-13


Probability of LIFR
10 20 30 40 50 60 70 80 90
Ceiling (agl) and Visibility Wed 05:00Z 13-Mar-13
GOES-W LIFR Probability 4km (%) Wed 05:00Z 13-Mar-13

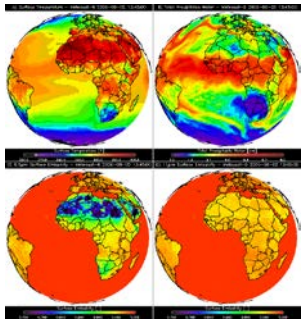
Fused Fog/Low Cloud Detection Approach

Satellite Data

-Minimum channel requirement: 0.65, 3.9, 6.7/7.3, 11, and 12/13.3 µm
-Previous image for temporal continuity (GEO only)
-Cloud Phase

+

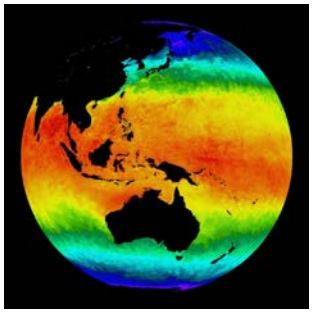
Static Ancillary Data



-DEM
-Surface Type
-Surface Emissivity

+

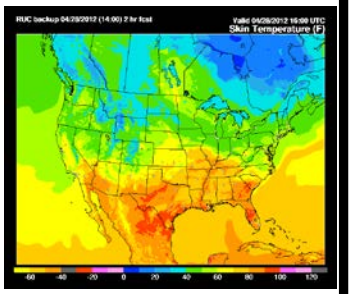
Daily SST Data



0.25 degree OISST

+

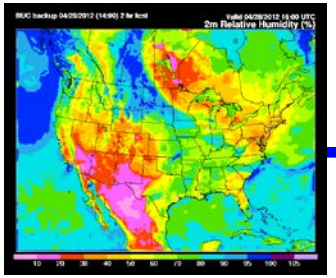
NWP



-Surface Temperature
-Profiles of T and q
-RUC/RAP (2-3 hr forecast) or GFS (12 hr forecast)

Clear Sky RTM

NWP RH Profiles

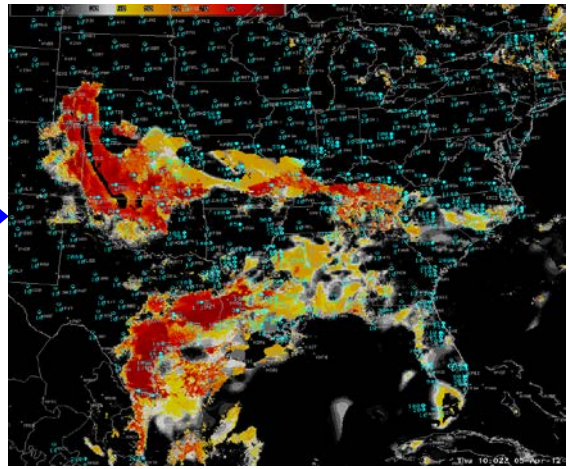


-RUC/RAP (2-3 hr forecast) or GFS (12 hr forecast)

Naïve Bayesian Model

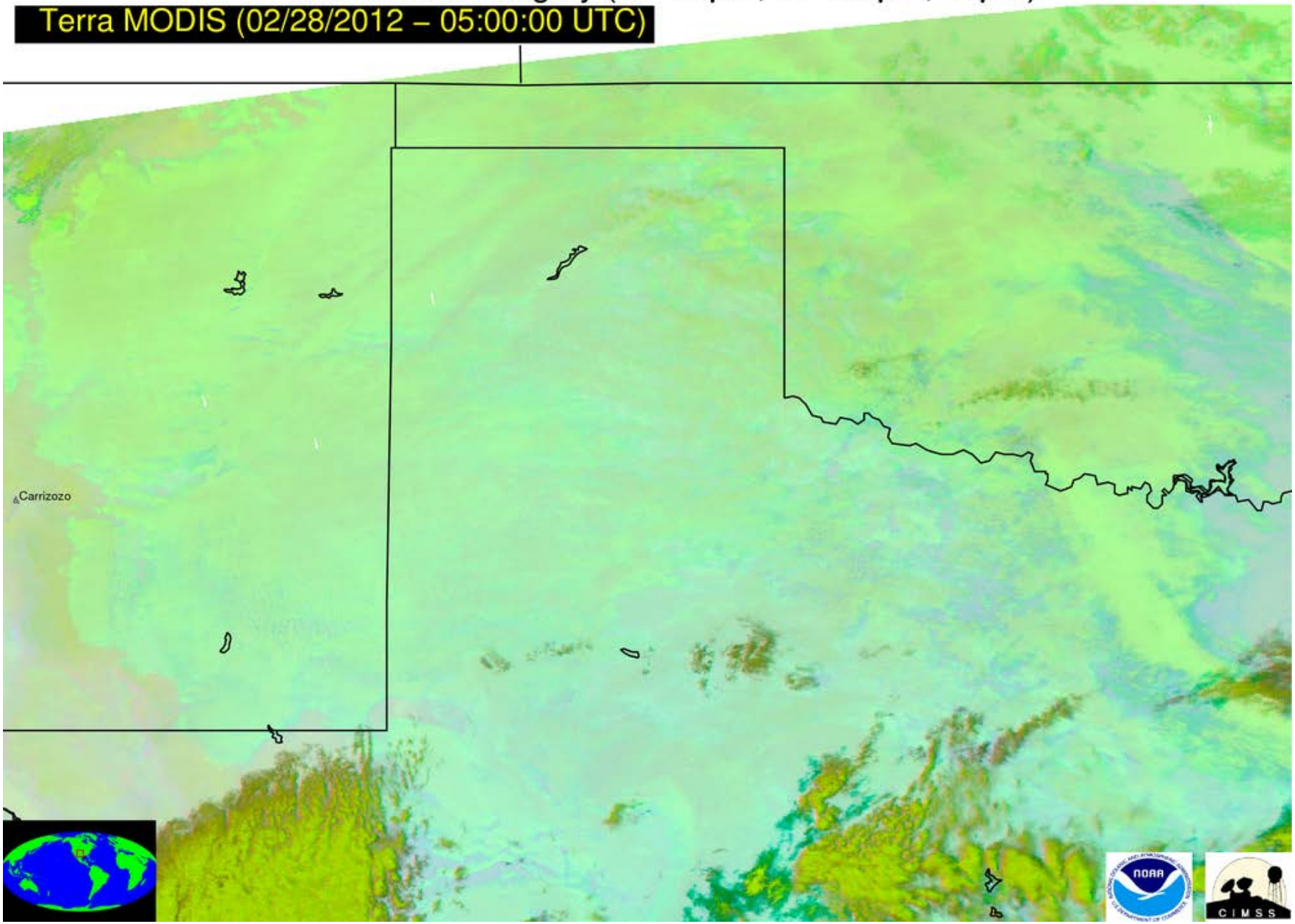
Total run time: 2 - 3 minutes

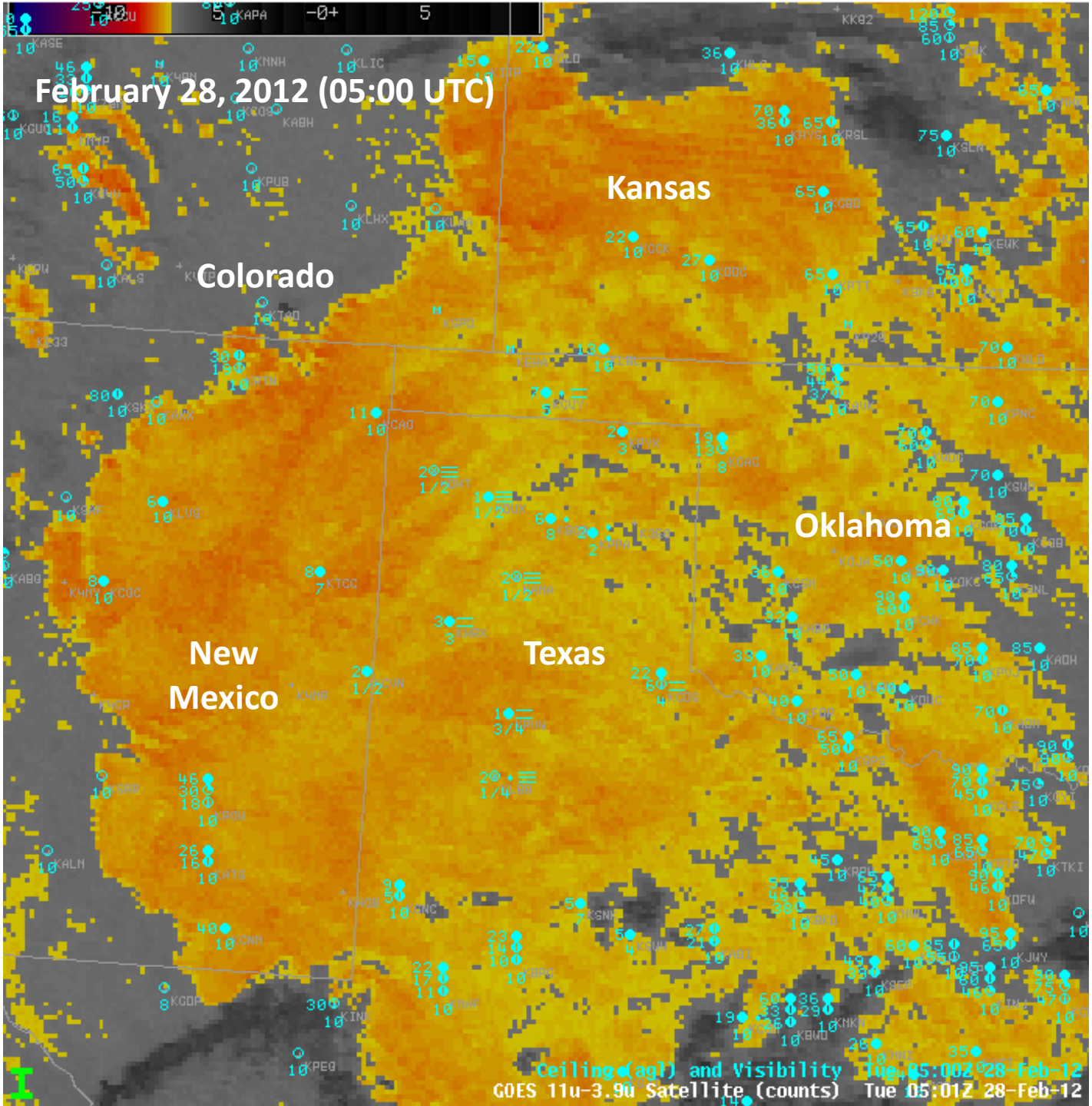
IFR and LIFR Probability

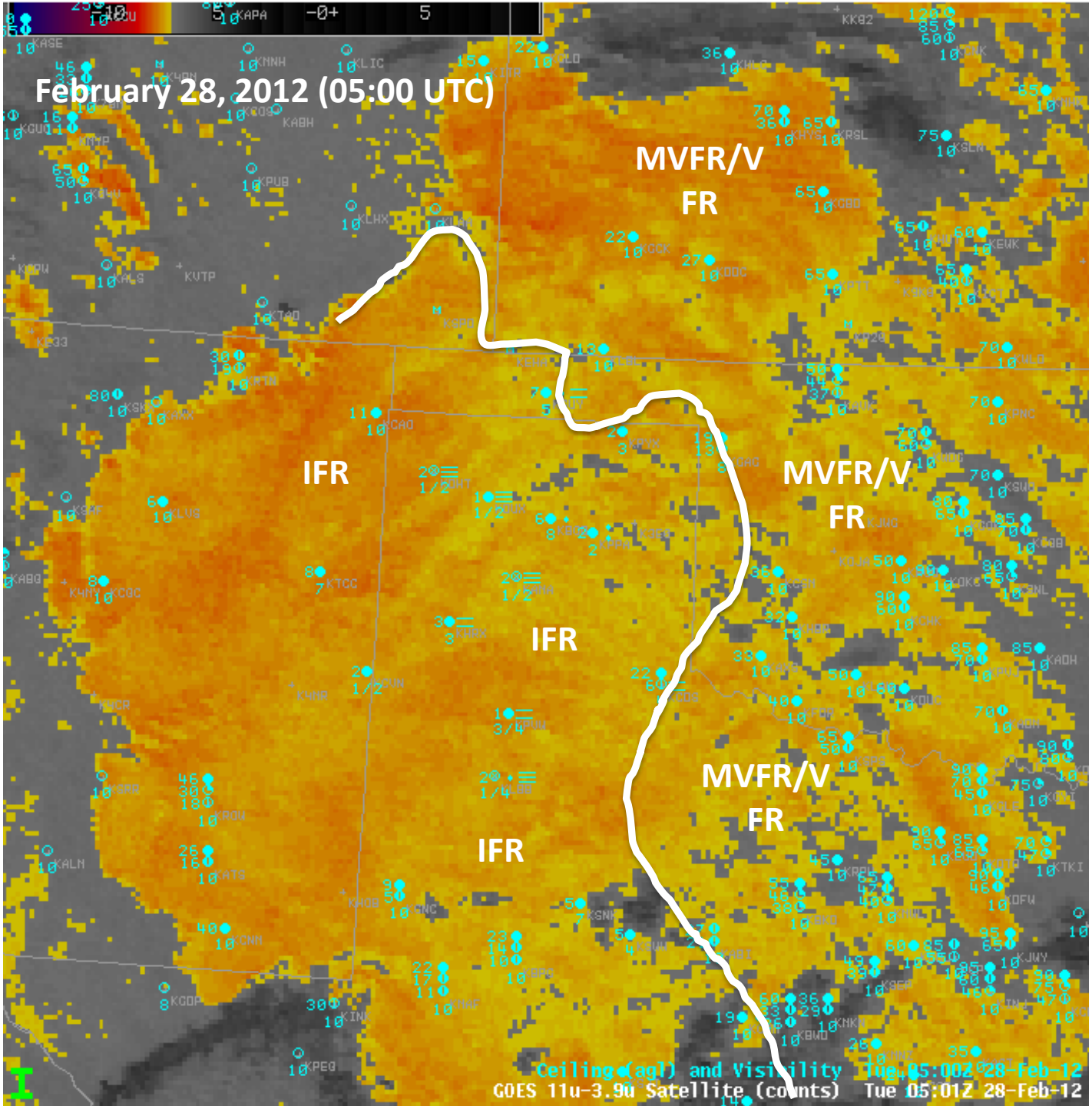


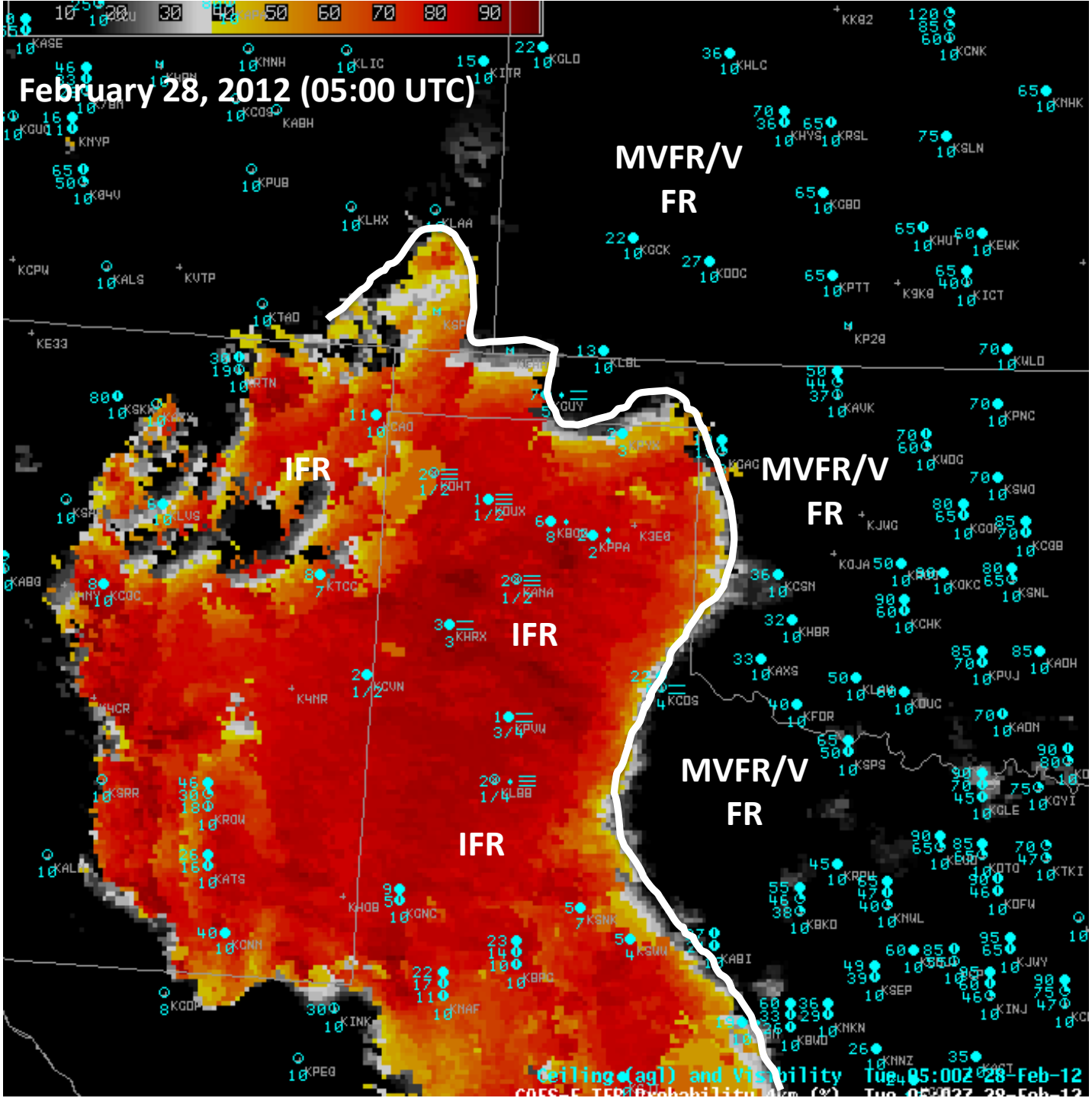
IMPORTANT: Other sources of relevant data (e.g. sfc obs) influence results through the model fields

False Color Imagery (12–11μm, 11–3.9μm, 11μm)



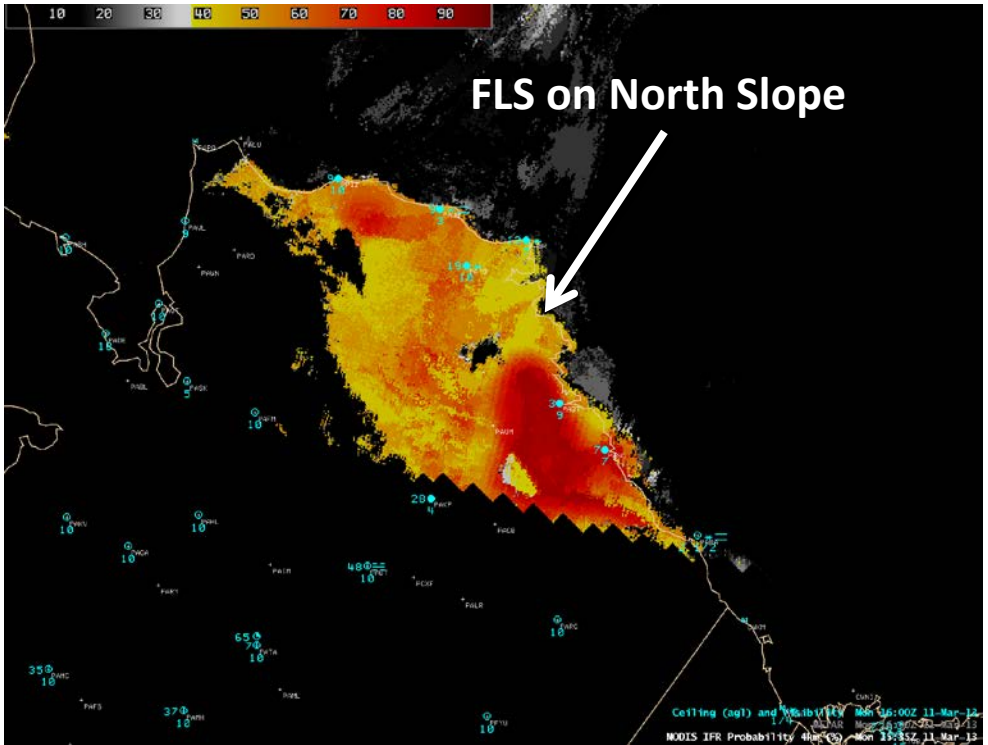

February 28, 2012 (05:00 UTC)
Kansas
Colorado
Oklahoma
New Mexico
Texas
Ceiling (agl) and Visibility Tue 05:00Z 28-Feb-12
GOES 11u-3.9u Satellite (counts) Tue 05:01Z 28-Feb-12


February 28, 2012 (05:00 UTC)
MVFR/V
FR
IFR
MVFR/V
FR
IFR
MVFR/V
FR
IFR
Ceiling (agl) and Visibility Tue 05:00Z 28-Feb-12
GOES 11u-3.9u Satellite (counts) Tue 05:01Z 28-Feb-12


February 28, 2012 (05:00 UTC)
MVFR/V
FR
IFR
MVFR/V
FR
IFR
MVFR/V
FR
IFR
Ceiling (agl) and Visibility Tue 05:00Z 28-Feb-12

NORTHERN ALASKA FORECAST DISCUSSION
NATIONAL WEATHER SERVICE FAIRBANKS AK
1258 PM AKDT MON MAR 11 2013

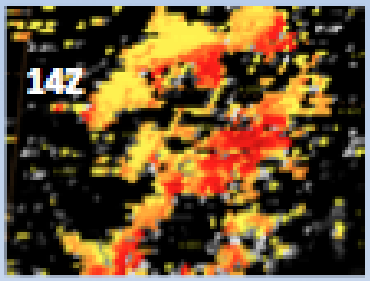
NORTH SLOPE...THE SUOMI NPP VIIRS SATELLITE FOG PRODUCT WAS INDICATING A DECENT LAYER OF STRATUS ALONG THE NORTH SLOPE. OBSERVATIONS ACROSS THE AREA GENERALLY INDICATED 1 TO 2 MILES IN VISIBILITY WITH FLURRIES AND FOG. THE IFR CONDITIONS ALIGN VERY WELL WITH THE HIGHER PROBABILITIES OF MODIS IFR PRODUCT. THERE ARE SOME VERY ISOLATED POCKETS OF HIGHER PROBABILITIES OF THE MODIS LIFR CONDITIONS. THESE CONDITIONS SHOULD REMAIN THROUGH TUESDAY EVENING OR WEDNESDAY MORNING AS THE SURFACE HIGH PRESSURE REMAINS WITHIN THE AREA. BY WEDNESDAY MORNING THE SURFACE PRESSURE GRADIENT BEGINS TO TIGHTEN...PROVIDING AN INCREASE IN WINDS AND PERHAPS A BREAK IN SOME OF THE FOG.

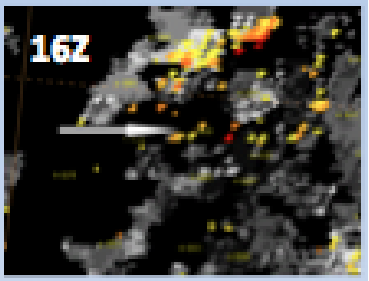


- **The GOES-R FLS products are currently used by several NWS WFO's with daily forecasts as evidenced by numerous AFD mentions (> 100 per year)**

Using GOES-R Probabilities of IFR Visibilities & Ceiling for Decision Support at the FAA Air Traffic Control System Command Center – Michael Eckert (NAM)

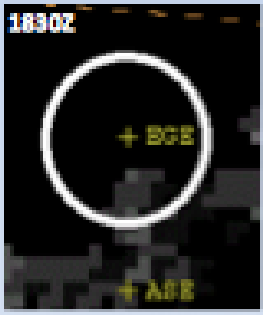
Eagle, CO Fog (12/29/13)





GOES-R shows loss of 1 pixel 70% IFR

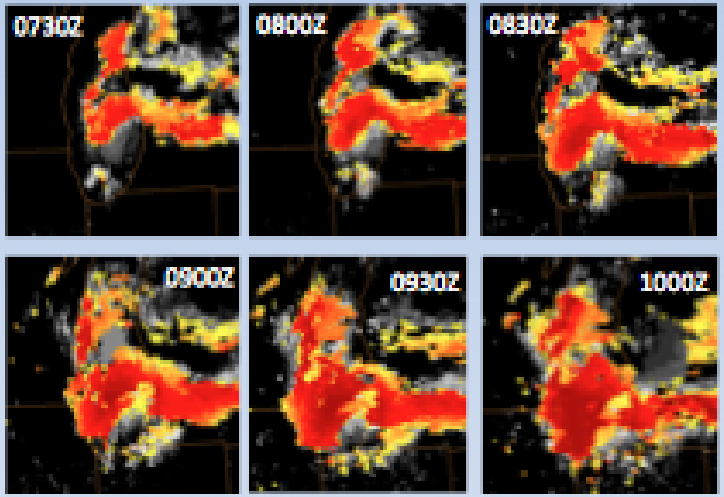
VFR ~1.5 hours after GOES-R indication of improving conditions



Ground Stop (GS) EGE (FOG)
Monitored GOES-R Probability
One Pixel 70% IFR lost
Notified ATCSCC/ZDV Clearing was imminent
GS canceled 60 min ahead of schedule
Delay cost → $76.00/min × 60 min × 50 aircraft

Savings ~ $228,000.00

ORD Stratus (6/18/13)



ORD TAF 180532Z 03008KT P6SM SCT060 BKN250
FM181300 04012G18KT P6SM SCT060 BKN150
ORD TAF 180907Z 03008KT P6SM SCT100 BKN250
FM181000 03007KT P6SM **BKN007**
ORD TAF 181125Z 03010KT **3SM BR OVC005**
TEMPO 1812/1816 **1SM BR**

ORD 181004Z ... **10SM OVC008...**
ORD 181034Z ... **4SM BR OVC004...**
ORD 181051Z ... **1 3/4SM R10L/5500VP6000FT BR OVC004...**
ORD 181055Z ... **1/4SM R10L/4500VP6000FT BR OVC004...**

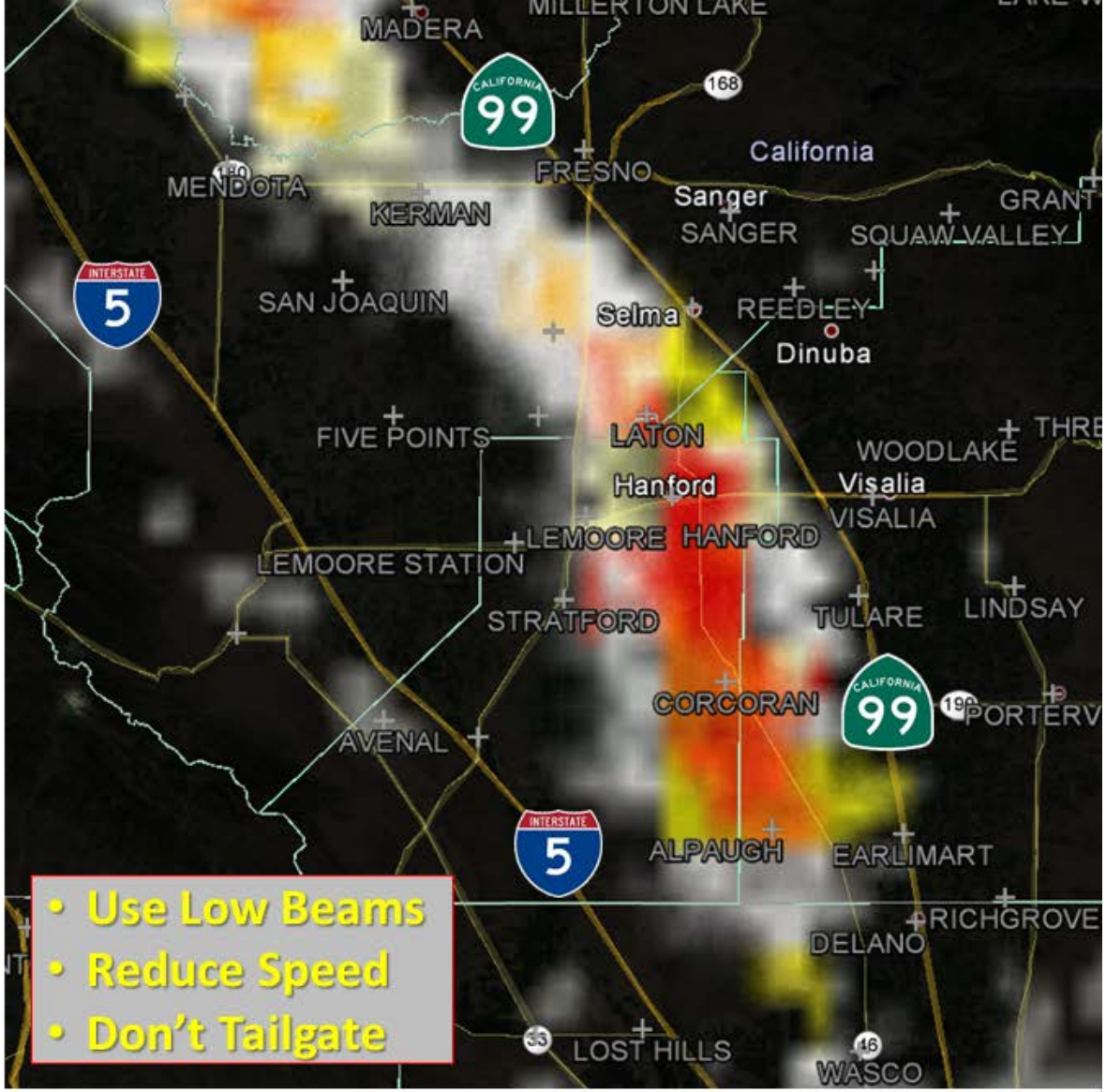
TAF had VFR forecast
Coordinated WFO LOT...GOES-R ↑ prob IFR moving to ORD
AMD issued...ZAU coordinated AMD to FAA
ORD/Airlines ready for IFR/LIFR (extra fuel for holding??)
Flights 10Z - 12Z = 60
Diversion cost ~$10,000/Flight..."NO DIVERSIONS"

SAVINGS ~$600,000 – EXTRA FUEL

#TuleFog Update

710 AM

Densest Fog Just West of Hwy 99 from Hanford to Corcoran



Interact With Us Weather.Gov/Hanford NWSHanford @NWSHanford NWSHanford

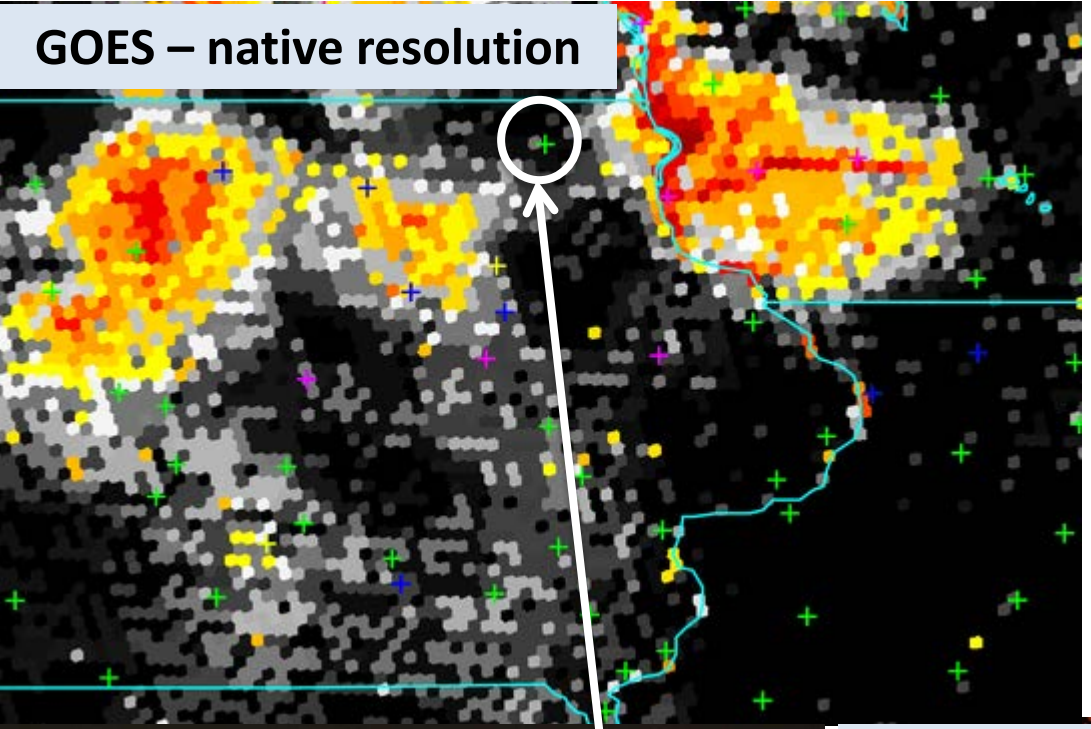
Weather Forecast Office
Hanford, CA

11/4/2014 7:16 am PST

Follow Us:

weather.gov/Hanford

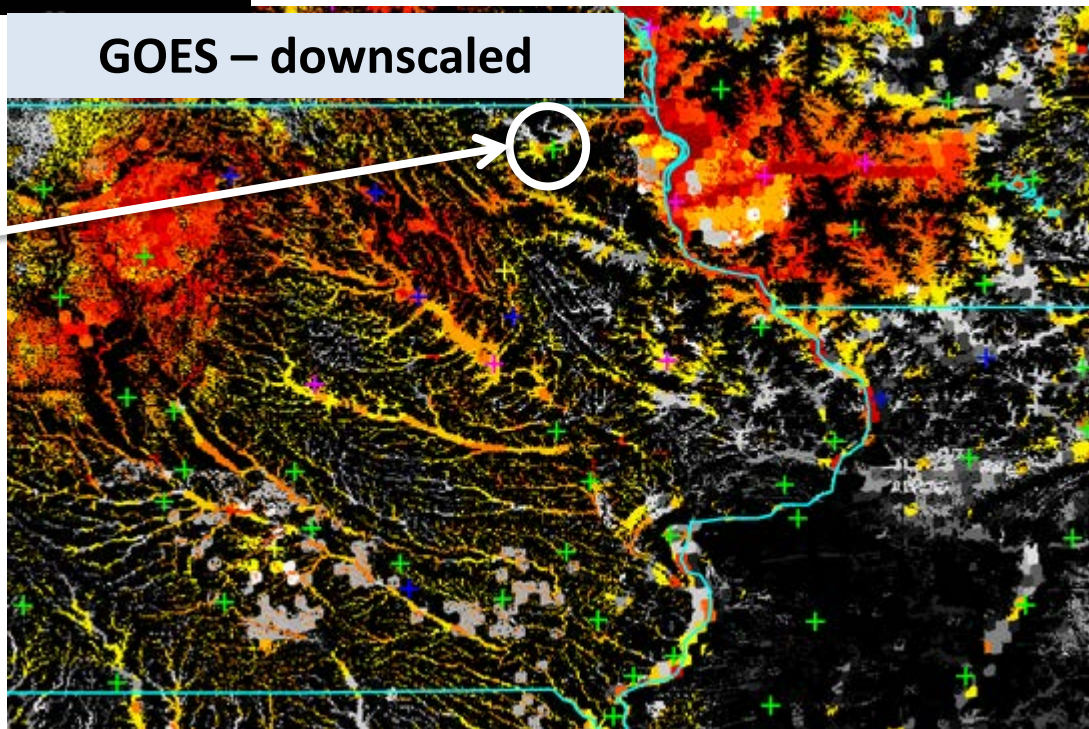
Future work will increase the ability for the FLS products to identify small-scale FLS events



Information from high-res DEMs (Shane Hubbard) and LEO satellites is used to downscale the FLS products

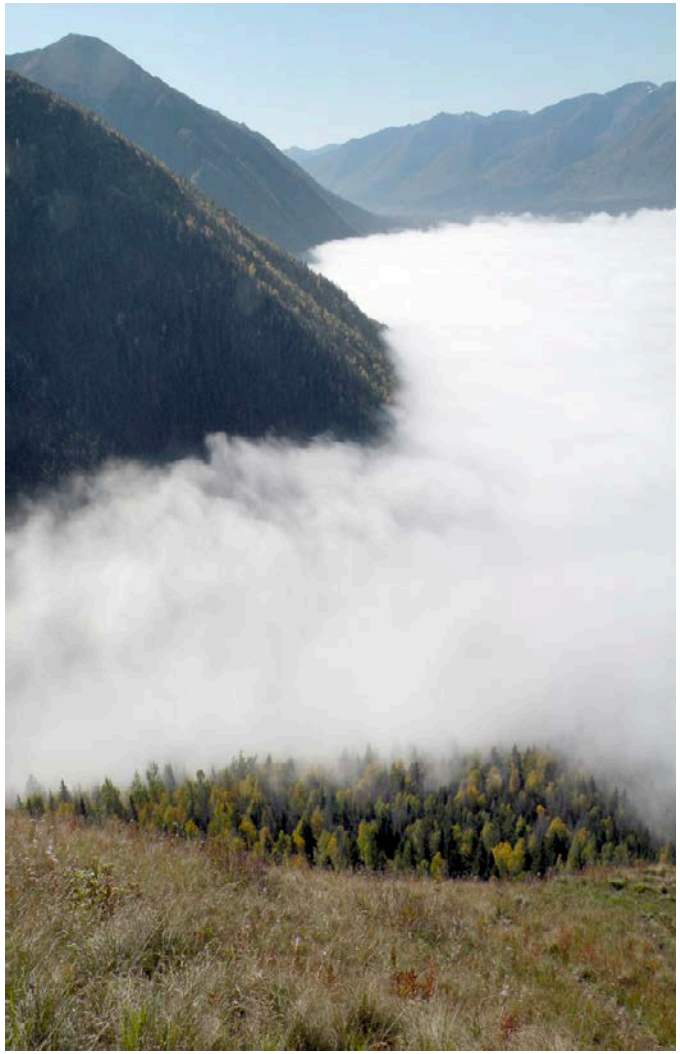
Increases the spatial resolution of the quantitative products from 4km to 0.5km

6:45 AM LST Decorah, IA



Operational Status and Impacts

- These products are currently in the process of being transitioned to NESDIS operations
- This operational transition only covers the current GOES satellite
- The products are and will be available from the University of Wisconsin and CSPP-GEO to help bridge gaps
- Operational generation of the FLS products for GOES-R is being planned



Product Info and Training Material

- **Product Training Module**
  http://cimss.ssec.wisc.edu/goes_r/proving-ground/SPC/SPC.html

- **GOES-R Radiation Fog Dissipation Relationship PDF**
  http://cimss.ssec.wisc.edu/~ccalvert/goesr_fls_training/FLS_dissipation

- **GOES-R Fog/Low Cloud Detection Fact Sheet**
  http://www.goes-r.gov/education/docs/Factsheet_Fog-Low%20Cloud_05-02-11.pdf

- **UW-CIMSS GEOCAT Realtime Cloud Product Website**
  http://cimss.ssec.wisc.edu/geocat/

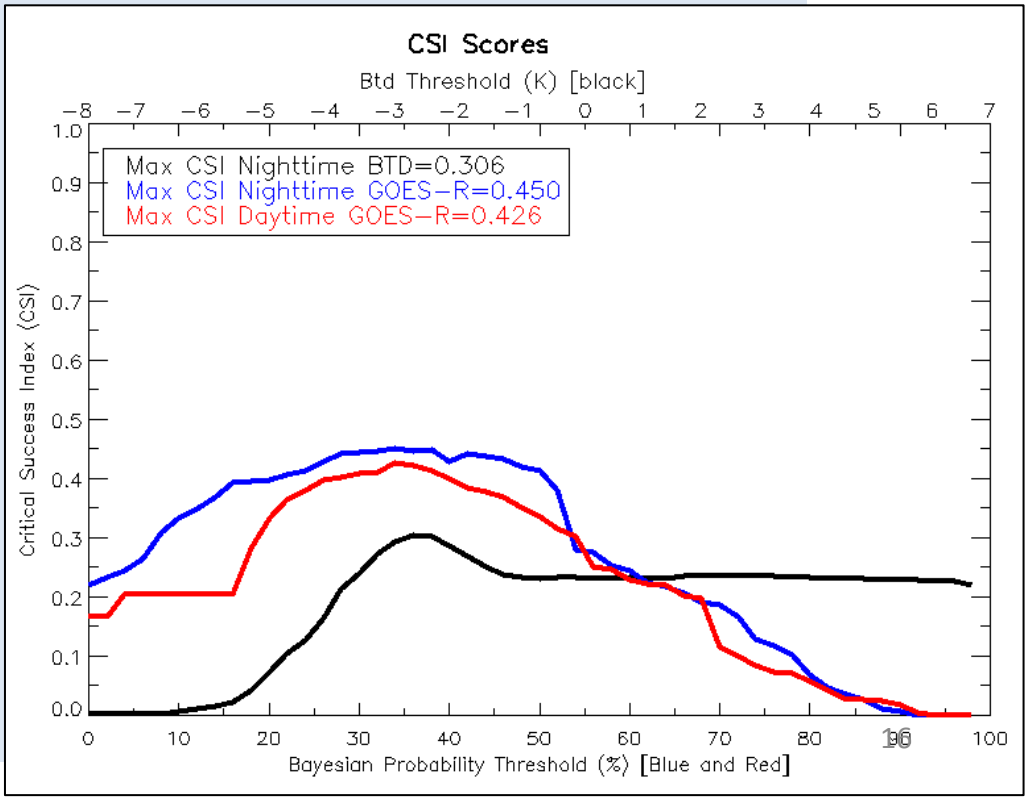
- **GOES-R FLS Detection and Thickness ATBD**
  http://cimss.ssec.wisc.edu/~mpav/goesr/GOESR_ABI_100pct_ATBD_Aviation_Fog_v2.0_revised12Sept2011_MS2004.doc

- **UW-CIMSS "Fog Blog"**
  http://fusedfog.ssec.wisc.edu

GOES-R FLS Validation Over Alaska

- **The FLS products were validated using surface observations of ceiling and visibility**

- **The plot below shows the Critical Success Index (CSI) of the daytime/nighttime GOES-R IFR probabilities along with the nighttime BTD product as a function of the threshold used to differentiate between FLS and non-FLS clouds**

- **The maximum CSI for the nighttime BTD product was calculated at 0.306**

- **The maximum CSI for the daytime/nighttime IFR probabilities were calculated at 0.426/0.450 respectively, significantly higher than the traditional BTD product**