Validation of a Modified Fog Algorithm at WFO Miami using NASA SPoRT Satellite Imagery and Surface Observations

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Overview

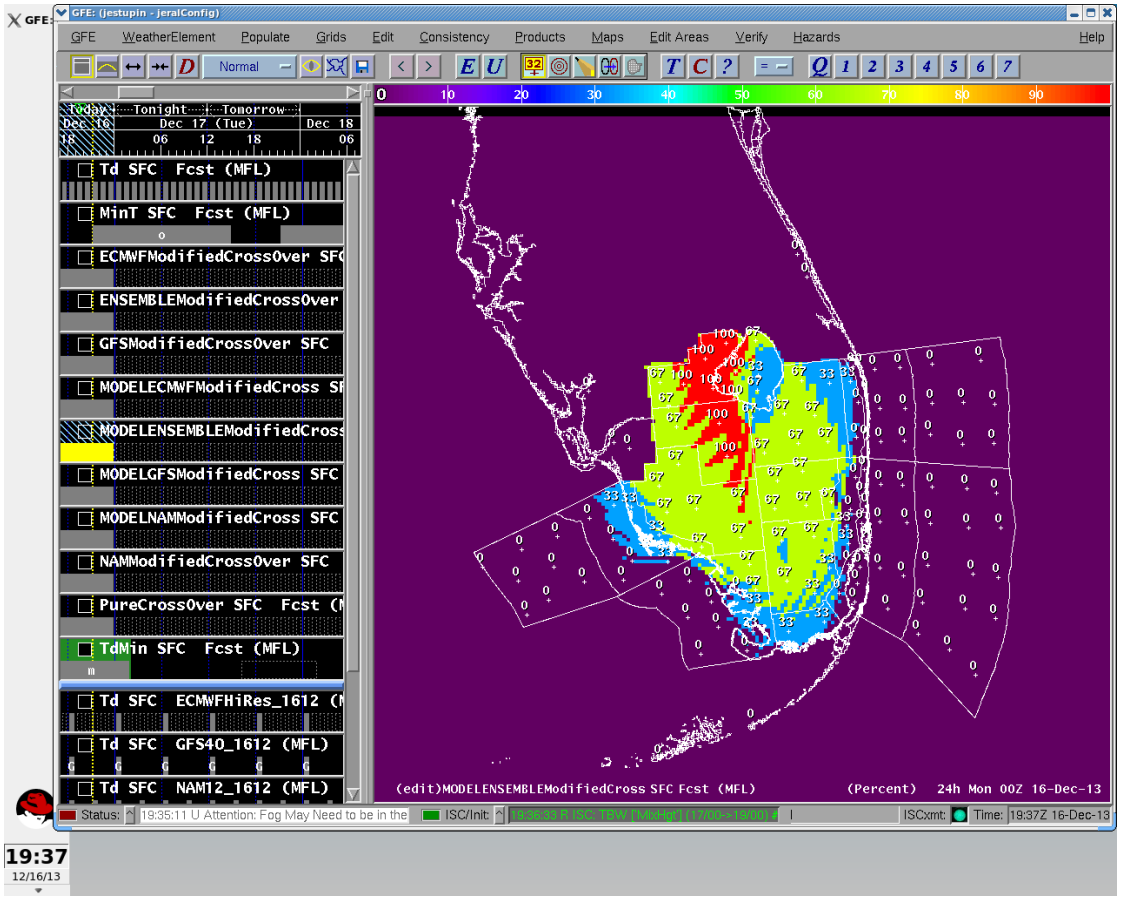
- The purpose of this study is to validate the new fog algorithm developed at the Miami Weather Forecast Office
- The algorithm is based on a combination technique that uses the crossover temperature (United Parcel Service (UPS) Airlines technique) in conjunction with a 15-knot maximum threshold of 925 mb winds.
- This study evaluates the results of the algorithm using the NASA SPoRT Nighttime Microphysics image, GOES Spectral Difference (11μm minus 3.9 μm), and surface observations.
- The period of this study starts on November 19 and will span toward the end of the 2013-2014 fog season for the Miami County Warning Area.

Overview Con't

- All nights/mornings for the fog season 2013-14 reporting fog by ground observations or visual confirmation of reporters are used in the study
- Days with confirmed fog reports are compared with the satellite imagery
- Preliminary results are shown here for 4 cases

12Z Fog Algorithm

- Captured images of the 12Z model runs for fog
- Example: 12Z Model Ensemble Modified Crossover Product from 2013DEC16
- Forecast model is valid for next day



METAR/AFOS

- Archived METAR data to verify fog events
- Archived AFOS data from IA Mesonet

C125 | fx | Y (BR)

	A	B	C	D
12	19Dec2013	KOBE	N	
13	20Dec2013	KHST	N	
14	20Dec2013	KTMB	N	
15	20Dec2013	KOBE	N	
16	21Dec2013	KHST	N	
17	21Dec2013	KTMB	N	
18	21Dec2013	KOBE	N	
19	22Dec2013	KHST	N	
20	22Dec2013	KTMB	N	
21	22Dec2013	KOBE	N	
22	23Dec2013	KHST	N	
23	23Dec2013	KTMB	N	
24	23Dec2013	KOBE	N	
25	24Dec2013	KHST	Y (BR)	0843-0858Z
26	24Dec2013	KTMB	Y	0410-1157Z
27	24Dec2013	KOBE	Y	0435-1315Z
28				
29				

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600
WWUS72 KMFL 241009
NPWMFL

URGENT - WEATHER MESSAGE
NATIONAL WEATHER SERVICE MIAMI FL
509 AM EST TUE DEC 24 2013

...DENSE FOG ADVISORY ACROSS HENDRY AND WESTERN PALM BEACH COUNTIES...

FLZ066-067-241300-
/O.NEW.KMFL.FG.Y.0023.131224T1009Z-131224T1300Z/
HENDRY-INLAND PALM BEACH-
INCLUDING THE CITIES OF...CLEWISTON...PAHOKEE...SOUTH BAY...
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* VISIBILITY...THERE HAVE BEEN REPORTS OF VISIBILITY OF LESS THAN
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  ALONG HIGHWAY 27 HAVE ALSO REPORTED HEAVY FOG.
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Example of AFOS data archived on 2013DEC24.
http://mesonet.agron.iastate.edu/wx/afos/

Products Used – RGB Nighttime Microphysics

- Important to help distinguish between low lying clouds and fog
- Uses difference between 10.8 and 3.9 channels, but also uses a new channel to determine surface temperature

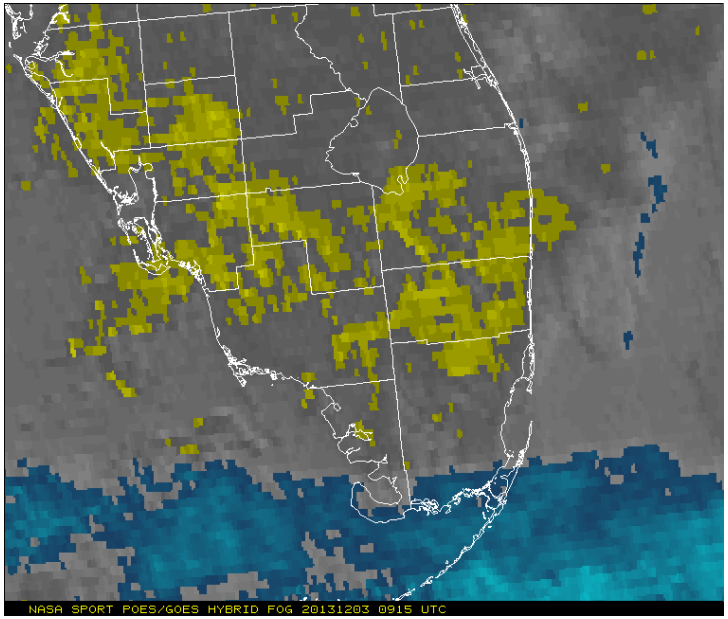
RGB Night-time Microphysics Product - What is used in the combine and what does each color represent?

Color	Band / Band Diff.	Physically Relates to....	Little contribution to composite indicates.....	Large contribution to composite indicates .....
Red	12.0 – 10.8	Optical Depth	Thin clouds	Thick clouds
Green	10.8 – 3.9	Particle Phase and Size	ice particles; surface (i.e. cloud free)	Water clouds with small particles
Blue	10.8	Temperature of surface	Cold surface	Warm surface

Courtesy: NASA SPoRT RGB Nighttime Microphysics Reference Guide

Products Used – MODIS Spectral Difference

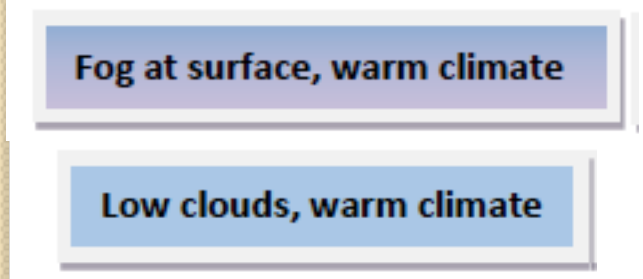
- Also called MODIS Fog Product
- 1km resolution model complementing the GOES fog product and Low Cloud Base Model



How Did We Use NASA SPoRT

- Identify the success rate of fog detection of the NASA SPoRT imagery

- Use NASA SPoRT to verify fog in interior sections of South Florida.



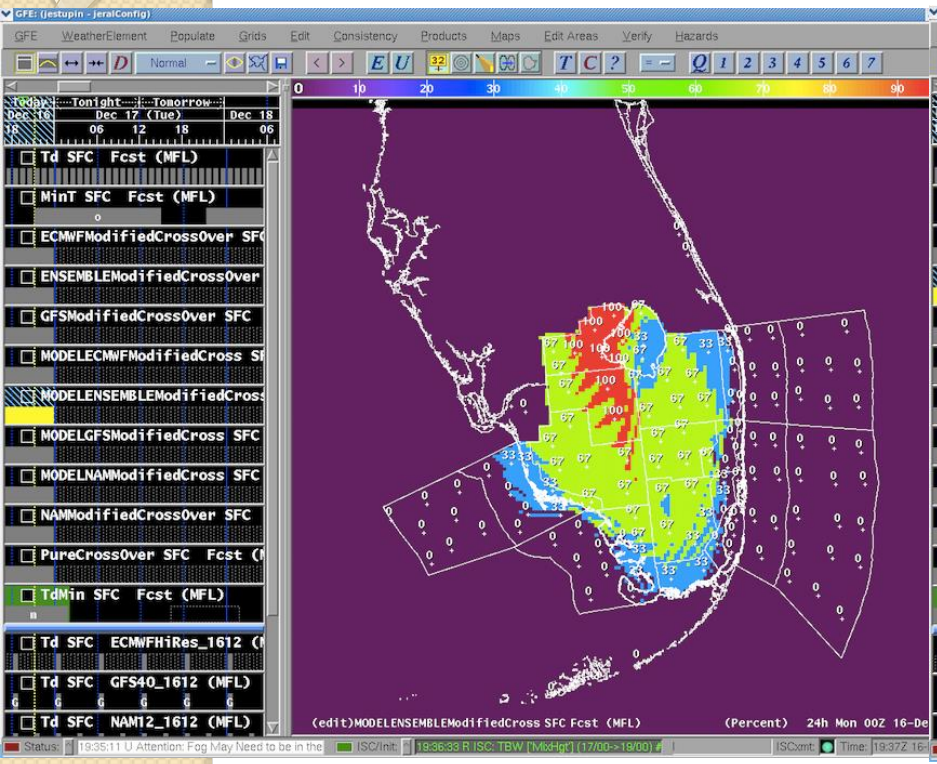
Parameters for detecting fog on RGB Nighttime Microphysics imagery. For the MODIS Fog Product, areas of yellow were used to indicate fog.

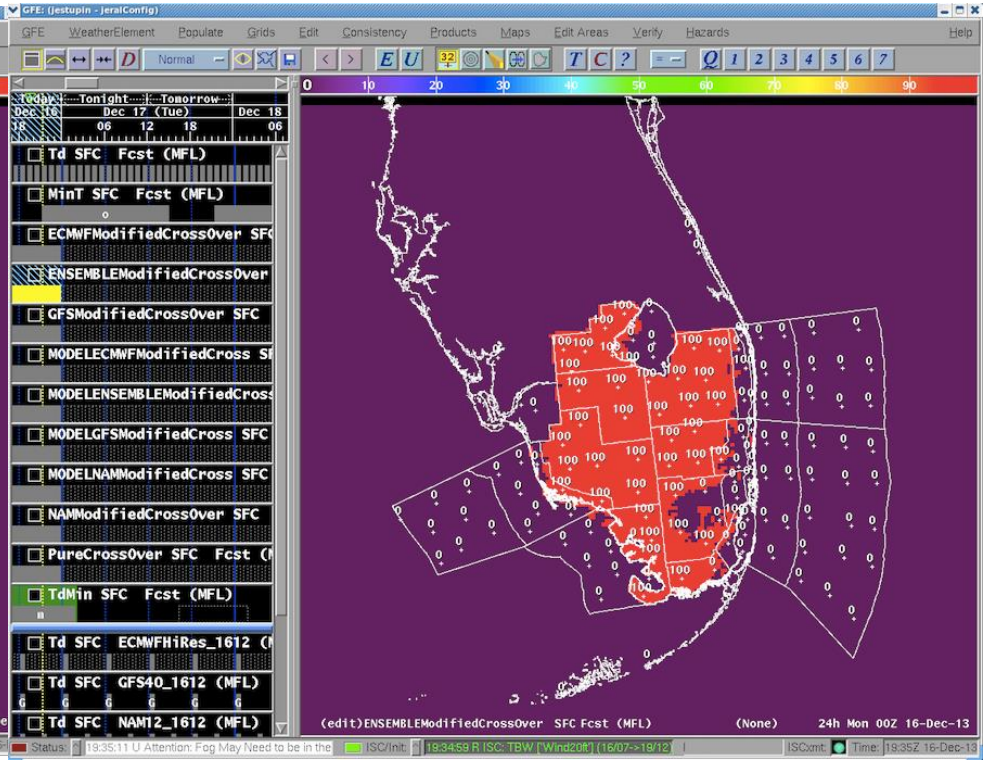
Courtesy: NASA SPoRT Training Modules and Nighttime Microphysics Reference Guide

The Results

- Project ongoing
- However, presenting 2 successful and unsuccessful algorithm days
  - 2013DEC17 and 2014JAN14 unsuccessful
  - 2013DEC24 and 2014JAN18 successful

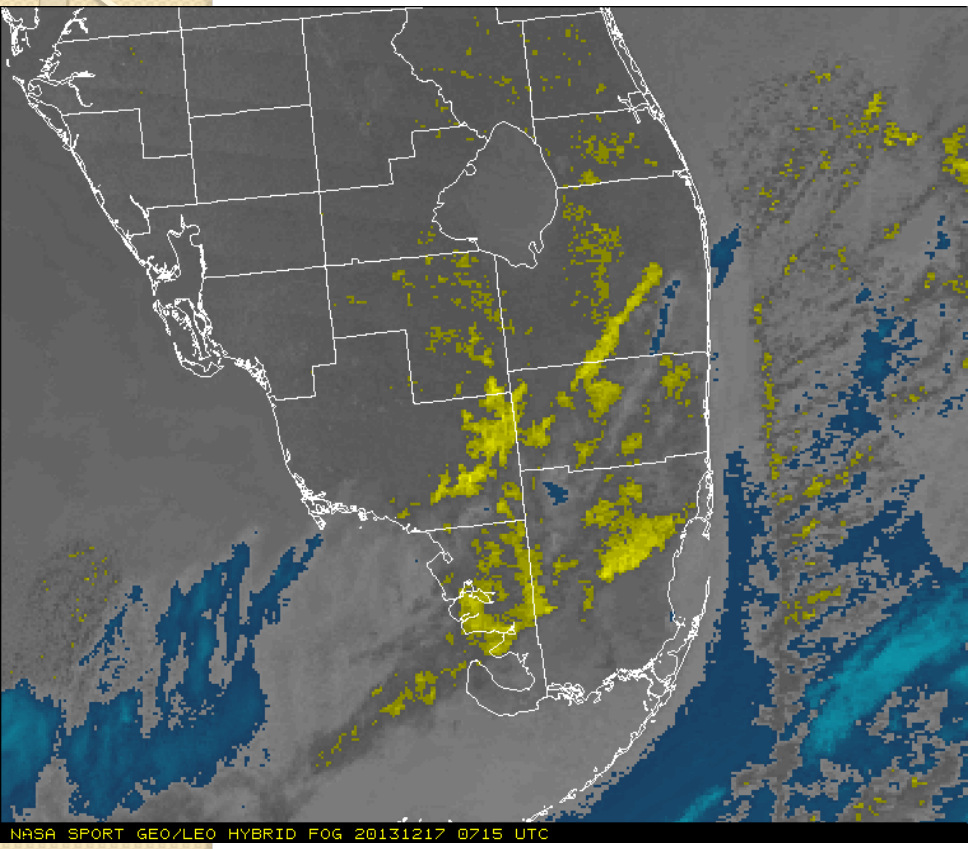
Case 1 – 2013DEC17

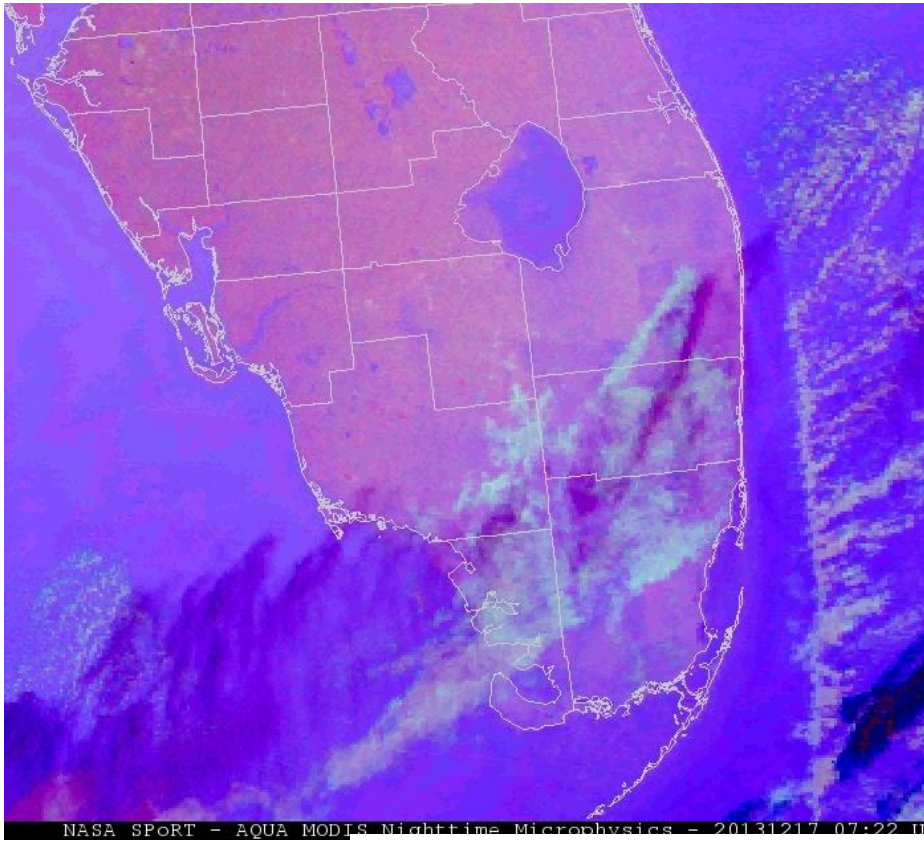




17Dec2013	KHST	N	METAR KHST 171058Z AUTO 34006KT 10SM BKN037 BKN060 16/15 A3013 RMK AO2 SLP206 T01630145=
17Dec2013	KTMB	N	METAR KTMB 171053Z AUTO 34006KT 10SM BKN035 BKN060 16/14 A3014 RMK AO2 SLP204 T01560144=
17Dec2013	KOBE	N	METAR KOBE 171055Z AUTO 35005KT 10SM CLR 08/07 A3019 RMK AO2

Case 1 – 2013DEC17 Results

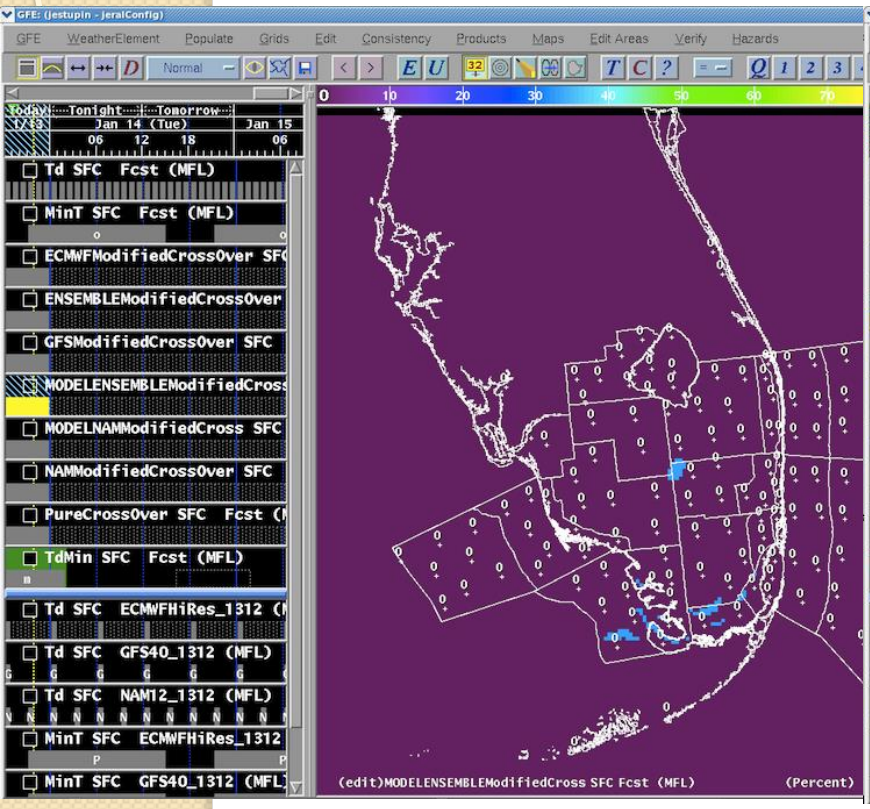


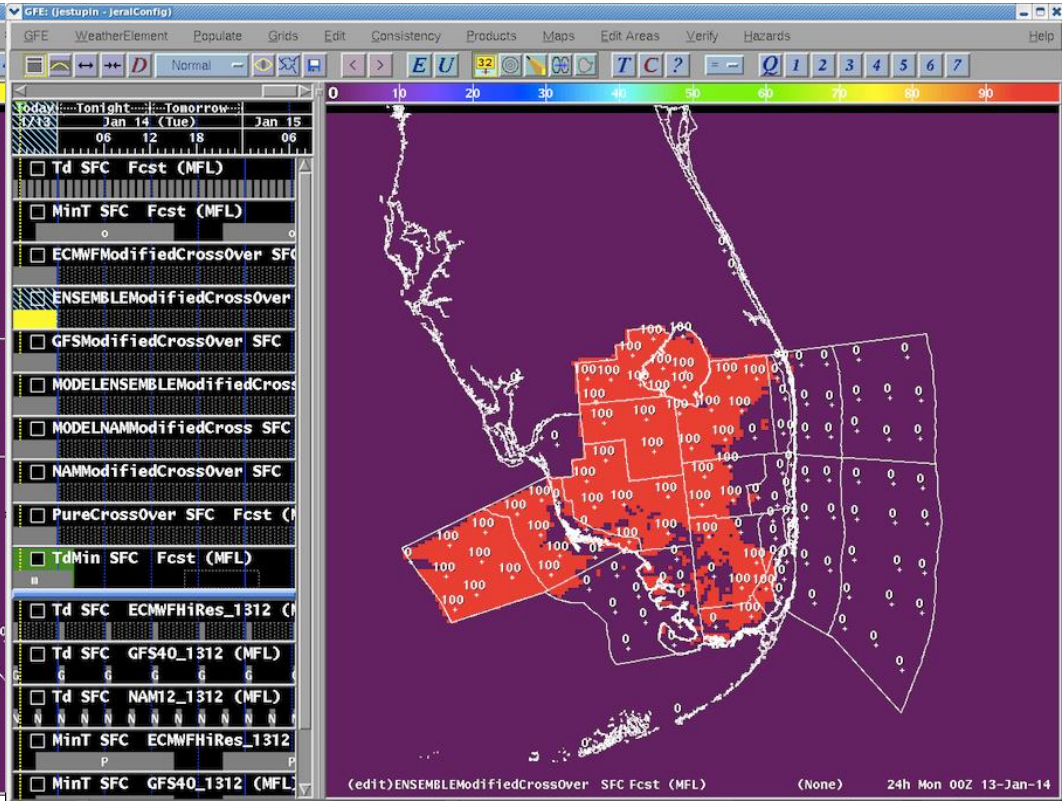


Low clouds, warm climate

Fog at surface, warm climate

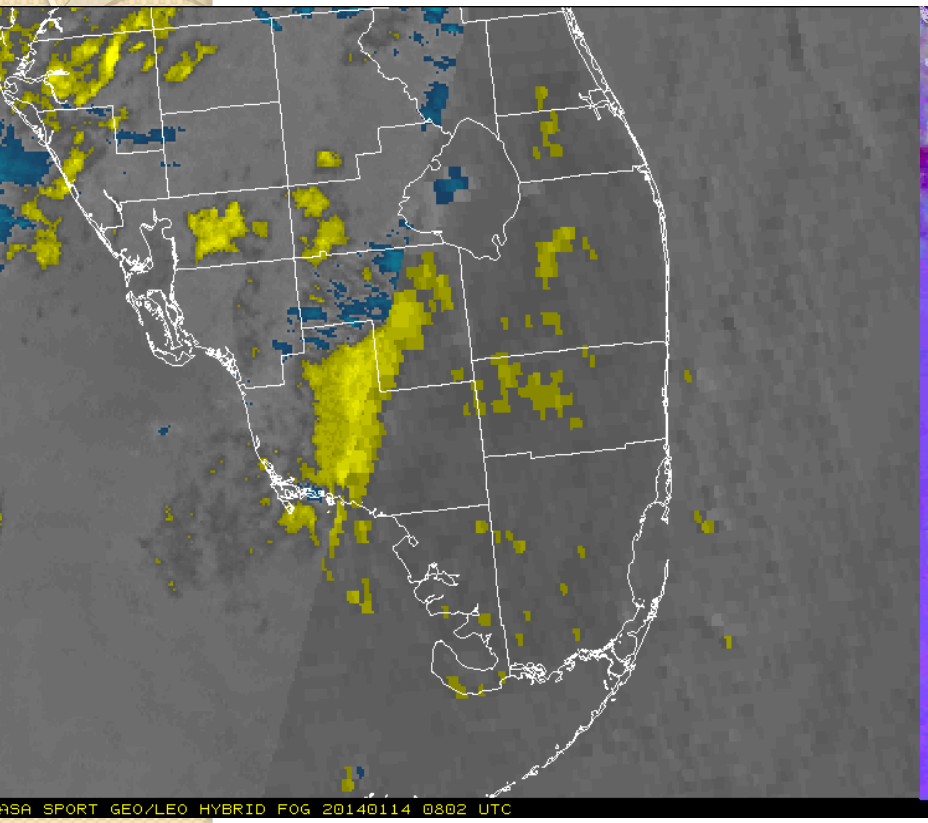
Case 2 – 2014JAN14

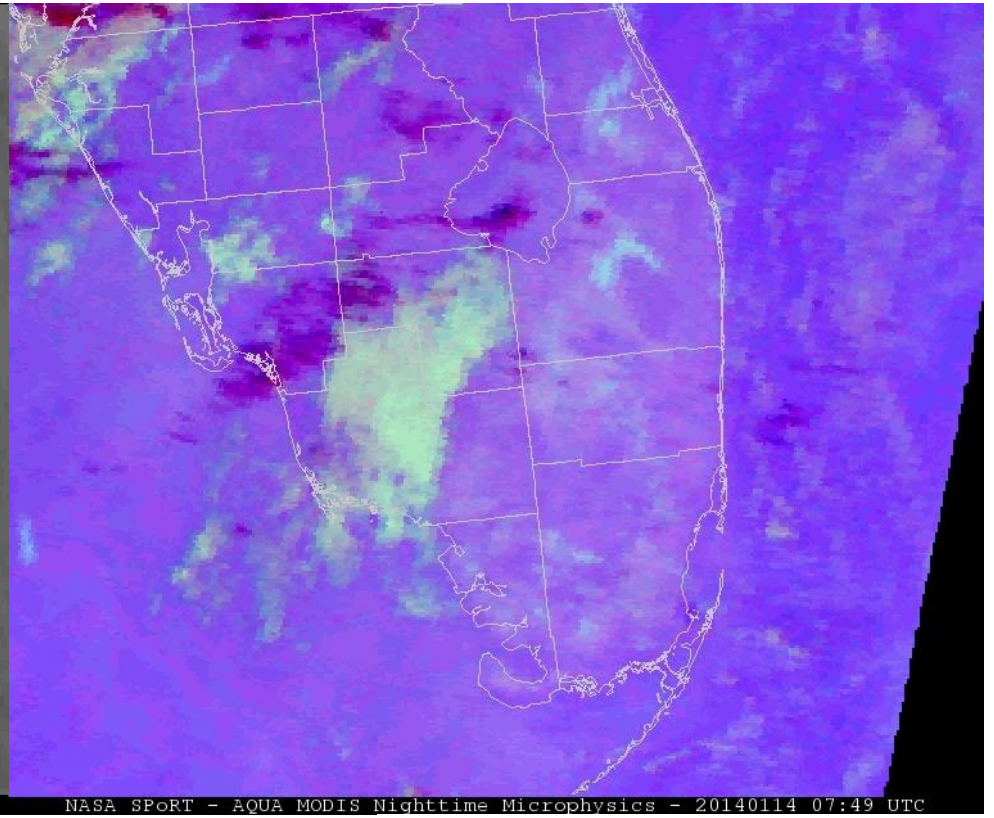




188	14Jan2014 KHST	Y	1018-1250Z
189	14Jan2014 KTMB	Y	0644-1226Z
190	14Jan2014 KOBE	N	

Case 2 – 2014JAN14 Results

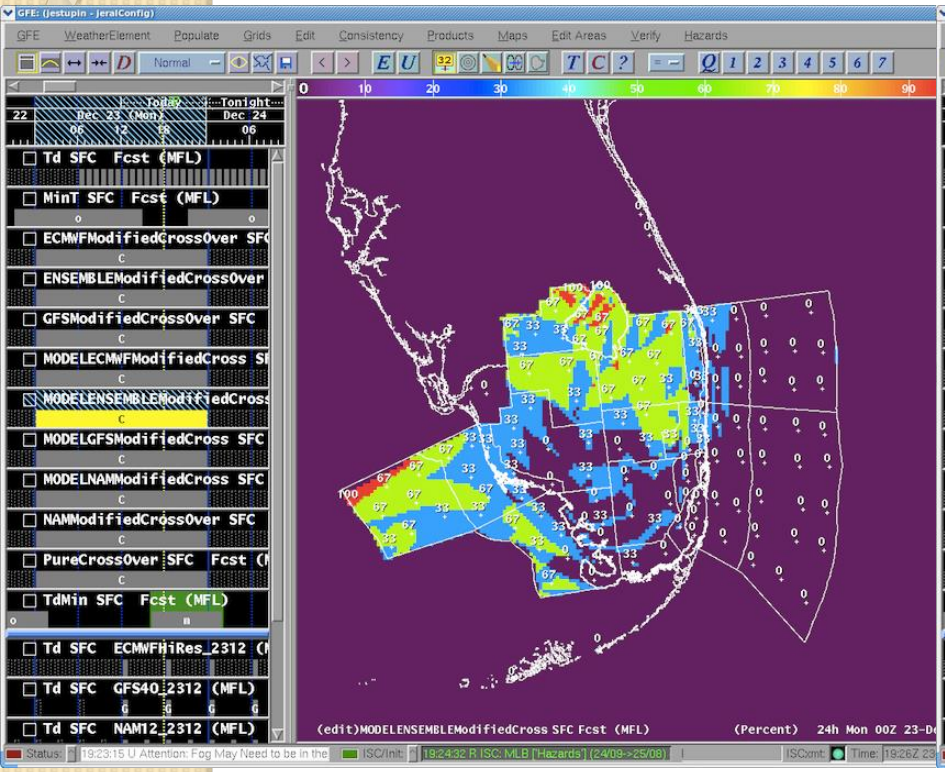


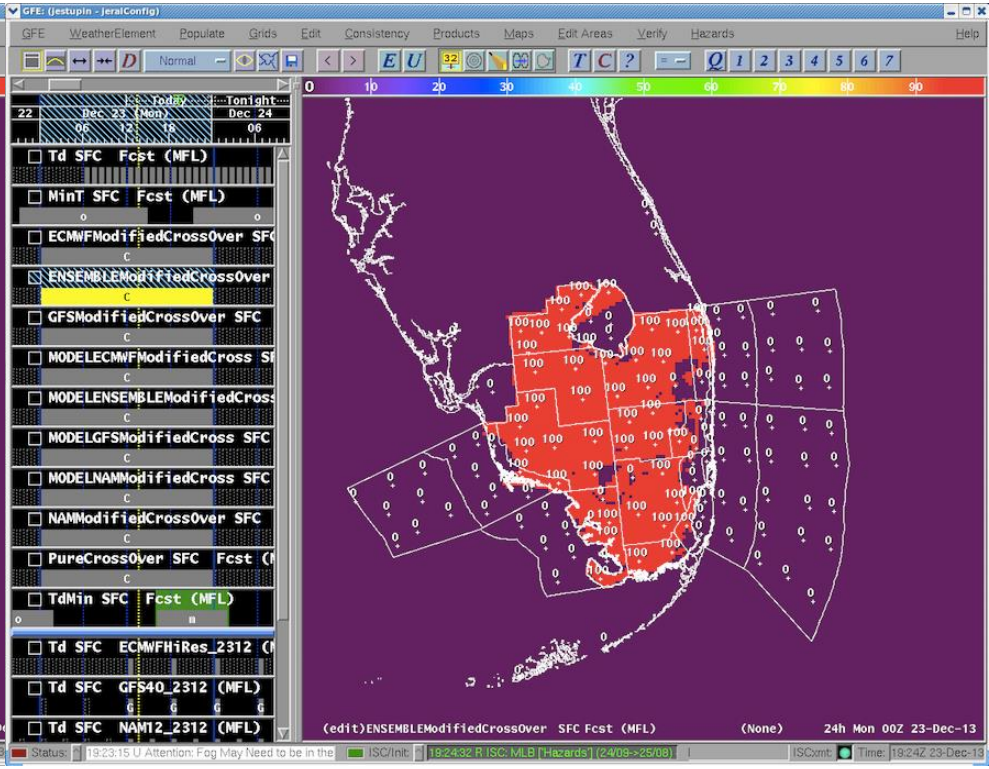


Low clouds, warm climate

Fog at surface, warm climate

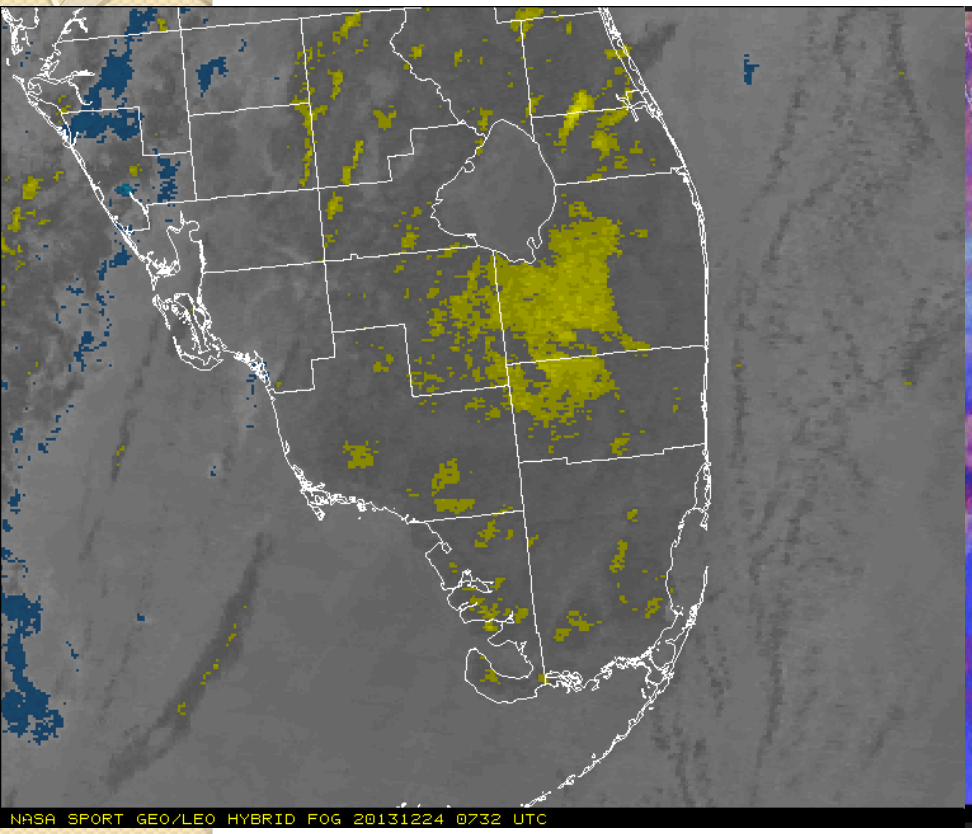
Case 3 – 2013DEC24

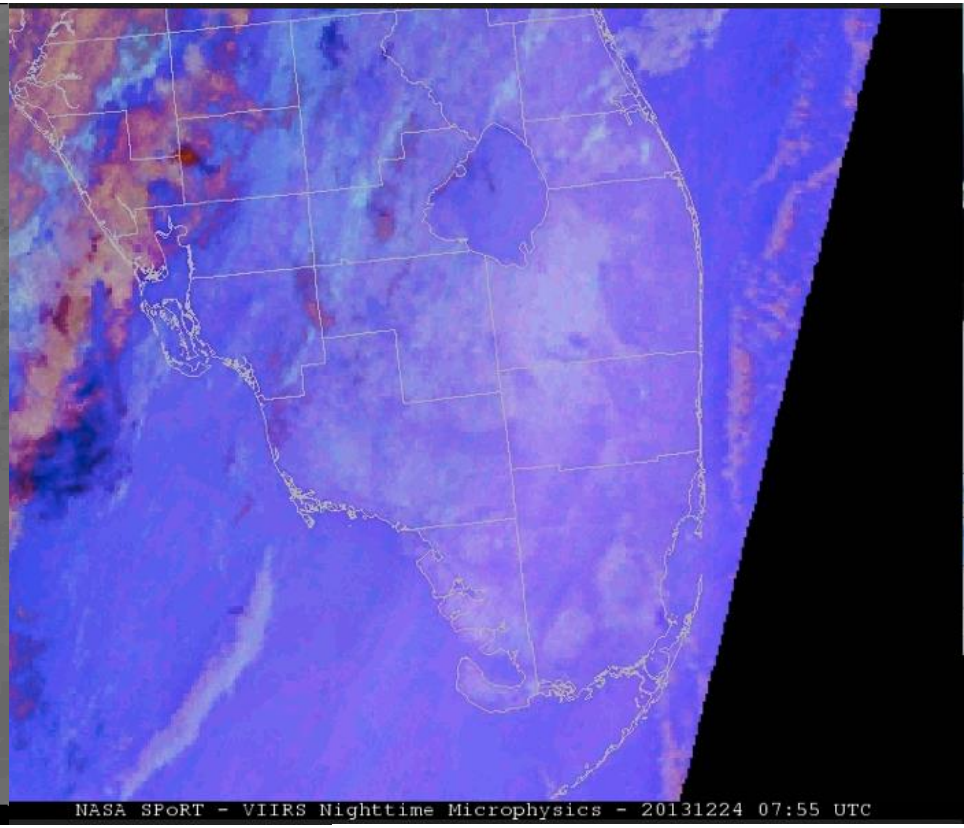




24Dec2013	KHST	Y (BR)	0843-0858Z
24Dec2013	KTMB	Y	0410-1157Z
24Dec2013	KOBE	Y	0435-1315Z

Case 3 – 2014DEC24 Results





Low clouds, warm climate

Fog at surface, warm climate

Why Case 3 is Considered Successful

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600
WWUS72 KMFL 241009
NPWMFL

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NATIONAL WEATHER SERVICE MIAMI FL
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/O.NEW.KMFL.FG.Y.0023.131224T1009Z-131224T1300Z/
HENDRY-INLAND PALM BEACH-
INCLUDING THE CITIES OF...CLEWISTON...PAHOKEE...SOUTH BAY...
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  1/8TH OF A MILE IN HENDRY COUNTY. AREAS AROUND BELLE GLADE AND
  ALONG HIGHWAY 27 HAVE ALSO REPORTED HEAVY FOG.

* IMPACTS...DENSE FOG WILL MAKE DRIVING VERY DIFFICULT. DRIVERS
  SHOULD TAKE PRECAUTIONS WHEN TRAVELING INTO THESE AREAS AS
  VISIBILITY MAY DROP VERY SUDDENLY.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

A DENSE FOG ADVISORY MEANS VISIBILITIES WILL FREQUENTLY BE
REDUCED TO LESS THAN ONE QUARTER MILE. IF DRIVING...SLOW
DOWN...USE YOUR LOW BEAM HEADLIGHTS...AND LEAVE PLENTY OF DISTANCE
AHEAD OF YOU.

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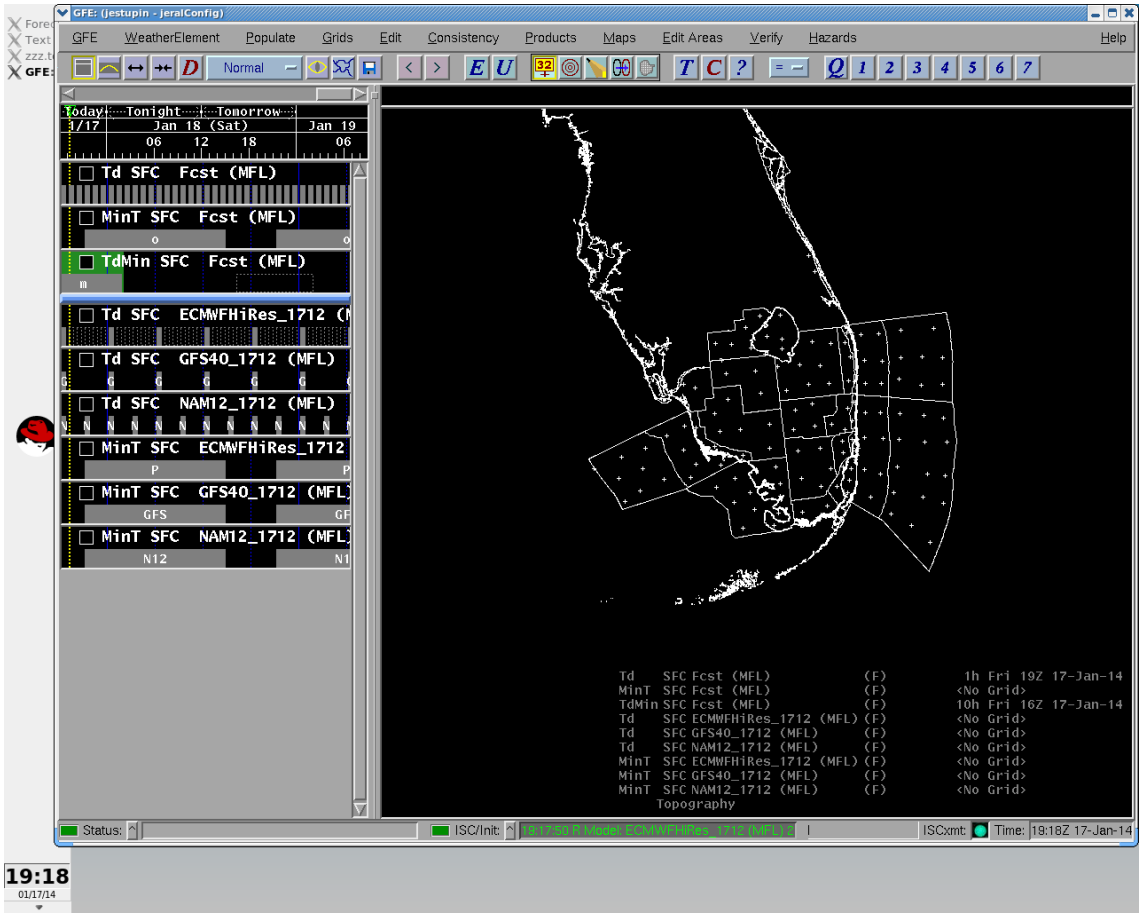
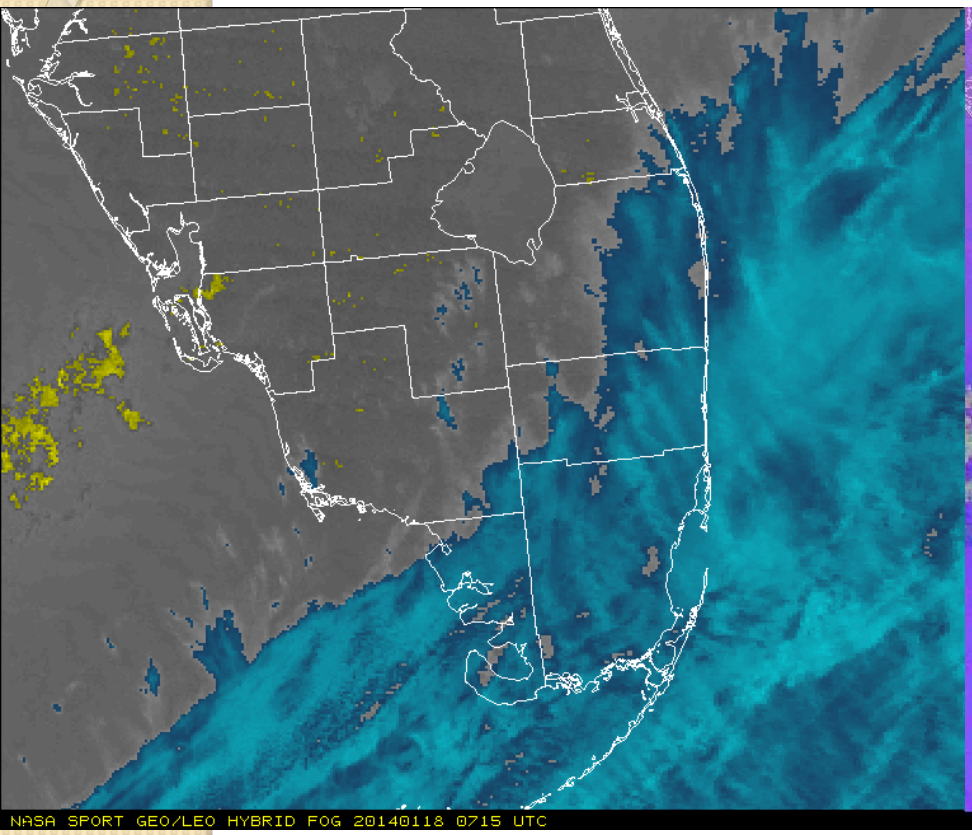
- All models forecast ground obscuration at three METAR stations
- Fog also reported at Naples Municipal (KAPF) and SW FL International Airport (KRSW)
- Mist reported at Ft. Myers (KFMY) and Hollywood (KHWO)
- Ensemble models were most accurate
- Dense fog advisories issued
- NASA SPoRT imagery verifies fog formation forecast by models

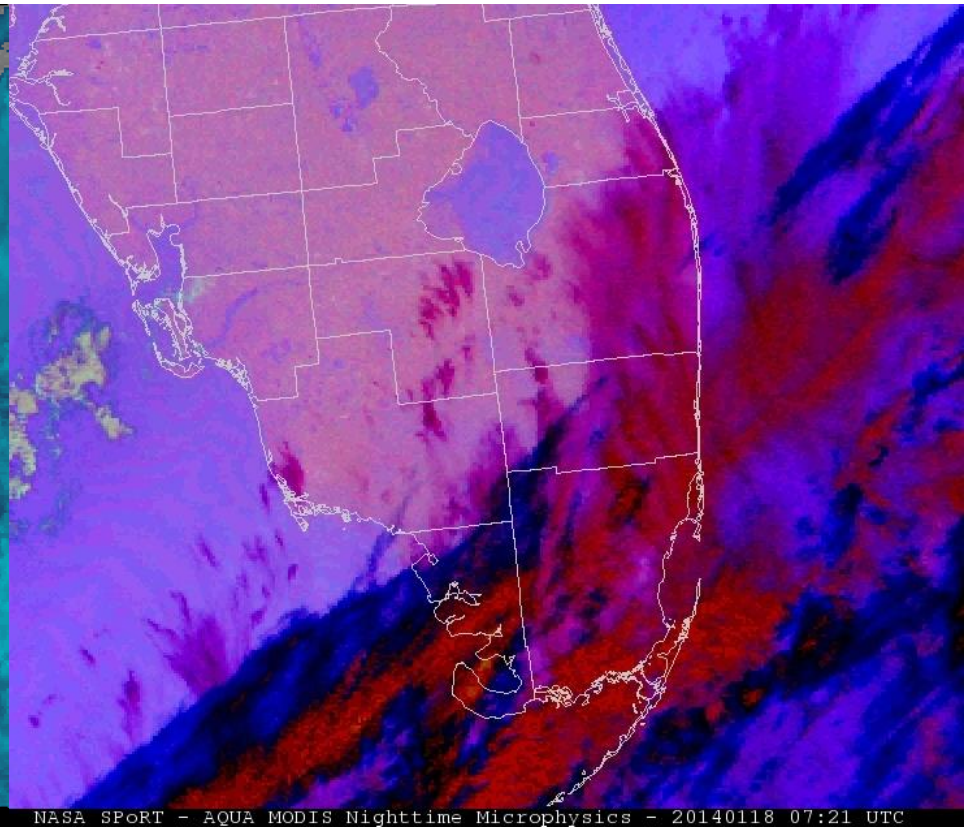
Case 4 – 2014JAN18



200	18Jan2014	KHST	N
201	18Jan2014	KTMB	N
202	18Jan2014	KOBE	N

Case 4 – 2014JAN18





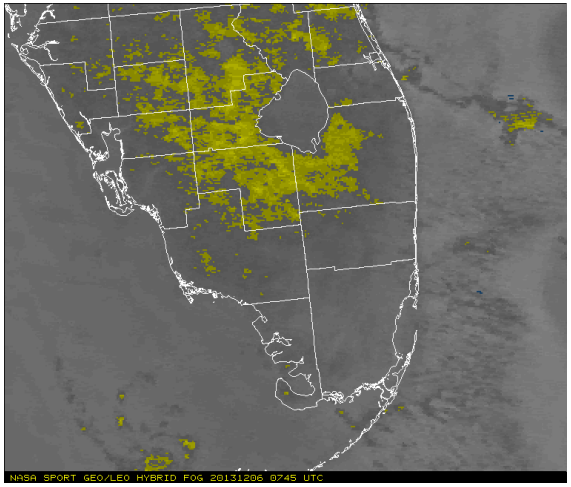
Why Case 4 is Considered Successful

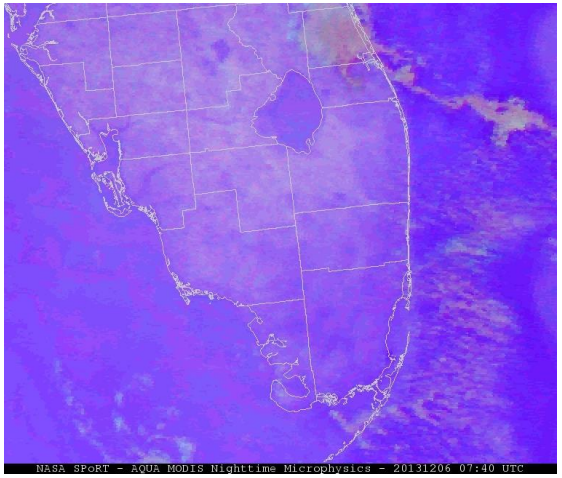
- The models for the fog algorithm did not forecast any fog for this day
- NASA SPoRT confirms this by showing no fog in the imagery

TABLE OF RESULTS

2013DEC06 KOBE METARs, Fog Product (0745Z), and Nighttime Microphysics (0740Z)

METAR KOBE 060515Z AUTO 00000KT 3SM BR CLR 18/18 A3014 RMK AO2
METAR KOBE 060535Z AUTO 09003KT 3SM BR CLR 18/18 A3014 RMK AO2
METAR KOBE 060555Z AUTO 00000KT 5SM BR CLR 18/18 A3014 RMK AO2
METAR KOBE 060615Z AUTO 00000KT 3SM BR CLR 17/17 A3013 RMK AO2
METAR KOBE 060635Z AUTO 00000KT 2SM BR CLR 17/17 A3013 RMK AO2
METAR KOBE 060655Z AUTO 00000KT 2SM BR CLR 17/17 A3013 RMK AO2 VIS 1 1/4V3
METAR KOBE 060715Z AUTO 00000KT 4SM BR CLR 17/17 A3013 RMK AO2
METAR KOBE 060735Z AUTO 00000KT 4SM BR CLR 18/18 A3012 RMK AO2
METAR KOBE 060755Z AUTO 00000KT 3SM BR CLR 17/17 A3013 RMK AO2
METAR KOBE 060815Z AUTO 00000KT 2SM BR CLR 17/17 A3013 RMK AO2
METAR KOBE 060835Z AUTO 00000KT 4SM BR CLR 17/17 A3012 RMK AO2
METAR KOBE 060855Z AUTO 00000KT 3/4SM BR VV005 17/17 A3013 RMK AO2
METAR KOBE 060915Z AUTO 00000KT 3/4SM BR VV005 17/17 A3013 RMK AO2
METAR KOBE 060935Z AUTO 00000KT 1/4SM FG VV002 17/17 A3013 RMK AO2
METAR KOBE 060955Z AUTO 00000KT 1/4SM FG VV002 17/17 A3014 RMK AO2
METAR KOBE 061015Z AUTO 00000KT 1/4SM FG VV002 17/17 A3014 RMK AO2
METAR KOBE 061035Z AUTO 00000KT 1/4SM FG VV002 16/16 A3014 RMK AO2
METAR KOBE 061055Z AUTO 00000KT 1/4SM FG VV002 16/16 A3014 RMK AO2
METAR KOBE 061115Z AUTO 00000KT 1SM BR VV007 16/16 A3015 RMK AO2
METAR KOBE 061135Z AUTO 00000KT 1/2SM FG VV005 16/16 A3016 RMK AO2
METAR KOBE 061155Z AUTO 07003KT 1 1/4SM BR VV007 16/16 A3016 RMK AO2
METAR KOBE 061215Z AUTO 00000KT 1/4SM FG VV002 16/16 A3017 RMK AO2
METAR KOBE 061235Z AUTO 00000KT 1/4SM FG VV002 16/16 A3017 RMK AO2
METAR KOBE 061255Z AUTO 00000KT 2 1/2SM BR CLR 18/18 A3017 RMK AO2





2013DEC07

METAR KOBE 070835Z AUTO 00000KT 5SM BR CLR 15/15 A3018 RMK AO2
METAR KOBE 070855Z AUTO 00000KT 1 1/2SM BR VV007 15/15 A3019 RMK AO2 VIS 1/2V5
METAR KOBE 070915Z AUTO 00000KT 7SM CLR 15/15 A3019 RMK AO2=
METAR KOBE 070935Z AUTO 00000KT 7SM CLR 15/15 A3019 RMK AO2=
METAR KOBE 070955Z AUTO 00000KT 5SM BR CLR 15/15 A3018 RMK AO2
METAR KOBE 071015Z AUTO 00000KT 1 1/2SM BR VV007 15/15 A3018 RMK AO2
METAR KOBE 071035Z AUTO 00000KT 7SM CLR 14/14 A3019 RMK AO2=
METAR KOBE 071055Z AUTO 00000KT 3SM BR CLR 15/15 A3019 RMK AO2
METAR KOBE 071115Z AUTO 00000KT 5SM BR CLR 14/14 A3020 RMK AO2
METAR KOBE 071135Z AUTO 00000KT 5SM BR CLR 13/13 A3020 RMK AO2
METAR KOBE 071155Z AUTO 00000KT 7SM CLR 13/13 A3021 RMK AO2=
METAR KOBE 071215Z AUTO 00000KT 1/2SM FG VV005 13/13 A3022 RMK AO22

Conclusions so far

- The project is ongoing, but there are signs of success in this validation of the fog algorithm.
- The results will allow to investigate performance of the algorithm for different intensities of fog (e.g. patchy fog or dense fog)
- NASA SPoRT's fog products have been crucial in both validating the WFO's fog algorithm and tracking fog operationally

Work Cited

- http://weather.msfc.nasa.gov/sport/jpsspg/rgb.html#ntmicro
- http://glossary.ametsoc.org/wiki/Fog
- http://weather.msfc.nasa.gov/sport/training/
- http://weather.msfc.nasa.gov/sport/training/MODIS_fog_training/player.html