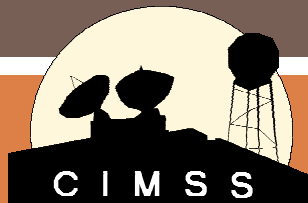
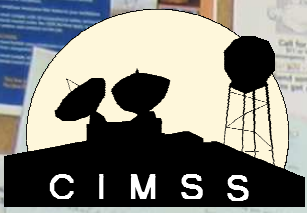


# HOW CIMSS CONTRIBUTES TO THE GOES-R PROVING GROUND, AND POSSIBLE IMPLICATIONS FOR ALASKA



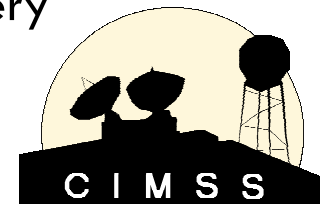
Jordan Gerth  
August 2009



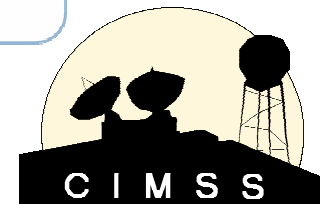
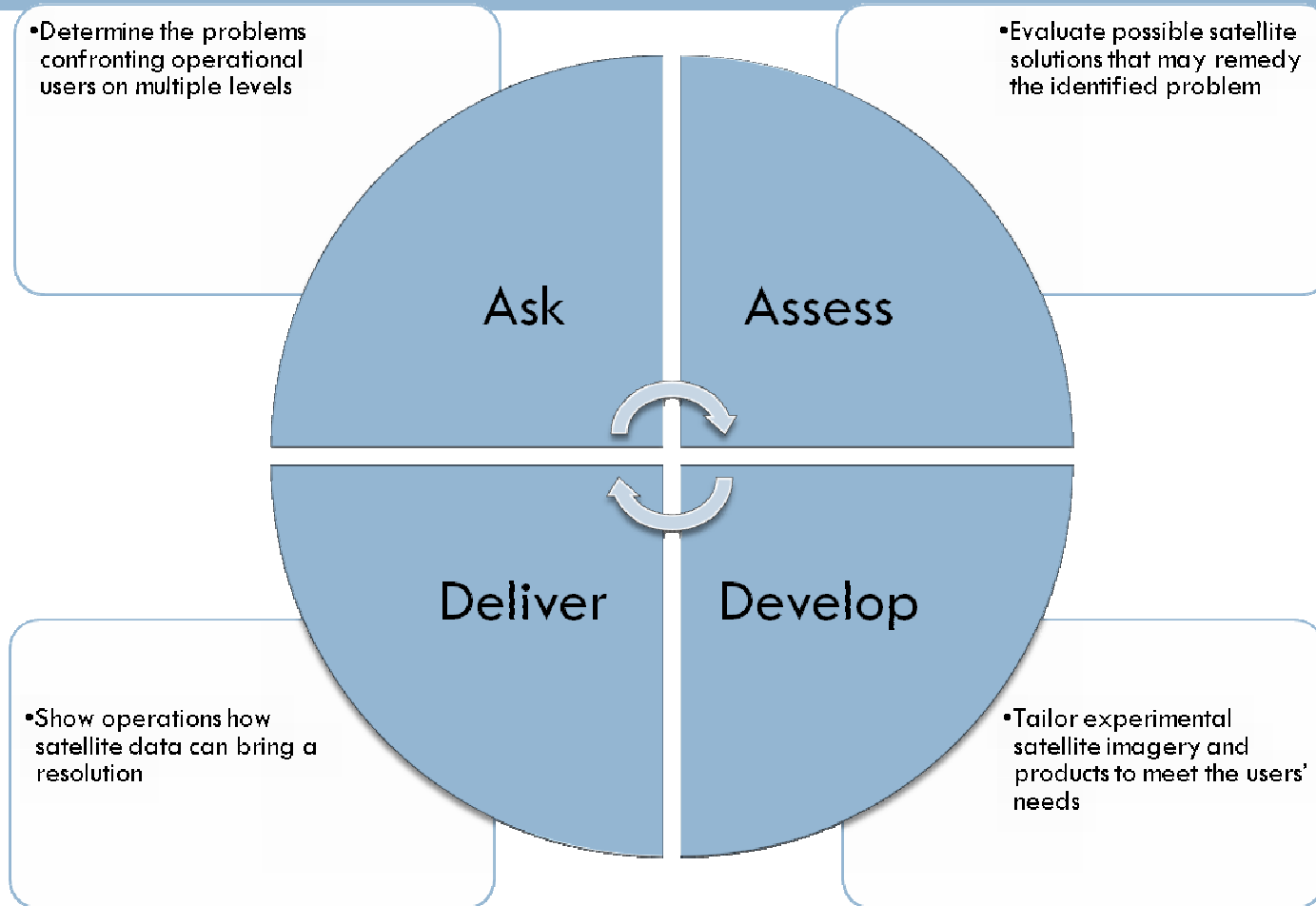
**3 YEARS**  
**of**  
**WFO-DIRECT**  
**RESEARCH TO**  
**OPERATIONS**

# Research to Operations: Our Distribution

- MODIS
  - Visible (Band 1)
  - Snow/Ice (Band 7)
  - Cirrus (Band 26)
  - 3.7 $\mu$ m (Band 20)
  - Water Vapor (Band 27)
  - IR Window (Band 31)
  - 11 $\mu$ m – 3.7 $\mu$ m (Fog)
  - Land Surface Temperature
  - Normalized Diff Veg Index
  - Total Precipitable Water
  - Cloud Phase
  - Cloud Top Temperature
  - Sea Surface Temperature
- MODIS (continued)
  - Lifted Index
  - Total Totals
  - K Index
  - True Color Sectors
  - Orbit Itinerary
- GOES Sounder
  - Total Column Ozone
  - Conv Available Potl Energy
- GOES Mesoscale Winds
- CRAS (NWP Model)
  - Standard model output
  - Synthetic IR imagery
  - Synthetic WV imagery

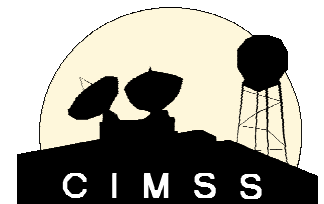


# Research to Operations: Our Model



# Ask

- The most important part of an end-to-end research to operations endeavor is to *bridge the gap* and engage the operational forecasters in a long-lasting, two-way *conversation* about how they might deliver a better forecast using new science and technology.
  - ▣ The forecaster may know a problem, but not how to solve it, or what to solve it with.
  - ▣ This requires making an initial effort to show interest in the forecaster's job and *following up* after a transitioned item has been implemented to consider improvement.
- There are multiple ways to do this:
  - ▣ Short, anonymous, multiple choice surveys conducted over the Internet
  - ▣ Formal or informal discussions with forecasters on site or over the phone





MODIS Imagery in AWIPS Survey - Windows Internet Explorer

http://www.ssec.wisc.edu/~jordang/awips-modis/survey/

File Edit View Favorites Tools Help

MODIS Imagery in AWIPS Survey

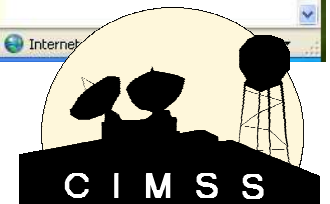
## MODIS Imagery in AWIPS Survey for National Weather Service forecasters

Wednesday, July 30, 2008, into Tuesday, August 12, 2008

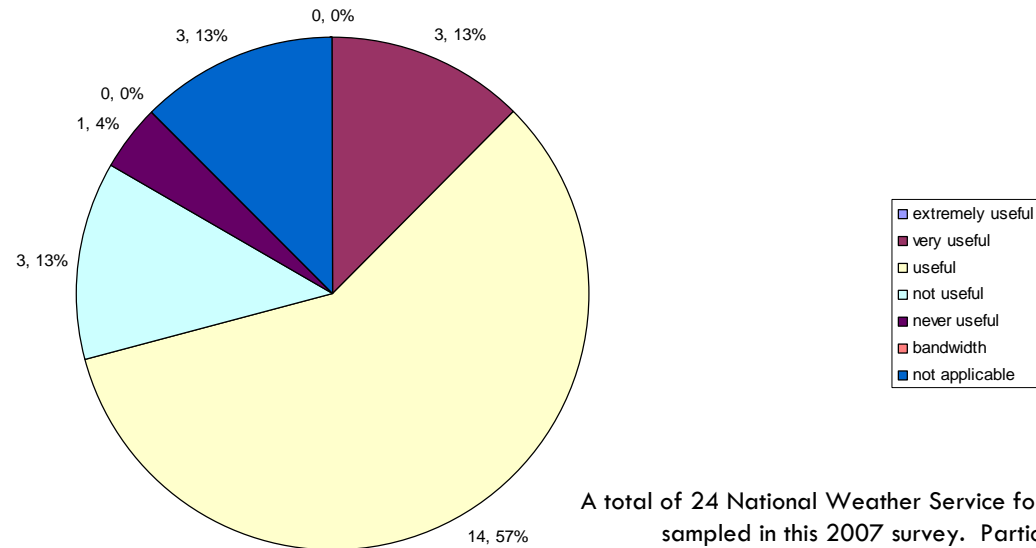
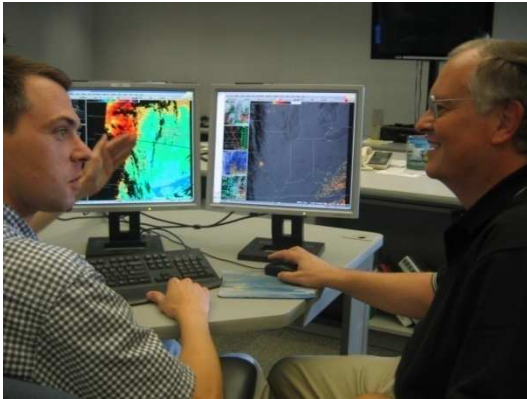
1. How many years have you been a National Weather Service employee? <i>(required, numbers only)</i>	<input type="text"/>
2. How often do you look at MODIS images and products available in AWIPS? <i>(required, select one)</i>	<input type="radio"/> Multiple times per shift <input type="radio"/> Once per shift <input type="radio"/> Every other shift <input type="radio"/> Once per week <input type="radio"/> Every other week <input type="radio"/> Once per month <input type="radio"/> Once per season <input type="radio"/> Only when the SOO is watching <input type="radio"/> Very seldom to never <input type="radio"/> Not in AWIPS, but on the web
3. In general, how useful are MODIS images and products in daily operations? <i>(required, select one)</i>	<input type="radio"/> Extremely useful (a primary source for satellite data) <input type="radio"/> Very useful (influences forecast and/or warning process) <input type="radio"/> Useful (a secondary source for satellite data) <input type="radio"/> Not useful (does not add any benefit) <input type="radio"/> Never useful (rarely offers relevant information) <input type="radio"/> Useful in slowing office Internet connection <input type="radio"/> Not applicable (do not use enough to gauge)
4. Have you participated in any training sessions related to MODIS imagery? <i>(required, select one)</i>	<input type="radio"/> Yes, VISITview only <input type="radio"/> Yes, in-house presentations from CIMSS/SSEC only <input type="radio"/> Yes, VISITview and in-house presentations <input type="radio"/> Nothing formal (searched Internet, asked others) <input type="radio"/> Not yet, but would like to receive training <input type="radio"/> No (do not plan to attend training, unless required)
5. How did you find out about MODIS imagery, and that it was in AWIPS? <i>(required, select one or more)</i>	<input type="checkbox"/> Fellow forecaster inside office <input type="checkbox"/> Forecaster at a different office <input type="checkbox"/> Surrounding office <input type="checkbox"/> Regional headquarters <input type="checkbox"/> Office Science Operations Officer <input type="checkbox"/> Office Information Technology Officer <input type="checkbox"/> VISITview training <input type="checkbox"/> Other contact with CIMSS/SSEC employee <input type="checkbox"/> Surfing Local Applications Database

Done

Internet

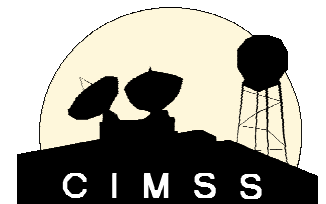


## In general, how useful are MODIS images and products in daily operations?

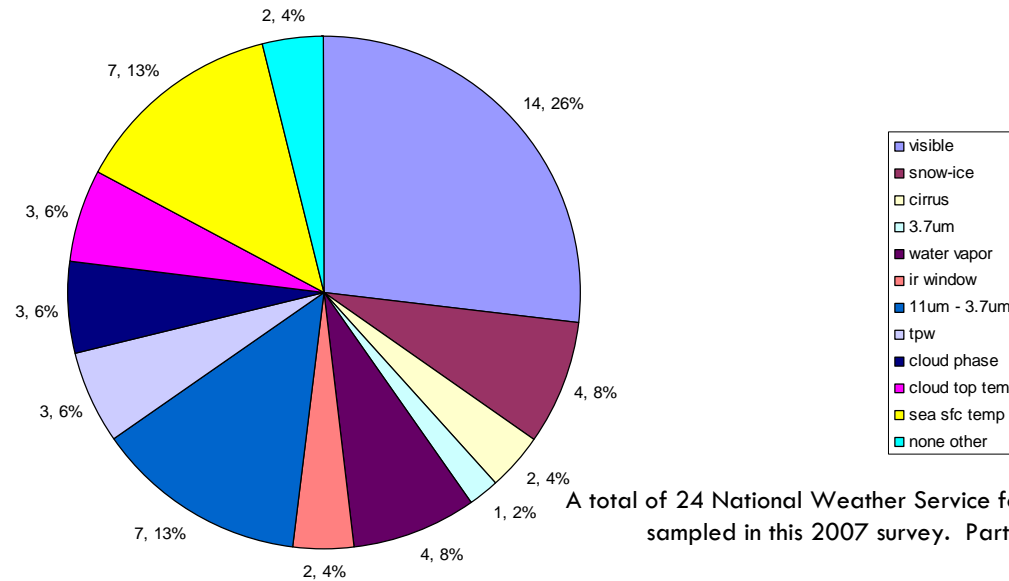


*“I love the MODIS product but I only get one picture PER SHIFT which really doesn't make it totally useful. I wish we could get MODIS pictures at least every 30 minutes, but every 15 would be excellent.”*

From National Weather Service Forecast Office in Indianapolis, Indiana



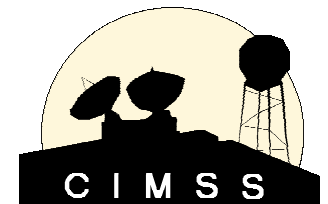
## What MODIS images and products in AWIPS do you use most frequently?



A total of 24 National Weather Service forecasters at five offices were sampled in this 2007 survey. Participation was optional.

*“This is a great dataset for WFO Operations. We would love to continue to see more and more data get into AWIPS. The Fog product I have found to be especially useful, as well as the Snow/Ice Band 7. Great stuff!”*

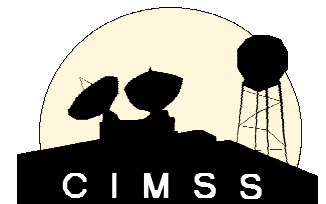
From National Weather Service Forecast Office in La Crosse, Wisconsin





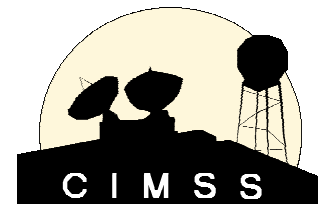
# Assess

- There are five points of consideration:
  - ▣ What are the available data resources, and which apply to the issue at hand?
  - ▣ How can the identified problem be remedied for presentation in the most *efficient* manner possible?
  - ▣ What, if anything, is presently available to the forecaster to assist with this problem, and does the remedy *add value* over it?
  - ▣ Will the proposed solution be both *reliable* and *consistent* in delivery? How can that be assured?
    - The lack of reliability and consistency poses a significant barrier to widespread use in operations!
  - ▣ What will the *future* hold?



# Develop

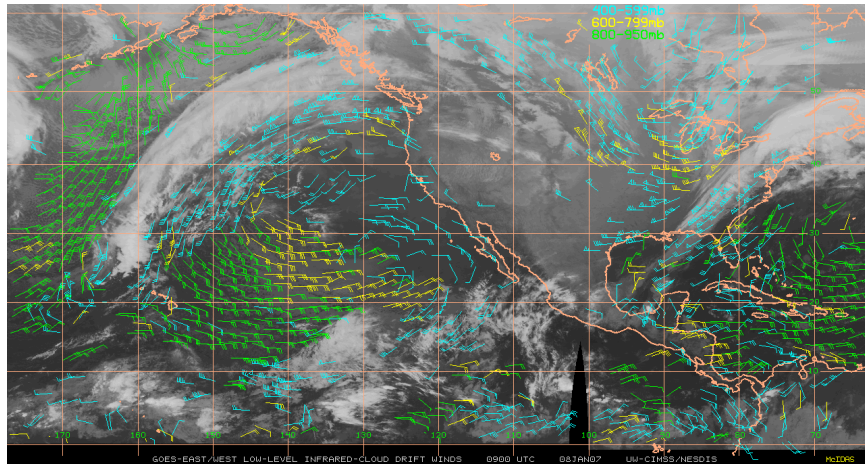
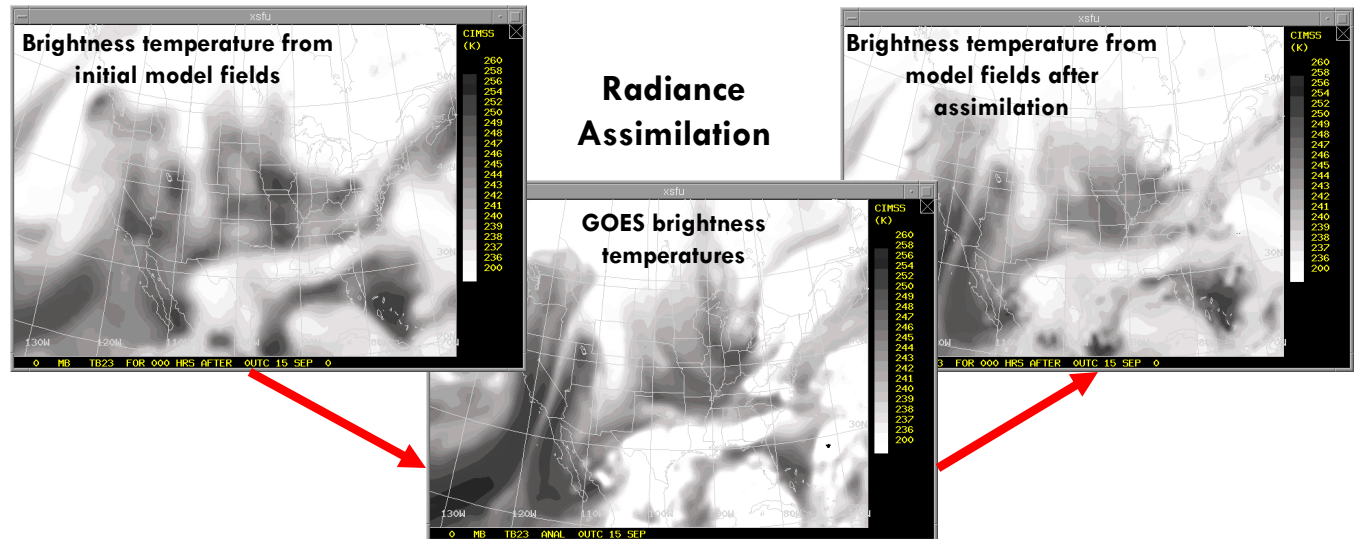
- There are three types of product development for research to operations projects:
  - ▣ Implementation of imagery or well-established derived products existing in a research capacity with little or no modification
  - ▣ The creation of a new product based on research not yet transferred to operations
    - Assure any new product validates prior to implementation. Research to operations projects should not be used for validation, only functionality and usability.
  - ▣ Infusing new or existing data into an algorithm or model for expected improvement
    - Specifically, using high-resolution data in adequate numerical weather prediction arrangements to better the initial conditions, create better forecasts



# Information Extracted from Satellites

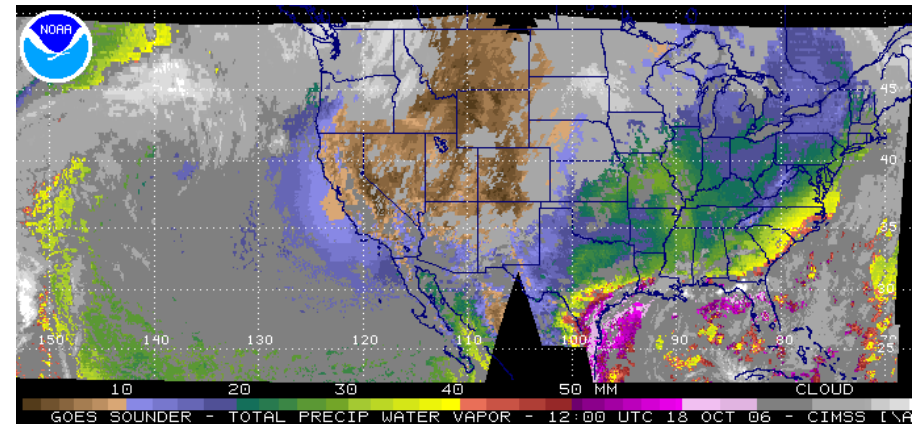
## Radiances

- Direct assimilation (3Dvar)
- Requires knowledge of errors
- Scale dependence
- Surface type restrictions



## Motion

- Cloud track, bright temperature
- Geo and Polar
- Height assignment errors
- Radiance tracking (4Dvar)

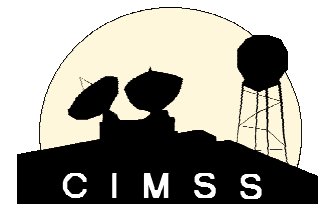


## Retrieved parameters

- Dependent variable assimilation (1,3Dvar)
- Requires knowledge of *retrieval errors*
- Physical accuracy, non-linearity
- Bypass surface type restrictions

# Deliver

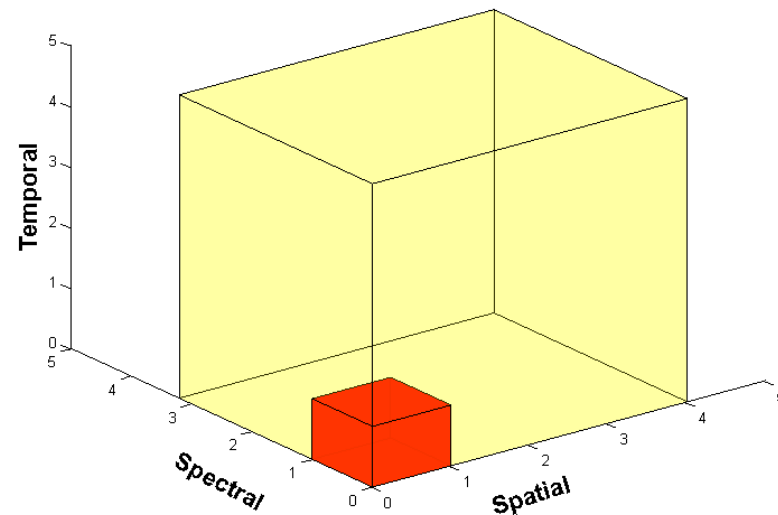
- Experimental data is delivered to the National Weather Service Forecast Offices using a server with the Local Data Manager (LDM) software provided by Unidata.
- Some is also posted to the Internet, including particularly new data. However, the preferred method is to make it available in the software the forecasters use most.
- The LDM sends and retrieves files over an event-driven stream consisting of defined feeds between active servers. We use the EXP and SPARE feeds.
- Files are first sent on a feed to an LDM server at the regional headquarters, then passed onto any requesting offices within that region. Offices can limit the number of files ingested from a given feed.
- Files are all delivered in an AWIPS-readable format. LDM is format unaware.



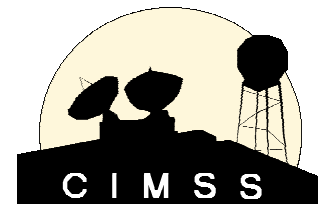
# A New Way to Deliver?

- What will happen to the SBN once GOES-R increases the deliverable data 60-fold?
- What about now? Lessons learned from AVHRR?
- What can we learn from how Alaska Region handles polar satellite data?

Improvement Factors: Current and Future GOES Imagers



NOAA/NESDIS ASPB

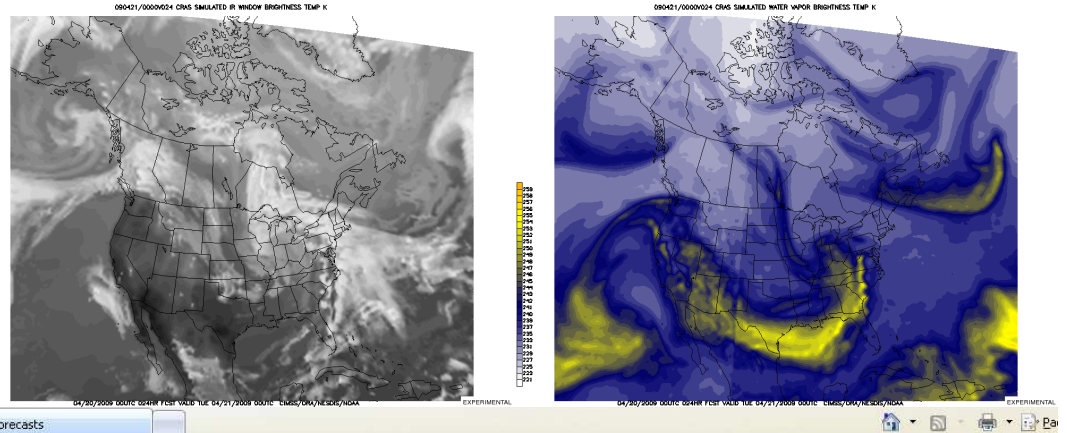




# Web Transitioning

<http://cimss.ssec.wisc.edu/cras/>

NOAA Collaborator: Robert Aune



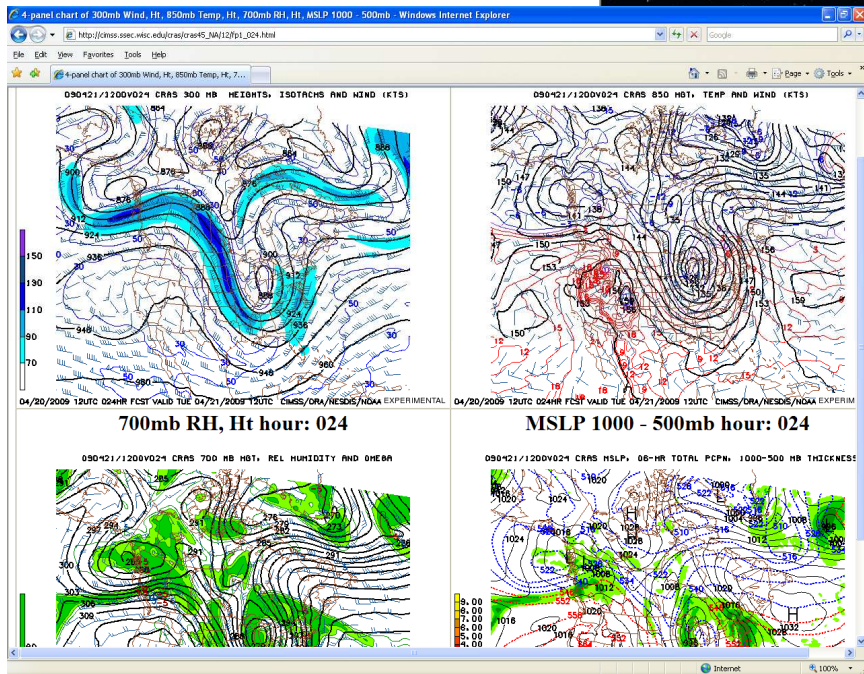
CIMSS Model Analyses and Forecasts

http://cimss.ssec.wisc.edu/cras/

File Edit View Favorites Tools

CIMSS Model Analyses and Forecasts

CIMSS » CIMSS Regional Assimilation System (CRAS)



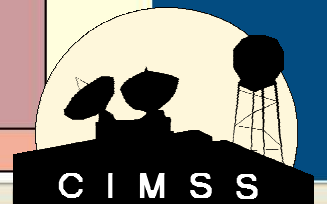
## The Daily CIMSS Regional Assimilation System Forecast

### CIMSS Model Analyses and Forecasts

Active runs: [CRAS45NA](#) || [CRAS45AK](#) || [CRAS20US](#) || [CRAS90NA](#) || [CRAS48SP](#)

Last updated: Mon Apr 20 16:42:00 UTC 2009

Northern Hemisphere				
	00 UTC	06 UTC	12 UTC	18 UTC
<b>CRAS 45NA</b>	coarse medium fine <a href="#">3-Hourly Charts</a> <a href="#">4-Panel Charts</a>		coarse medium fine <a href="#">3-Hourly Charts</a> <a href="#">4-Panel Charts</a>	
	2009-04-20		2009-04-20	
CRAS45NA — 84-hour Forecast for North America Assimilates GOES Sounder water vapor and clouds				
<b>CRAS 45AK</b>	coarse medium fine <a href="#">3-Hourly Charts</a> <a href="#">4-Panel Charts</a>		coarse medium fine <a href="#">3-Hourly Charts</a> <a href="#">4-Panel Charts</a>	
	2009-04-20		2009-04-20	
CRAS45AK — 84-hour Forecast for Alaska-North Pac Assimilates GOES Sounder, Aqua/Terra MODIS water vapor and clouds				
<b>CRAS 20US</b>	coarse medium fine <a href="#">3-Hourly Charts</a> <a href="#">4-Panel Charts</a>		coarse medium fine <a href="#">3-Hourly Charts</a> <a href="#">4-Panel Charts</a>	
	2009-04-20		2009-04-20	
CRAS20US — 48-hour Forecast for United States Assimilates GOES Sounder water vapor and clouds				

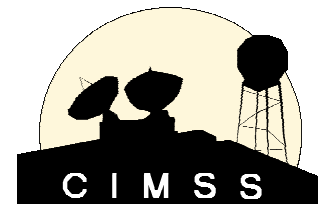


CIMSS

Done

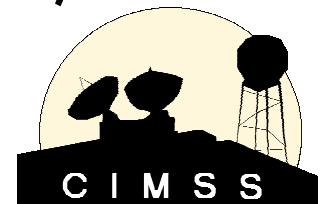
# GEMPAK/N-AWIPS

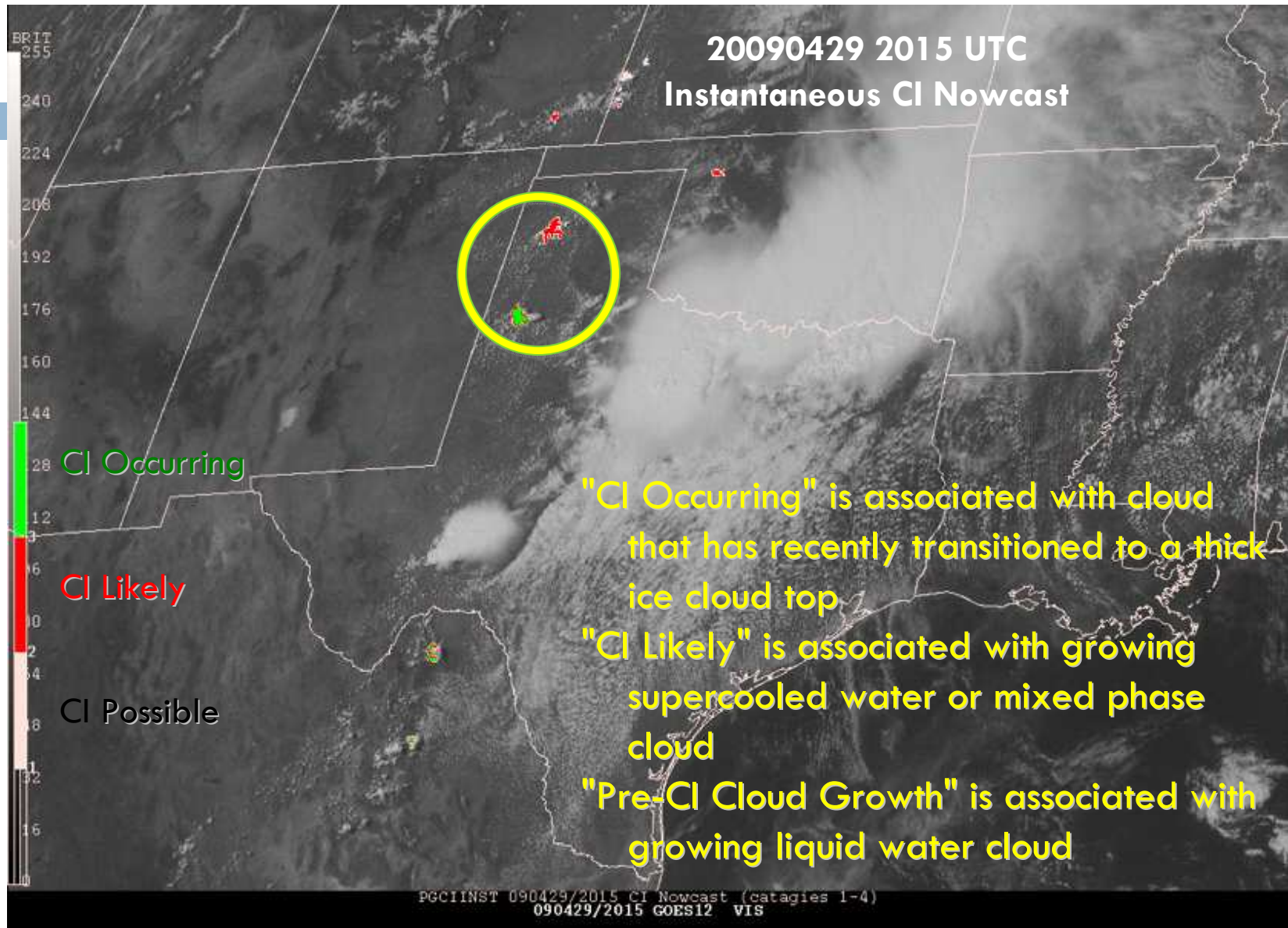
- GEMPAK/N-AWIPS is meteorological data display software developed by the National Centers for Environmental Prediction (NCEP) and supported by Unidata with analysis and product generation capabilities for viewing archived and real-time data.
- Active development of the software has ended.
- It contains both graphical user interfaces (GUIs) and standard input applications with graphical output to disk or display.



# GEMPAK/N-AWIPS

- It is employed by the National Centers (such as Storm Prediction Center, Tropical Prediction Center, etc.) to produce operational Redbook Graphics and other text forecast products which are disseminated over the Satellite Broadcast Network.
- CIMSS uses N-AWIPS to produce web graphics for the CRAS and deliver/quality-control convective initiation and cloud top cooling products to the Storm Prediction Center (SPC).

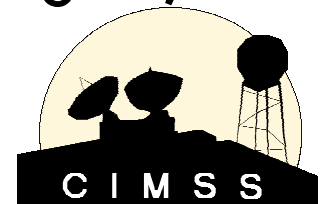






# AWIPS

- The Advanced Weather Interactive Processing System (AWIPS) is Linux-based software used exclusively by the National Weather Service that consists of a data management structure and display tool for raw weather information transmitted over the Satellite Broadcast Network (SBN).
- AWIPS can be customized to a local area and special datasets can be added.
- Raw data from the SBN is acquired and decoded into special netCDF files and stored until purged, when the data reaches expiration.





(fxa)Text Workst

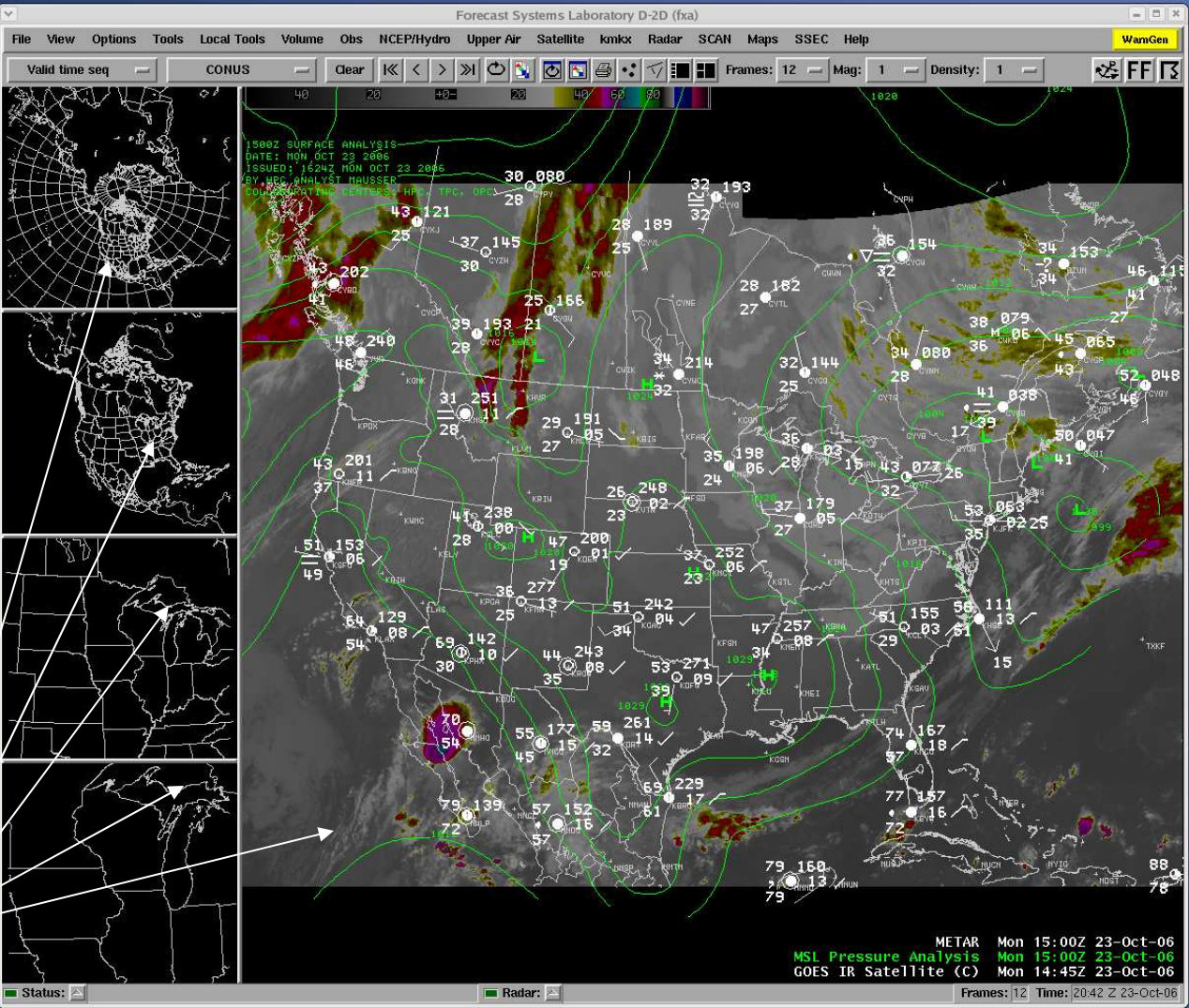
File Windows



Mon 23 Oct 2006 20:43 UTC  
Mon 23 Oct 2006 20:43 GMT

Alarm/Alert

- Text 1
- Text 2
- Text 3
- Text 4



Panes

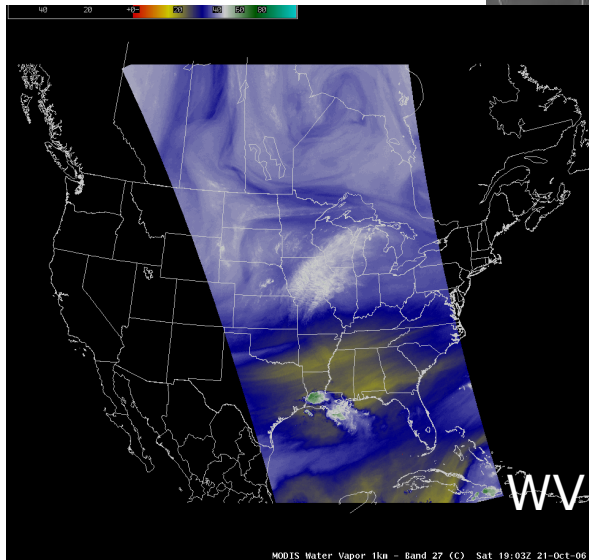


# AWIPS

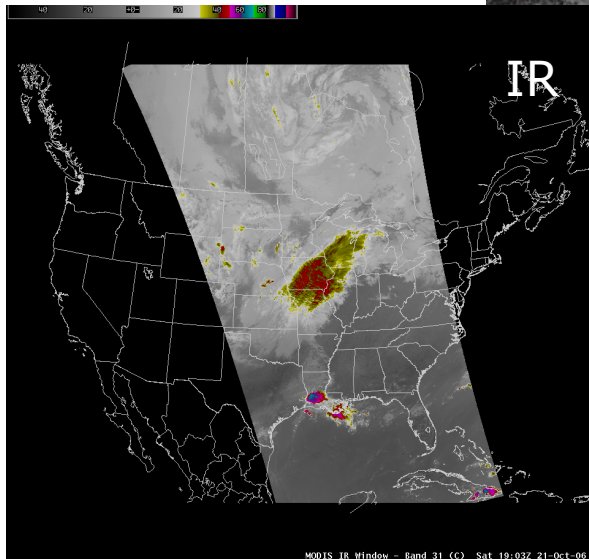
- CIMSS delivers AWIPS-ready netCDF files via the LDM of experimental satellite imagery and products. We have developed this software for use locally with builds from the NWS WDTB and produced “AWIPS local applications” for the field.
- The graphical user interface (GUI) which serves as a front-end for data access is Display Two-Dimensions (D-2D). Data is limited to 8 bits (256 possible values). AWIPS has essentially no command-line interface except the localization scripts.
- Users can create procedures for easy loading.



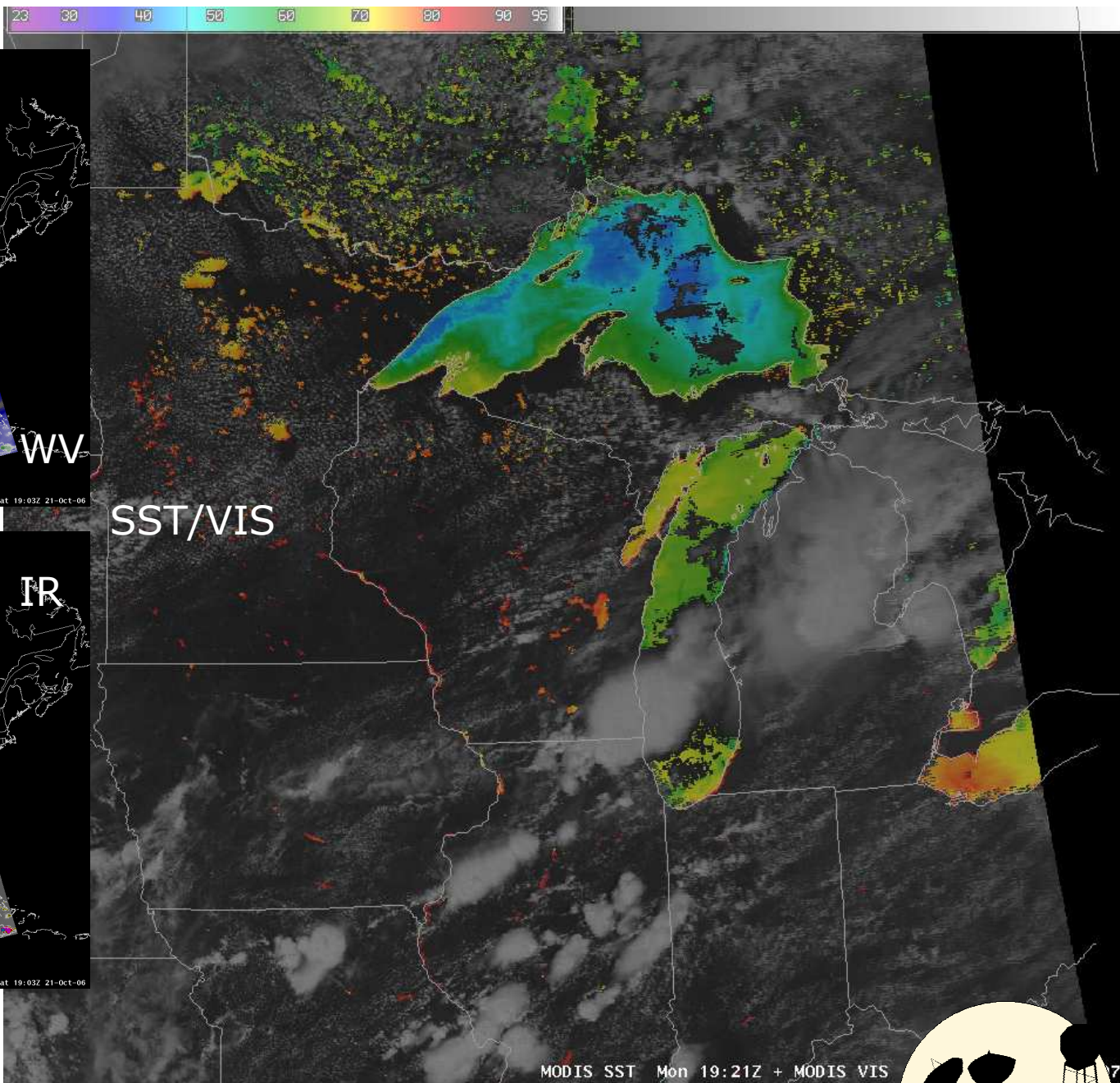




WV



IR

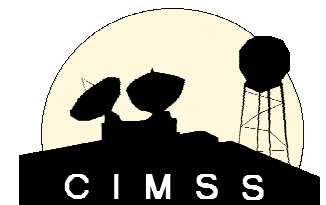


SST/VIS



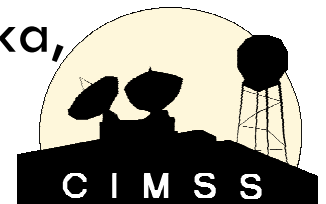
# Fx-Net/Fx-Collaborate

- ❑ CIMSS has previously acquired the Fx-Net/Fx-C software package for potential use in research to operations activities (similar to our product transitions in AWIPS).
- ❑ There was some early interest from NWS WSO Barrow about using the Fx-Net mechanisms to deliver and display data from MODIS to remote WSOs in the Alaska Region.
- ❑ We are interested in assessing the bandwidth and limitations of the software to determine feasibility and timeliness of this approach.
- ❑ The future of Fx-Net/Fx-C appears uncertain with the integration of collaboration tools in the new migrated AWIPS infrastructure.



# GFE

- All forecast preparation is done using the Graphical Forecast Editor (GFE) for the National Digital Forecast Database.
- CIMSS has implemented a local version of the GFE in order to explore possible applications for satellite data in the spatial and temporal visual forecast process.
- We have tested the capabilities of the software with adding satellite datasets (such as MODIS) to the GFE databases and evaluating how new SmartTools can use satellite products to modify gridded values, especially for short range predictions.
- In addition, CIMSS is producing a module which will add the CRAS to the list of gridded data sources. CRAS runs are produced twice daily (00Z, 12Z). Domains include Alaska, Hawaii, CONUS, and the Midwest.



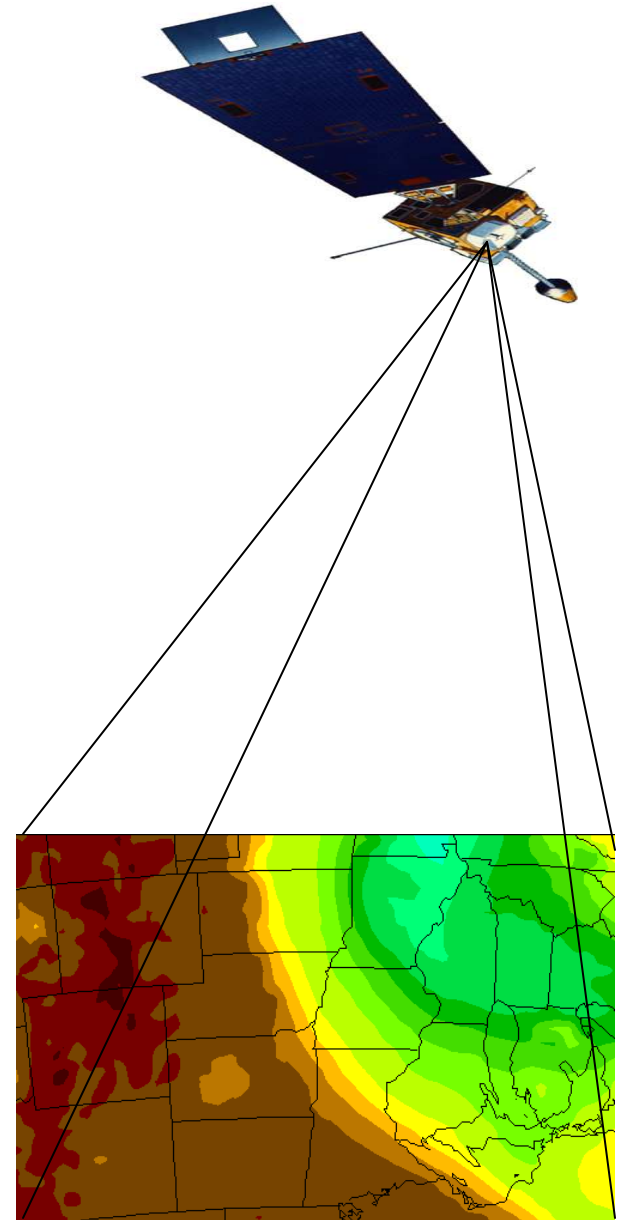


# CIMSS Regional Assimilation System

**CRAS**

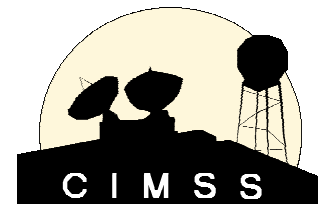
The Cooperative Institute for Meteorological Satellite Studies (CIMSS) uses the CIMSS Regional Assimilation System (CRAS) to assess the impact of space-based observations on numerical forecast accuracy.

CRAS is unique in that, since 1996, it's development was guided by validating forecasts using information from GOES.



# CRAS

- CIMSS is particularly interested in implementing a sky cover algorithm in the CRAS post-processor to produce a gridded product for the GFE.
- We are in the early stages of defining a celestial dome and perform a geometric calculation such that the output sky cover expresses coverage over nine adjacent grid cells.
- The hope is to eliminate the bi-modal appearance and relative humidity reliance of many model output sky cover products, without significantly smoothing the gradients of the predictions.
- Is “sky cover” another “probability of precipitation”?

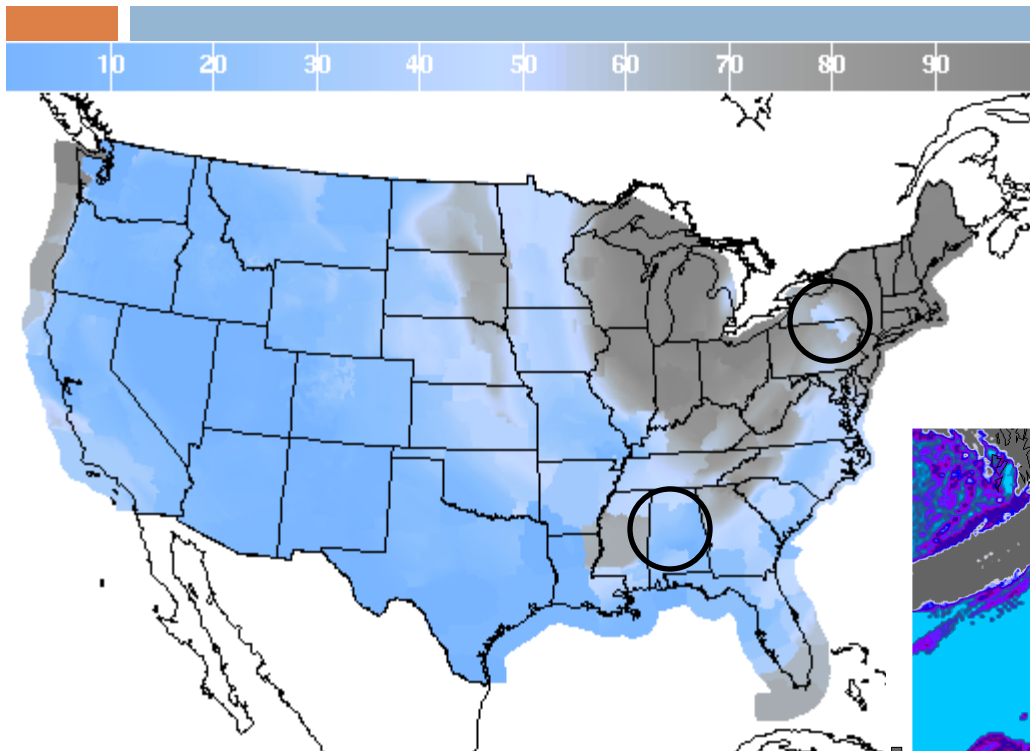


# Sky Cover Prediction

We respond! Pre-release commentary from National Weather Service Science Operations Officers:

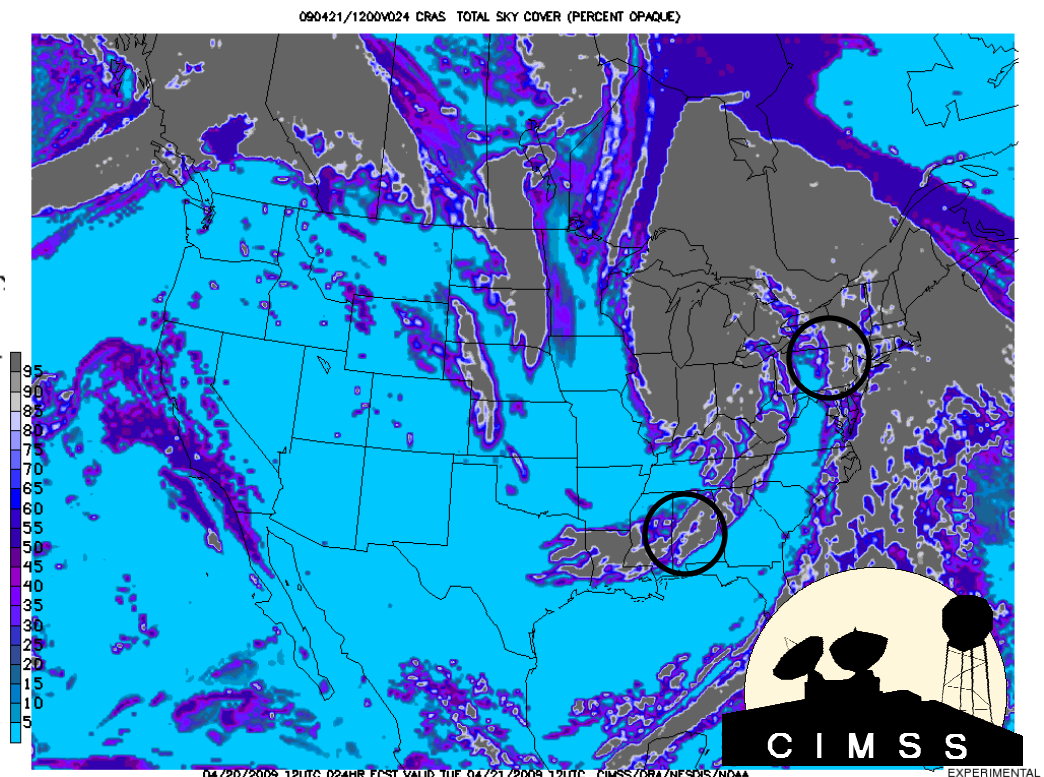
**“[The] field really does need something to help with the sky grids.”**

**“Obviously great potential for (the) NDFD!”**



Sky Cover (%) For Tue Apr 21 2009  
(Tue Apr 21 2009 12Z)

National Digital Forecast Database  
23z issuance      Graphic created-Apr 20 7:12PM EDT



04/20/2009 12UTC 024HR FCST VALID TUE 04/21/2009 12UTC CIMSS/CRA/NESDIS/NOAA

EXPERIMENTAL

# Sky Cover Prediction

## Some Problems:

*What is 100% sky cover? Both celestial domes are completely covered with cloud. Do we use an incoming light standard? If so, what do we do at night? What about smoke and fog?*

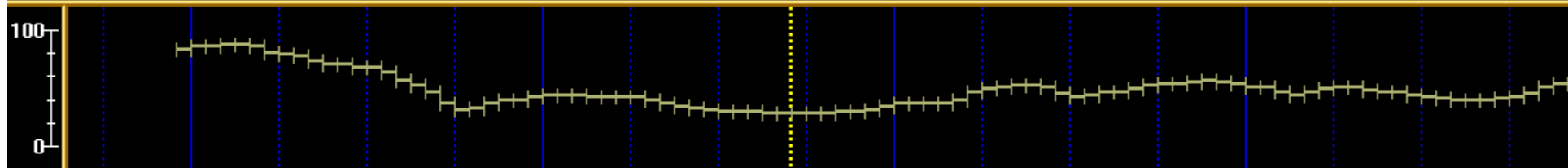


Photos courtesy of National Weather Service Southern Region Headquarters

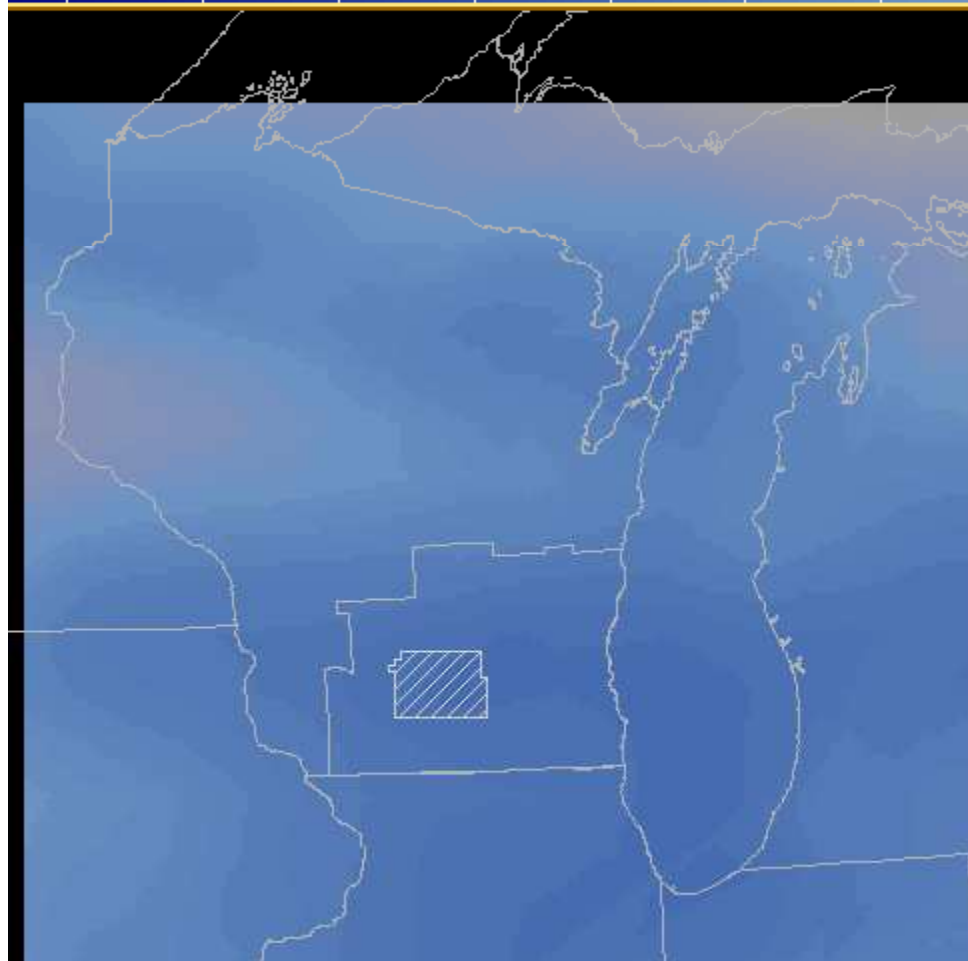


t 07 (Tue)	Oct 08 (Wed)	Oct 09 (Thu)	Oct 10 (Fri)	Oct 11 (Sat)
12 18	06 12 18	06 12 18	06 12 18	06 12 18

SFC Fcst\_Prac (MKX)



5 10 15 20 25 30 35 40 45 50 55 60 65 70



- T SFC Fcst\_Prac (MKX) (
- Td SFC Fcst\_Prac (MKX) (
- RH SFC Fcst\_Prac (MKX) (
- MaxT SFC Fcst\_Prac (MKX) (
- MinT SFC Fcst\_Prac (MKX) (
- WindChill SFC Fcst\_Prac (MKX) (
- HeatIndex SFC Fcst\_Prac (MKX) (
- Wind SFC Fcst\_Prac (MKX) (
- WindGust SFC Fcst\_Prac (MKX) (
- (edit) Sky SFC Fcst\_Prac (MKX) (
- Wx SFC Fcst\_Prac (MKX) (
- Pop SFC Fcst\_Prac (MKX) (
- QPF SFC Fcst\_Prac (MKX) (
- SnowAmt SFC Fcst\_Prac (MKX) (
- StormTotalSnow SFC Fcst\_Prac (MKX) (
- SnowLevel SFC Fcst\_Prac (MKX) (
- Hazards SFC Fcst\_Prac (MKX) (
- FzLevel SFC Fcst\_Prac (MKX) (
- IceCoverage SFC Fcst\_Prac (MKX) (
- LkSfcT SFC Fcst\_Prac (MKX) (
- Period SFC Fcst\_Prac (MKX) (
- Period2 SFC Fcst\_Prac (MKX) (
- Swell SFC Fcst\_Prac (MKX) (



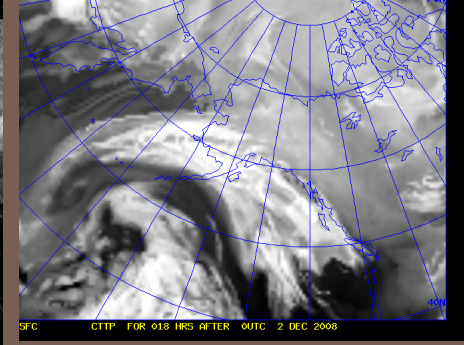
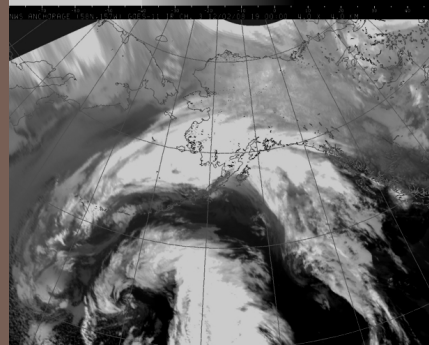
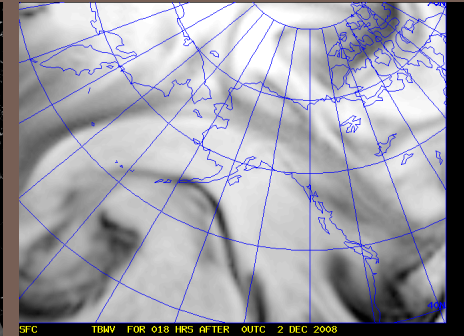
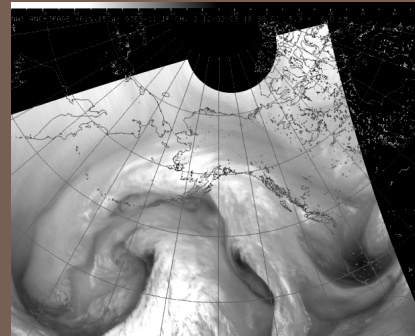
CIMSS



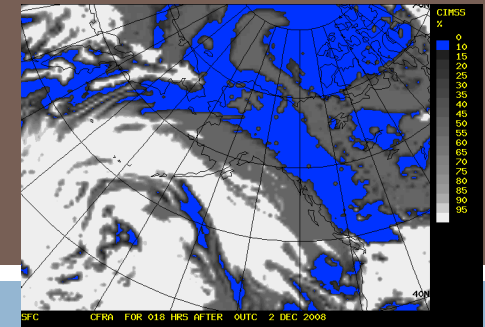
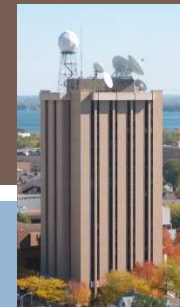
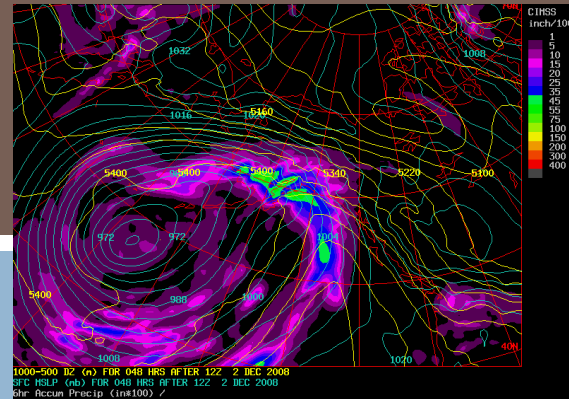
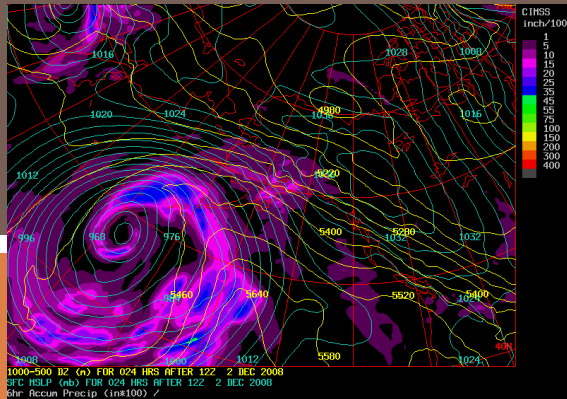
# CRAS FORECAST PRODUCTS FOR THE ALASKA REGION

CIMSS has configured the CRAS for Anchorage, Alaska. It uses precipitable water and cloud-top pressure from MODIS and from the GOES-11 sounder to initialize water vapor and clouds. The domain is a superset of the AWIPS 216 grid so forecast products can be transferred directly to AWIPS.

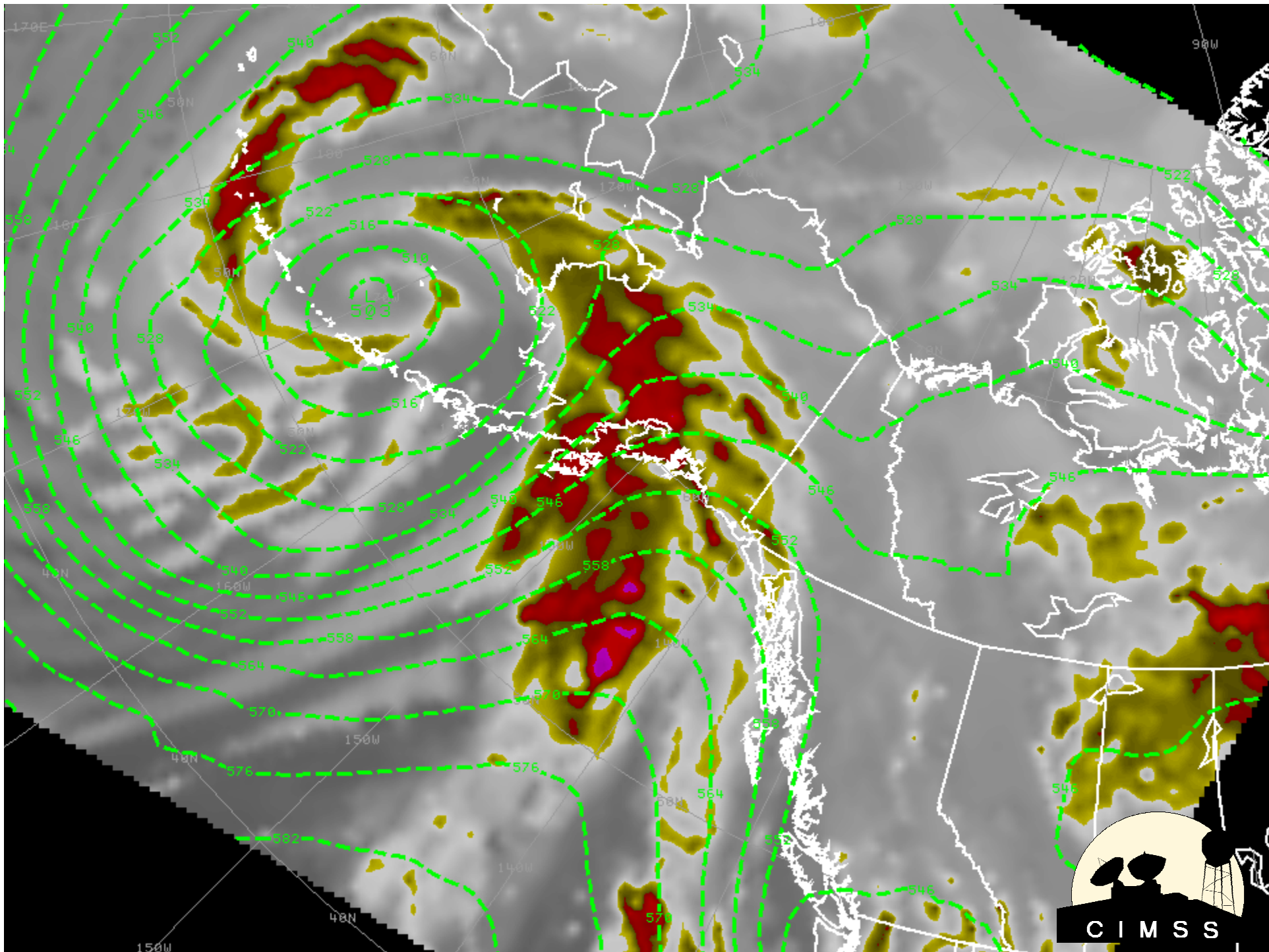
Shown at right are some comparisons between 18-hour CRAS forecast images and images from the GOES-11 imager. The 6.7u CRAS images are generated using the GOES-11 radiative transfer model to generate clear sky brightness temperatures. The 11u CRAS images are computed using the predicted cloud mixing ratio to attenuate the predicted skin temperature. **Note: The map projection on the GOES-11 images are slightly different than on the CRAS images.**

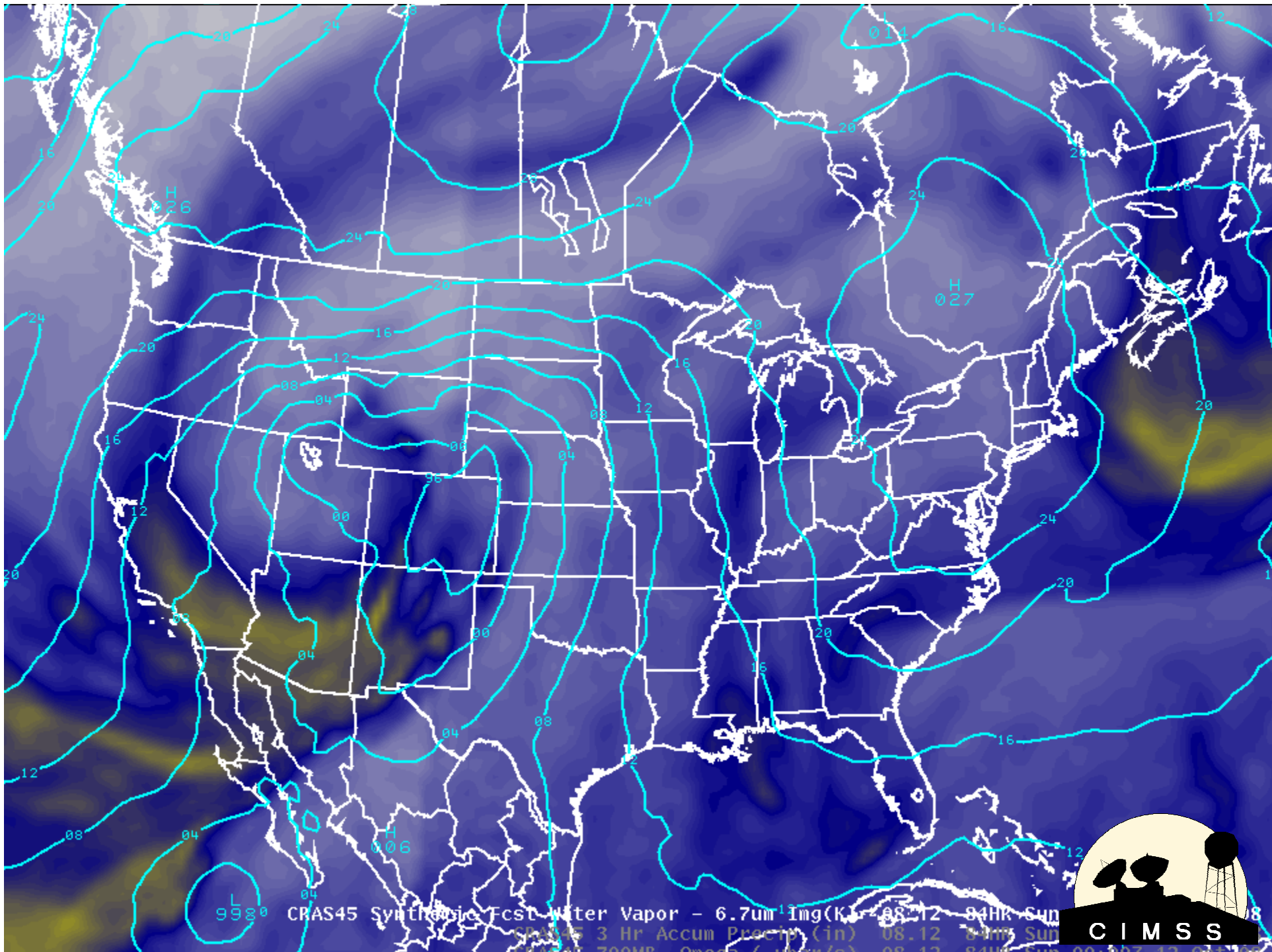


24 and 48-hour forecasts of 6-hour accumulated precipitation, 1000hPa – 500hPa thickness and mean sea-level pressure valid 12UTC 04Dec08



18-hour forecast sky cover (0% - 100%) valid 18UTC 02Dec08



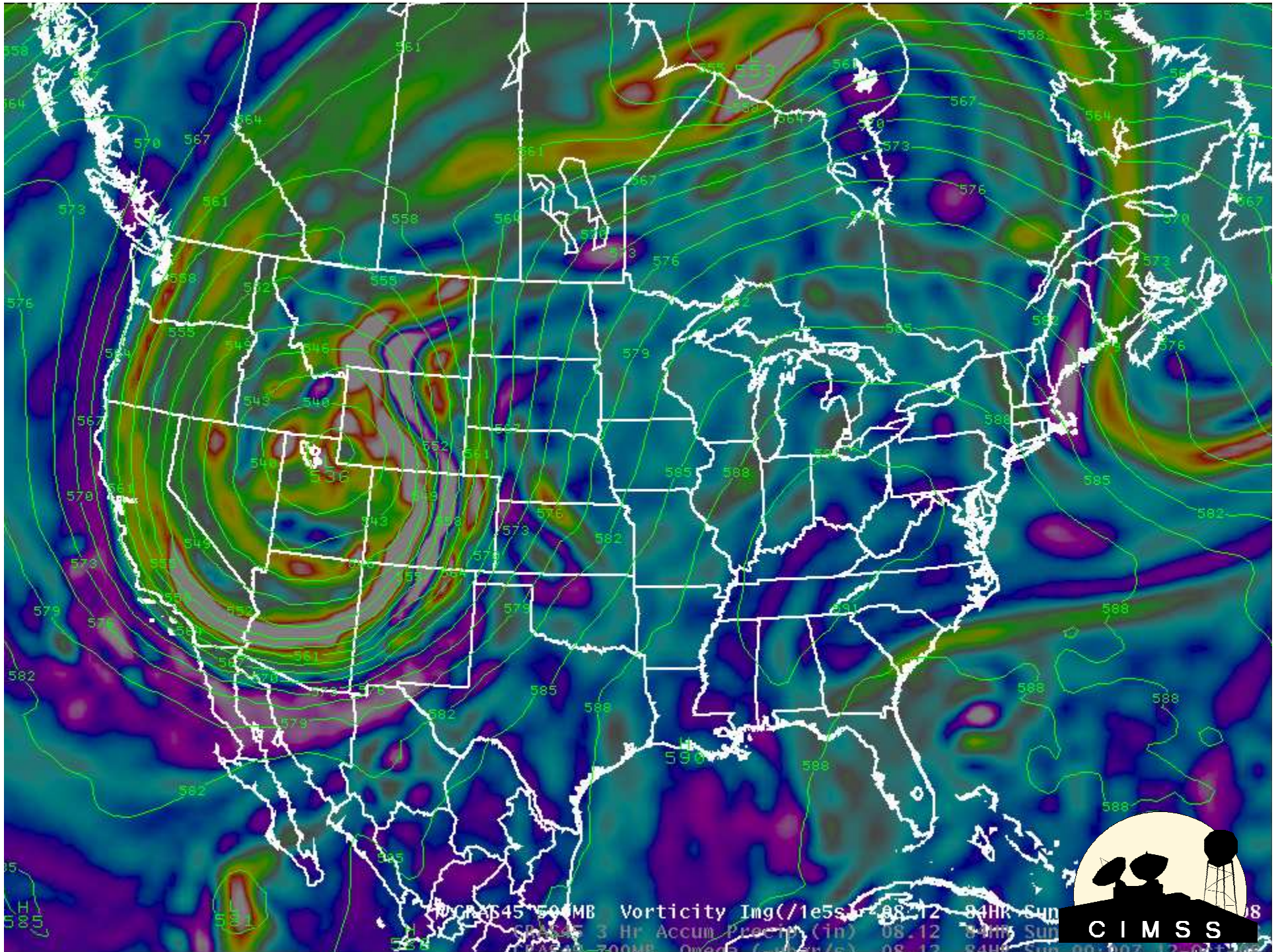


CRAS45 Synthetic Fcst Water Vapor -  $6.7 \mu\text{m}^{-1} \text{mg}(\text{K})$  08.12 84HK Sun  
 CRAS45 3 Hr Accum Precip (in) 08.12 84HK Sun  
 CRAS45 700MB Omega ( $\mu\text{bar}/\text{s}$ ) 08.12 84HK Sun

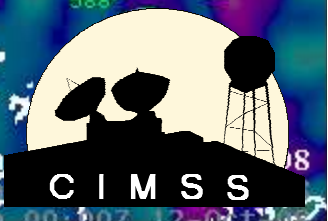


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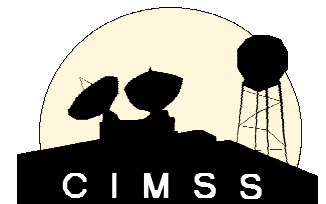
NOAA/CI 500MB Vorticity  $10^5 s^{-1}$  08.12 84HK Sun  
3 Hr Accum Precip (in) 08.12 84HK Sun  
700MB Omega ( $10^{-4} s^{-1}$ ) 08.12 84HK Sun





# IC4D

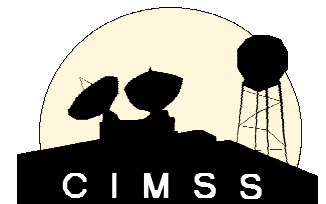
- ❑ CIMSS was recently informed that the Alaska Region is developing and using IC4D for the visualization of meteorological datasets and fields.
- ❑ Though we know it is similar and based on the GFE, we have not established the full extent to which IC4D is applied in the fields and relevant to satellite data display and dissemination.
- ❑ In order to meet the needs of our Alaskan interests, we are interested in obtaining a copy of the IC4D if it is expected to remain a viable software package during and following the AWIPS migration process.



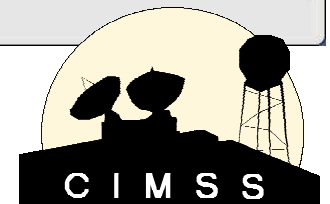
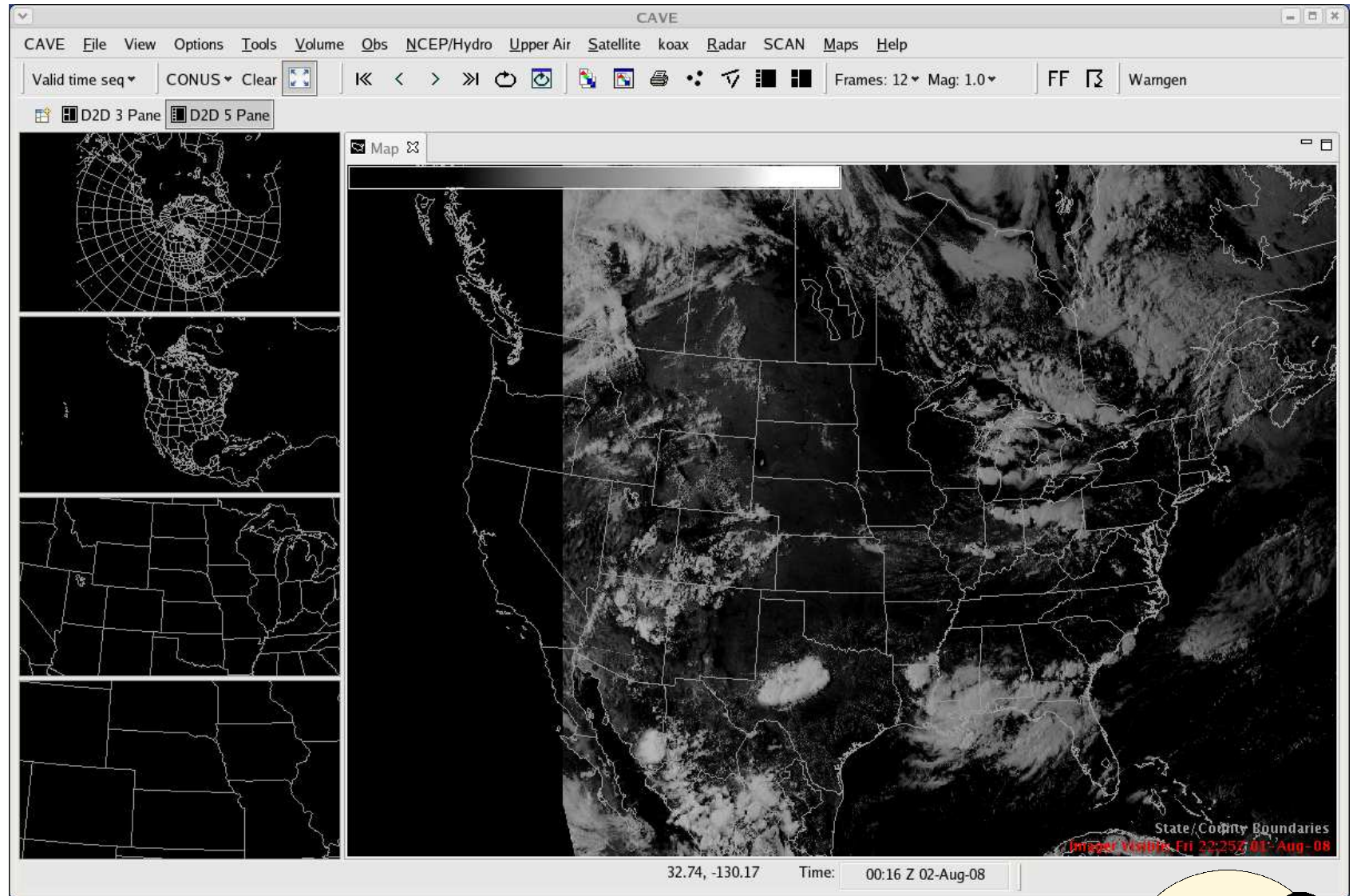


# AWIPS II

- The AWIPS Technology Infusion (ATI) project is ongoing and consists of two primary parts:
  - ▣ Transitioning the existing AWIPS baseline functionality into a new Java-based service-oriented architecture
  - ▣ Extending and expanding AWIPS II components to allow for the migration of N-AWIPS and WES functionality
- AWIPS II will also enhance online collaboration through new visual tools, data delivery with smart push/pull, information generation, and visualization through three dimensions and streamlined zooming.
- AWIPS II is currently undergoing beta testing with an initial deployment scheduled in 2010.

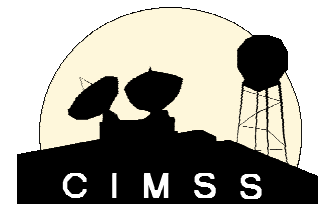


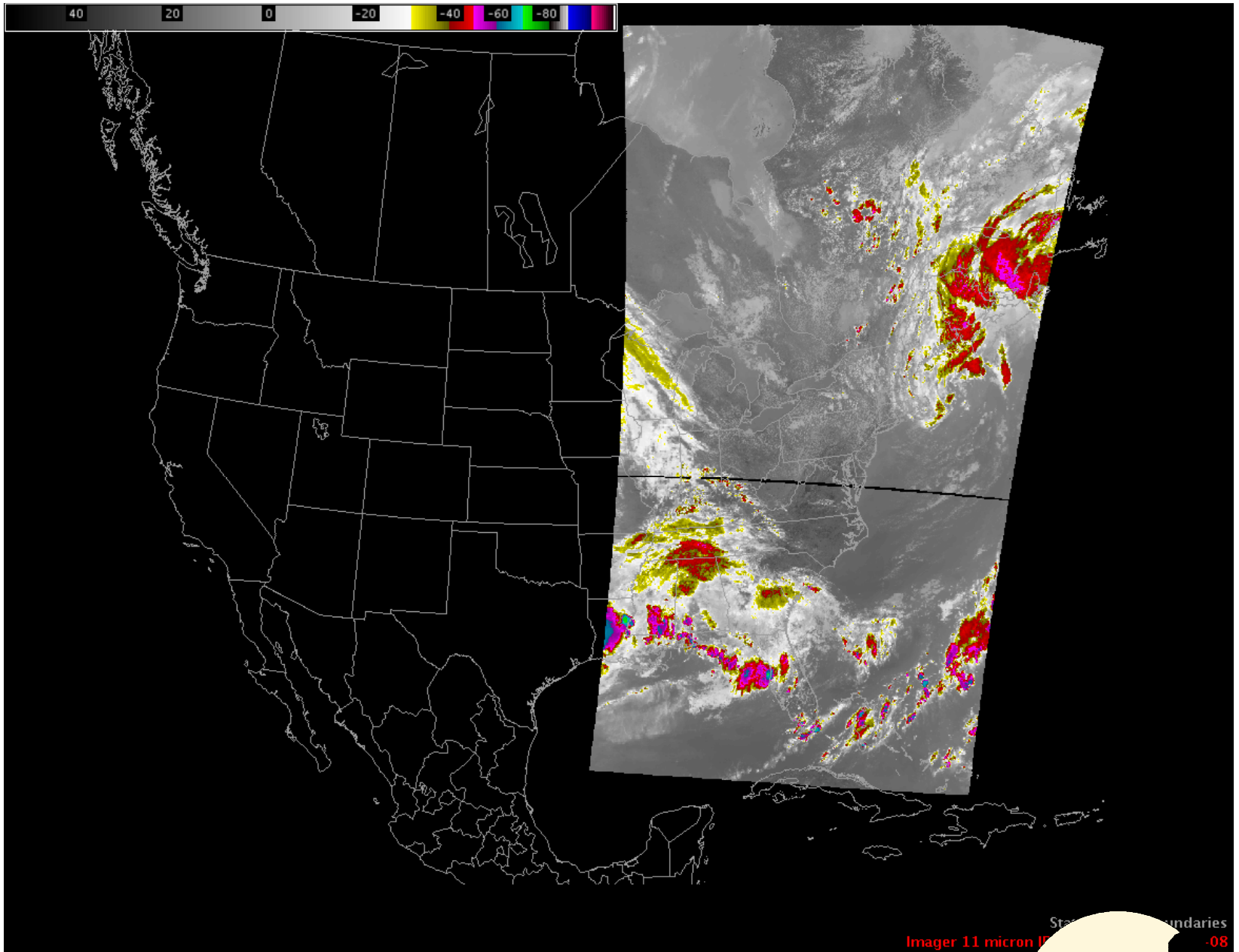
# Common AWIPS Visualization Environment (CAVE)



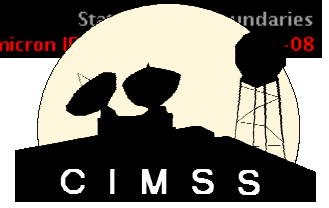
# AWIPS II

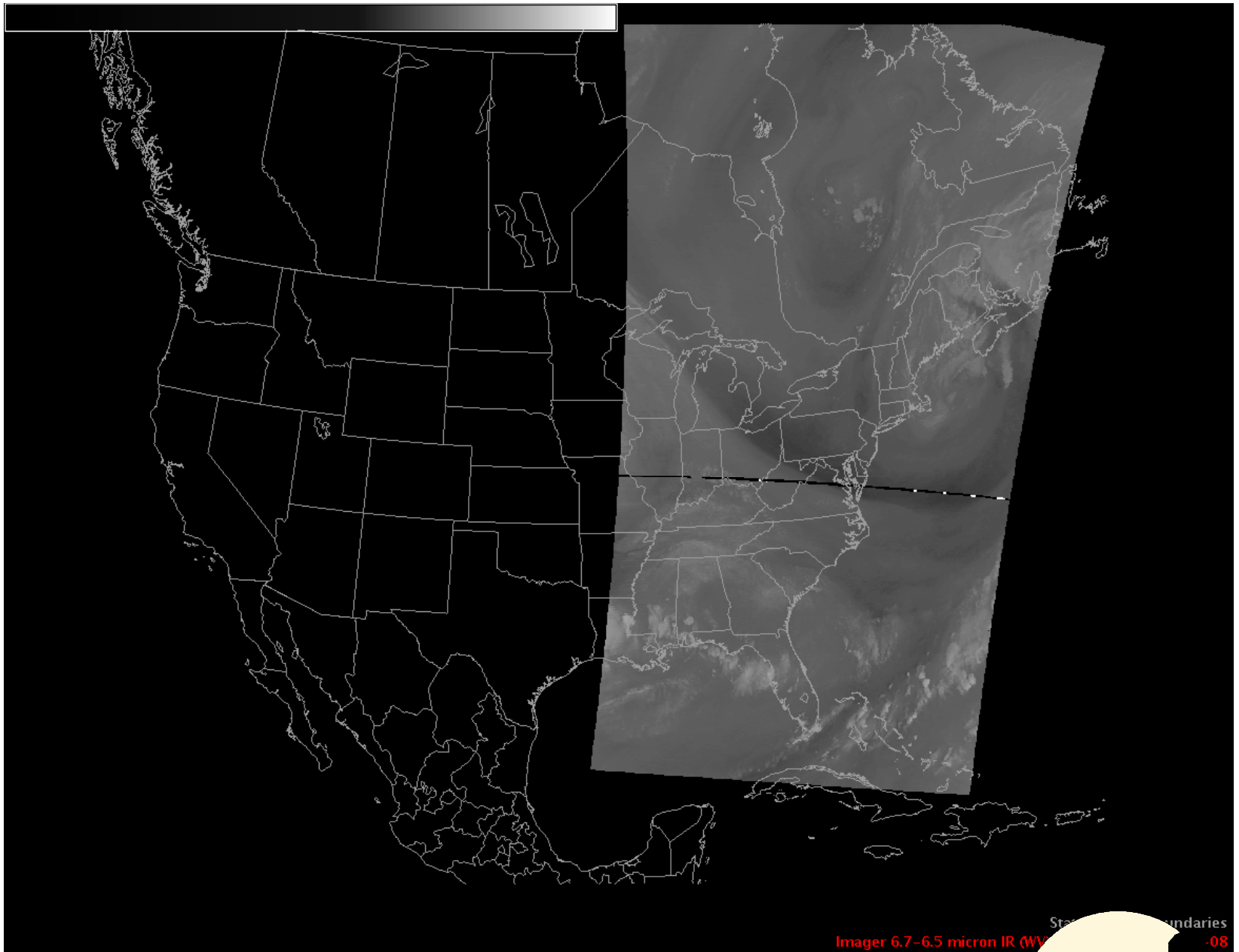
- Per an action item from our annual PG meeting, CIMSS is currently waiting to participate in the Technical Interchange Meeting (TIM) involving the transition of AWIPS I experimental products to the migrated AWIPS environment.
- The new data storage structure of AWIPS II will not allow for the AWIPS I method of sending individual netCDF files for the various bands and products.
- CIMSS has demonstrated a new process for experimental satellite product visualization in AWIPS II.
- We are preparing to work on the migration of our “local applications” into the AWIPS II environment, and will hopefully participate in NCLADT meetings and workshops this upcoming fall.



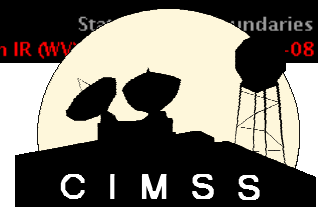


State boundaries  
Imager 11 micron IR -08





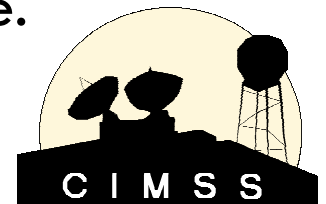
State boundaries  
Imager 6.7-6.5 micron IR (WV) -08





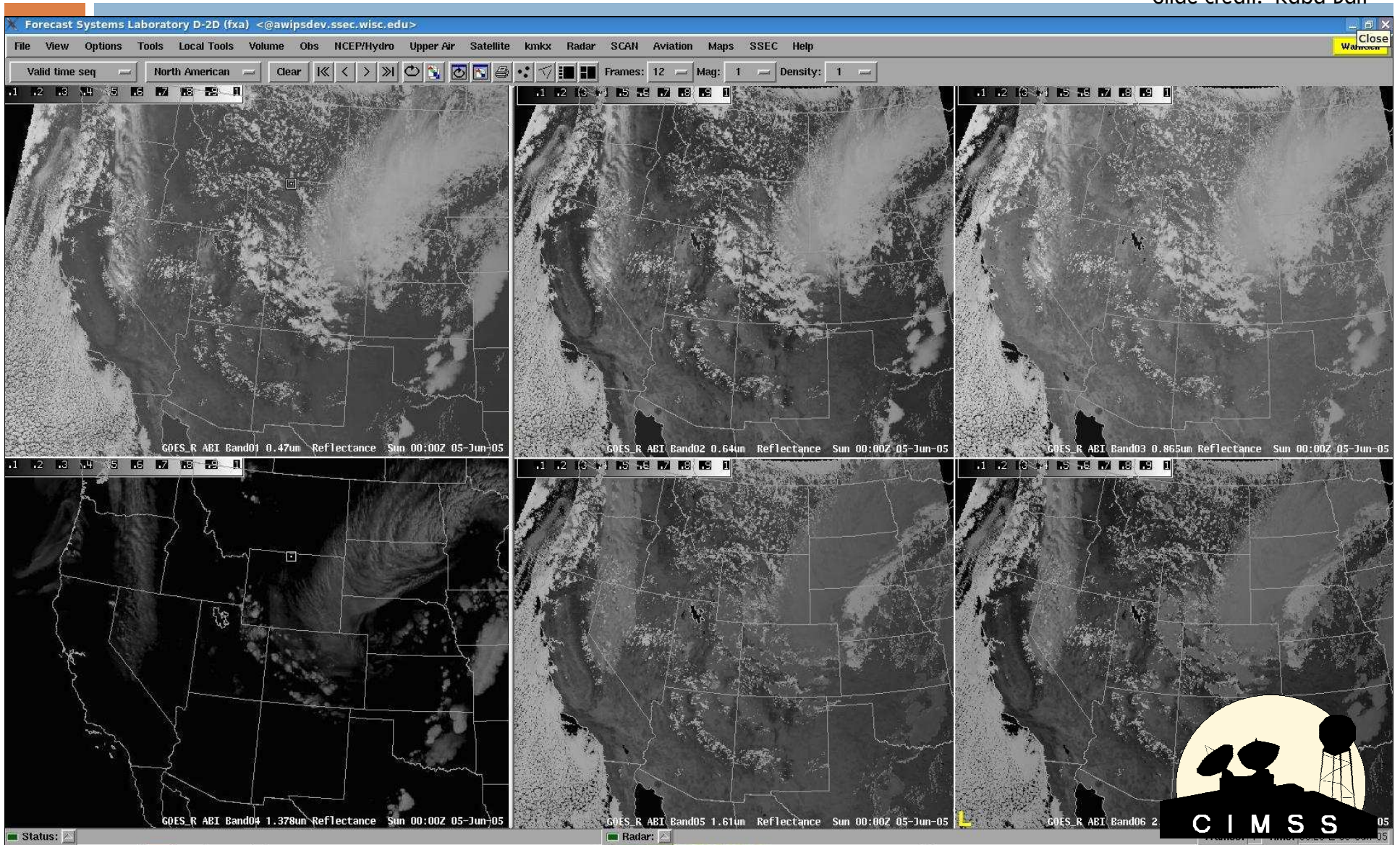
# Weather Event Simulator

- The Weather Event Simulator (WES) is a two-part interface for reviewing archived weather data (in the form of netCDF files) from AWIPS:
  - ▣ The front-end GUI D-2D operating on static data
  - ▣ Tools developed by the Warning Decision Training Branch (WDTB) for replaying data and annotating a case
- The WES is primarily a National Weather Service training tool to allow forecasters to use their decision-making skills with real datasets and examine data from a recent event. WES cases can be created with pop-up annotations in the form of text, still images, and videos synchronized to certain times to give the WES user a real-time feel.
- CIMSS is developing a GOES-R simulated ABI WES case.



# Sample Visible and Near-IR Bands of the GOES-R Advanced Baseline Imager in AWIPS/WES

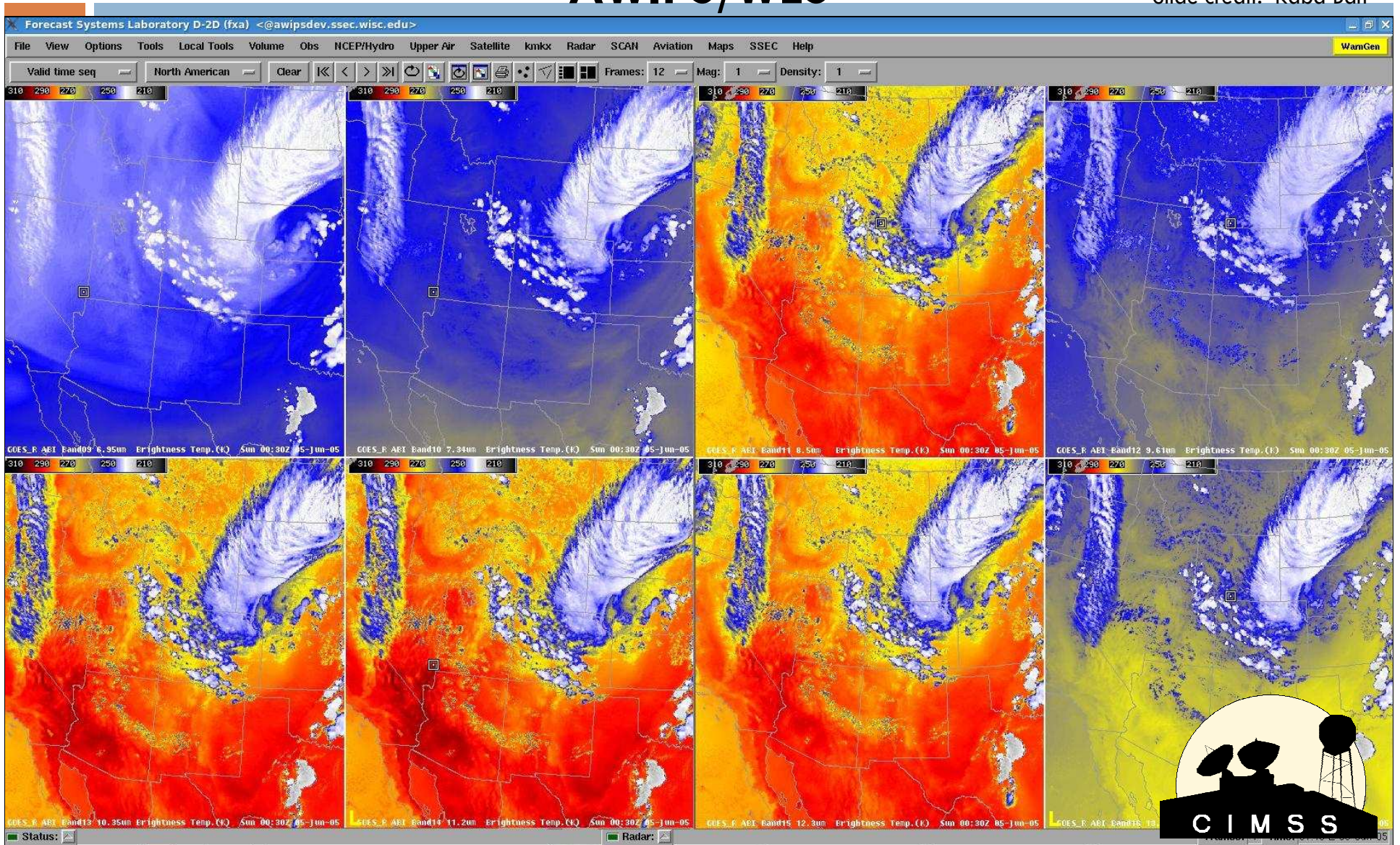
Slide credit: Kaba Bah





# Sample IR Bands of the GOES-R Advanced Baseline Imager in AWIPS/WES

Slide credit: Kaba Bah





# Comments or Questions?

- [jordang@ssec.wisc.edu](mailto:jordang@ssec.wisc.edu)
- [Jordan.Gerth@noaa.gov](mailto:Jordan.Gerth@noaa.gov)



<http://cimss.ssec.wisc.edu/goes/blog/>

A screenshot of a Windows Internet Explorer browser window displaying the CIMSS Satellite Blog. The browser's address bar shows the URL <http://cimss.ssec.wisc.edu/goes/blog/>. The page features a blue header with the CIMSS logo and the text "CIMSS Satellite Blog" and "A weblog of meteorological satellite imagery relevant to current weather events". Below the header, there is a search bar and a main article titled "Of large eyes and midget tropical cyclones" dated "October 8th, 2008". The article includes a satellite image of Hurricane Norbert and a text block describing the storm's eye and intensification. On the right side, there are sections for "Pages" and "Archives" with a list of months from 2005 to 2008. The browser's status bar at the bottom shows "Done" and "Internet".