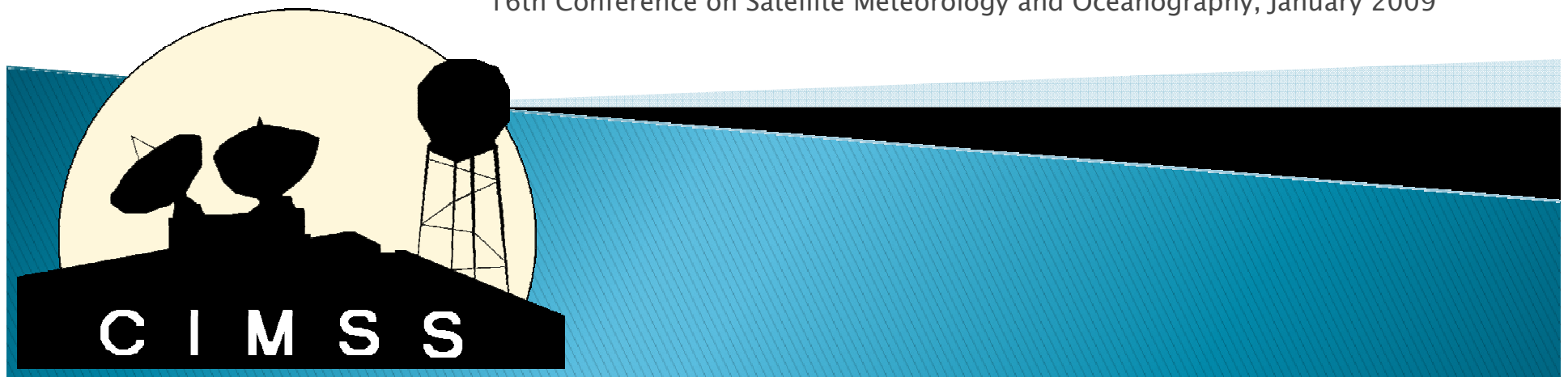


Transitioning Satellite Products to National Weather Service Operations, and Future Directions for the GOES-R Era

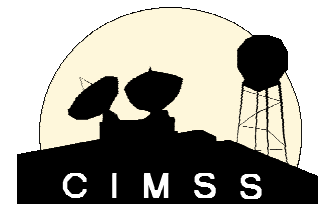
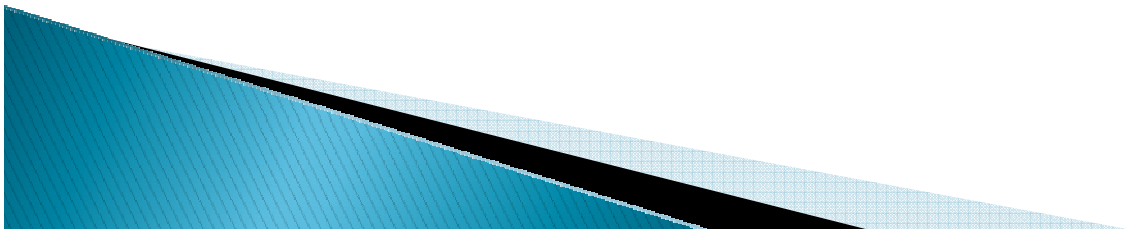
Jordan J. Gerth and A. Scott Bachmeier
Cooperative Institute for Meteorological Satellite Studies
Space Science and Engineering Center
University of Wisconsin at Madison

16th Conference on Satellite Meteorology and Oceanography, January 2009



Presentation Outline

- ▶ Research to Operations
 - Our Distribution; Our Model
 - Delivering to the National Weather Service:
 - Satellite imagery to operations originally intended for use in a research environment (leveraging existing space resources)
 - New satellite products under development (tailor to users)
 - Datasets infused with satellite data, bettering initial conditions for numerical weather prediction models
 - Operations to Research
 - Honest feedback is *critical* to success
- ▶ N-AWIPS, AWIPS, AWIPS II
- ▶ Weather Event Simulator
- ▶ GOES-R Proving Ground



Research to Operations: Our Distribution

▶ MODIS

- Visible (Band 1)
- Snow/Ice (Band 7)
- Cirrus (Band 26)
- 3.7 μ m (Band 20)
- Water Vapor (Band 27)
- IR Window (Band 31)
- 11 μ m – 3.7 μ 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

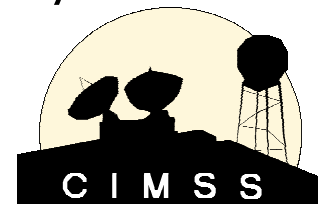
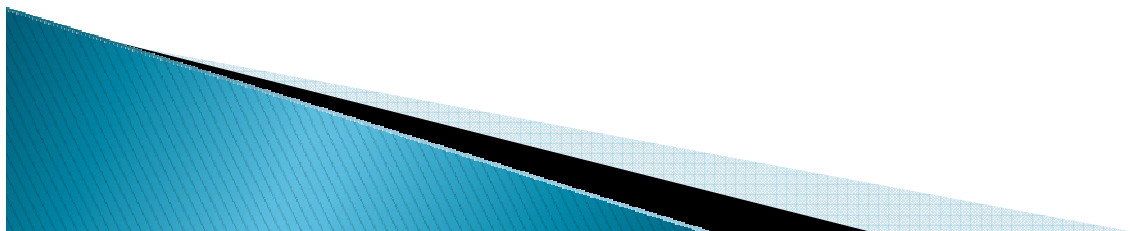
▶ GOES Sounder

- Total Column Ozone
- Conv Available Potl Energy

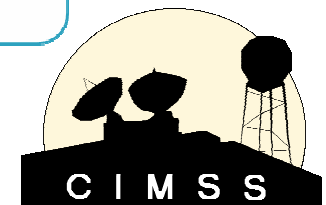
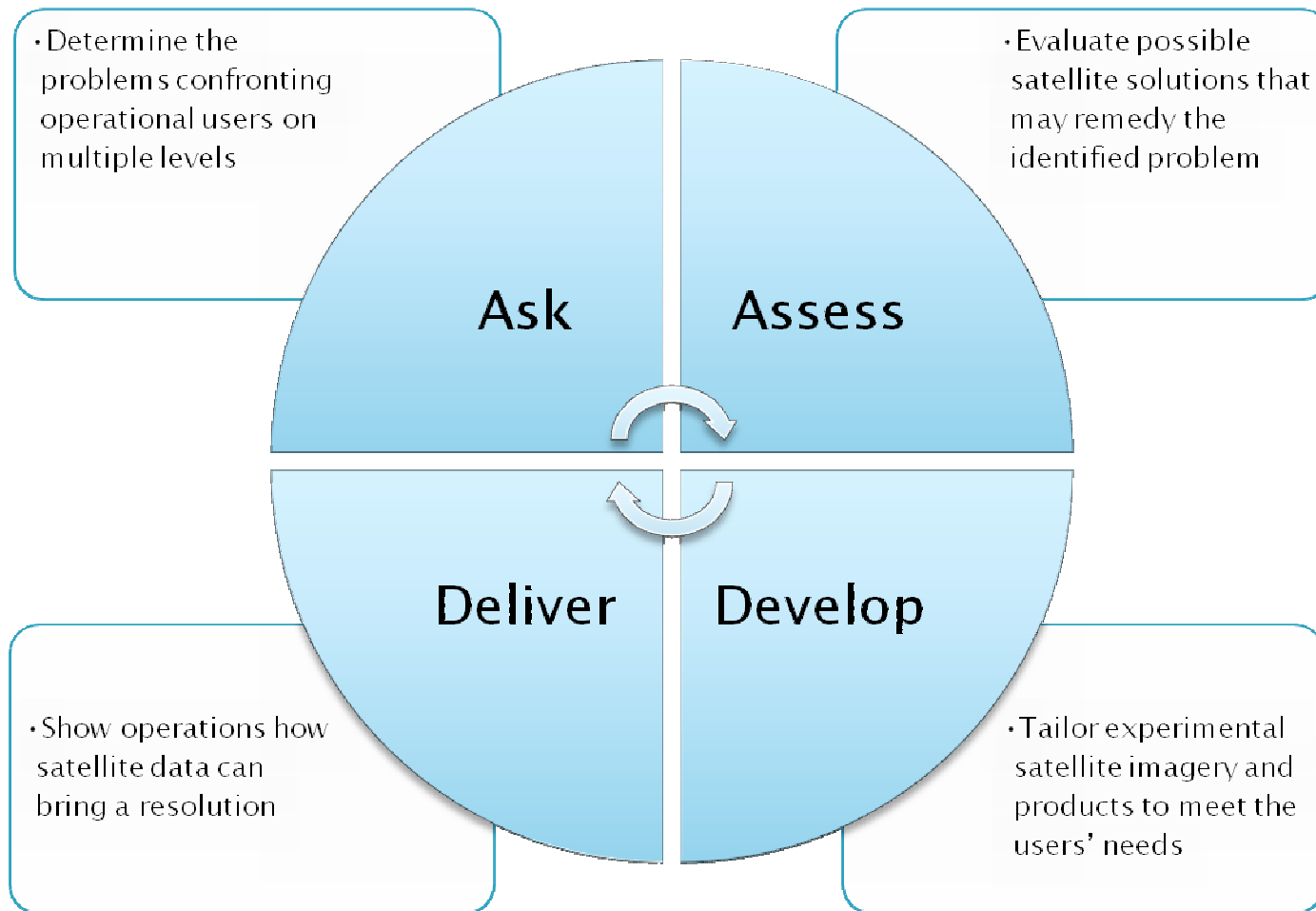
▶ GOES Mesoscale Winds

▶ CRAS (NWP Model)

- Standard model output
- Synthetic IR imagery
- Synthetic WV imagery

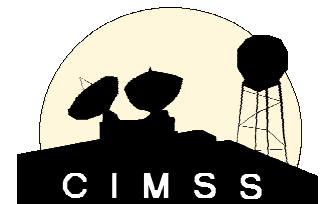
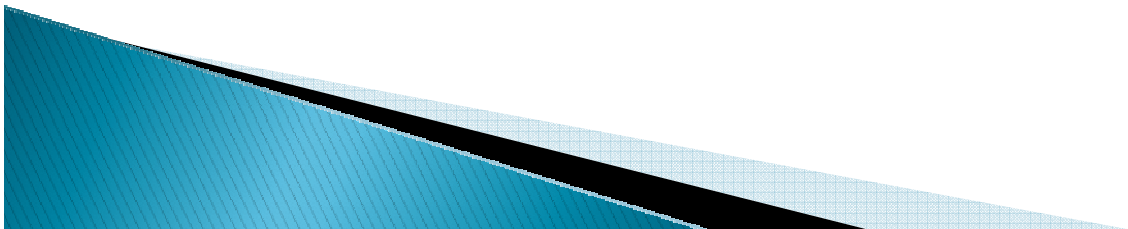


Research to Operations: Our Model



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

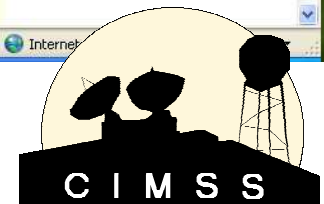
MODIS Imagery in AWIPS Survey for National Weather Service forecasters

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

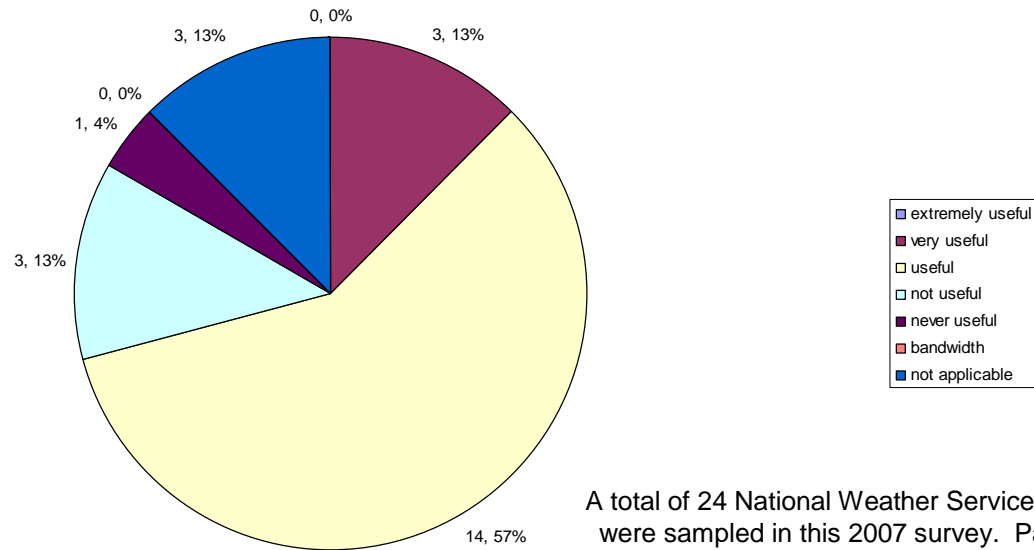
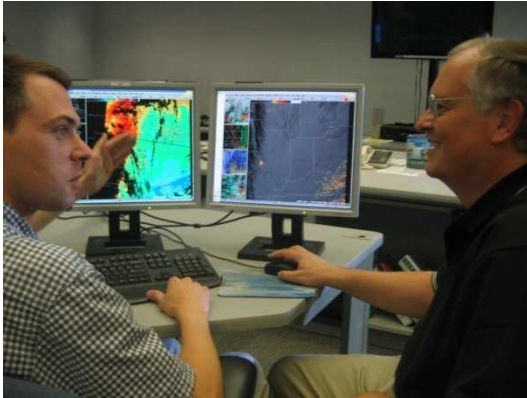
1. How many years have you been a National Weather Service employee? <i>(required, numbers only)</i>	<input type="text"/>
2. How often do you look at MODIS images and products available in AWIPS? <i>(required, select one)</i>	<input type="radio"/> Multiple times per shift <input type="radio"/> Once per 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



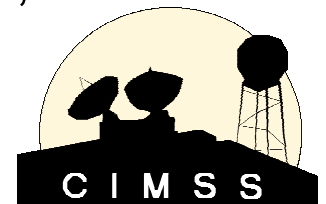
In general, how useful are MODIS images and products in daily operations?



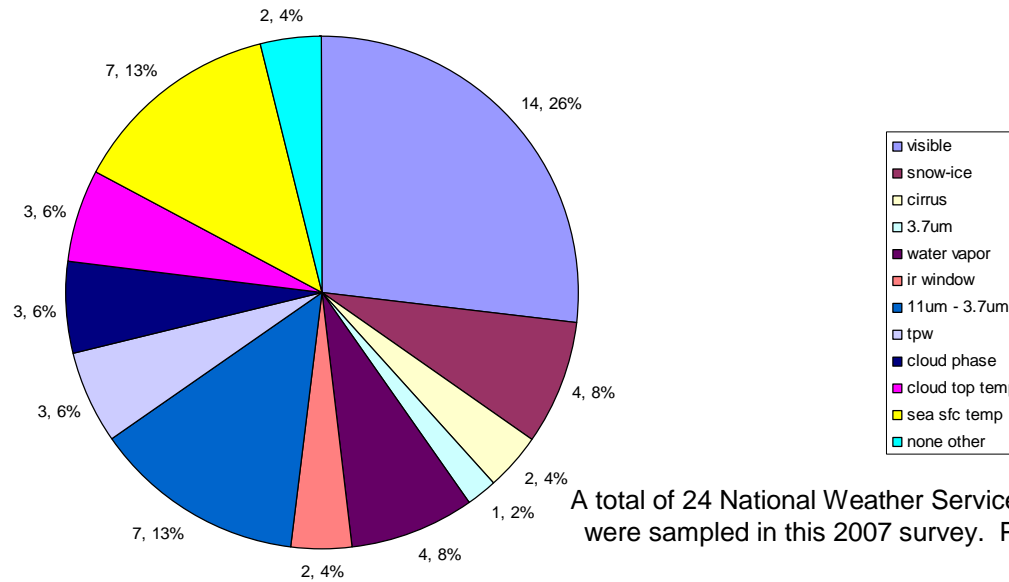
A total of 24 National Weather Service forecasters at five offices were sampled in this 2007 survey. Participation was optional.

“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



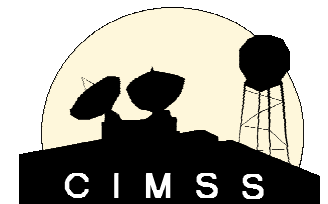
What MODIS images and products in AWIPS do you use most frequently?



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

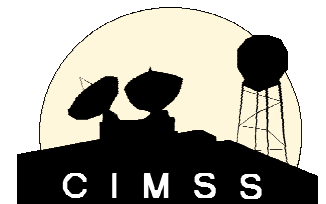
“This is a great dataset for WFO Operations. We would love to continue to see more and more data get into AWIPS. The Fog product I have found to be especially useful, as well as the Snow/Ice Band 7. Great stuff!”

From National Weather Service Forecast Office in La Crosse, Wisconsin



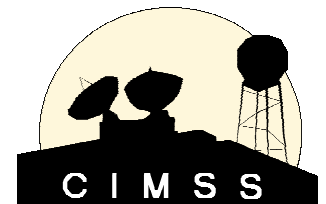
Assess

- ▶ 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

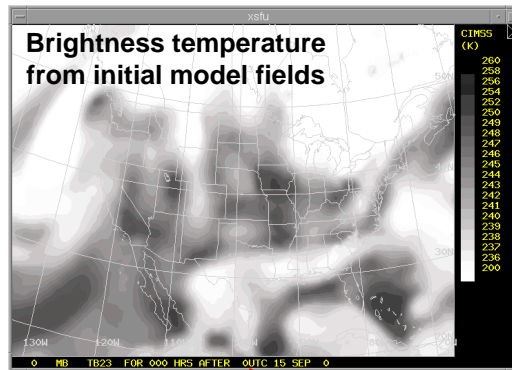
- ▶ There are three types of product development for research to operations projects:
 - Implementation of imagery or well-established derived products existing in a research capacity with little or no modification
 - The creation of a new product based on research not yet transferred to operations
 - 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



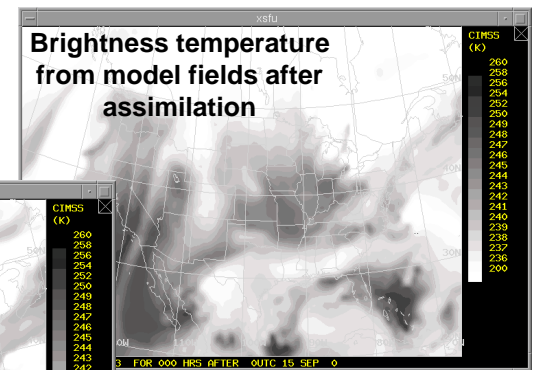
Information Extracted from Satellites

Radiances

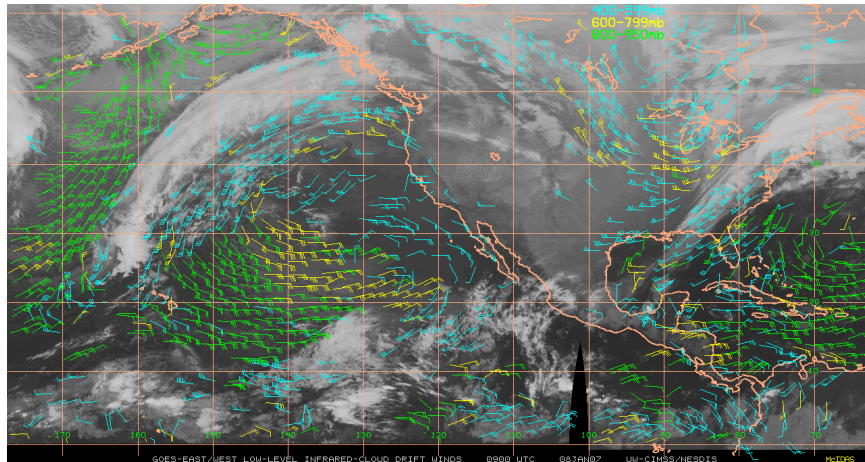
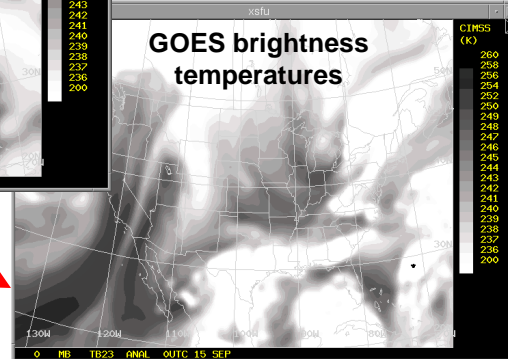
- Direct assimilation (3Dvar)
- Requires knowledge of errors
- Scale dependence
- Surface type restrictions



Radiance Assimilation

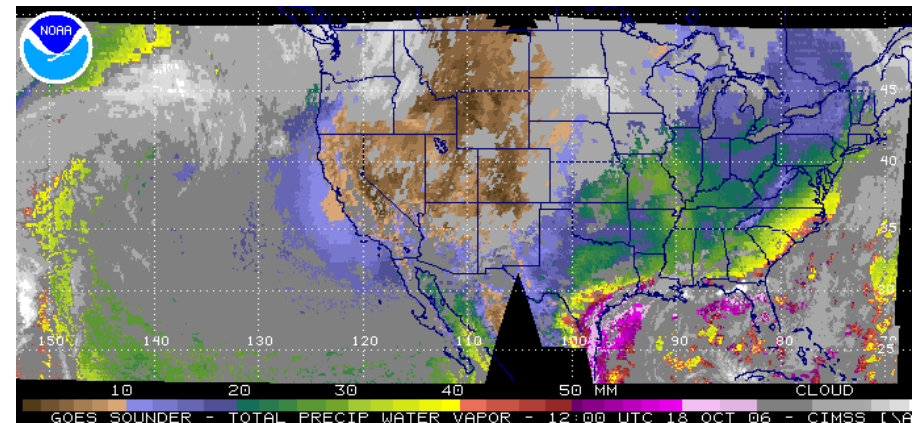


GOES brightness temperatures



Motion

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



Retrieved parameters

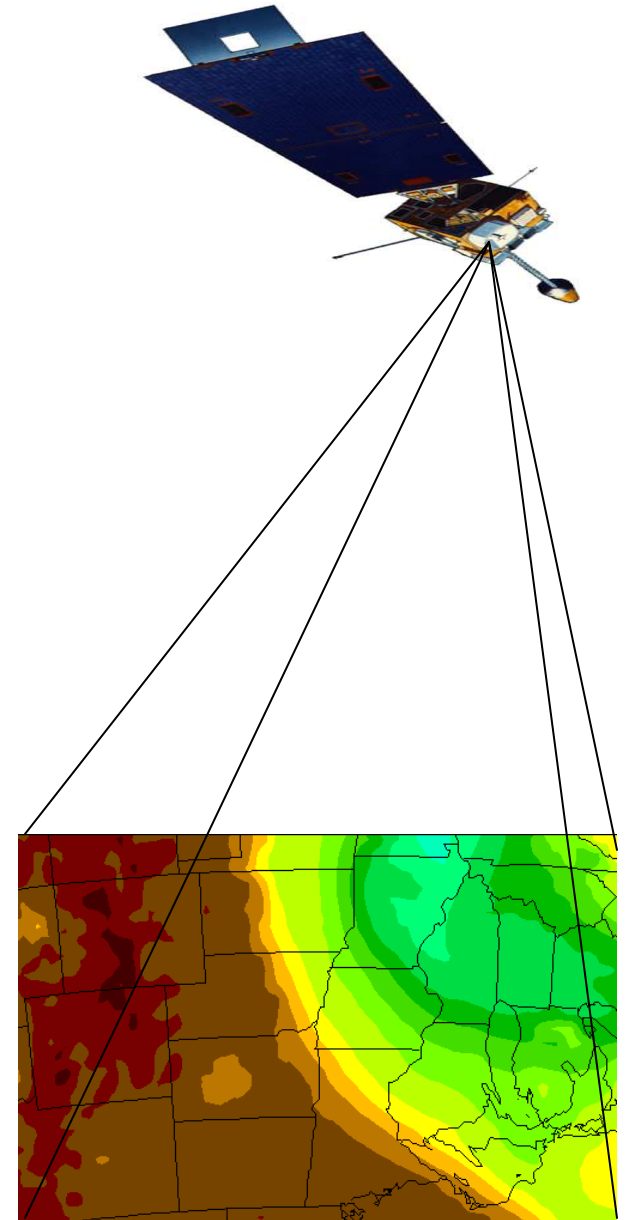
- Dependent variable assimilation (1,3Dvar)
- Requires knowledge of retrieval errors
- Physical accuracy, non-linearity
- Bypass surface type restrictions

CIMSS Regional Assimilation System

CRAS

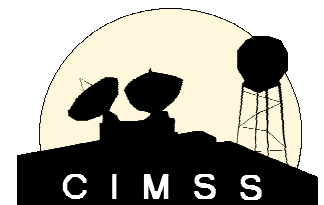
The Cooperative Institute for Meteorological Satellite Studies (CIMSS) uses the CIMSS Regional Assimilation System (CRAS) to assess the impact of space-based observations on numerical forecast accuracy.

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



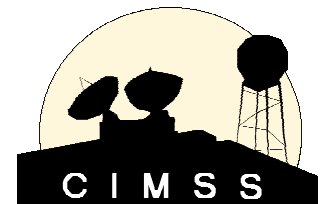
Deliver

- ▶ Experimental data is delivered to the National Weather Service Forecast Offices using a server with the Local Data Manager (LDM) software provided by Unidata.
- ▶ 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.



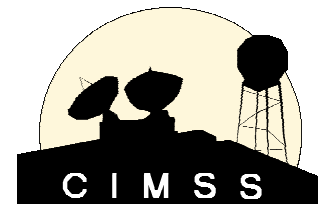
N-AWIPS

- ▶ 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.
- ▶ It contains both graphical user interfaces (GUIs) and standard input applications with graphical output to disk or display.
- ▶ It is employed by the National Centers (such as Storm Prediction Center, Tropical Prediction Center, etc.) to produce operational Redbook Graphics which are disseminated over the Satellite Broadcast Network.



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.
- ▶ The graphical user interface (GUI) which serves as a front-end for data access is Display Two-Dimensions (D-2D). AWIPS has essentially no command-line interface except the localization scripts.
- ▶ Users can create procedures for easy loading.



(fxa)Text Workst

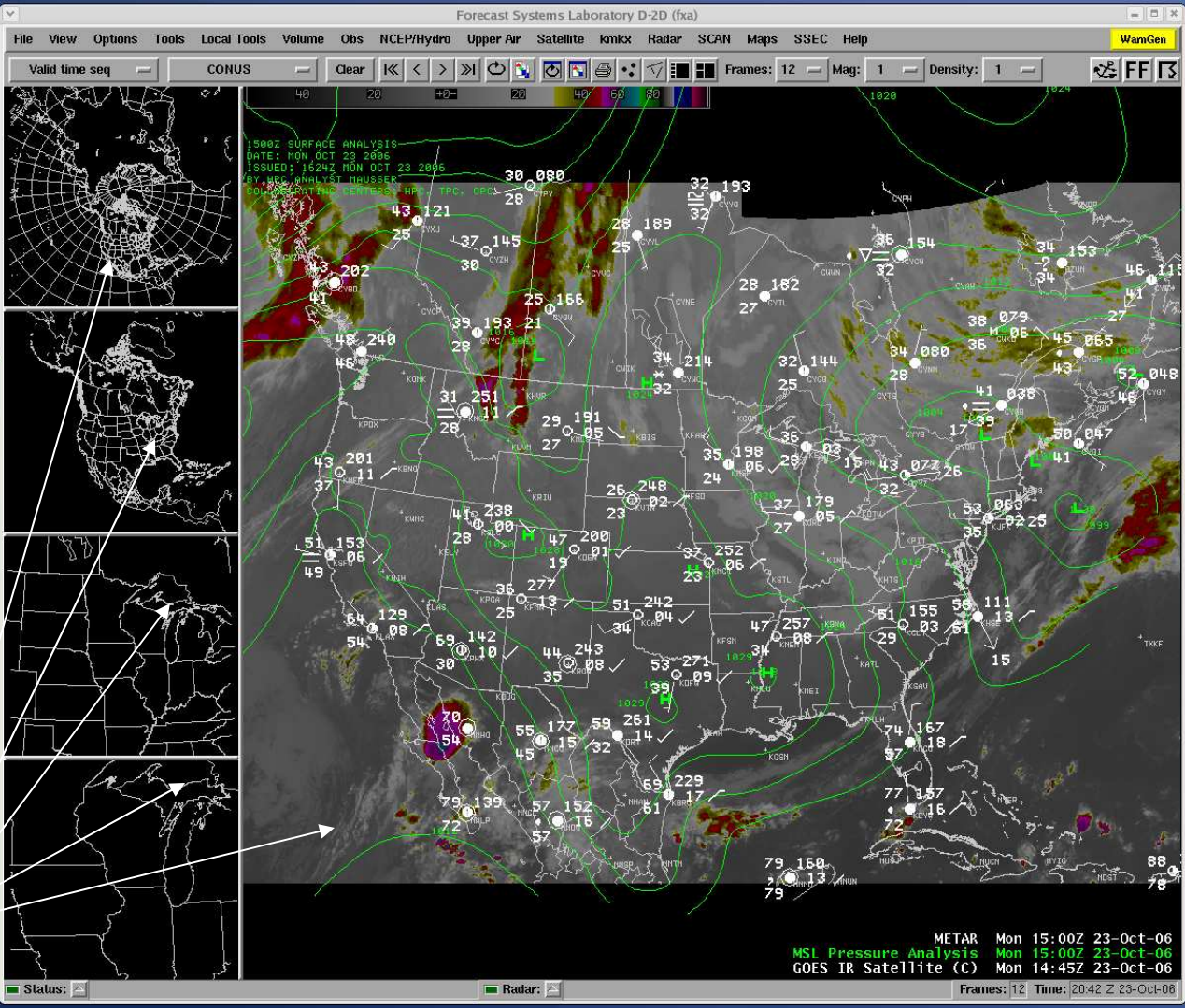
File Windows



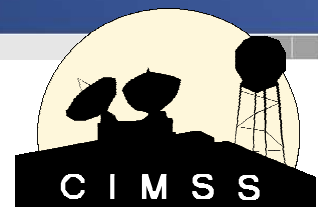
Mon 23 Oct 2006 20:43 UTC
Mon 23 Oct 2006 20:43 GMT

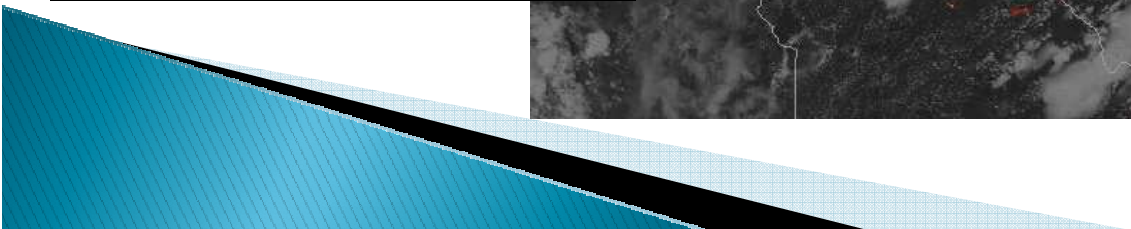
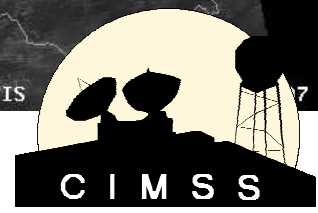
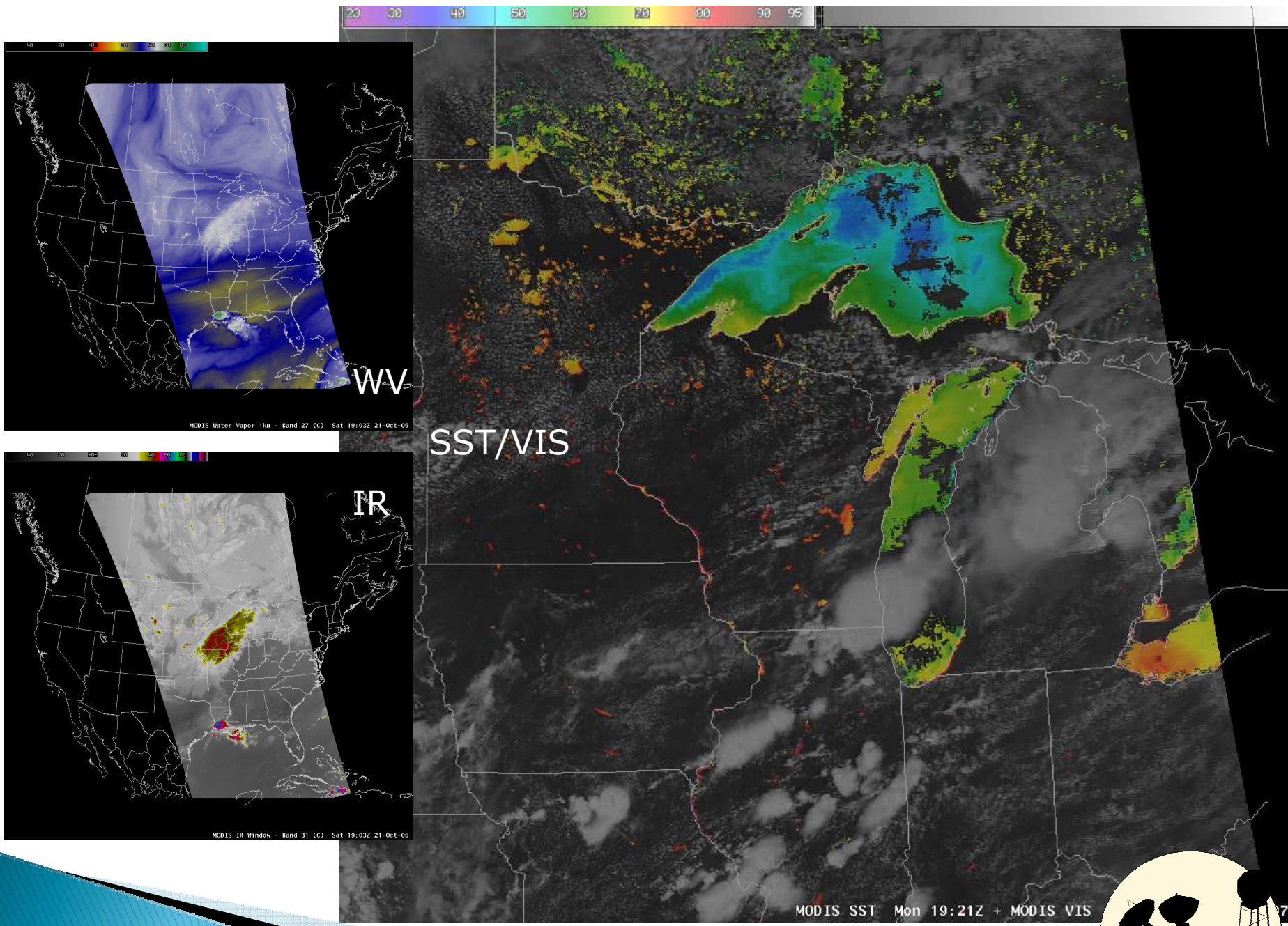
Alarm/Alert

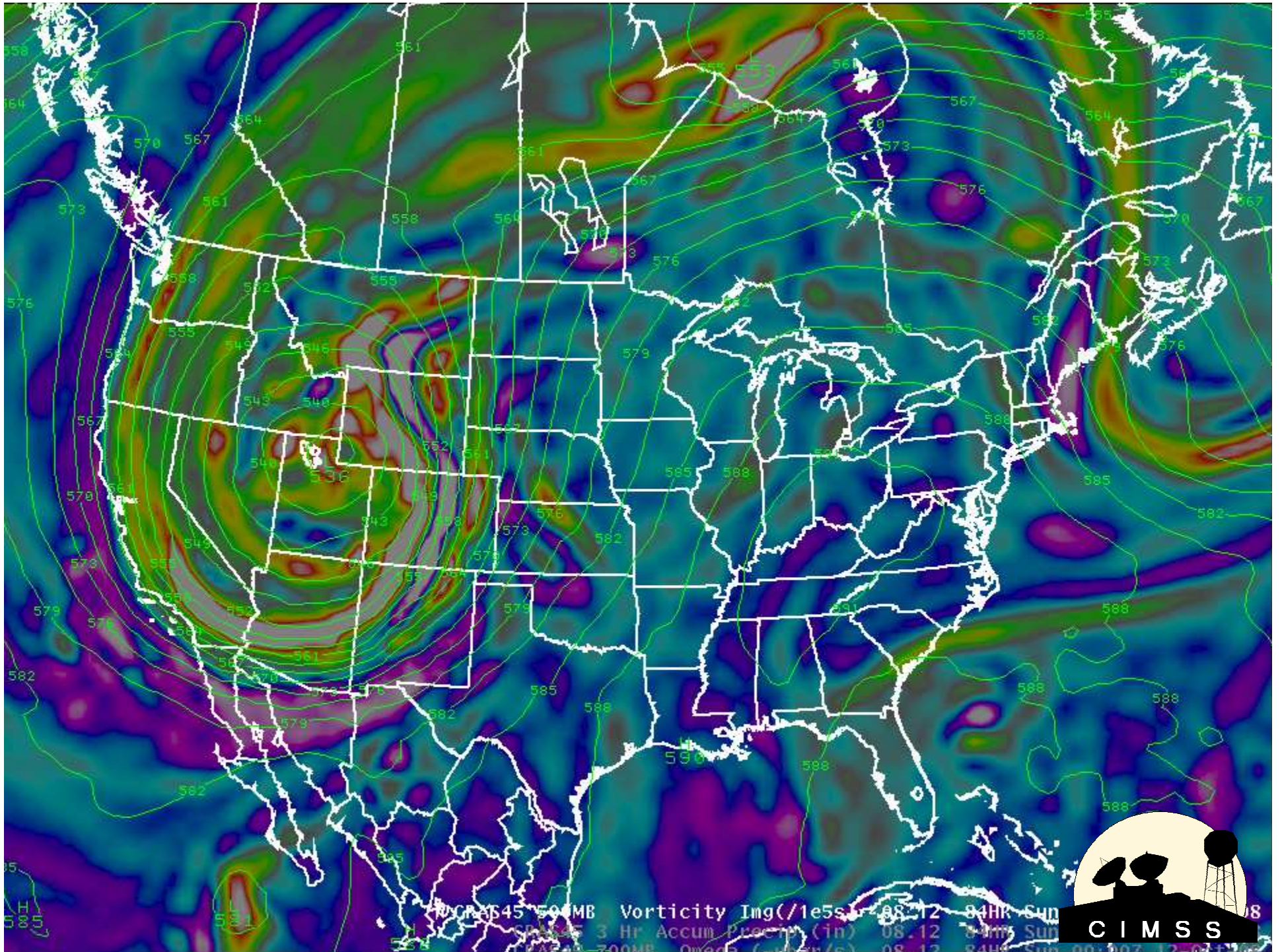
- Text 1
- Text 2
- Text 3
- Text 4



Panes



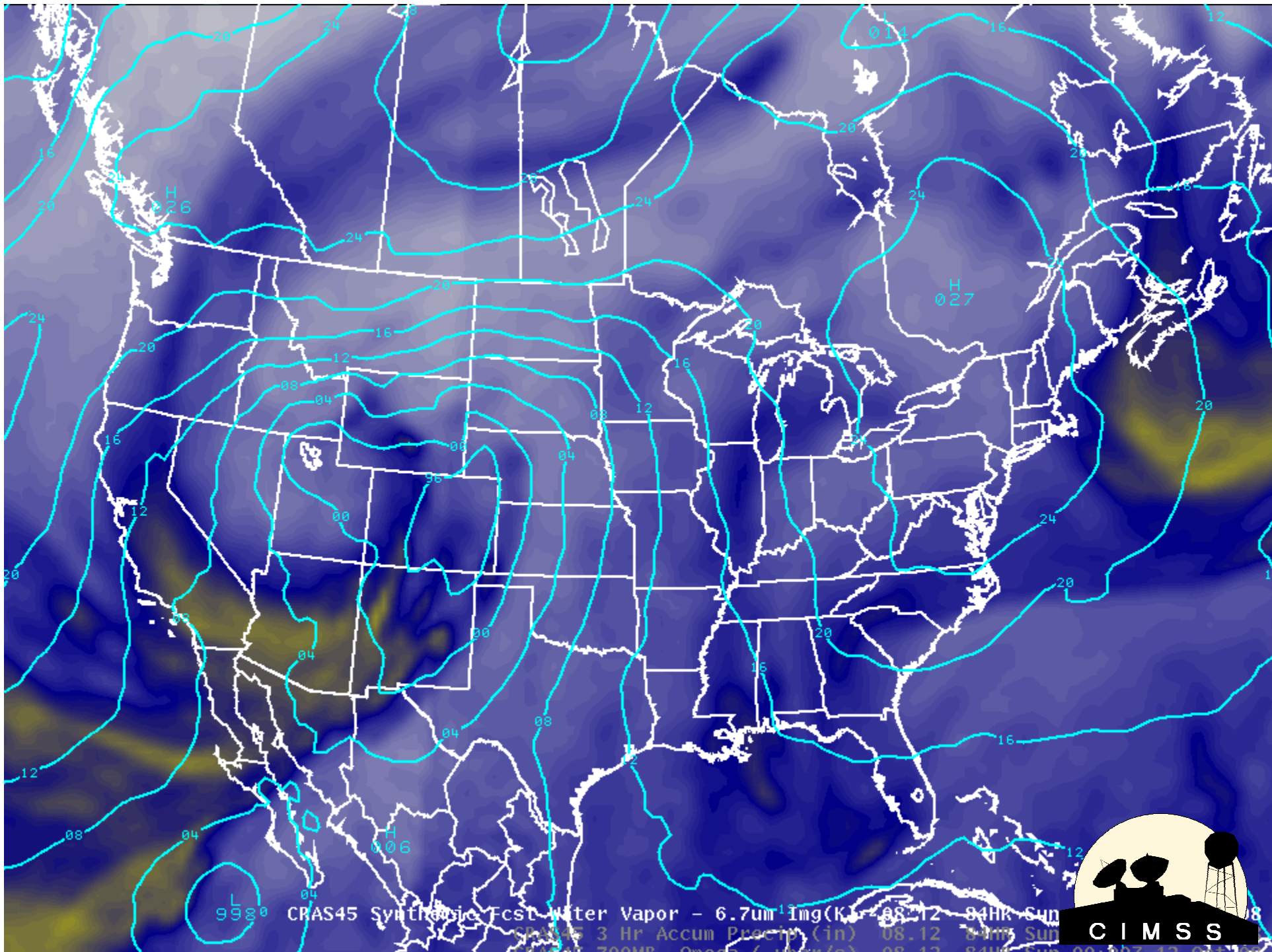




08.12 84HK Sun
 08.12 84HK Sun
 08.12 84HK Sun
 00:00Z 12-07-12



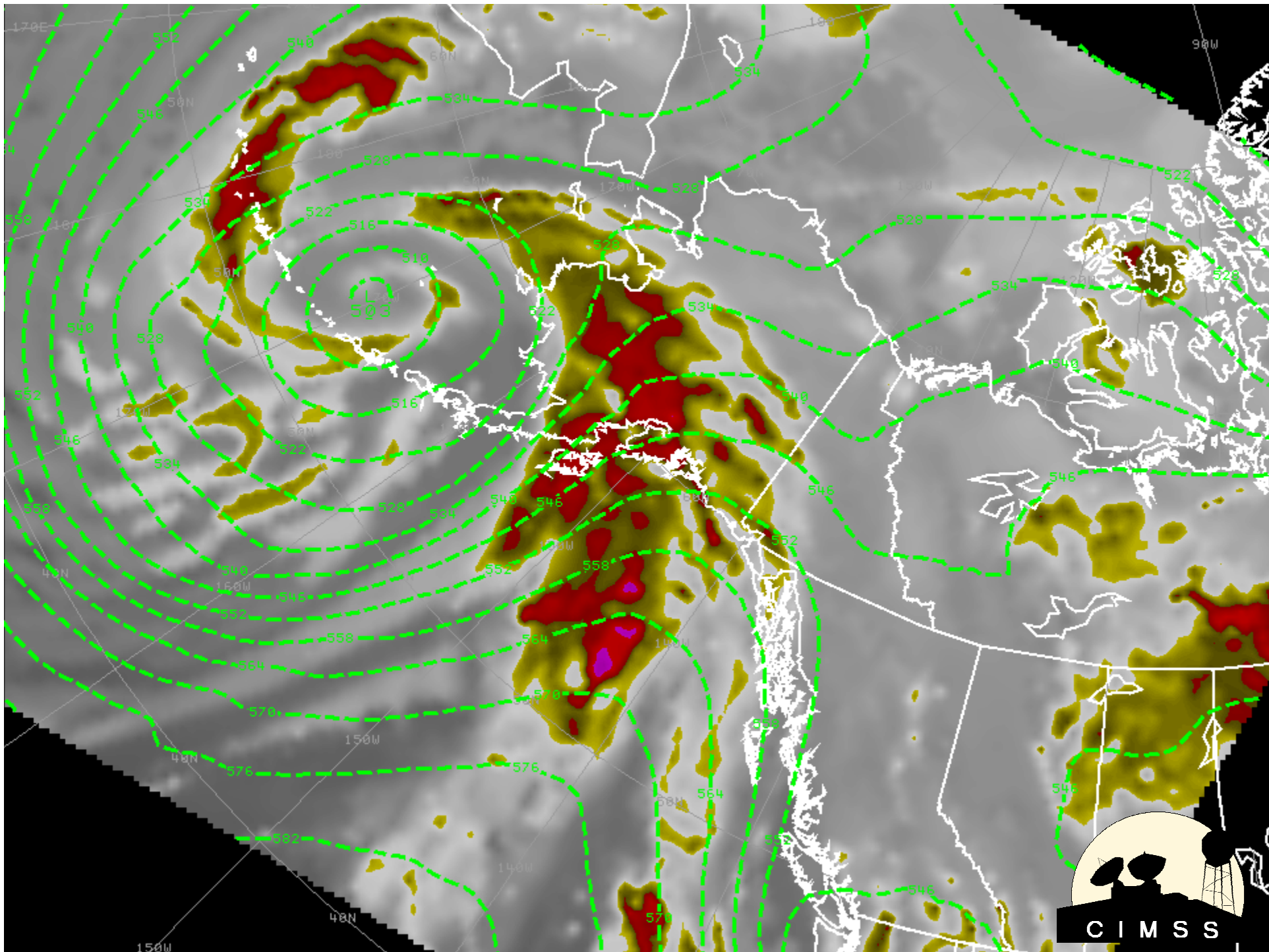
CIMSS



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 00:00Z 12-07-05

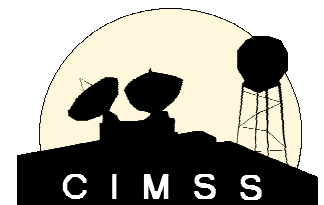


CIMSS

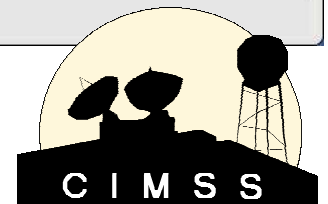
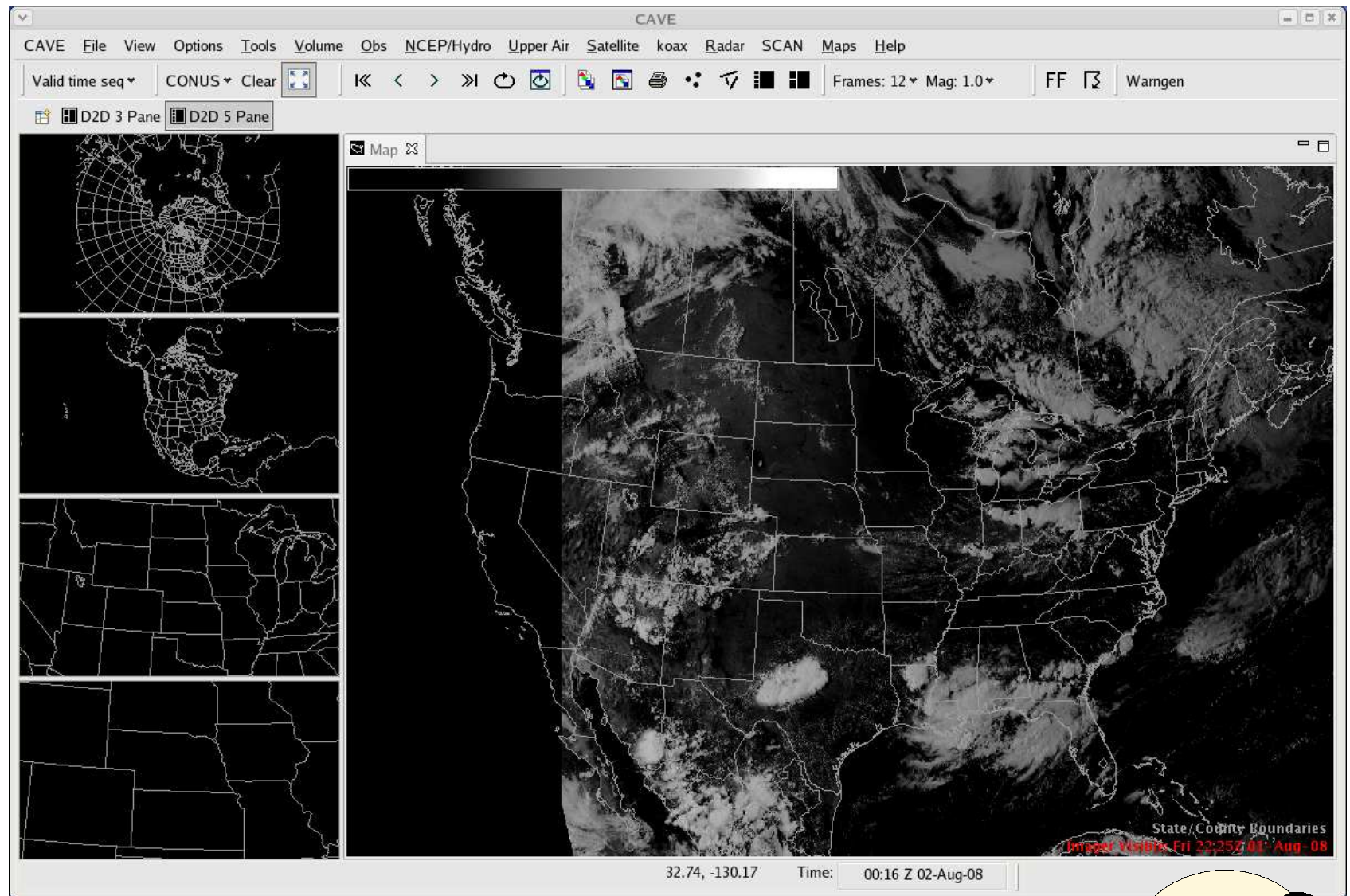


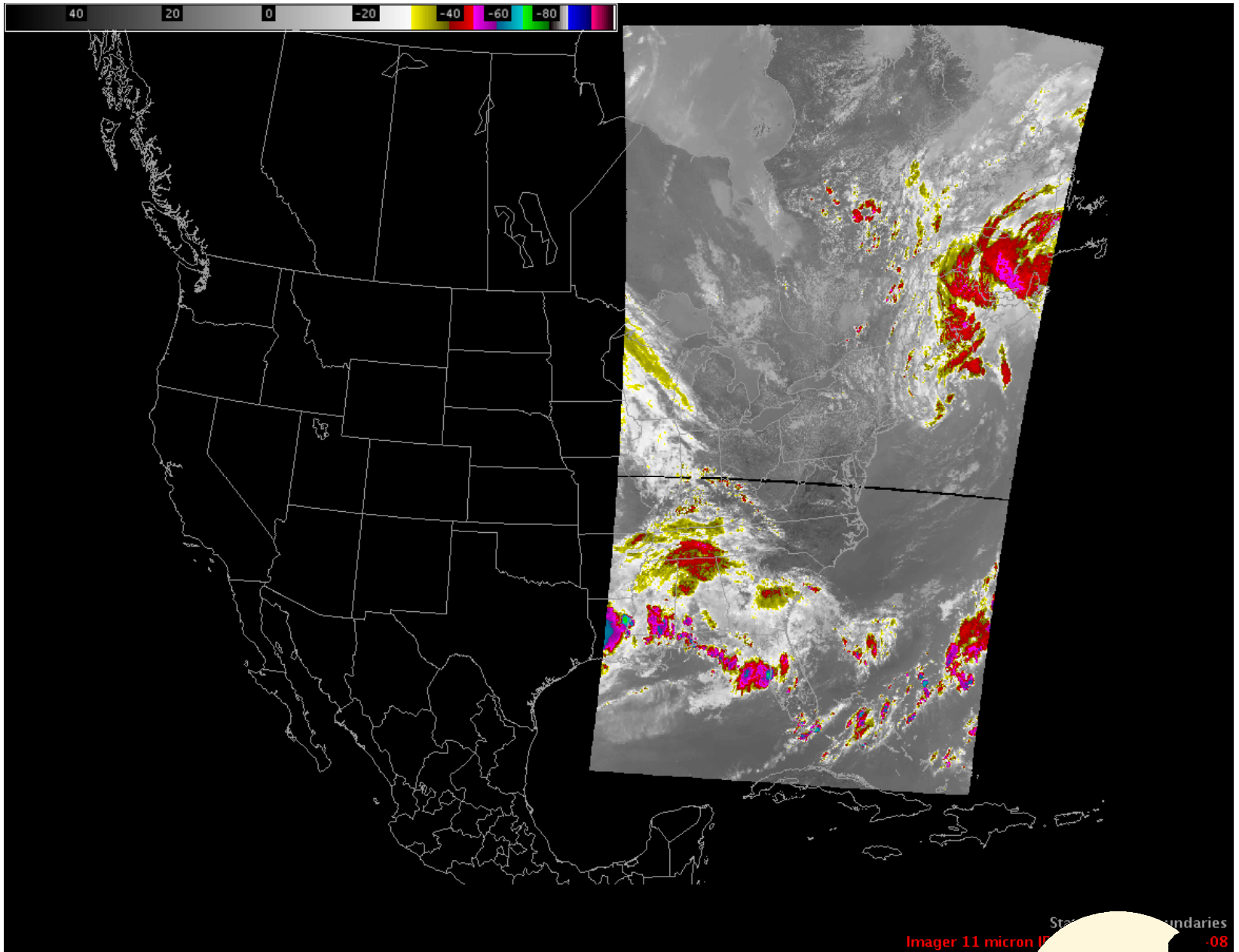
AWIPS II

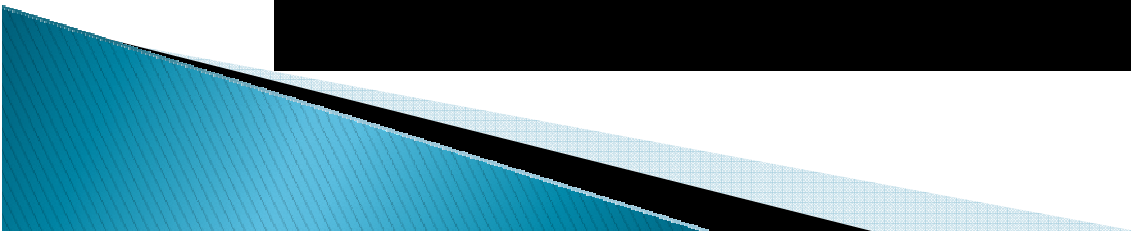
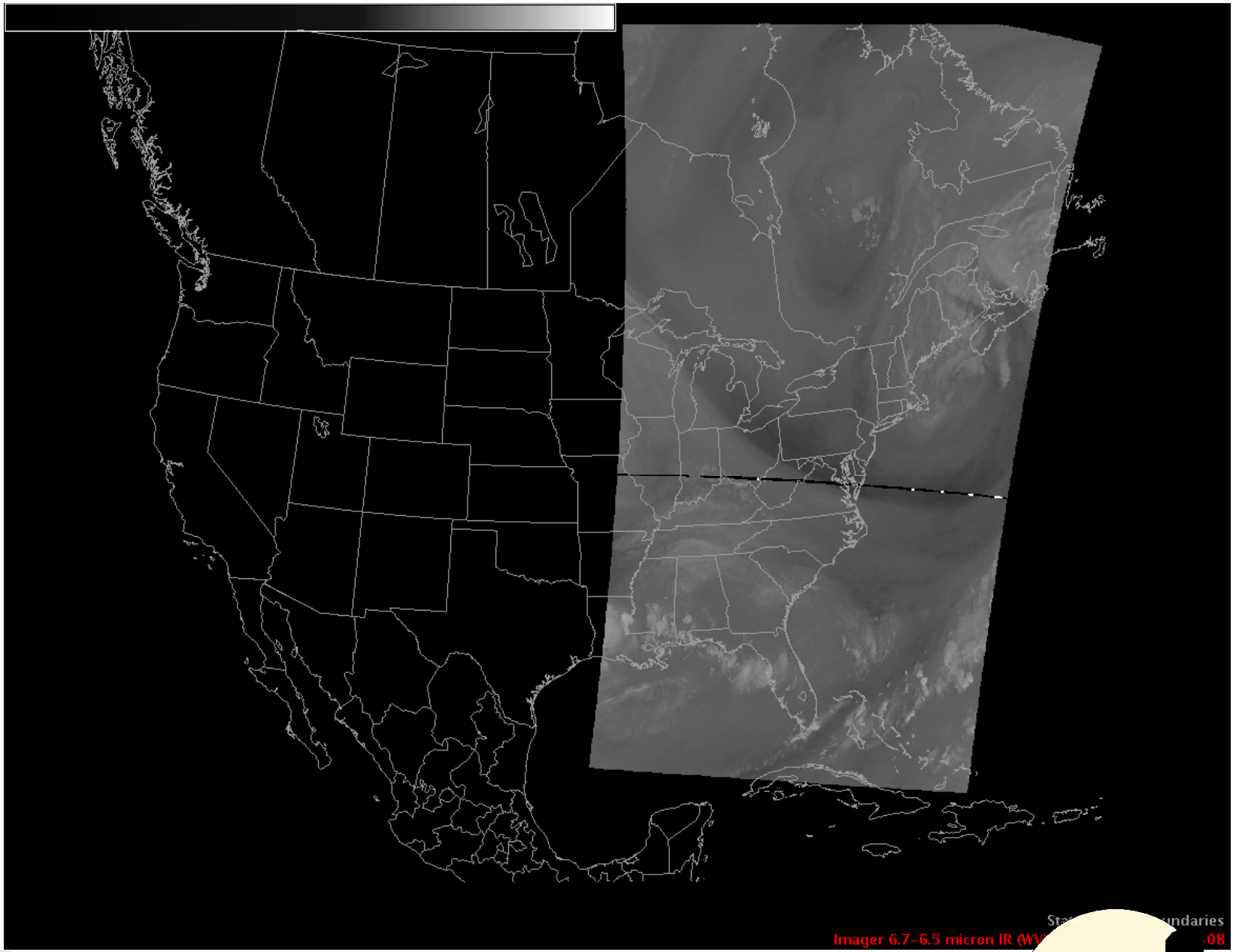
- ▶ The AWIPS Technology Infusion (ATI) project is ongoing and consists of two primary parts:
 - Transitioning the existing AWIPS baseline functionality into a new Java-based service-oriented architecture
 - Extending and expanding AWIPS II components to allow for the migration of N-AWIPS and WES functionality
- ▶ 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 early 2010.



Common AWIPS Visualization Environment (CAVE)

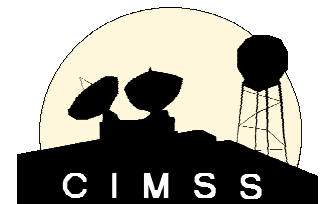
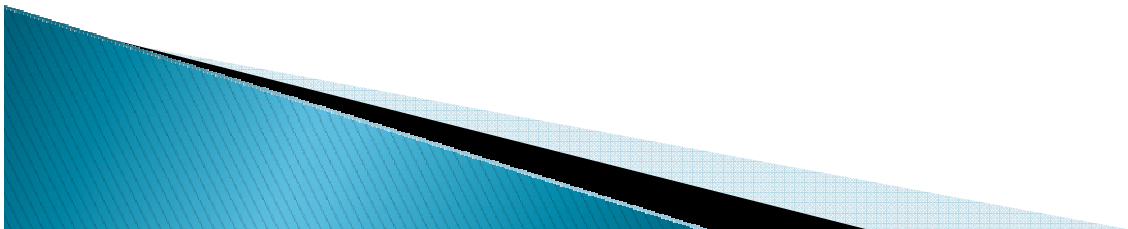






Weather Event Simulator

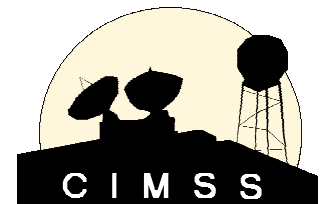
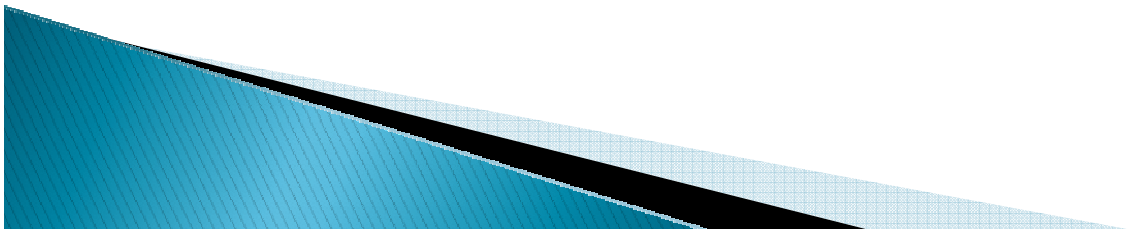
- ▶ The Weather Event Simulator (WES) is a two-part interface for reviewing archived weather data (in the form of netCDF files) from AWIPS:
 - The front-end GUI D-2D operating on static data
 - Tools developed by the Warning Decision Training Branch (WDTB) for replaying data and annotating a case
- ▶ 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.



GOES-R Proving Ground

▶ Mission Statement:

- The Geostationary Operational Environmental Satellite R-Series (GOES-R) Satellite Proving Ground project engages the National Weather Service (NWS) forecast and warning community in pre-operational demonstrations of selected capabilities anticipated from the next generation of National Oceanic and Atmospheric Administration (NOAA) geostationary earth observing systems.
- The Proving Ground project objective is to bridge the gap between research to operations by:
 - Utilizing current systems (satellite, terrestrial, or model/synthetic) to emulate various aspects of future GOES-R capabilities
 - Infusing GOES-R products and techniques into the NWS operational environment, with emphasis on the Advanced Weather Information Processing System (AWIPS) and transitioning to AWIPS-II.
 - Engaging in a two-way dialogue to provide feedback to the developers from the users



GOES-R Proving Ground - Windows Internet Explorer

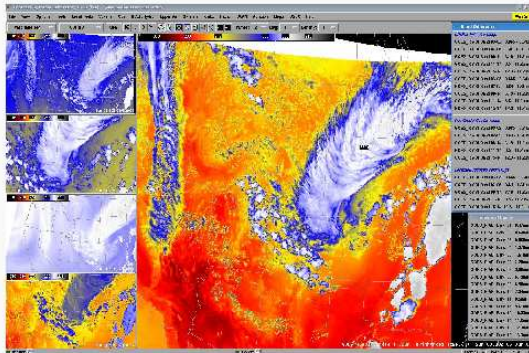
http://cimss.ssec.wisc.edu/goes_r/proving-ground.html

File Edit View Favorites Tools Help

GOES-R Proving Ground

GOES-R Proving Ground

Home GOES-R Proving Ground



Simulated GOES-R ABI Imagery in AWIPS

GOES-R Satellite Proving Ground Mission Statement

The Geostationary Operational Environmental Satellite (**GOES-R**) Satellite Proving Ground project engages the National Weather Service (NWS) forecast and warning community in an interactive demonstration of selected capabilities anticipated from the next generation of National Oceanic and Atmospheric Administration (NOAA) geostationary earth observing systems.

The Proving Ground project objective is to bridge the gap between research to operations by:

- Utilizing current systems (satellite, terrestrial, or model/synthetic) to emulate various aspects of future GOES-R capabilities
- Focusing on environmental applications bearing highest practical value to NWS users
- Infusing GOES-R products and techniques into the NWS operational platform, the Advanced Weather Information Processing System (AWIPS).

A key element of this activity is a sustained interaction between Proving Ground team and NWS users for the purposes of training, product evaluation, and solicitation of user feedback. The Proving Ground relies on close coordination with the GOES-R Algorithm Working Group (AWG) and Risk Reduction

Research

- CIMSS F Ground Proc
- CIRA Proving Ground Products

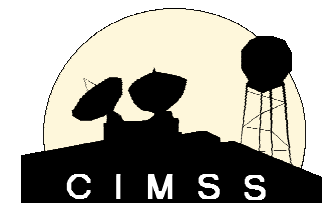
Real-time GOES-13 data

- GOES-13 Image Browser
- GOES-13 ("GOES-Central") Sounder DPI
- GOES-13 Visible Imagery

Internet 100%

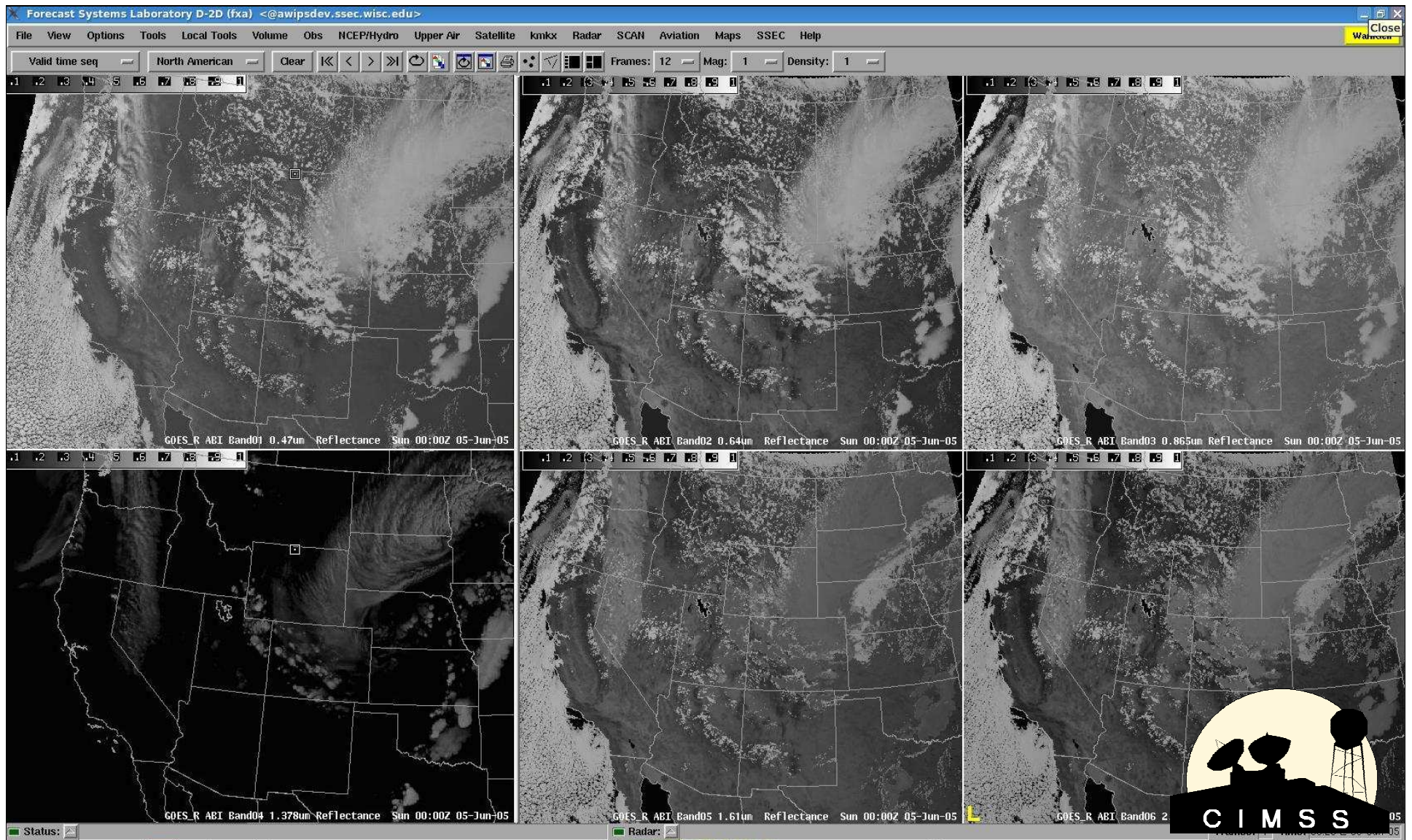
http://cimss.ssec.wisc.edu/goes_r/proving-ground.html

The GOES-R Proving Ground will facilitate the testing and validation of new ideas, technologies and products before they become integrated into operational use. This proving ground is an essential component of GOES-R risk reduction, which will help to ensure that users are ready for the new types of satellite imagery and products that will be available in the upcoming GOES-R era.



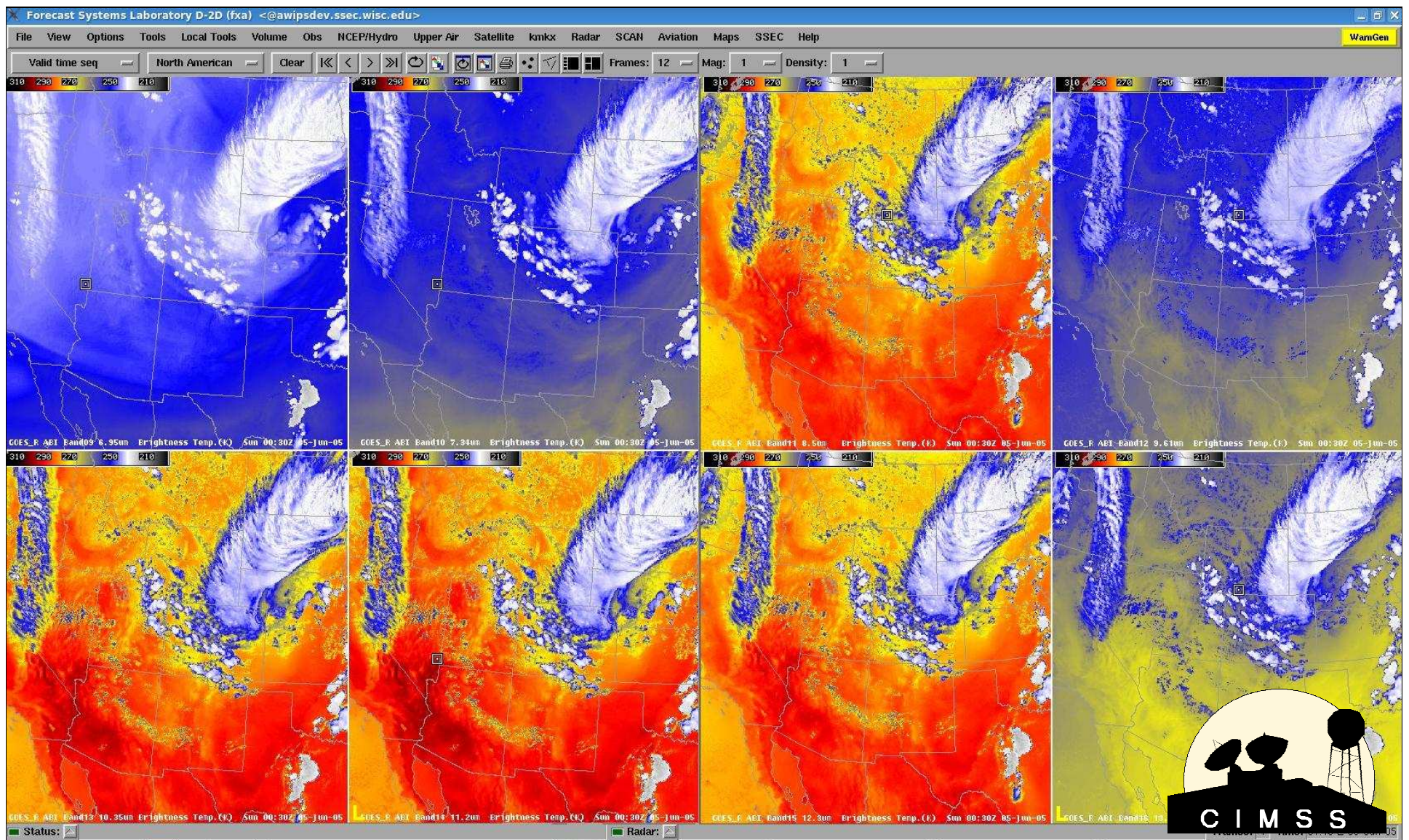
Sample Visible and Near-IR Bands of the GOES-R Advanced Baseline Imager in AWIPS/WES

Slide credit: Kaba Bah



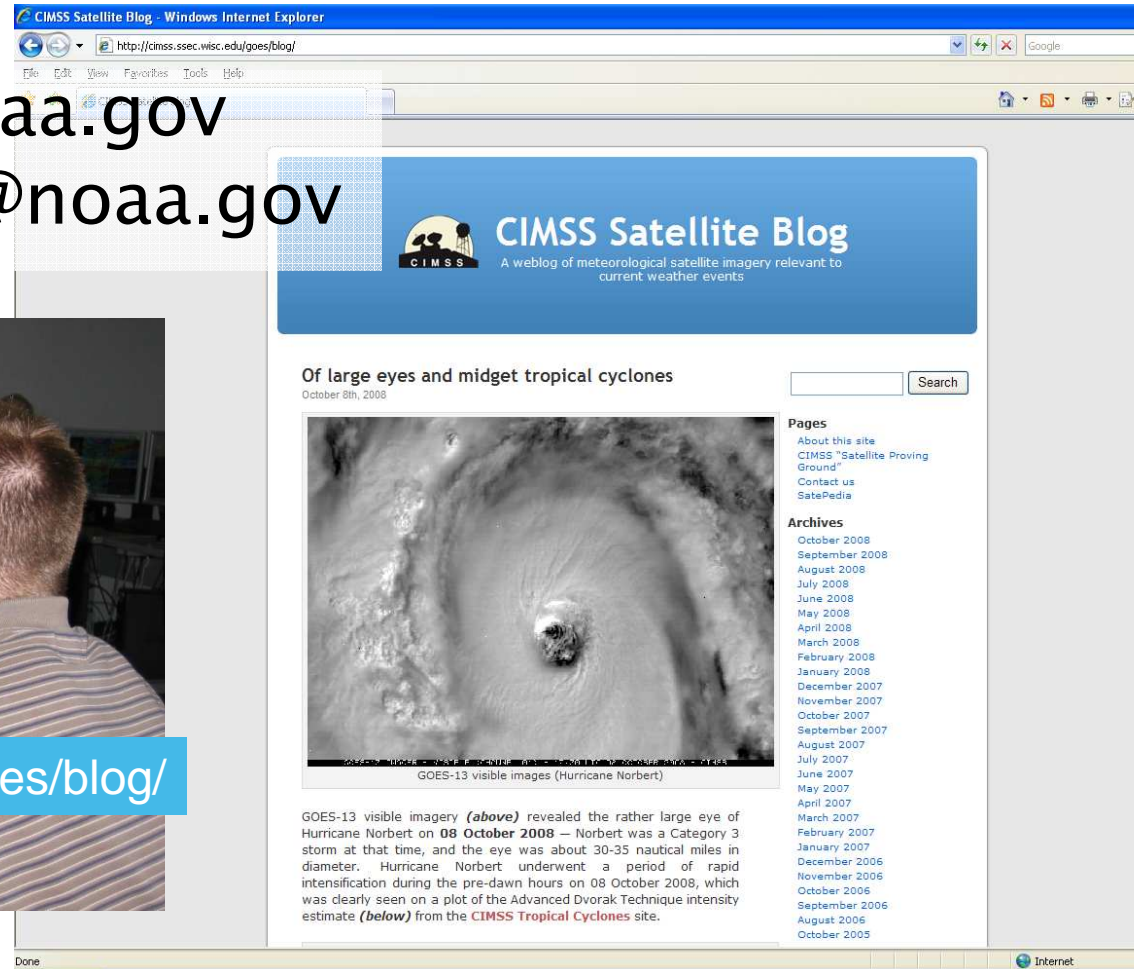
Sample IR Bands of the GOES-R Advanced Baseline Imager in AWIPS/WES

Slide credit: Kaba Bah



Comments or Questions?

- ▶ Jordan.Gerth@noaa.gov
- ▶ Scott.Bachmeier@noaa.gov

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". The main content area displays a post titled "Of large eyes and midget tropical cyclones" dated October 8th, 2008. The post includes a satellite image of Hurricane Norbert and a caption: "GOES-13 visible images (Hurricane Norbert)". Below the image is a paragraph of text describing the hurricane's eye and its rapid intensification. The right sidebar contains sections for "Pages" and "Archives". The browser's status bar at the bottom shows "Done" and "Internet".