Alaska High Latitude Proving Ground - Product Evaluation Report

April 11, 2012

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1. **Project Title:** 2010-2011 Experiment

2. **Organizations:** NWS Alaska Forecast Offices and Aviation Weather Unit

3. **Evaluators:** Alaska Region Forecasters, SOOs, and MICs

4. **Duration of Evaluation:** July 2011 - October 2011

5. **Products Evaluated:**

1	MODIS Ash Mass Loading AK
2	MODIS Ash Height AK
3	MODIS Ash Effective Radius AK
4	GEOCAT MODIS SO2 Detection AK
5	GEOCAT MODIS SO2 Loading AK
6	GEOCAT MODIS IFR AK
7	GEOCAT MODIS MVFR AK
8	GEOCAT MODIS Fog Depth AK
9	GEOCAT MODIS Cloud Type AK

Examples of all products are shown in Appendix A.

6. **Timeline:**

- Identify products (May 2010)
- Identify AWG Leads (May 2010)
- Produce demonstration products (October 2010)
- Distribute products (AK WFOs and AAWU, January 2011)
- Training (March - April 2011)
- Product Evaluation (March 2011– October 2011)
- Forecaster, SOO, and MIC interviews (October 2011)
- Final Report (March 2012)

7. **Summary of Evaluation Program and Outcomes:**

The Alaska High Latitude Proving Ground supports the NESDIS GOES-R program goal of Day 1 readiness of algorithms, data products, and analysis tools in support of the satellite's top priority client, the National Weather Service. A suite of GOES-R algorithms and products developed in Madison, Wisconsin by NOAA STAR and University of Wisconsin Madison CIMSS scientists, was tested in the filed in the NWS Alaska Region. These products were generated from real-time MODIS data captured at the University of Alaska Fairbanks; this MODIS data serves as a proxy for data from the ABI sensor on the GOES-R satellite, due to launch in 2015.

The products tested in the first evaluation period focused on two themes: volcanic ash and SO2 products and cloud and fog products. Unfortunately for the experiment, Alaska and Kamchatka volcanoes were unusually quiet during the evaluation period. One significant eruption was observed and evaluated. Based on this very small sample, the volcanic products were deemed to be of good quality and utility. Cloud and fog products were also distributed and evaluated at all Alaska WFOs. The evaluation from forecasters were mixed, but generally positive. Most negative comments related to the visualization of the data or questions about its applications in practice.

Training was performed prior to the evaluation period by the lead algorithm developer, Mike Pavolonis. The training was well- received and evaluated favorably.

8. **Architecture of the Data Flow from satellite to forecast desk:**

Data from the MODIS Sensor on the NASA Terra and Aqua satellites is used as a proxy for the ABI sensor to be flown on the GOES-R satellite. The University of Alaska Fairbanks Geographic Information Network of Alaska owns an X-band direct receiving station that captures MODIS data (Figure 1) used to generate products. Under the current system configuration, the MODIS data is captured in Fairbanks, then sent to Madison, where it is processed using the GOES-R algorithms. The products are converted into AWIPS-compatible formats and placed on a LDM server in Madison, then make their way through the LDM network to UAF then onto the NWS LDM at the Fairbanks WFO, located on the UAF campus. From the Fairbanks WFO's LDM, the products then make their way around the Alaska Region LDM network into the Juneau and Anchorage WFOs and the Alaska Aviation Weather Unit (AAWU) in Anchorage (Figure 2).

Figure 1. UAF-GINA's X-band receiving station antenna is inside the radome in the center of the photograph. The large, fixed dish to its left is the NWS Fairbanks WFO's NOAAport antennna. The small radome in the upper right holds an L-band antenna.

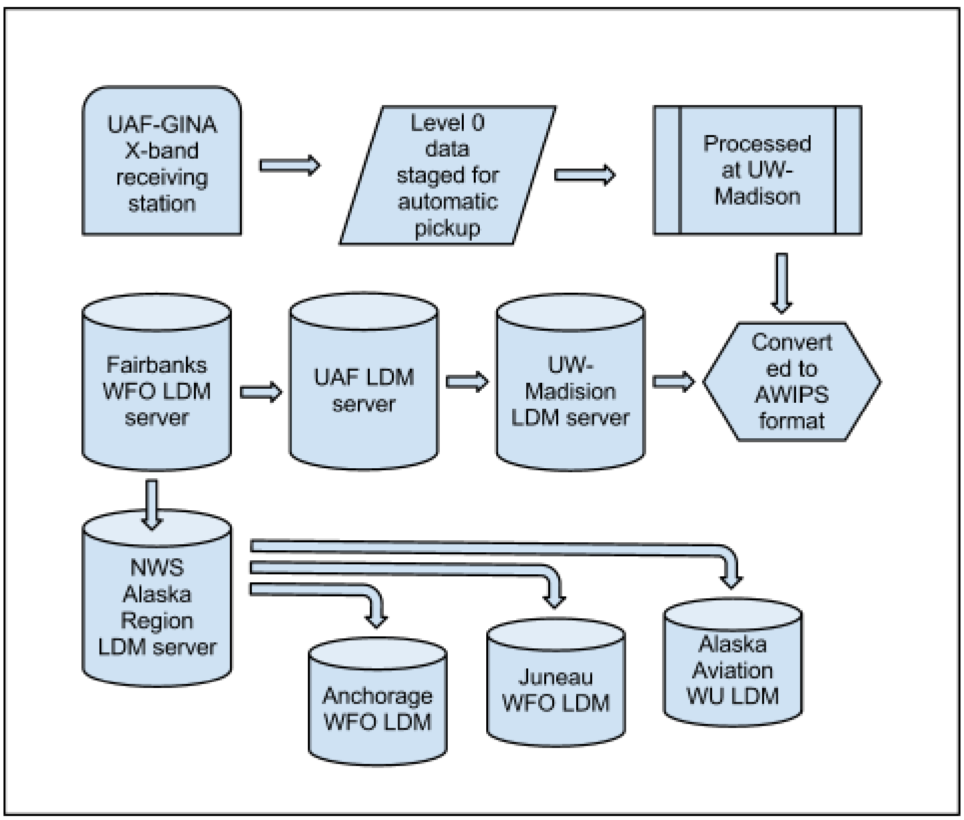


Figure 2. Data flow from capture if data to delivery to Alaska WFOs and AAWU.

9. **Product evaluations:**

Eleven forecasters were interviewed in person to collect their feedback for fog and cloud products. Of those 11 forecasters, five attended live training, three reviewed the training materials independently, and three received no training. We gave less weight to the comments from those who were unable to be exposed to training. Also, early in the rollout of the project, the *IFR Probability* product was initially called *“Fog Probability,”* and the *MVFR Probability* product was called *“Fog Mask.”* Based on feedback from forecasters who found the initial product names confusing, the new product names were adopted and deployed in all Alaska Region offices. Notes from these interviews are summarized in detail in Appendix C.

The volcanic ash and SO_2 products were not part of this interview evaluation process. A separate report and feedback was provided by the AAWU/VAAC SOO and is attached as Appendix B.

The *probability of MVFR* product reports the probability that the cloud ceiling is < 3000 feet, regardless of surface visibility, and the *probability of IFR* product reports the probability that the cloud ceiling is < 1000 feet, regardless of surface visibility. IFR, MVFR, and fog depth products were a clear favorite with forecasters across Alaska. Alaskans heavily depend on aviation for their daily life. So, predicting the flight condition is critical. IFR and MVFR provide the good detectors of low stratus and /or fog to help forecasting fight condition. Fog depth provides the depth of fog at night (solar zenith angle > 90 degree), which is very helpful to night flight. All three together, provide both day and night information of low cloud/fog prediction. Almost all the forecasters expressed interested in higher temporal resolution in the products. They also appreciate the ways to present the data and think they are easy to understand and straight forward coloring.

Cloud type product provides the classification of the highest cloud layer: liquid water ($T_{cloud} > 0ºC$), supercooled liquid water ($T_{cloud} < 0ºC$), mixed phase (both supercooled liquid water and ice are present), thick ice (opaque cloud with glaciated top), thin ice (usually cirrus), and multilayered ice. This information reveals the vertical structure of atmosphere and synoptic scale feature. A few forecasters did careful reviews of the cloud type product, and felt cloud type product was “consistent with surface observations”. Although fewer forecasters were incorporating this dataset into their daily forecasting duty than the IFR, MVFR, and fog depth products in both the Fairbanks and Anchorage offices, they think the product was understandable and felt it was accurate in most occasions. Forecasters came to recognize and appreciate the added usefulness of the cloud products at night due to limitations of the current GOES products.

10. **Suggested changes to products and operations:**

Archive and allow review of the datasets. A few forecasters were familiar with GINA’s SwathViewer and thought that would be a good location to browse through the data archive.

Use the ability to review the archive event and have forcasters rate the products effectiveness.

In locations that ground site observations are available, such as webcams or ground observation lasers for ceiling fog, check against the products and rate.

Use these the results to generate reliability diagrams and share with forecasters to help them get a better feel for how much they can trust the products in real world locations they are familiar with.

The Alaska Aviation Weather Unit's primary tool for generating forecasts is IC4D and AWIPS is a secondary system. Currently there is no satellite data in IC4D. *The forecasters expressed interest in seeing the satellite products put into IC4D and GFE.* This would allow forecasters to use the satellite data to verify forecasts and supplement observational data. Improving the sanity checking of forecasts as Alaska has a spare observation network available for verification.

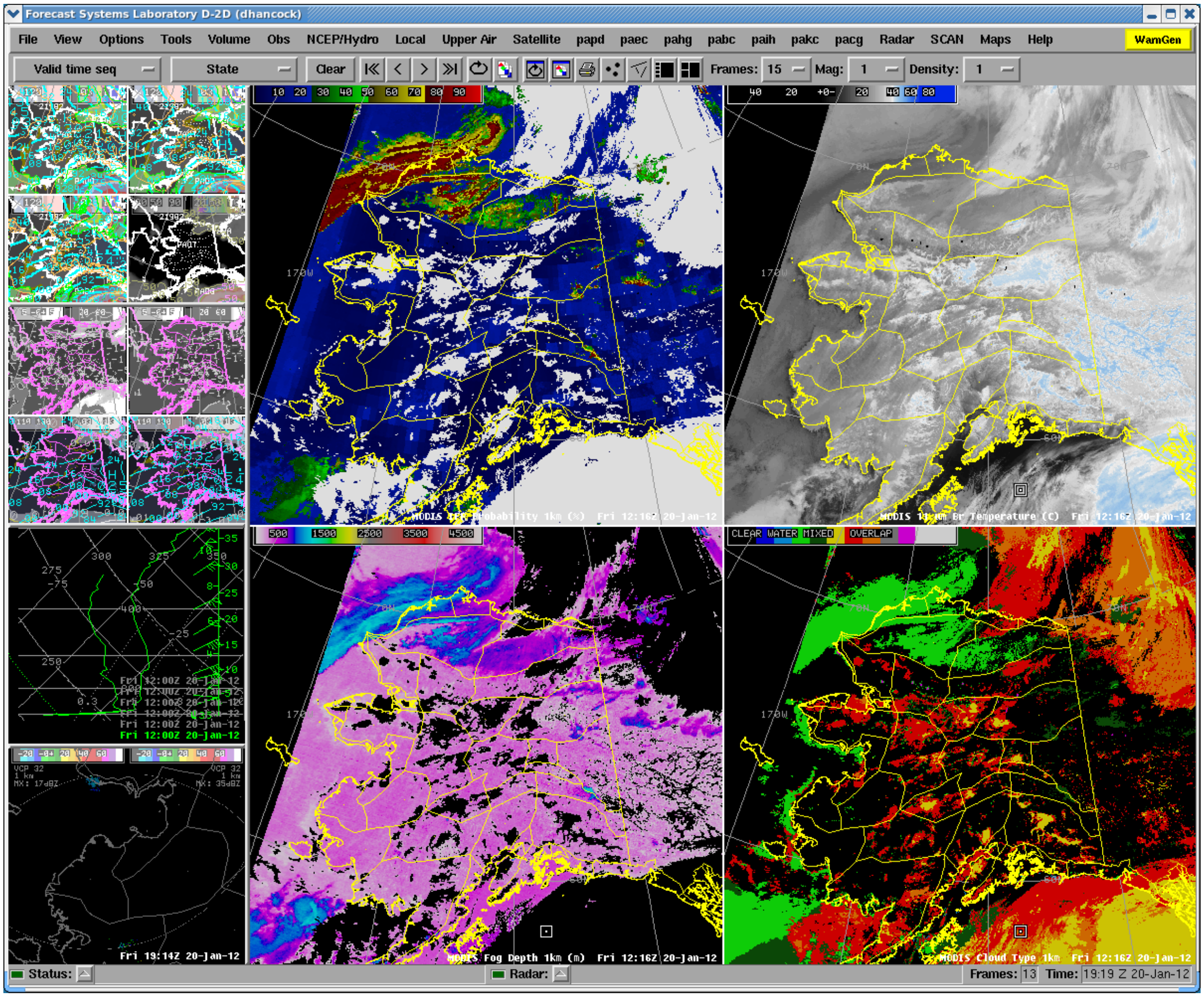
The forecasters face a lot of information when they do routine forecasting. *They would welcome data fusion products rather than just images products.* More training and outreach are necessary to promote them to use these next generation products.

11. **Plans for the products in the future:**

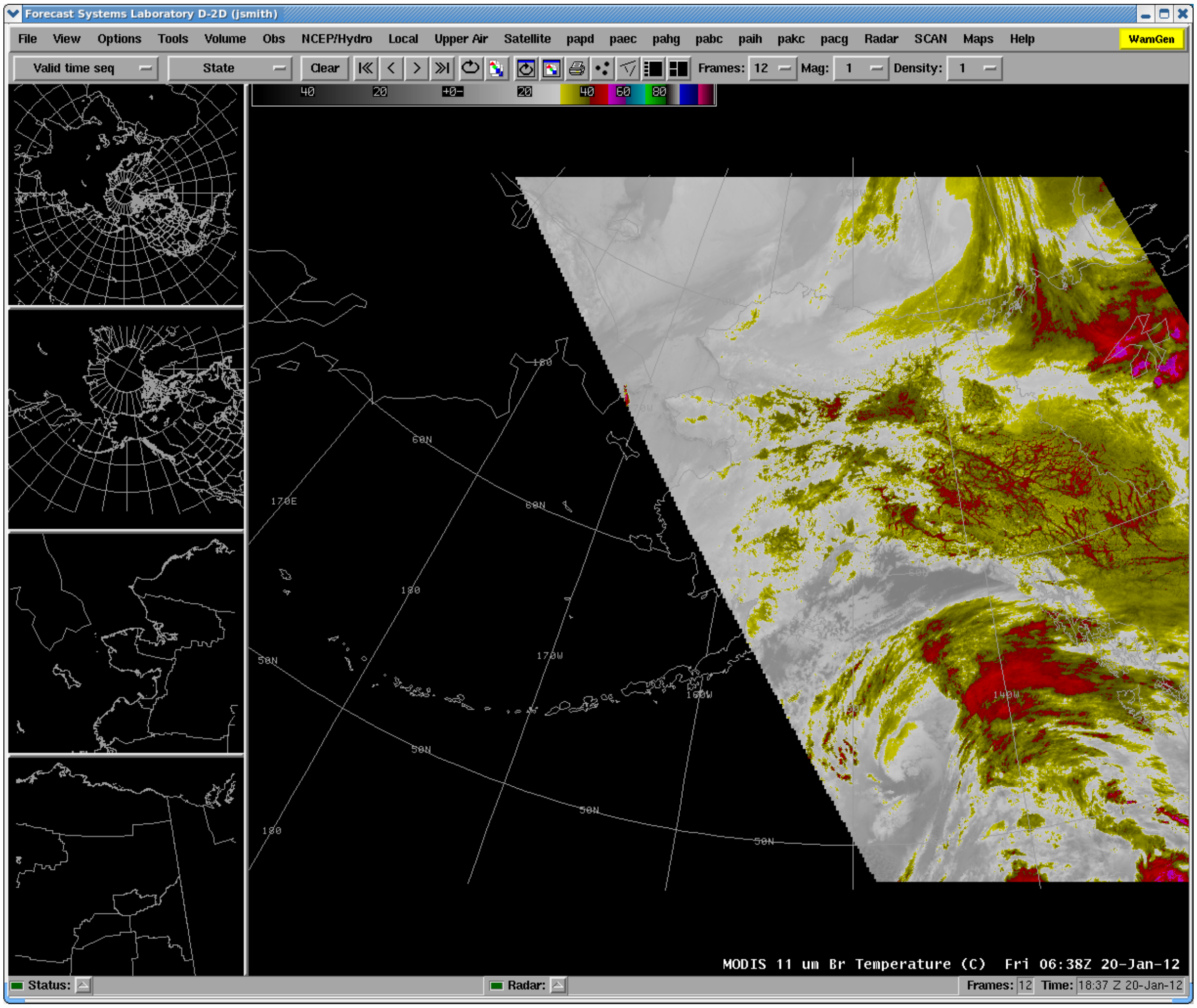
- Processing will be moved from Madison, Wisconsin to the NOAA NESDIS satellite ground receiving facility in Fairbanks, Alaska in the first half of 2012. This will reduce product latency and provide 24/7 monitoring by NESDIS staff.
- When setting up data feeds to flow data into AWIPS will also setup secondary feeds into archiving and browse systems such as the UAF-GINA SwathViewer, a web accessible mapping system tuned for viewing remote sensing products on a virtual globe.
- Evaluate what other file formats and delivery locations might expand the places the data can be integrated into forecasters environments, such as the IC4D system for the Aviation Weather Unit.
- Plan to use the NWS product archive system in the Anchorage WFO in order to have post event evaluations of how well the data performed.
- Since the start of the Alaska experiment, the GOES-R products have been improved significantly. The improved products can be provided should another evaluation take place.
- Fog/low cloud products for GOES can also be provided for evaluation.
- Provide improved product training.

Appendix A. Product examples.

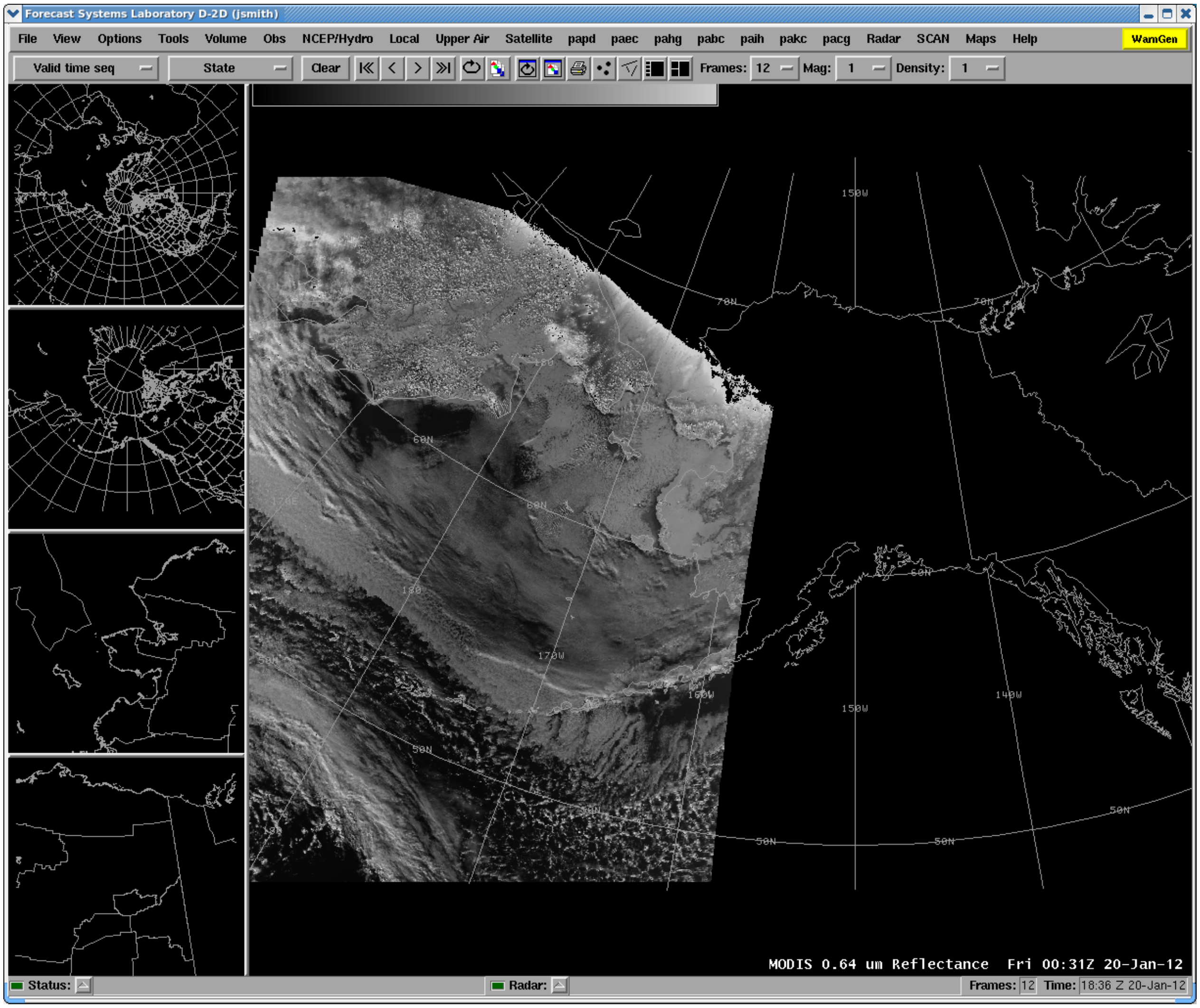
Screen capture credits: Daniel Hancock, Jay Smith, John Lingaas. Alaska NWS.



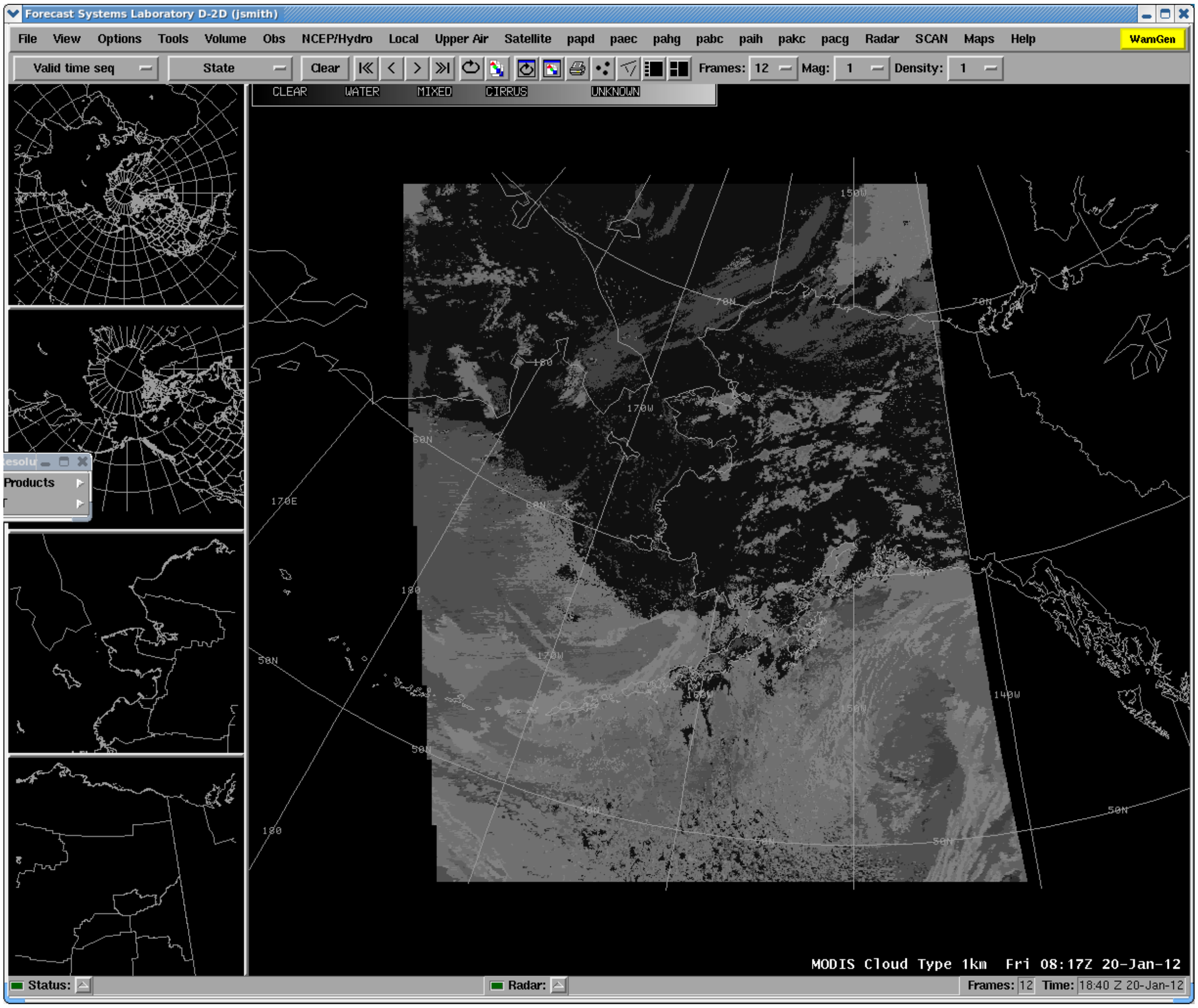
Fog and cloud product four panel display.



11μm brightness temperature.



6.4μm reflectance.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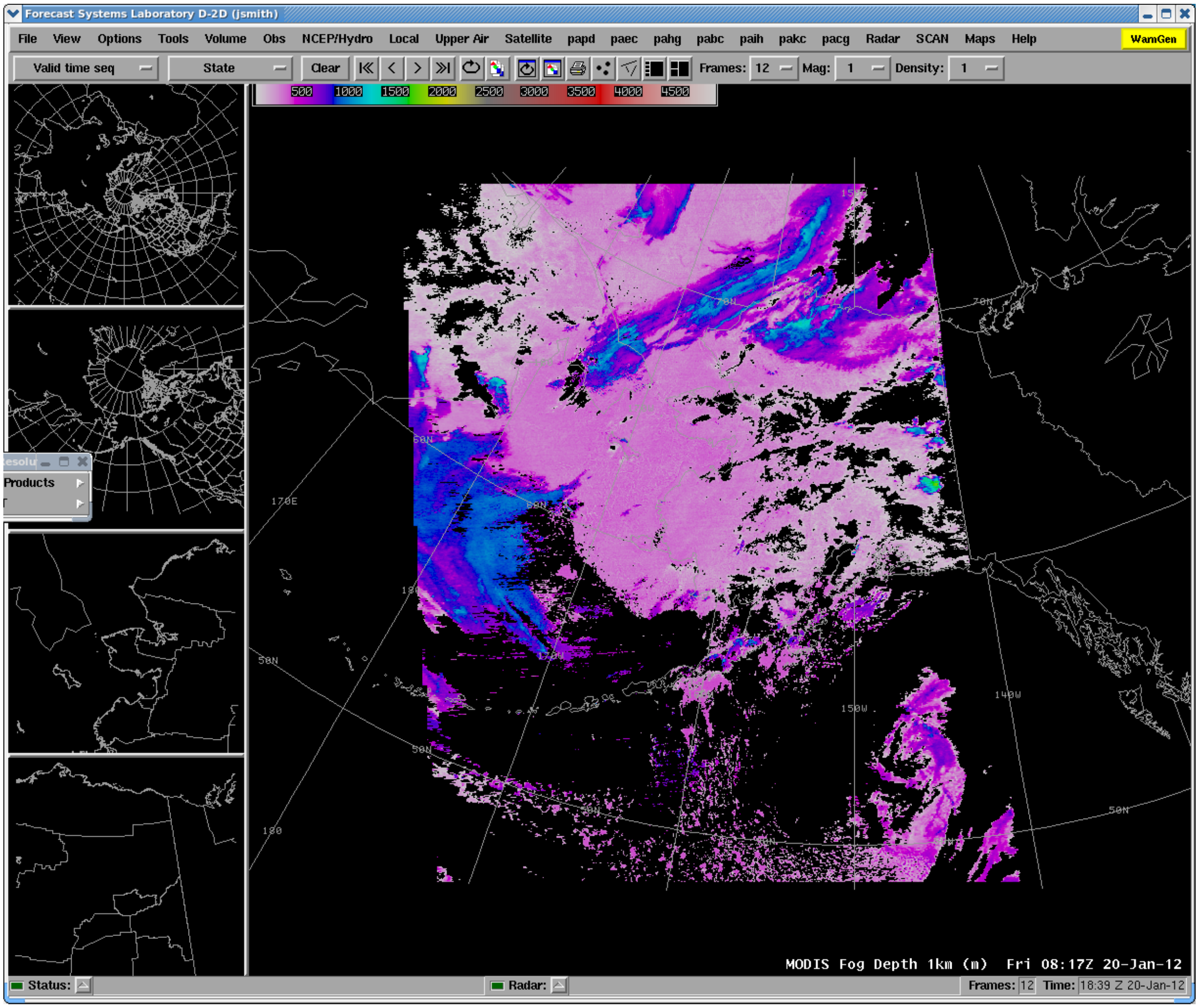
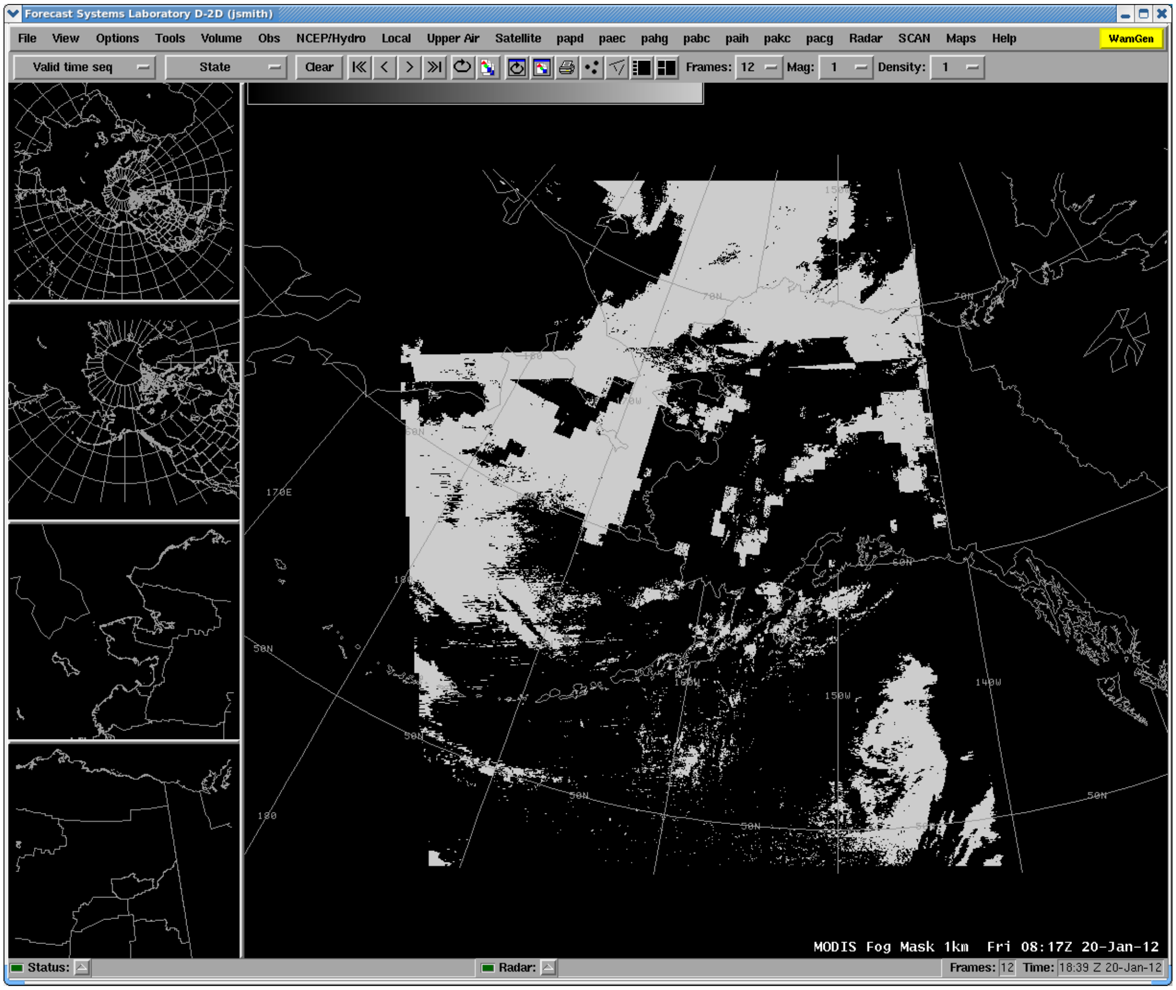
File View Options Tools Volume Obs NCEP/Hydro Local Upper Air Satellite papd paec pahg pabc paih pakc pacg Radar SCAN Maps Help
WarnGen
Valid time seq
State
Clear
Frames: 12
Mag: 1
Density: 1
CLEAR WATER MIXED CIRRUS UNKNOWN
MODIS Cloud Type 1km Fri 08:17Z 20-Jan-12
Status:
Radar:
Frames: 12
Time: 18:40 Z 20-Jan-12

Cloud type


Forecast Systems Laboratory D-2D (jsmith)
File View Options Tools Volume Obs NCEP/Hydro Local Upper Air Satellite papd paec pahg pabc paih pakc pacg Radar SCAN Maps Help
WarnGen
Valid time seq
State
Clear
Frames: 12
Mag: 1
Density: 1
500 1000 1500 2000 2500 3000 3500 4000 4500
Products
MODIS Fog Depth 1km (m) Fri 08:17Z 20-Jan-12
Status:
Radar:
Frames: 12
Time: 18:39 Z 20-Jan-12

Fog depth.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File View Options Tools Volume Obs NCEP/Hydro Local Upper Air Satellite papd paec pahg pabc paih pakc pacg Radar SCAN Maps Help
WarnGen
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Mag: 1
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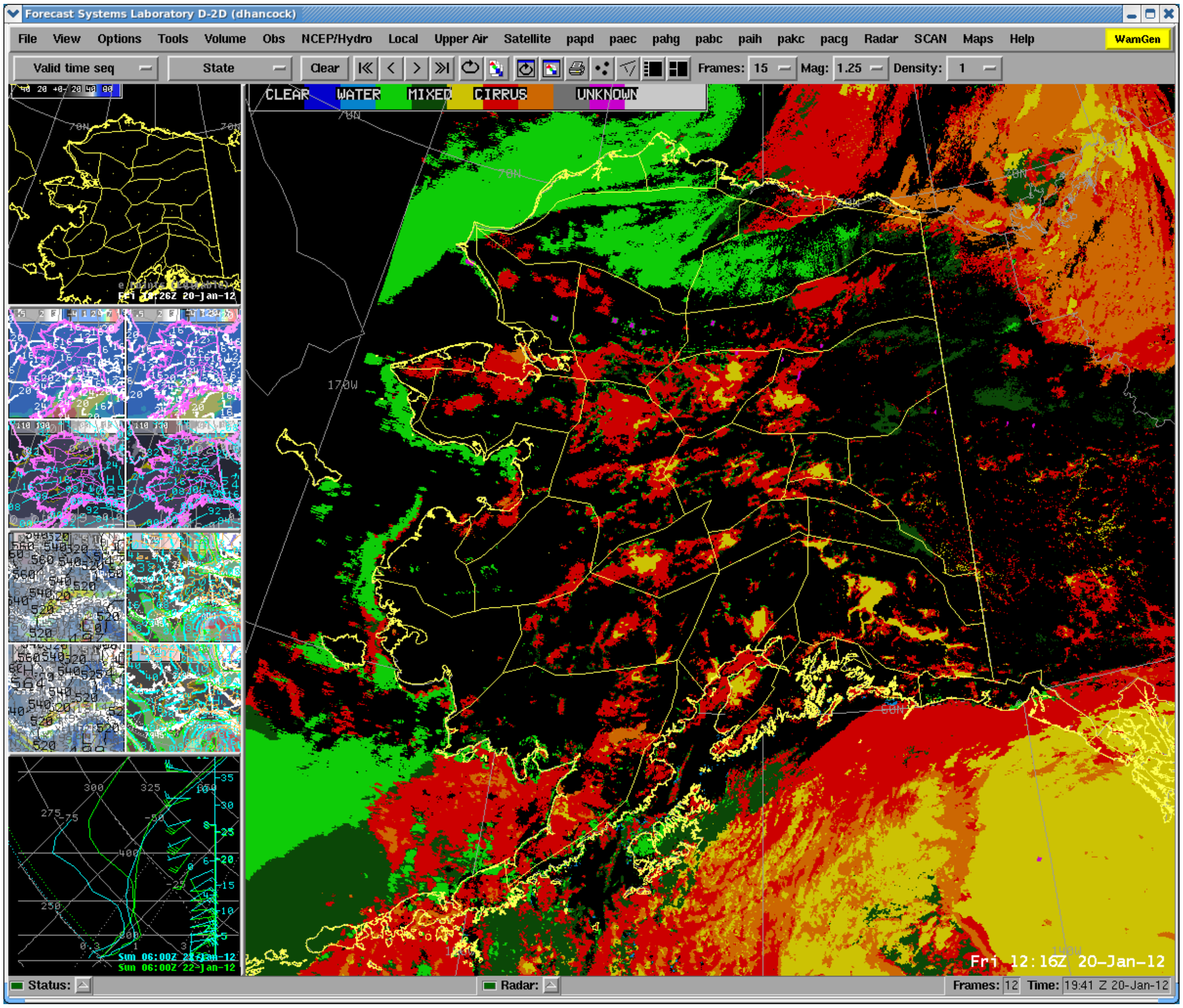
MODIS Fog Mask 1km Fri 08:17Z 20-Jan-12
Status:
Radar:
Frames: 12
Time: 18:39 Z 20-Jan-12

Fog mask.


Forecast Systems Laboratory D-2D (dhancock)
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WarnGen
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State
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Mag: 1.25
Density: 1
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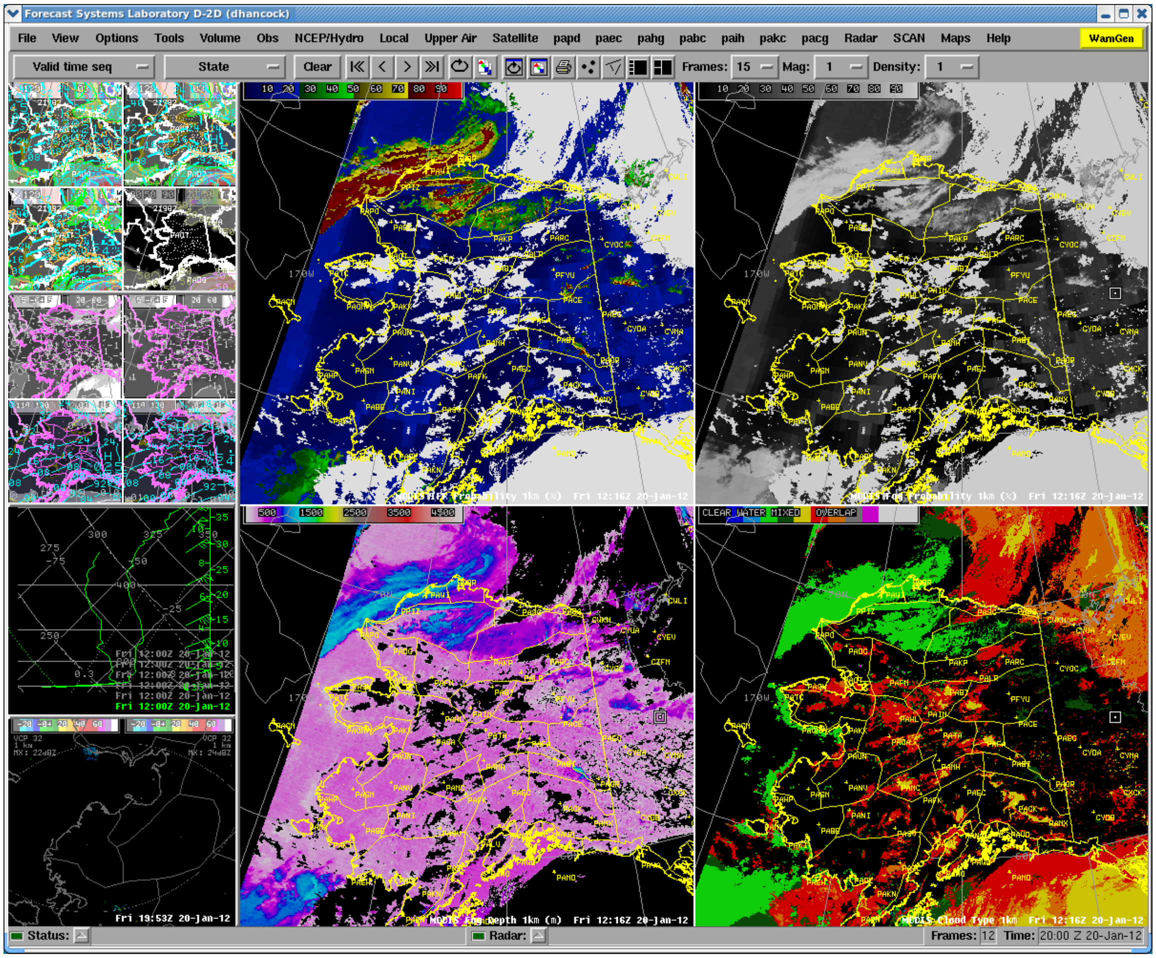
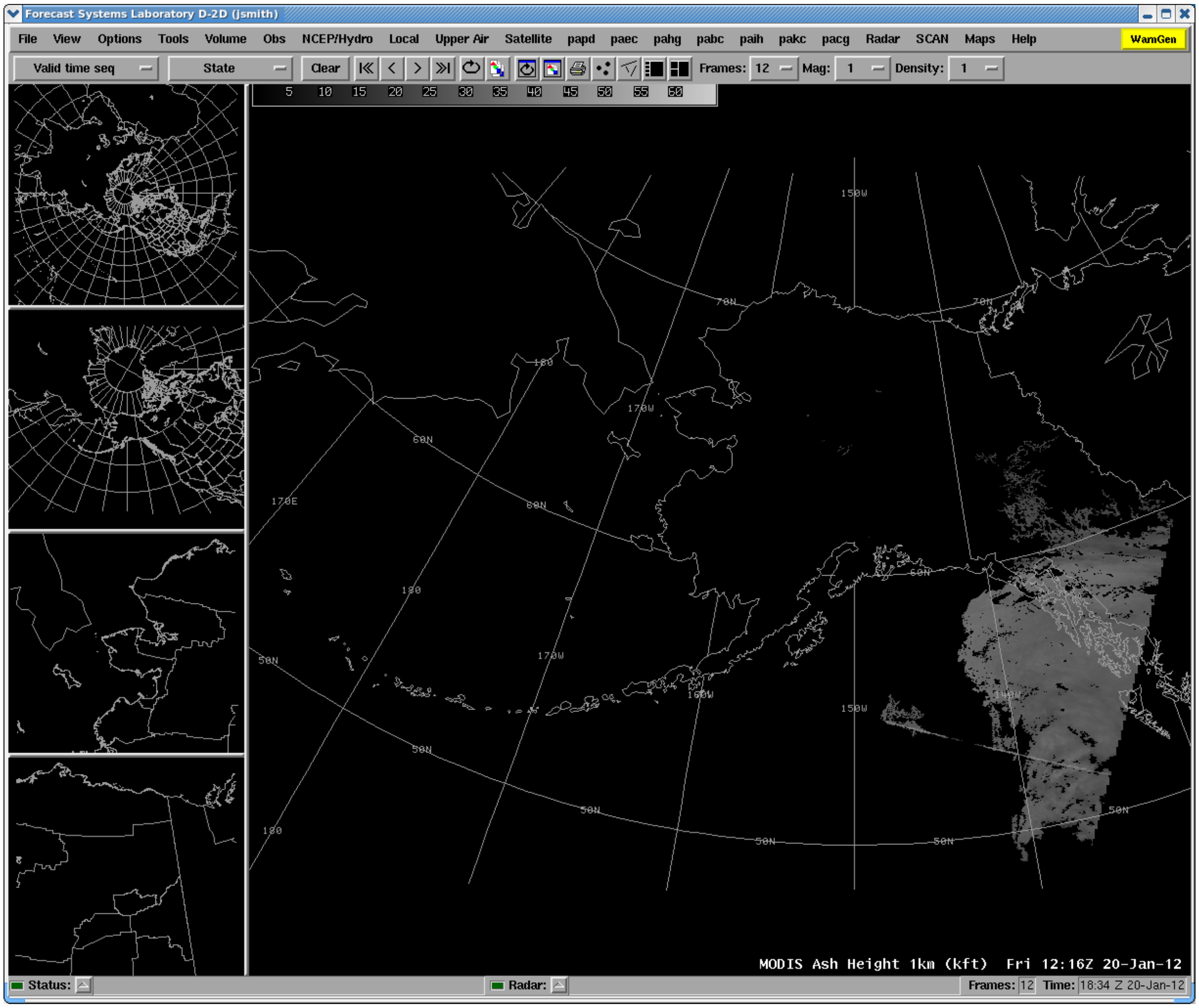
Fri 12:16Z 20-Jan-12
Status:
Radar:
Frames: 12
Time: 19:41 Z 20-Jan-12

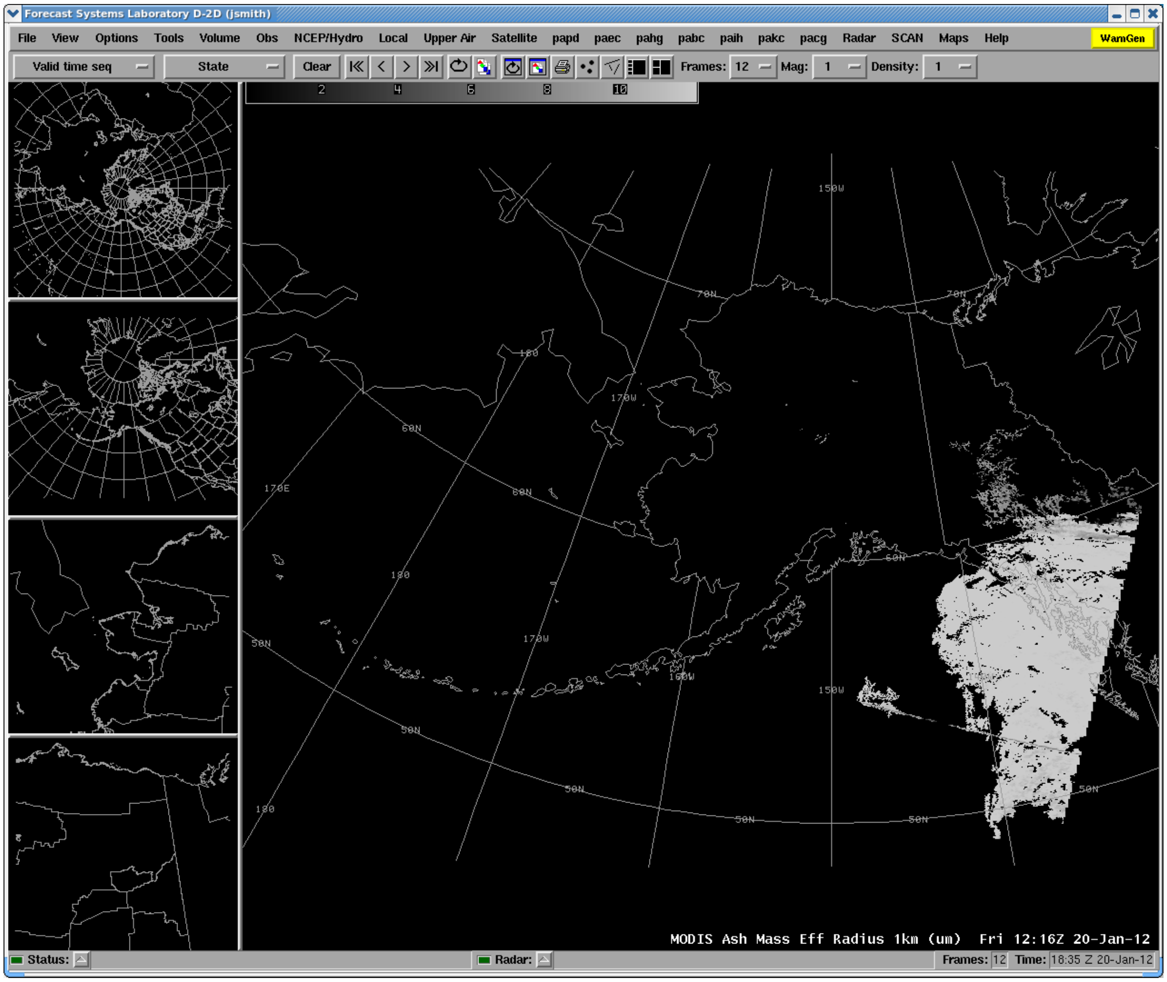
Cloud type.



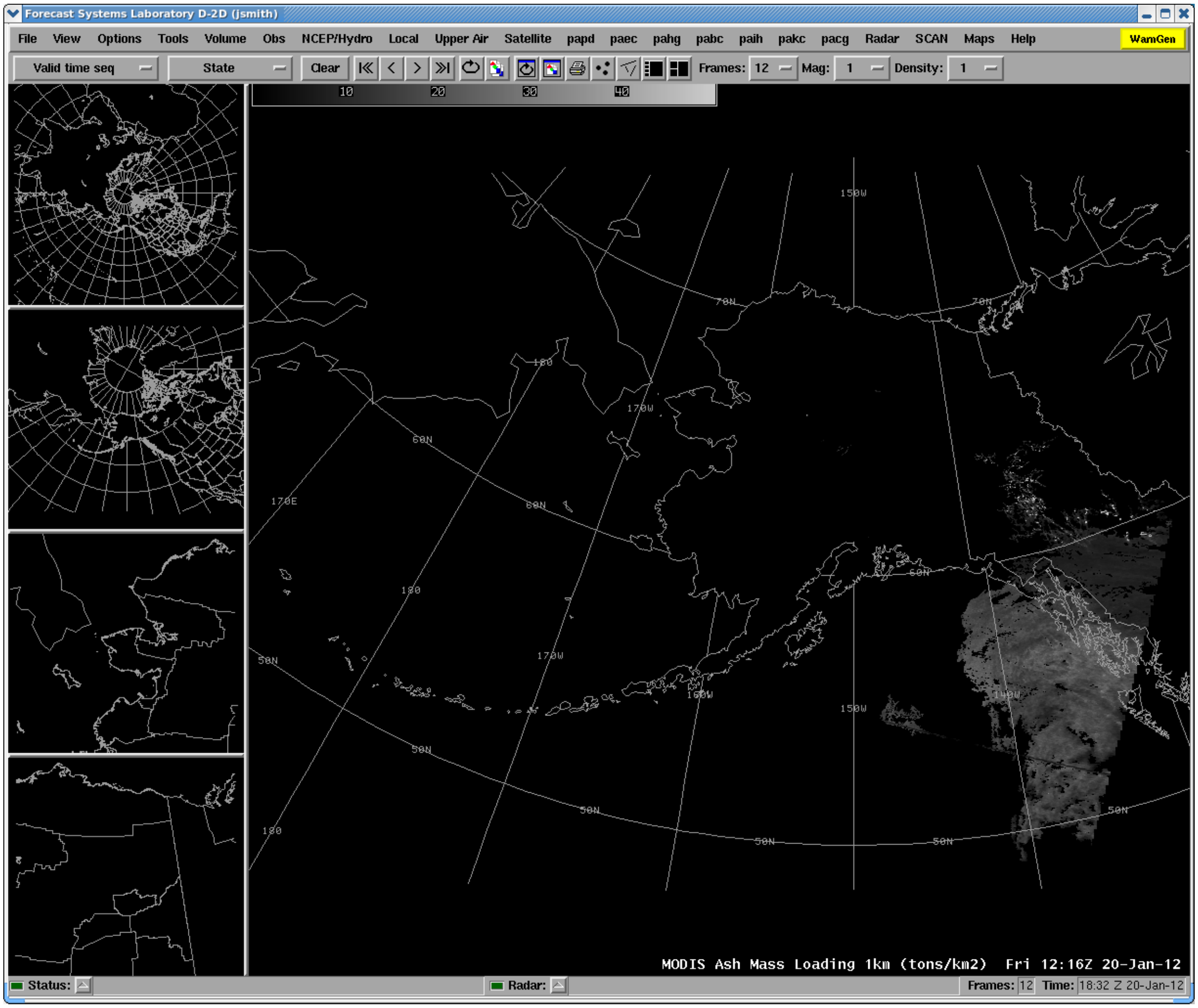
IFR probability, fog probability, cloud type, and fog depth (clockwise from upper left).


Forecast Systems Laboratory D-2D (jsmith)
File View Options Tools Volume Obs NCEP/Hydro Local Upper Air Satellite papd paec pahg pabc paih pakc pacg Radar SCAN Maps Help
WarnGen
Valid time seq
State
Clear
Frames: 12
Mag: 1
Density: 1
5 10 15 20 25 30 35 40 45 50 55 60
MODIS Ash Height 1km (kft) Fri 12:16Z 20-Jan-12
Status:
Radar:
Frames: 12 Time: 18:34 Z 20-Jan-12

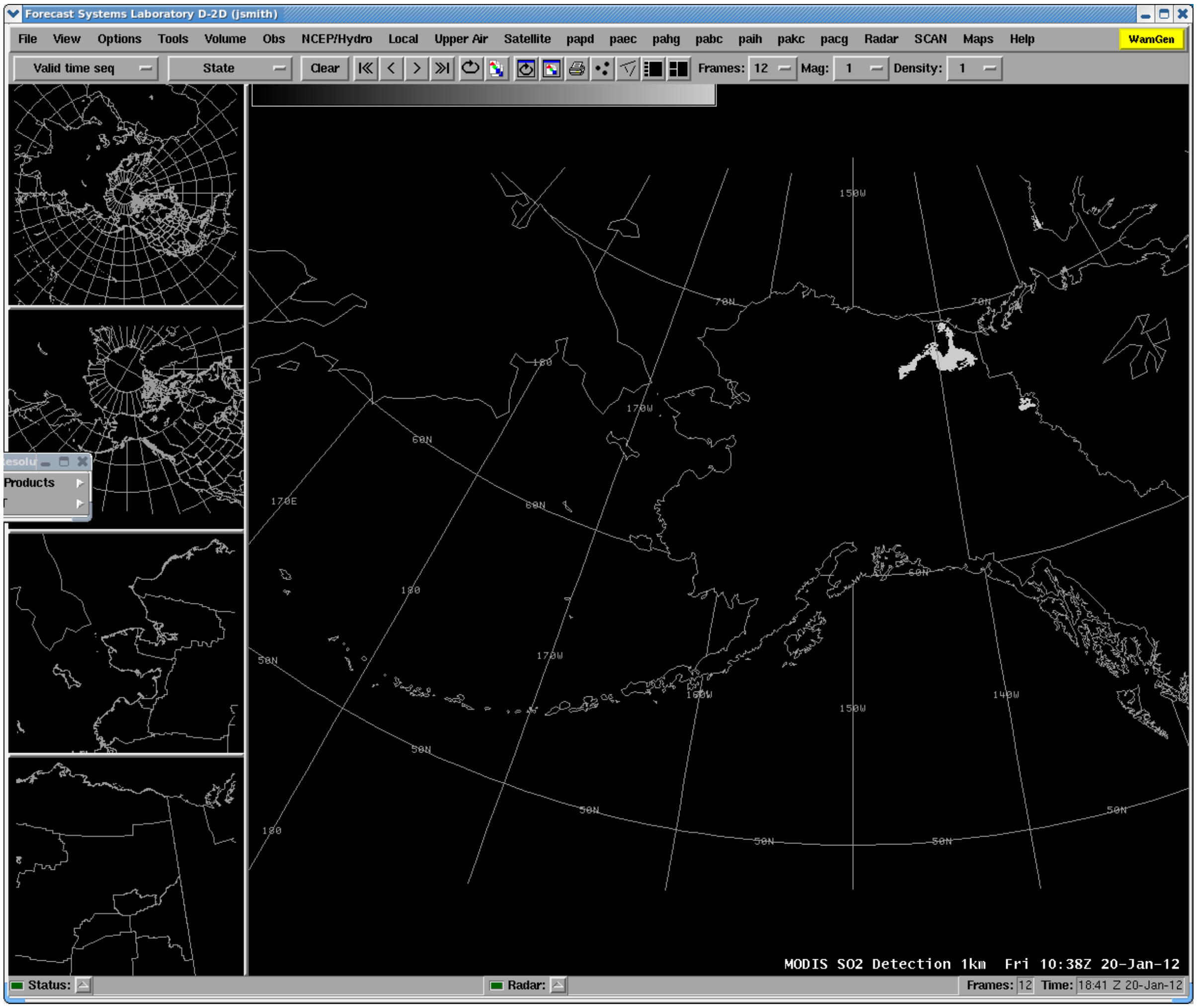
Ash height.



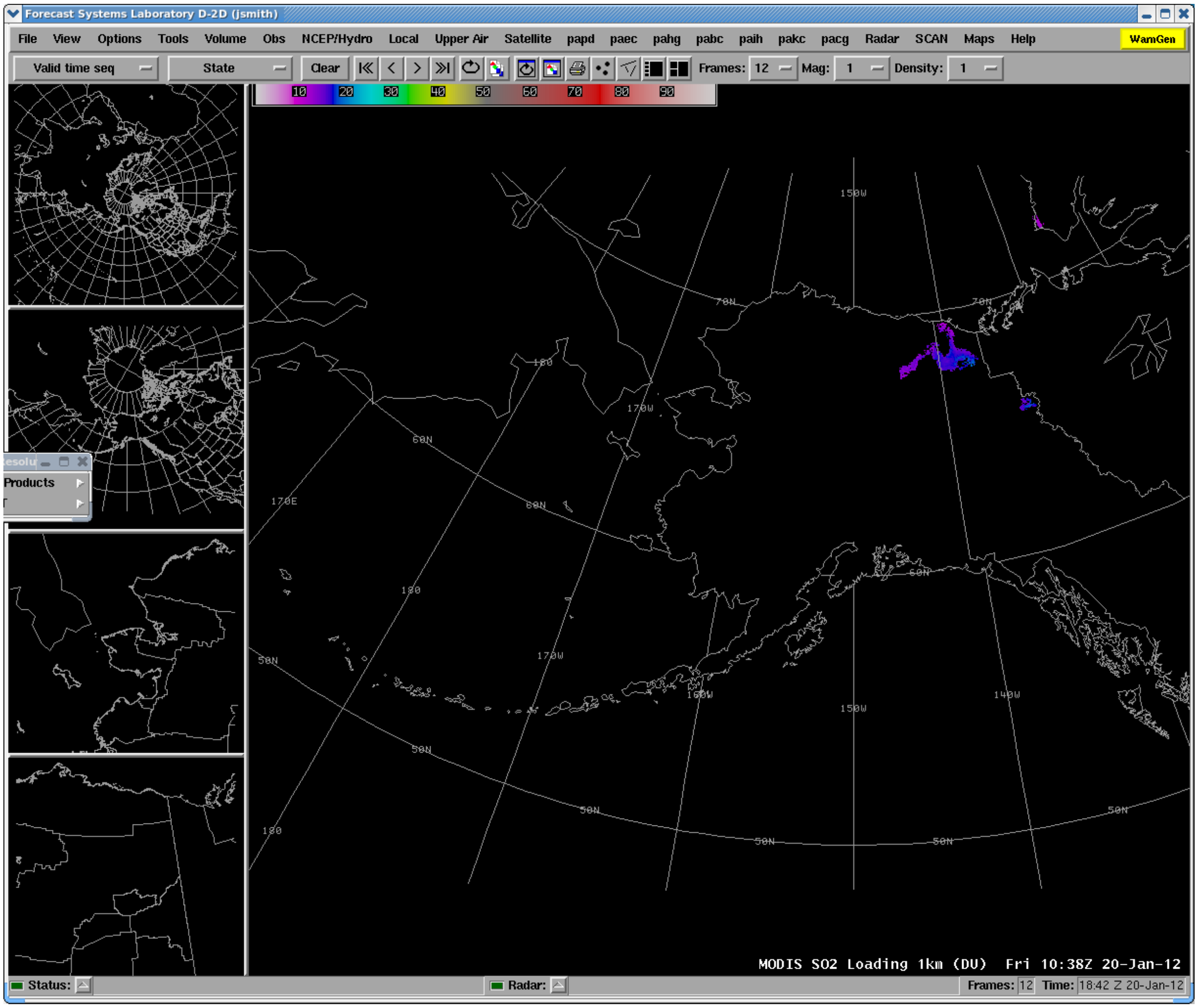
Ash effective radius.



Ash mass loading.



SO$_2$ detection



SO_2 loading.

Appendix B. Nathan Eckstein (Alaska Aviation Weather Unit SOO) review of volcano products for the April 7, 2011 Kizimen and Sheveluch Volcano Event

Attached.

Appendix C. Forecaster interview notes

Attached.

Appendix D. Acknowledgements

UAF GINA would like to thank the Alaska Region NOAA National Weather Service personnel who helped to implement the products in the field offices, used the products, and spent their time providing evaluations. We would also like to thank university and NOAA STAR personnel at the University of Wisconsin Madison Cooperative Institute for Meteorological Satellite Studies who implemented processing and generation of AWIPS products.

Appendix E. Acronyms

AAWU (Alaska Aviation Weather Unit)

IFR (Instrumental Flight Rules) – refers to sky conditions where the cloud ceiling is less than 1000 feet and/or the visibility is less than 3 statute miles. Two subcategories of IFR include LIFR and VLIFR. These are used to characterise very low cloud ceilings and visibilities.

MVFR (Marginal Visual Flight Rules) – refers to sky conditions where the cloud ceiling is between 1000 and 3000 feet, and/or the visibility is between 3 and 5 statute miles.

SOO (Science Operations Officer) Lead scientist in a NWS unit.

VAAC (Volcano Ash Advisory Center)

WFO (Weather Forecast Office)