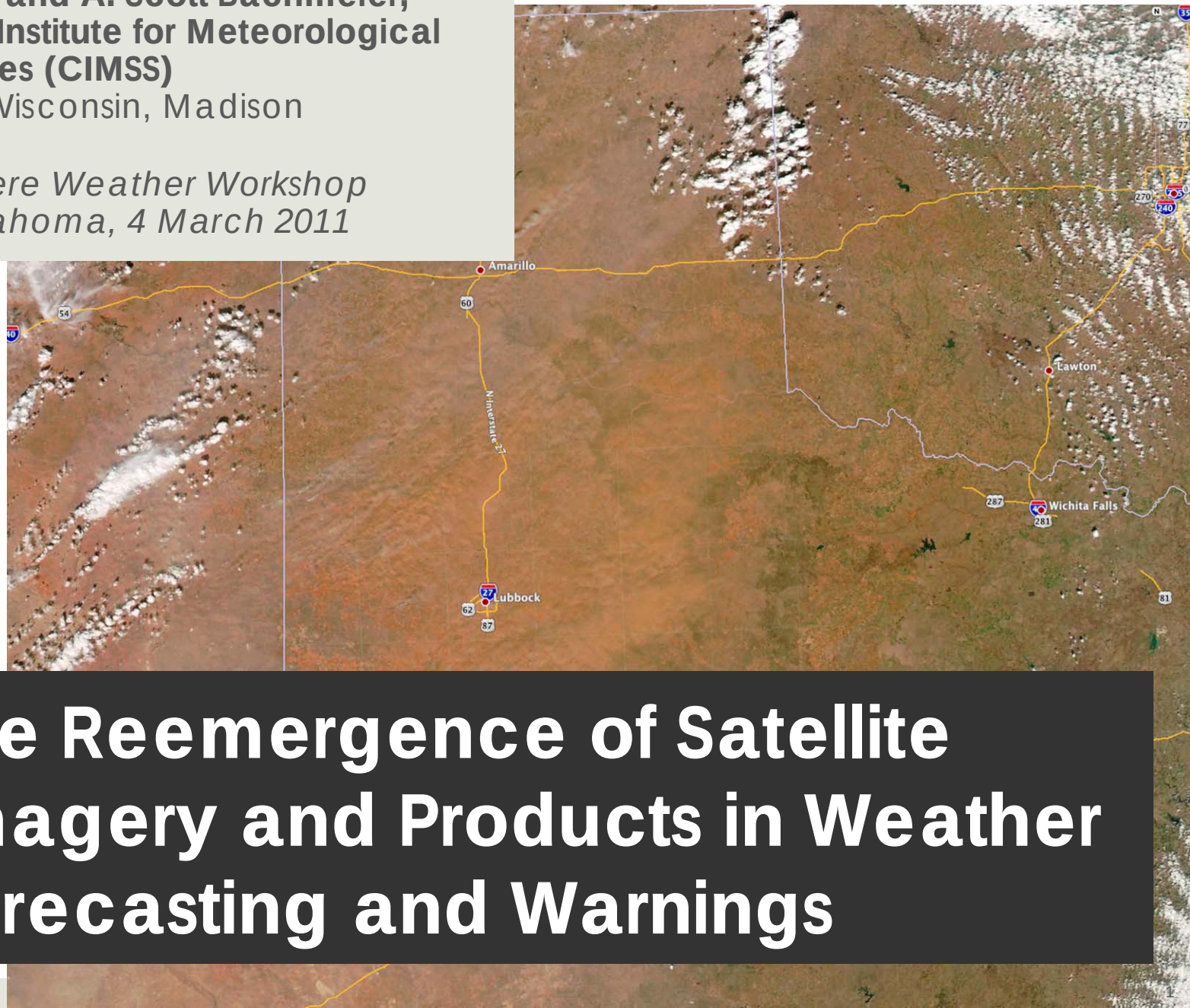
**Jordan Gerth and A. Scott Bachmeier,**
**Cooperative Institute for Meteorological Satellite Studies (CIMSS)**
University of Wisconsin, Madison

*National Severe Weather Workshop*
*Norman, Oklahoma, 4 March 2011*

**Blowing dust on 27 February 2011**




# The Reemergence of Satellite Imagery and Products in Weather Forecasting and Warnings

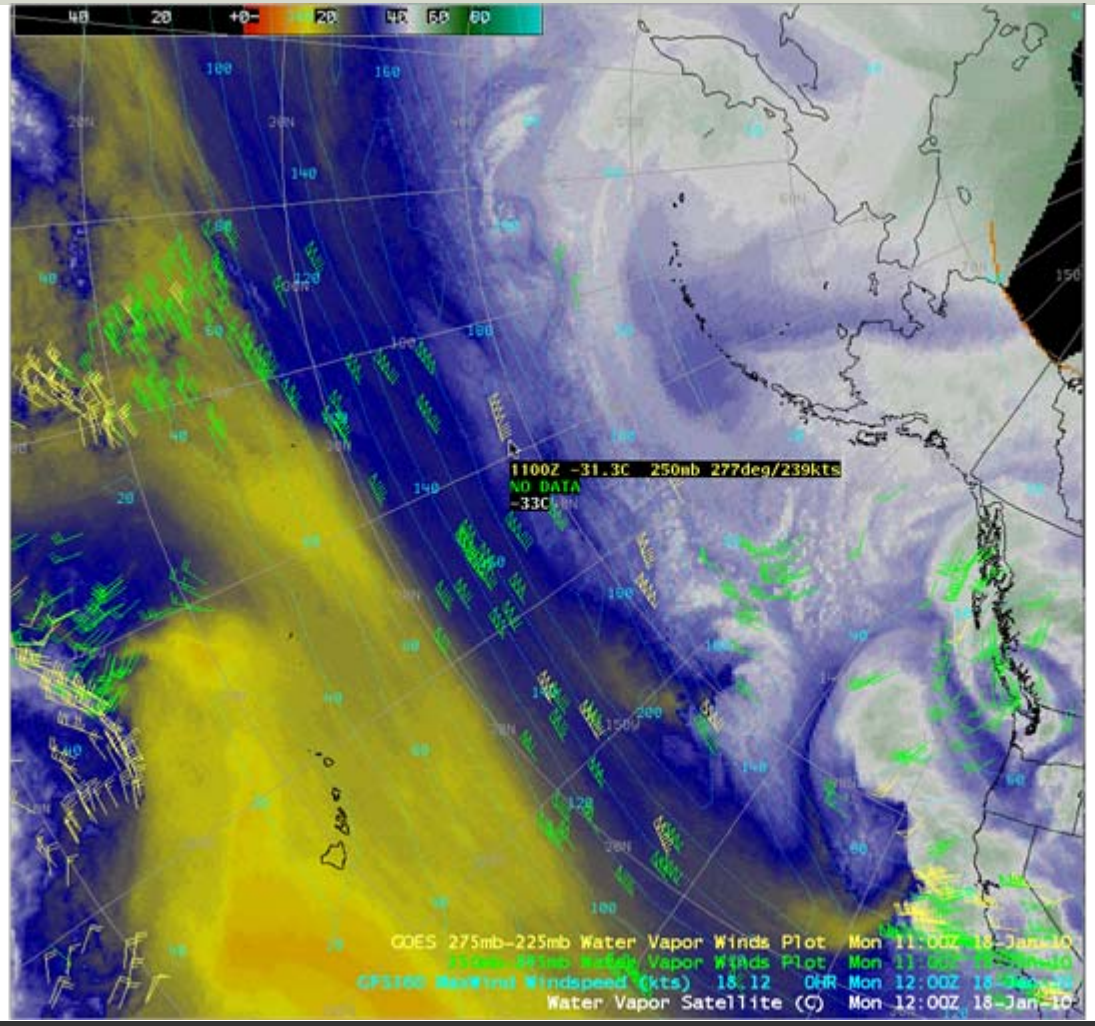
# Introduction

- The new technology that accompanies the NASA National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project (NPP) and Geostationary Operational Environmental Satellite R-Series (GOES-R) will provide satellite imagery and products on a spatial scale down to 400 meters and a temporal scale of down to 30 seconds.

- Observations of this resolution will allow meteorologists to study unique meteorological phenomena in great detail, likely leading to breakthroughs which will increasingly bring data collected from satellites back into the warning process, as well as improve forecast decisions.

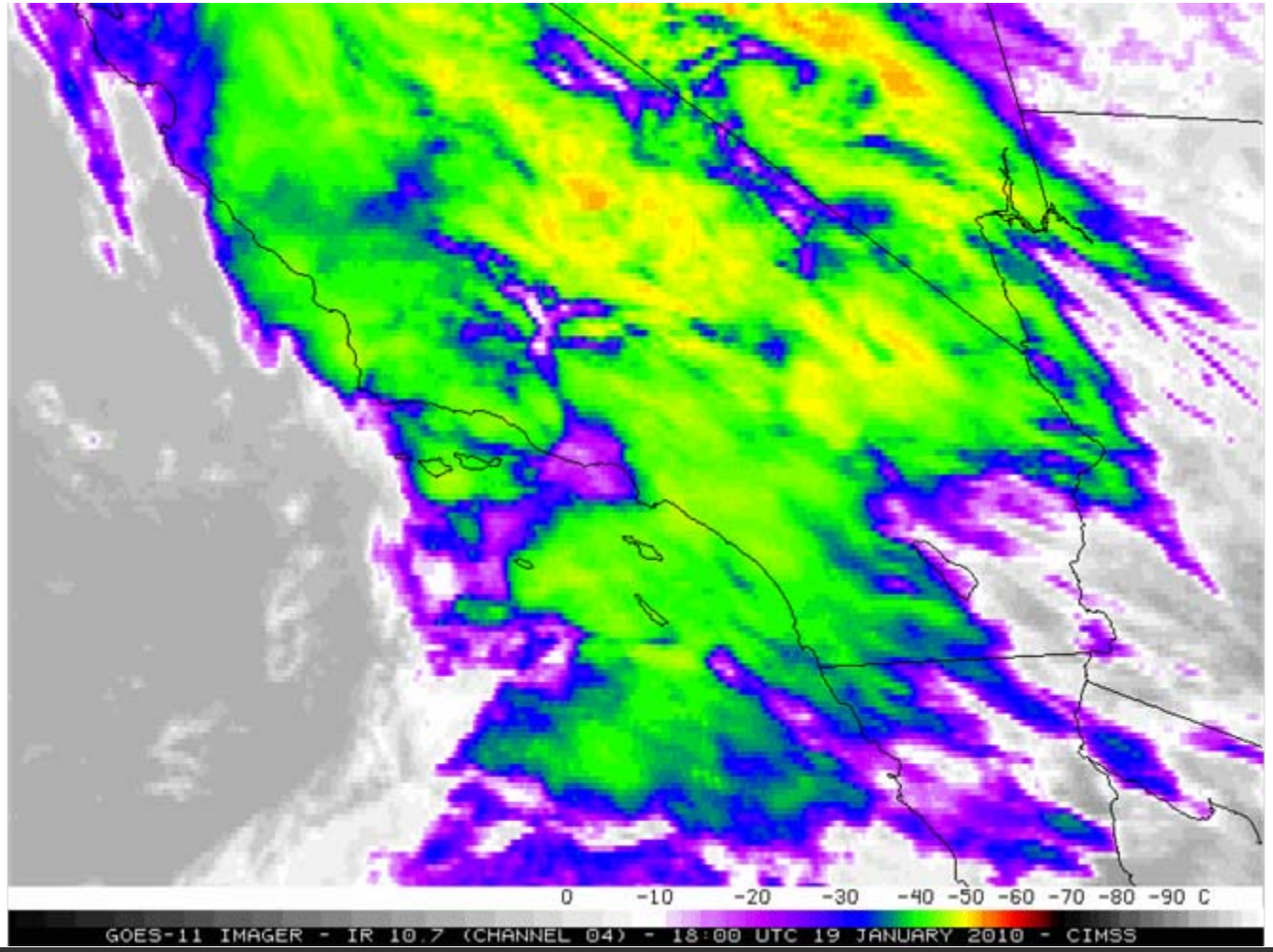
# Introduction

This talk will discuss ways in which satellite imagery and products can be used within the operational environment today and in the future. Examples telling of the utility of these scientific and technological advancements, courtesy of the Cooperative Institute for Meteorological Satellite Studies' (CIMSS) Satellite Blog (updated frequently at http://cimss.ssec.wisc.edu/goes/blog), will be shown pertaining to recent current weather events.



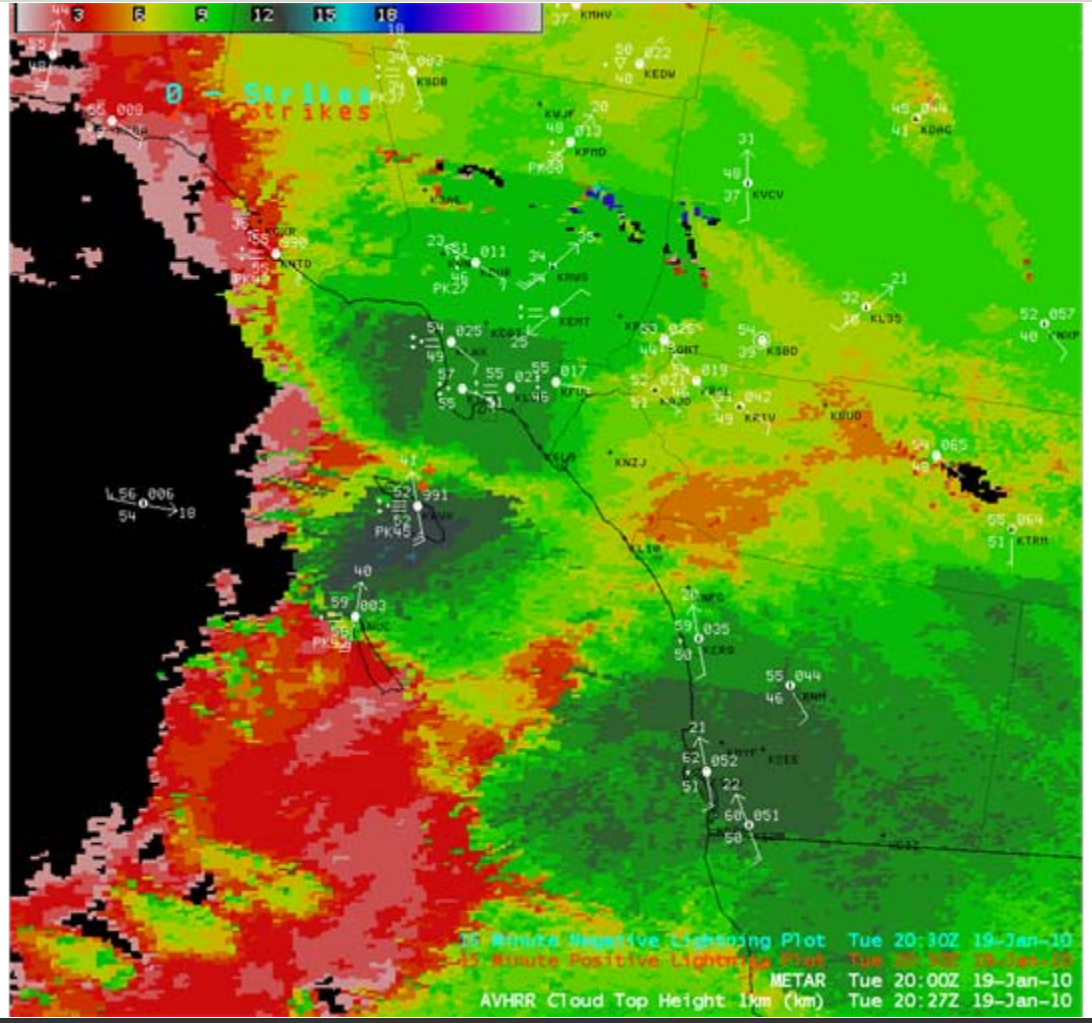

# 18 January 2010

On 18 January, The GFS360 model Level of Maximum Wind isotach field indicated that winds just exceeded 200 knots within the core of the jet stream; however, GOES-11 satellite-derived water vapor winds (below) suggested that speeds were as high as 239 knots along the jet stream axis.



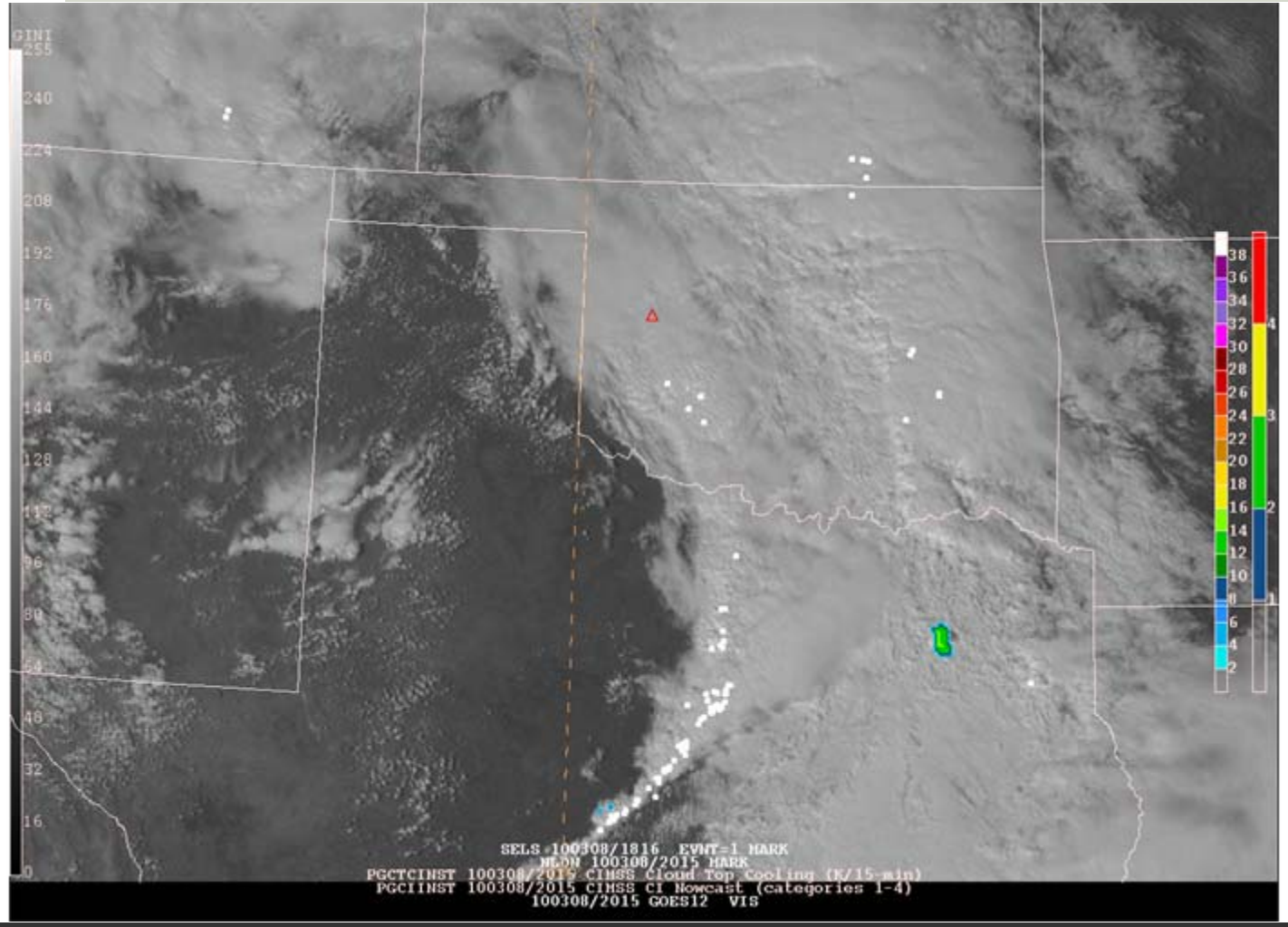

# 19 January 2010

McIDAS images of the 4-km resolution GOES-11 10.7 µm IR channel data (above) showed the development of convection that moved onshore across southern California during the afternoon hours on 19 January 2010. Of particular interest is the strong convective cluster that developed just offshore over the Santa Catalina and San Clemente Island area — the GOES-11 IR brightness temperatures of this feature cooled to -53º C (darker orange color enhancement) as it was moving inland around 20:46 UTC (12:46 pm local time).



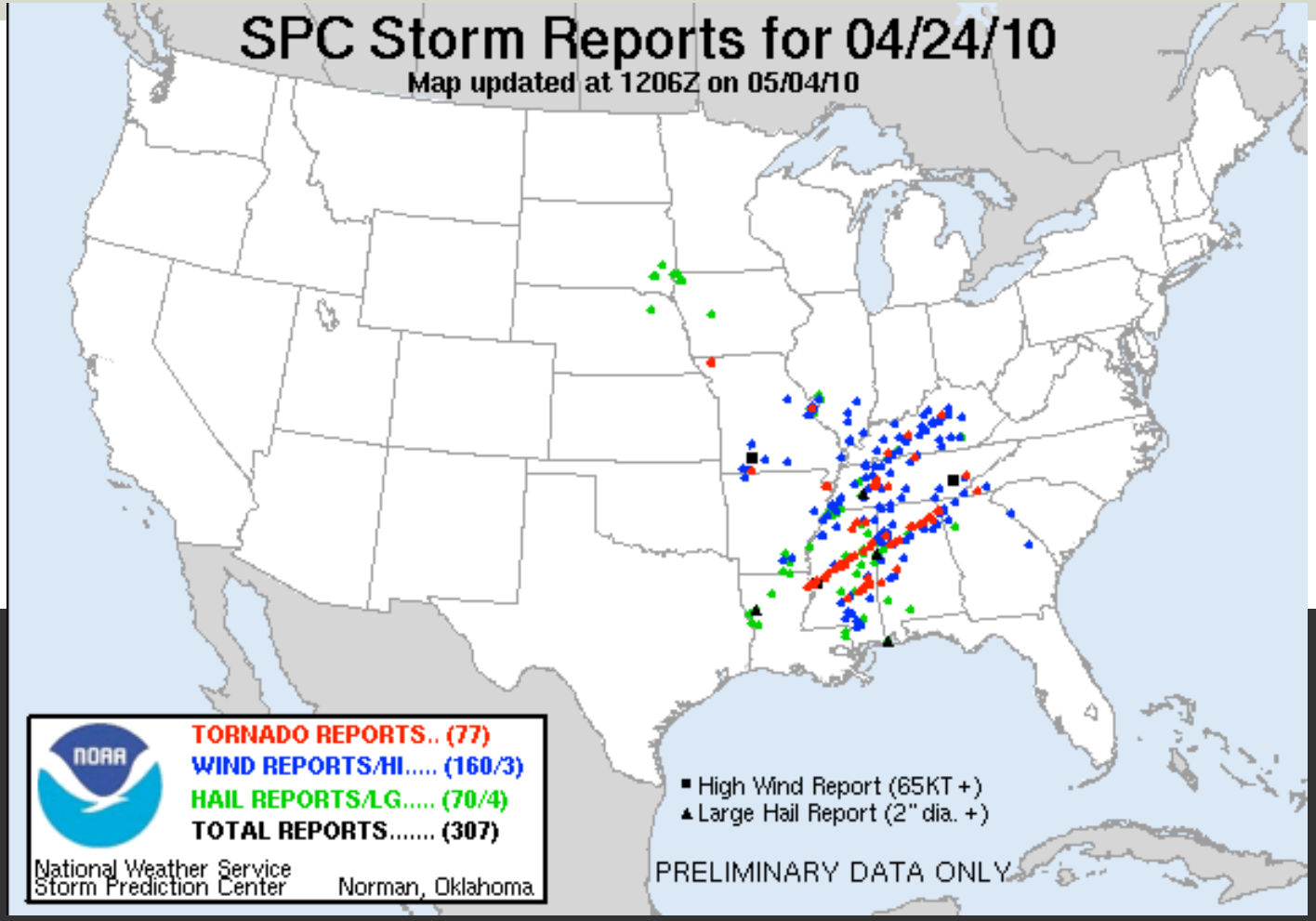

# 19 January 2010

The 1-km resolution POES AVHRR Cloud Top Temperature (CTT) product (above) indicated that the coldest CTT value with this storm was -56º C, with the Cloud Top Height product (below) showing the maximum cloud tops at a height of 14 km.



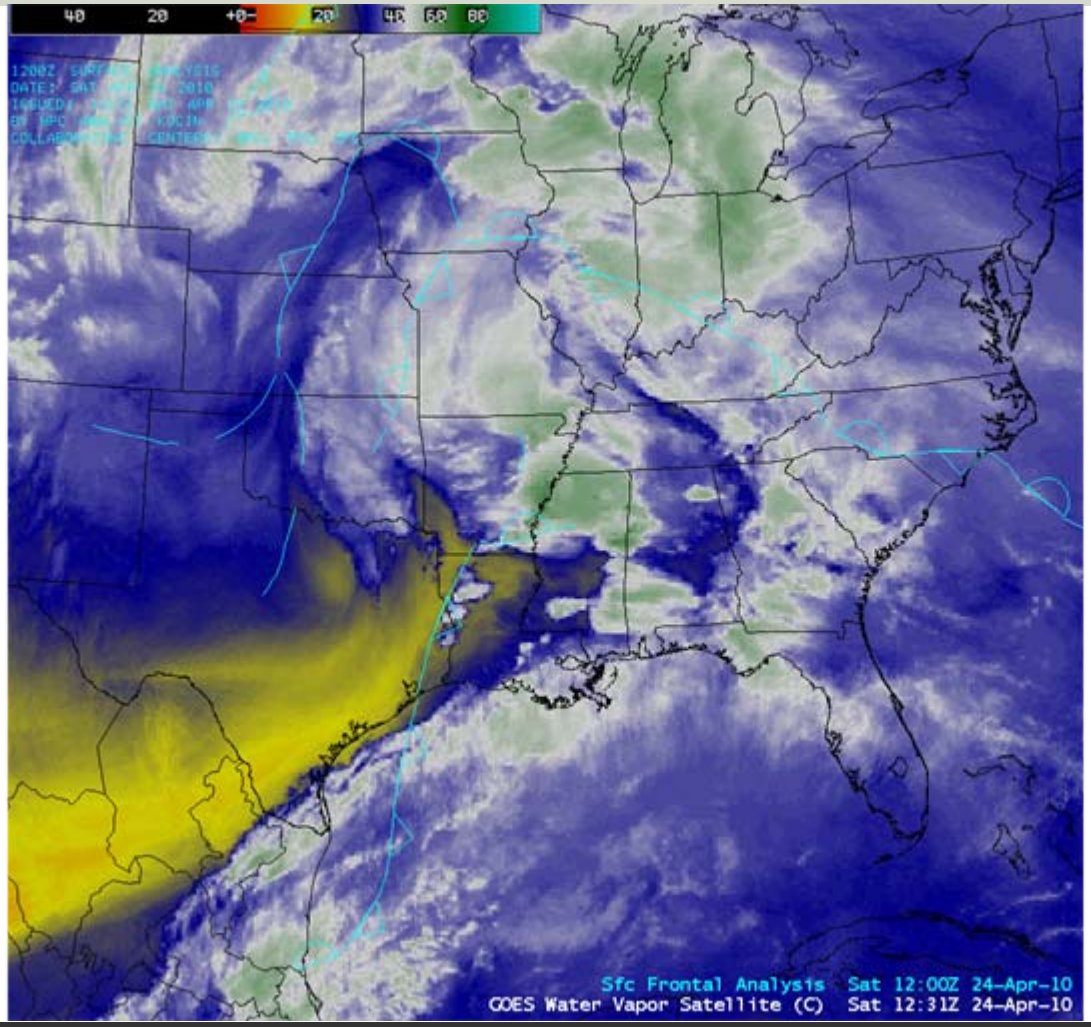

# 8 March 2010

Two tornadoes touched down near sunset in western Oklahoma, near the town of Hammon. The above animation from NAWIPS shows 1-km GOES-12 visible imagery with superimposed contours of cloud-top cooling (and lightning strikes) from about 2000 UTC on 9 March to 0015 UTC on the 10th, shortly after tornado touchdown (the tornado location is indicated by the red triangle in the animation).



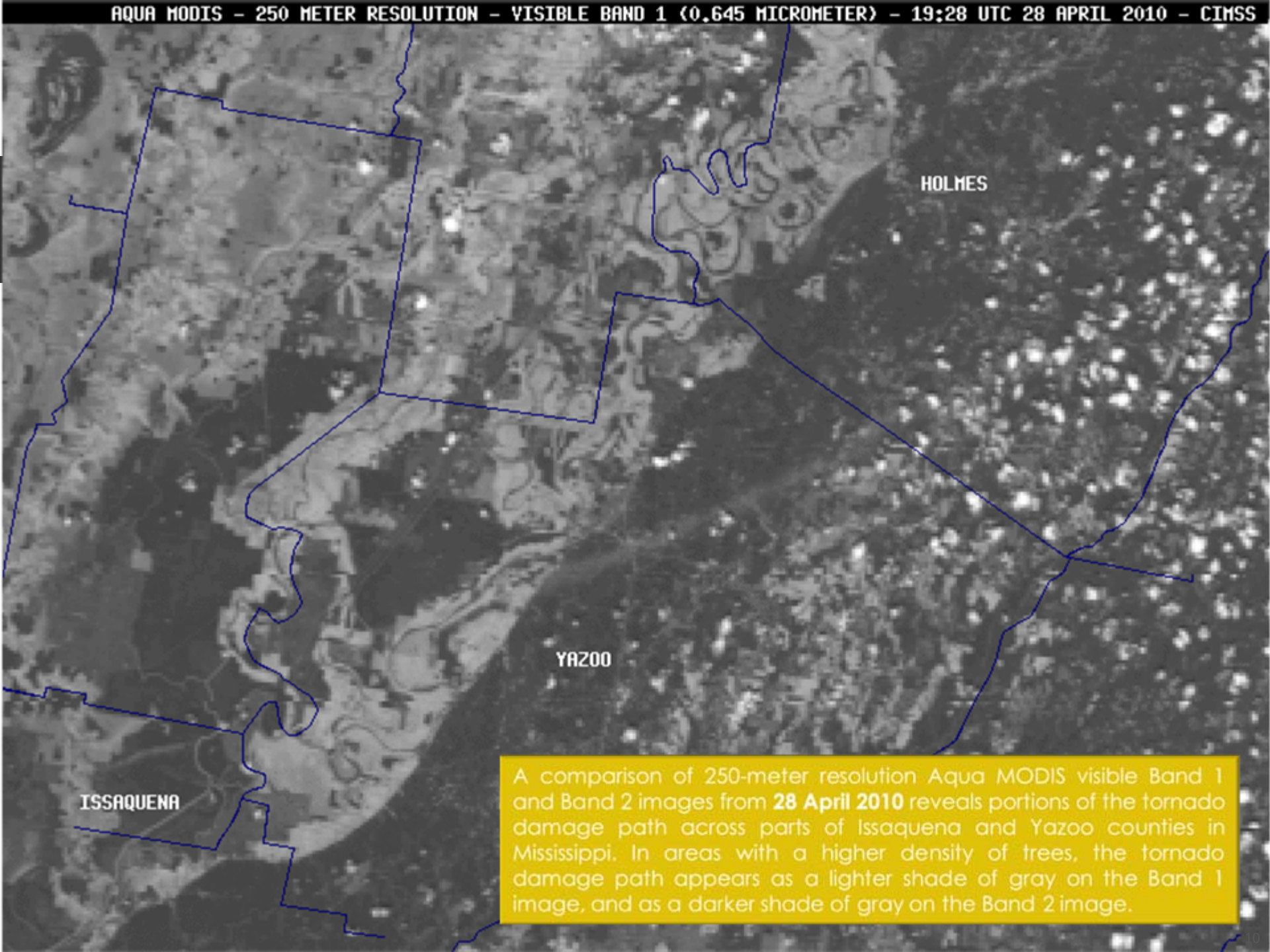

# 24 April 2010

On a rare "High Risk" SPC Convective Outlook day, a significant tornado outbreak occurred across the Deep South region of the US on 24 April 2010 which produced long-track tornadoes that were responsible for at least 10 fatalities across parts of Mississippi (SPC storm reports | NWS Jackson MS event summary).



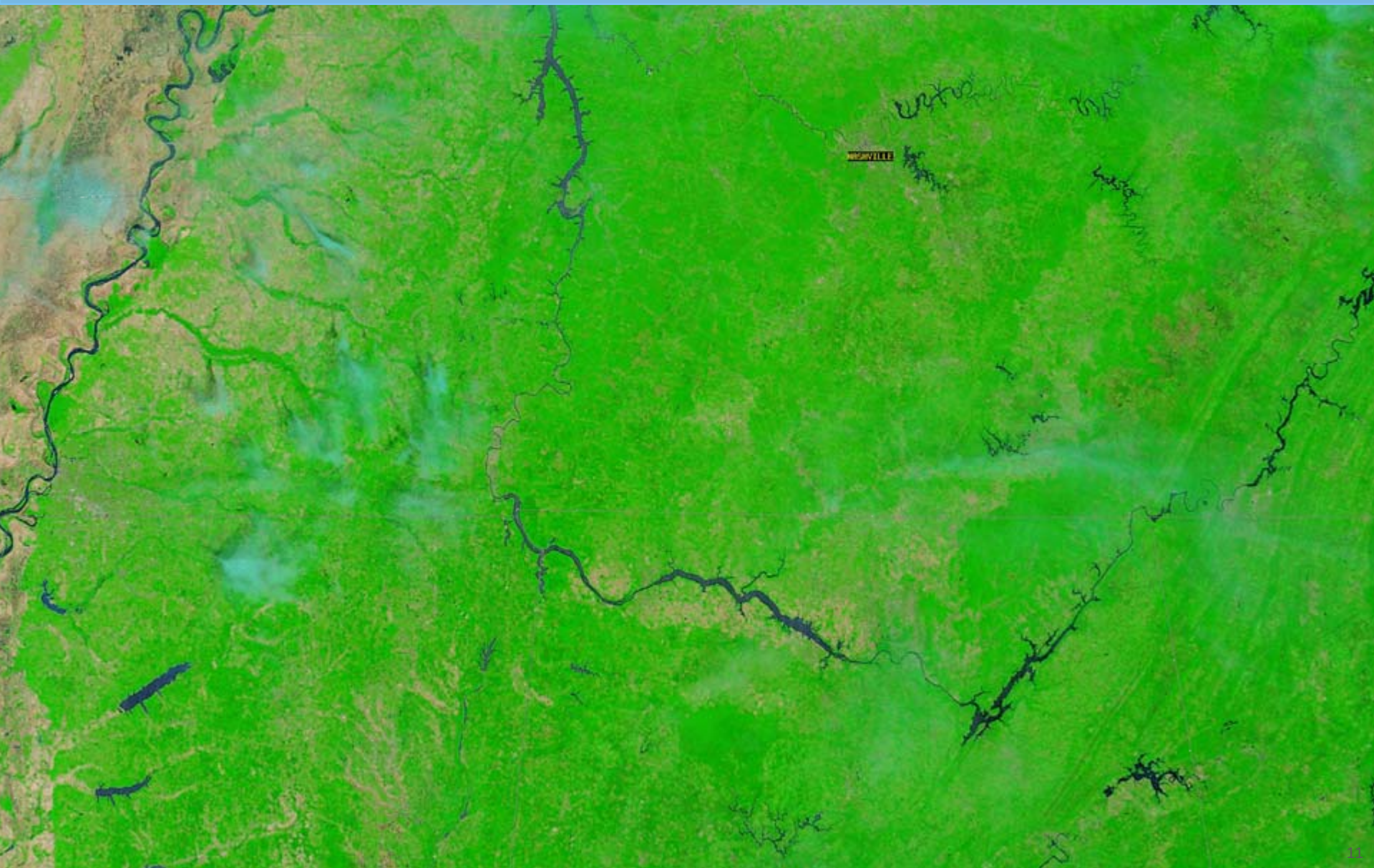

# 24 April 2010

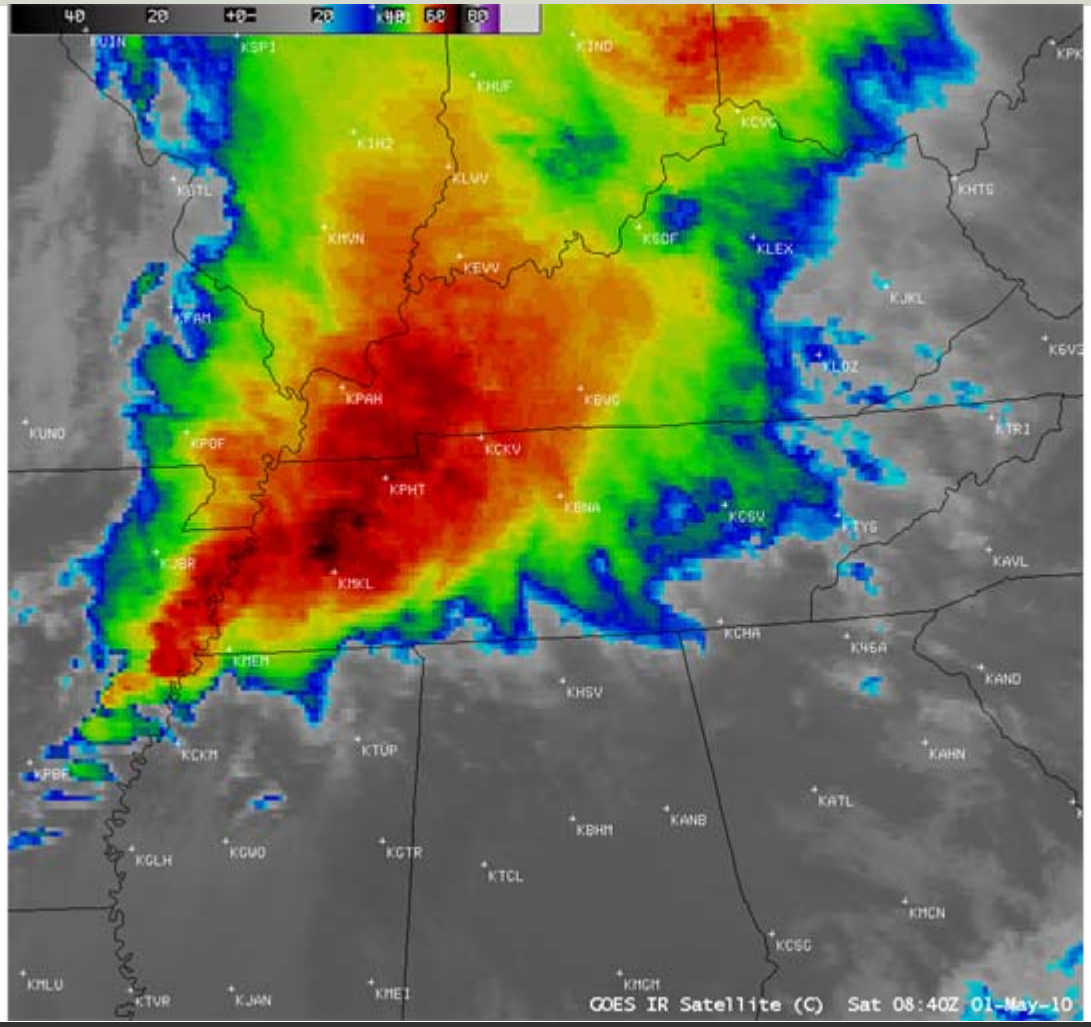
AWIPS images of the GOES-13 6.5 µm water vapor channel data with overlays of surface fronts (above) showed a cold frontal boundary advancing eastward across the region, with a strong punch of dry air aloft associated with an upper level jet stream.




A comparison of 250-meter resolution Aqua MODIS visible Band 1 and Band 2 images from **28 April 2010** reveals portions of the tornado damage path across parts of Issaquena and Yazoo counties in Mississippi. In areas with a higher density of trees, the tornado damage path appears as a lighter shade of gray on the Band 1 image, and as a darker shade of gray on the Band 2 image.

During **1 May – 2 May 2010** the 2-day total precipitation at Nashville, Tennessee was 13.57 inches — by far the wettest 2-day period on record for that location (the old record was 6.68 inches on 13-14 September 1979, in association with Hurricane Fredrick). With 7.25 inches falling on 02 May (5.57 inches of that in just 6 hours!), this also set a record for the wettest calendar day on record. And, remarkably, only 2 days into the month May 2010 is already the wettest May on record for Nashville.

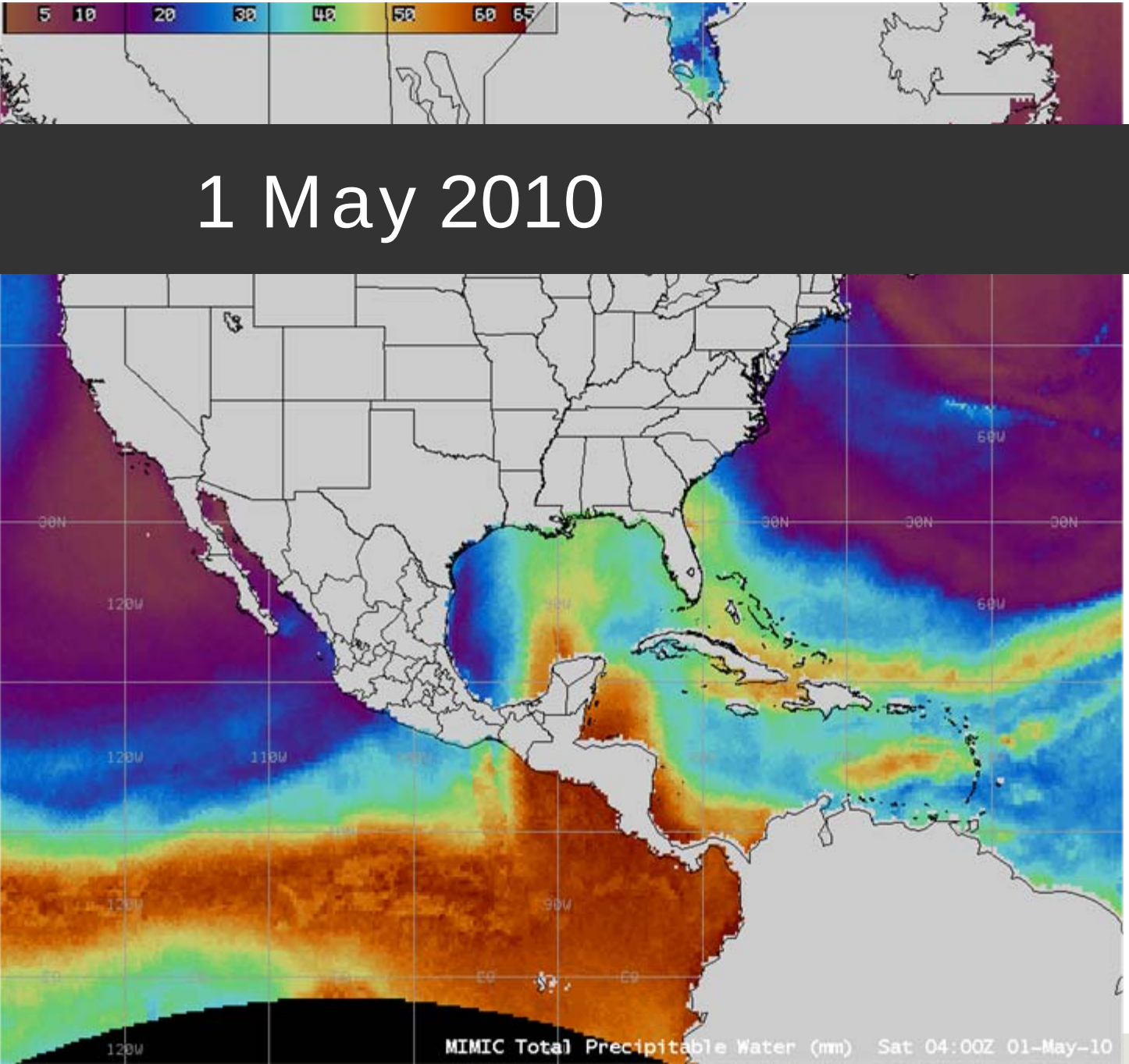




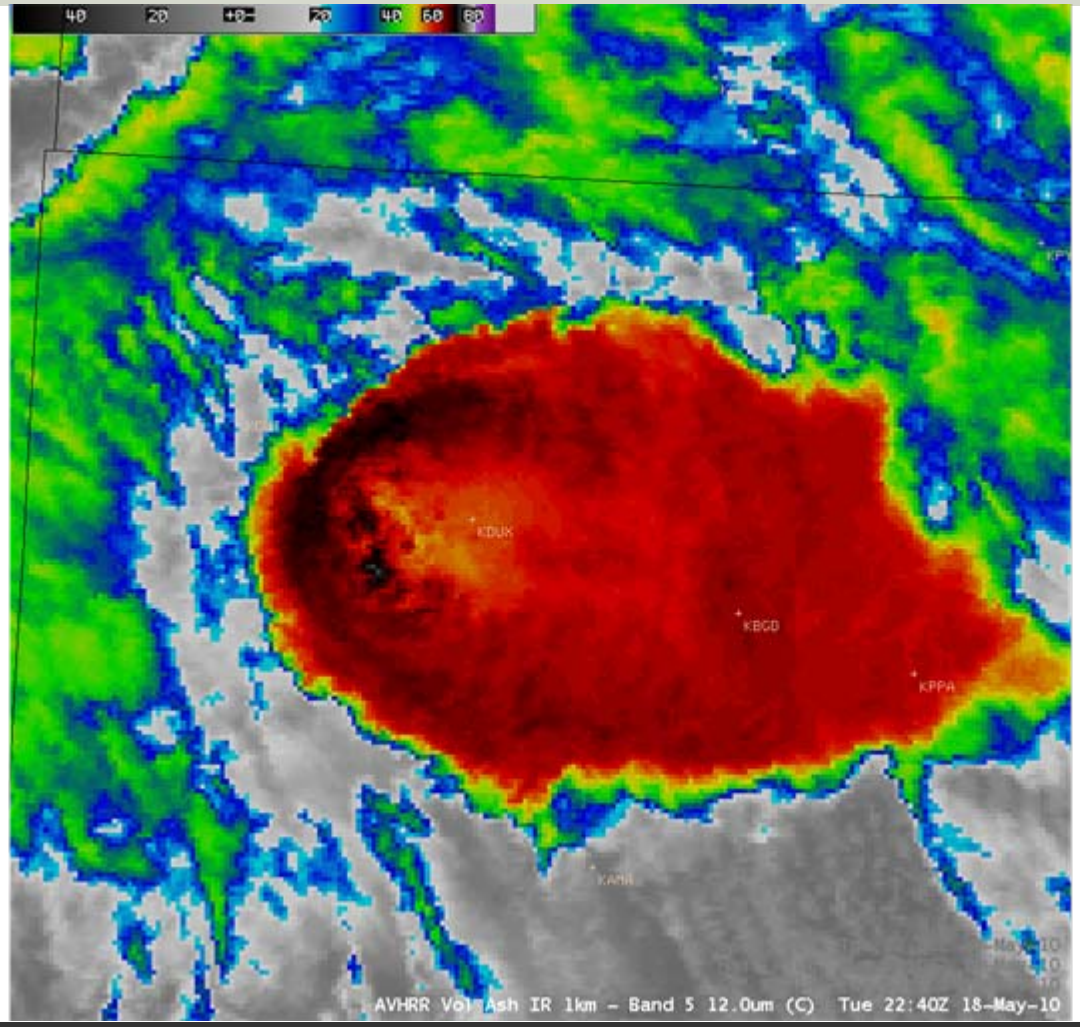

# 1 May 2010

AWIPS images of 4-km resolution GOES-13 10.7 µm IR channel data (above) showed several rounds of deep convection moving northeastward across the region during the period, with some cells exhibiting IR cloud top brightness temperatures as cold as -74º C. This convection was developing along and ahead of a slow-moving cold frontal boundary.

# 1 May 2010

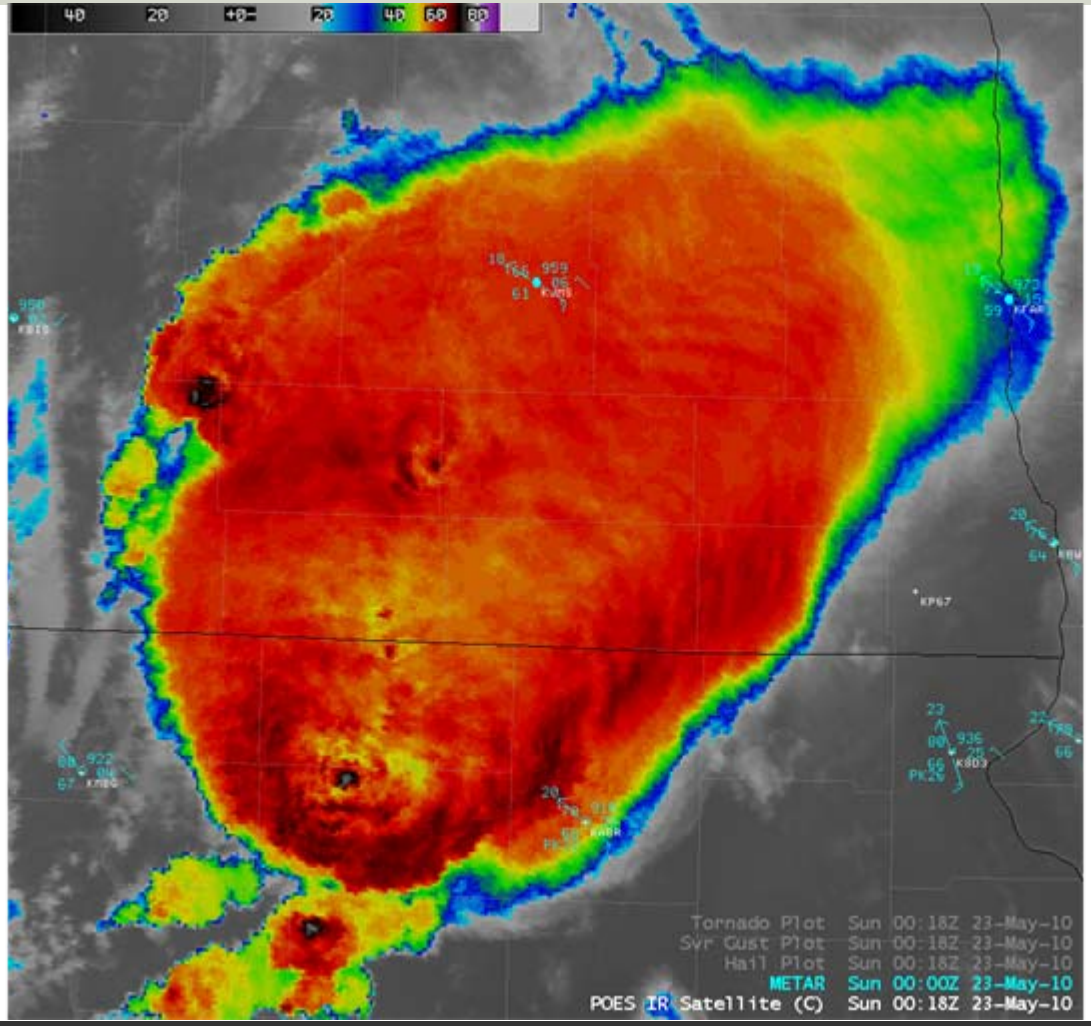



- Atmospheric river brings deep tropical moisture well in excess of seasonal normals into the southern United States



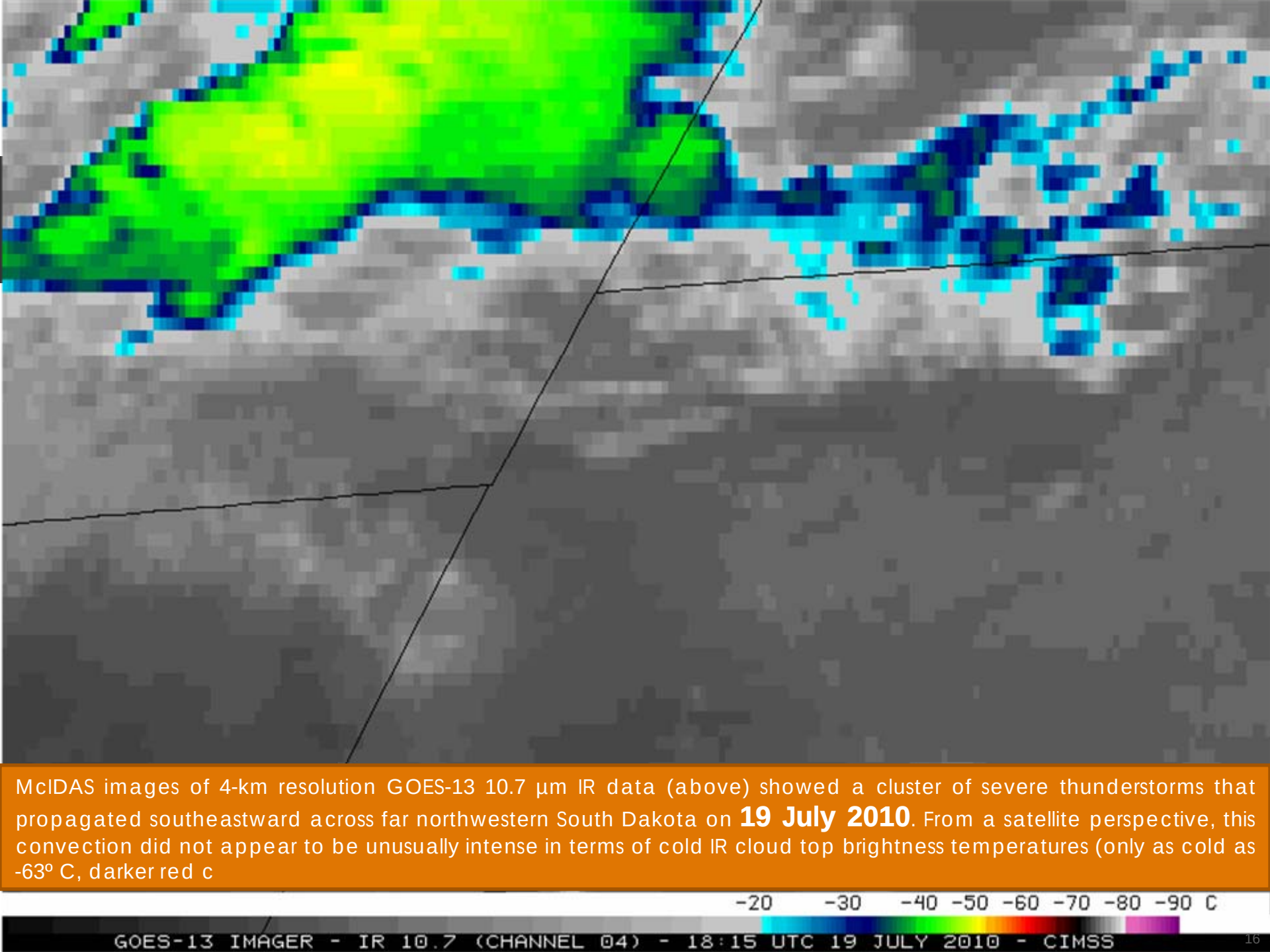

# 18 May 2010

An AWIPS image of the 1-km resolution POES AVHRR 12.0 µm IR channel data (above) displayed a classic and well-defined example of an "Enhanced-V" storm top signature over the northern Texas Panhandle region on 18 May 2010. Overlays of SPC storm reports and cloud-to-ground (CG) lightning strikes near the time of the image showed that this severe thunderstorm was producing hail as large as 2.75 inch in diameter, as well as a couple of tornadoes — and there were a large number of CG strikes within the Enhanced-V signature.




# 23 May 2010

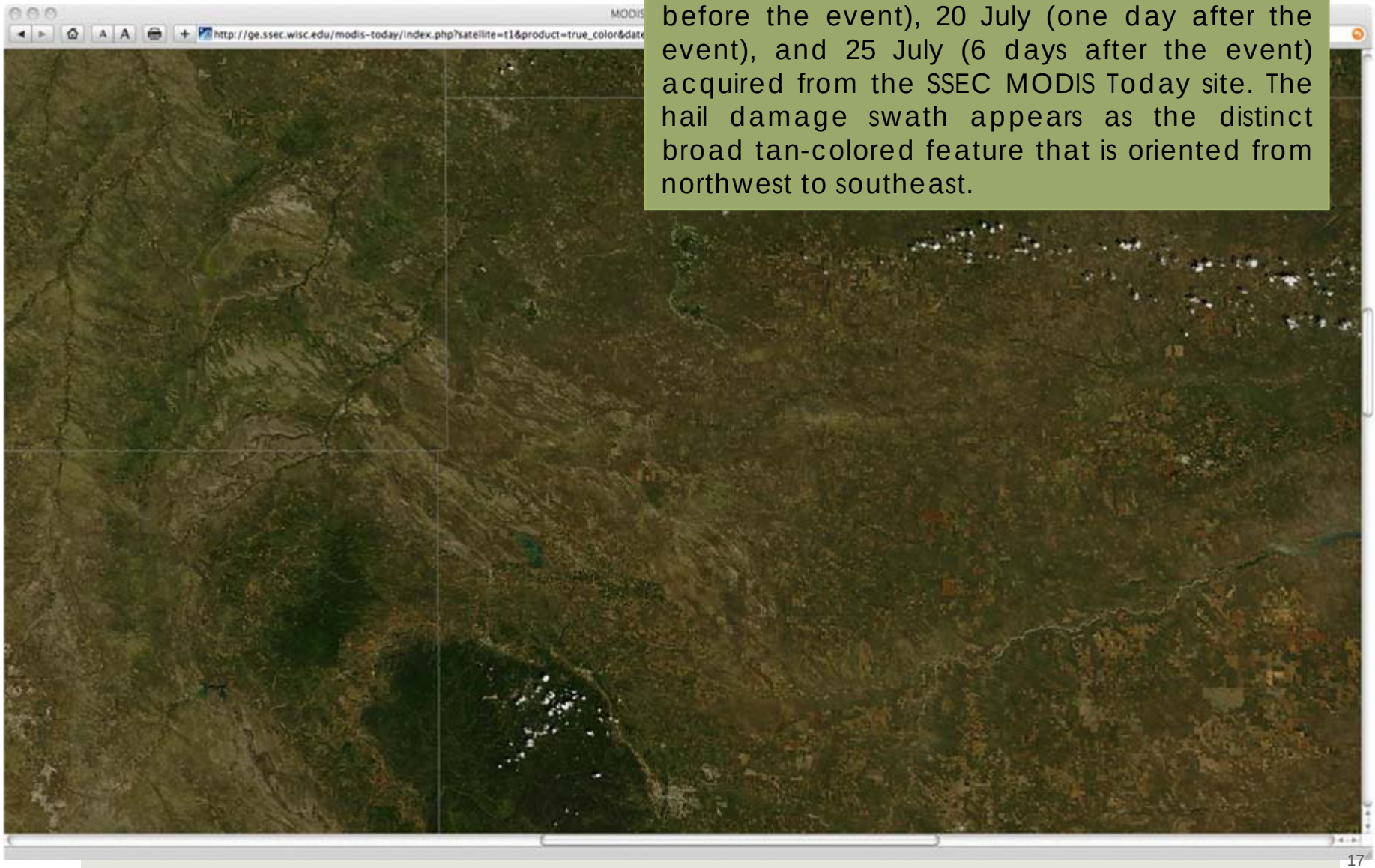
AWIPS images of the 1-km resolution POES AVHRR 11.0 µm IR channel data (above) showed a detailed view of the severe thunderstorm that produced a very large and violent "wedge" tornado that was responsible for EF4 damage in northeastern South Dakota on 22 May 2010. The coldest IR brightness temperature on the image was -77º C. An overlay of the corresponding SPC storm reports is also shown; this storm also produced hail up to 1.75 inch in diameter.

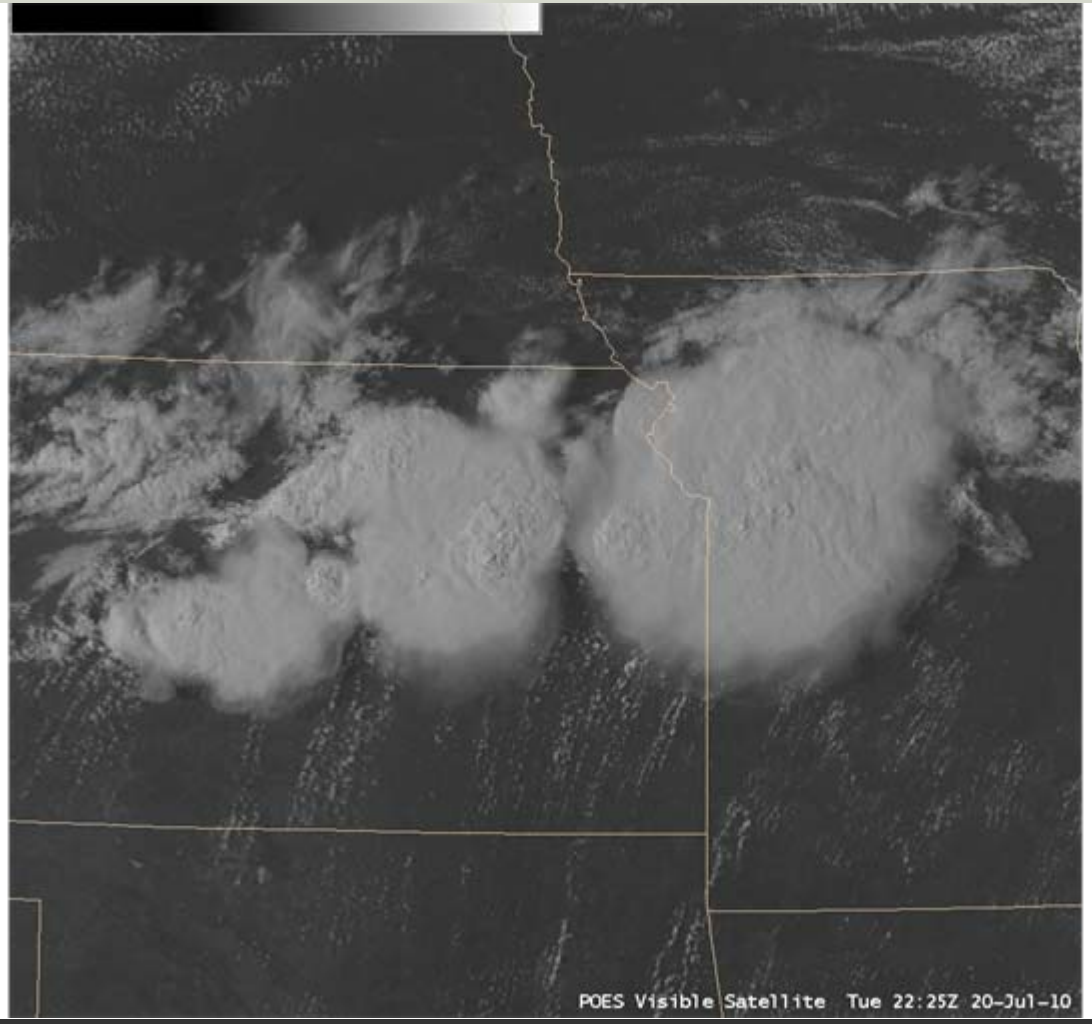



McIDAS images of 4-km resolution GOES-13 10.7 µm IR data (above) showed a cluster of severe thunderstorms that propagated southeastward across far northwestern South Dakota on **19 July 2010**. From a satellite perspective, this convection did not appear to be unusually intense in terms of cold IR cloud top brightness temperatures (only as cold as -63º C, darker red c

# 19 July 2010

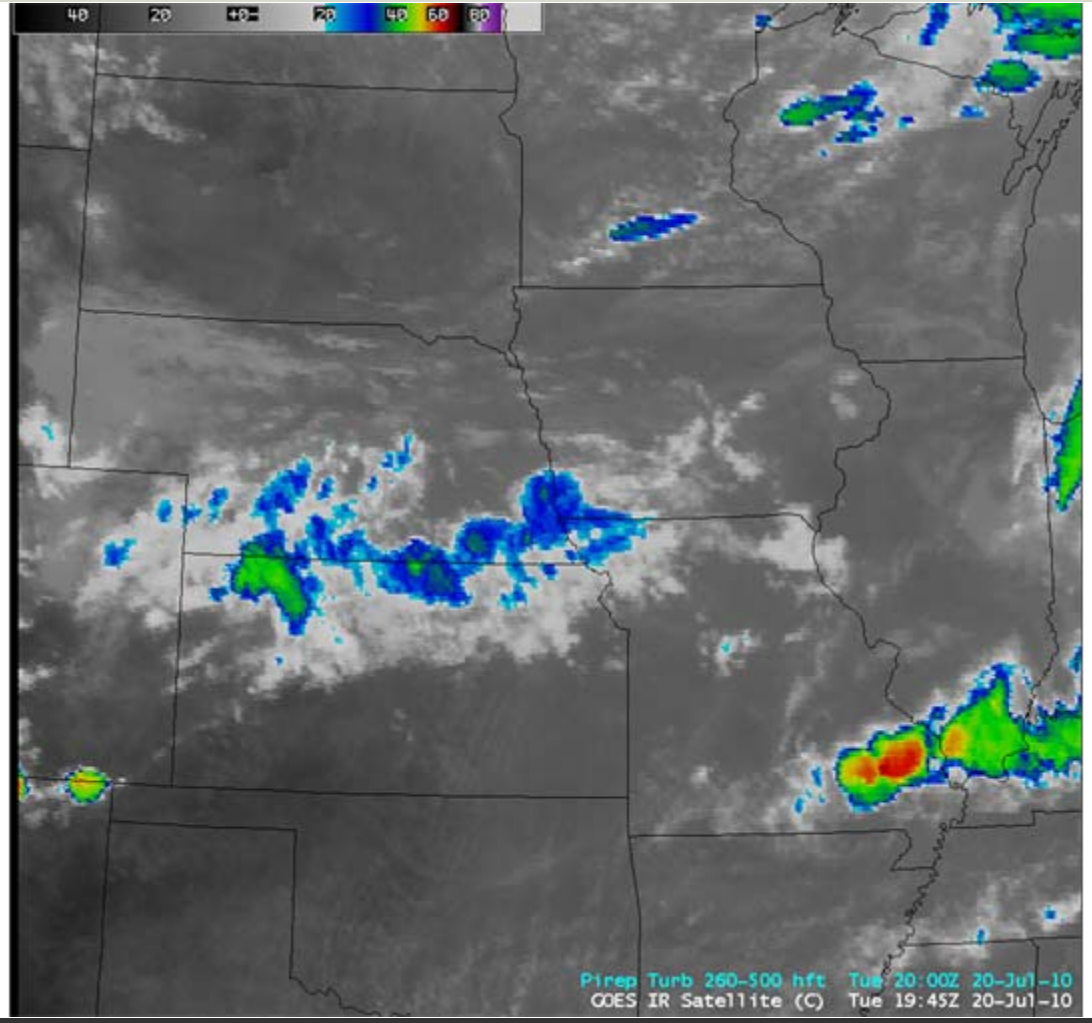
This wind-driven hail damage path can be seen on the comparison of three 250-meter resolution MODIS true color Red/Green/Blue (RGB) images (created using bands 4/3/1) from 15 July (4 days before the event), 20 July (one day after the event), and 25 July (6 days after the event) acquired from the SSEC MODIS Today site. The hail damage swath appears as the distinct broad tan-colored feature that is oriented from northwest to southeast.





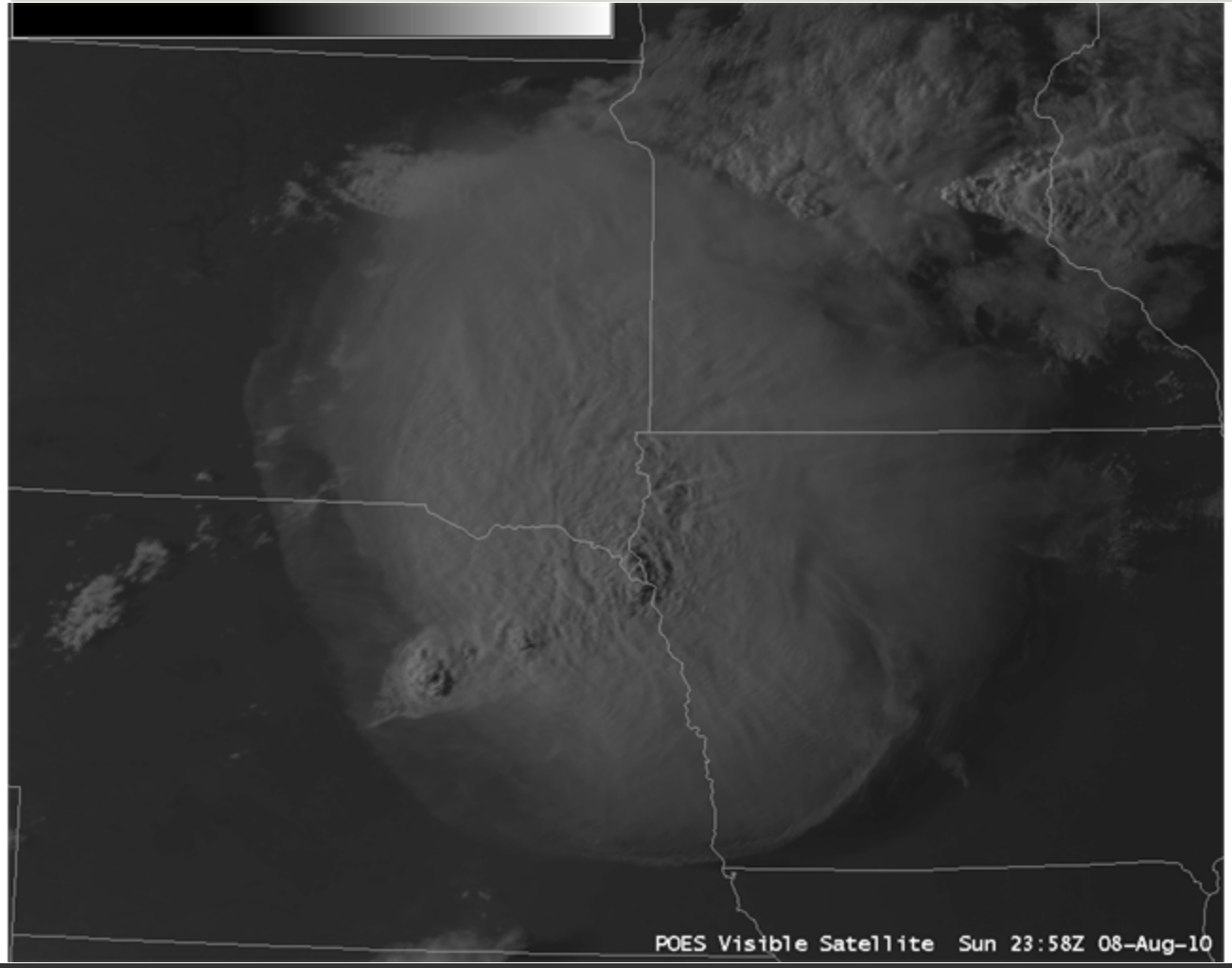

# 20 July 2010

On 20 July 2010, United Airlines Flight 967 en route from Washington Dulles to Los Angeles encountered severe turbulence over the central US, and had to divert and land at Denver to medically treat nearly 30 passengers who suffered significant injuries.



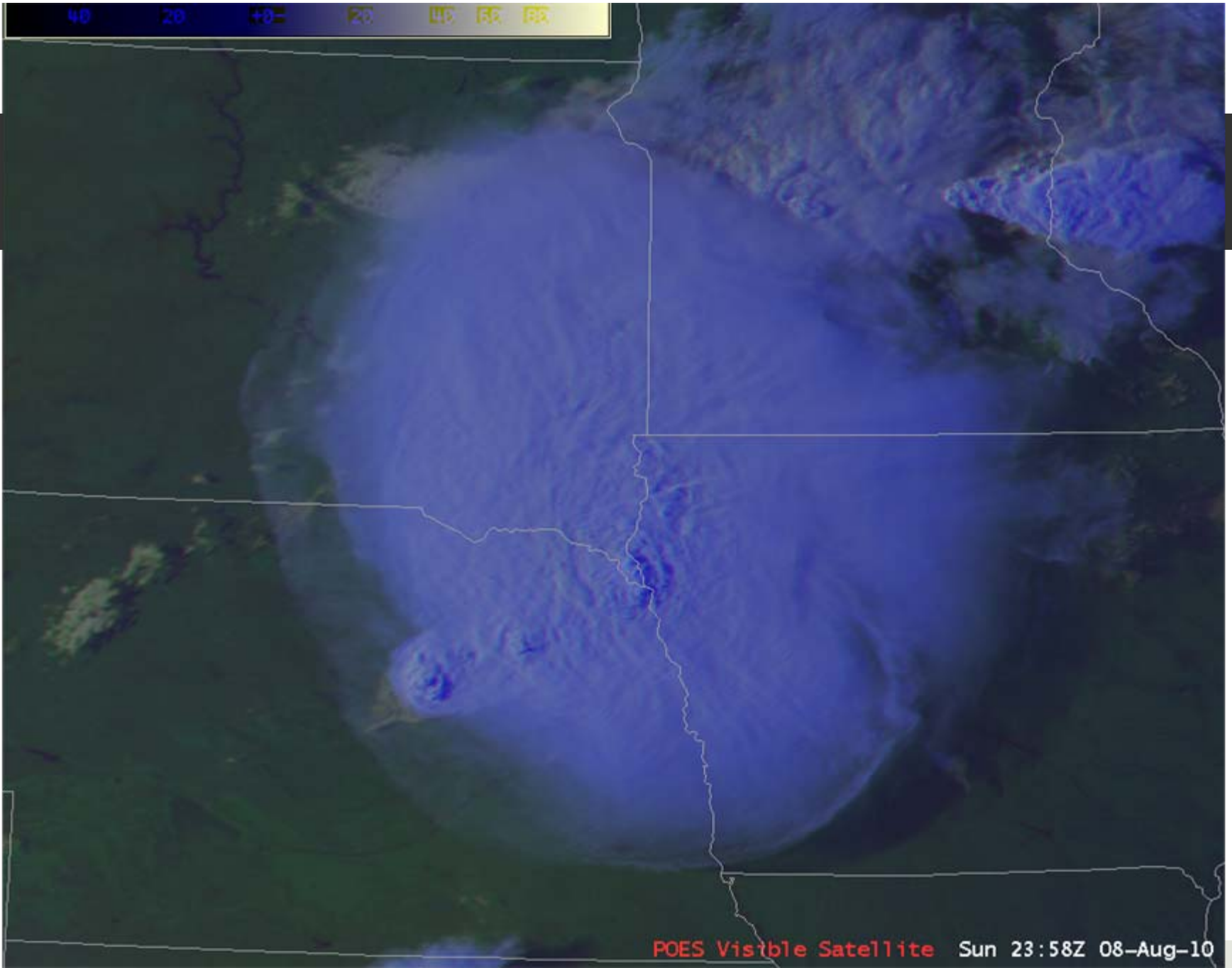

# 20 July 2010

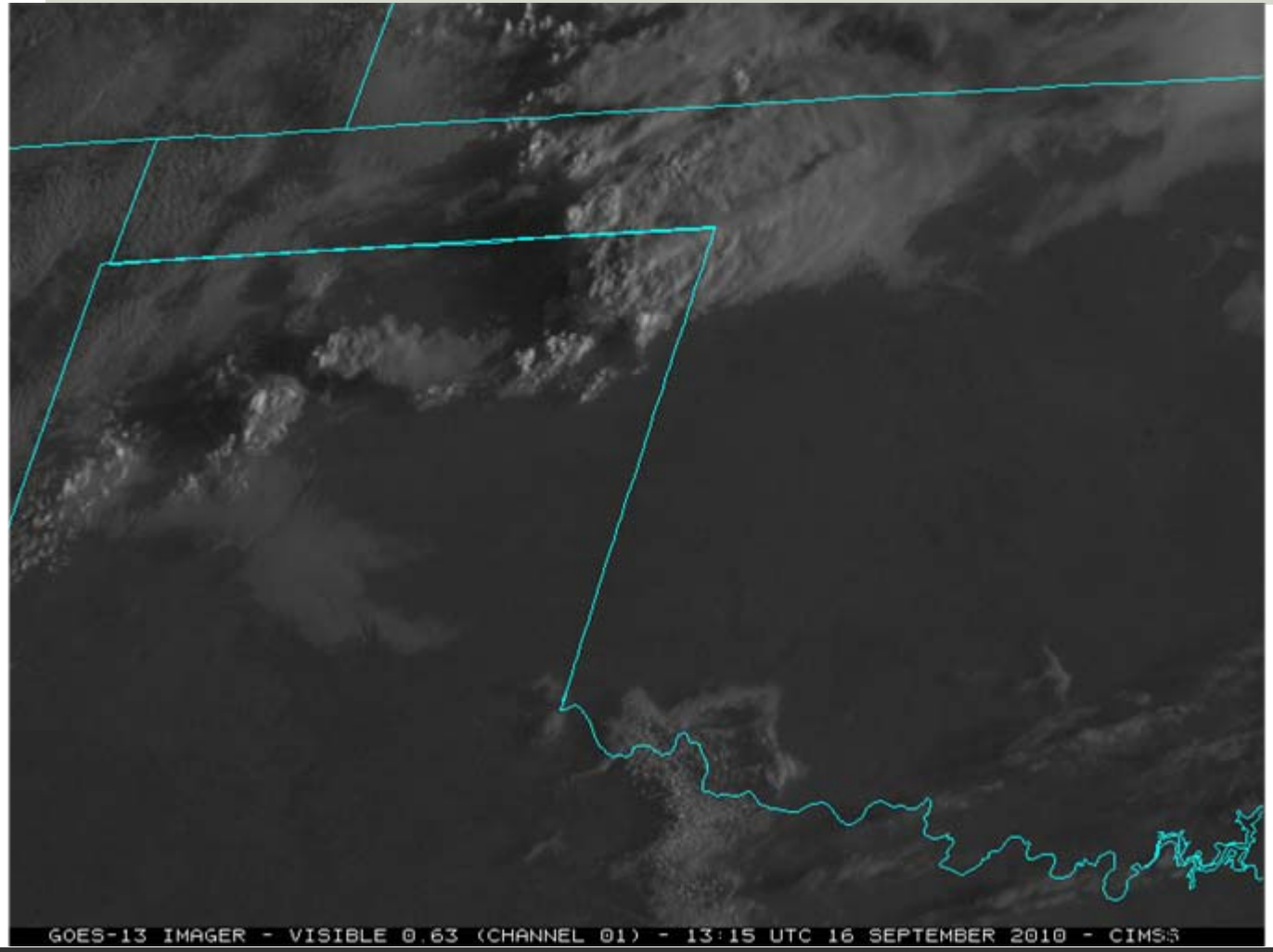
AWIPS images of 4-km resolution GOES-13 10.7 µm IR channel data (above) revealed large clusters of rapidly-developing thunderstorms over Kansas and Missouri during the afternoon and evening hours. The coldest GOES-13 cloud top IR brightness temperature was -81º C (violet color enhancement) at 22:45 UTC. However, it is unclear of the exact location of the turbulence encounter, since AWIPS plotted a SEVERE TURB report from UAL967 at Flight Level 34,000 feet over both Missouri and Kansas.




# 8 August 2010

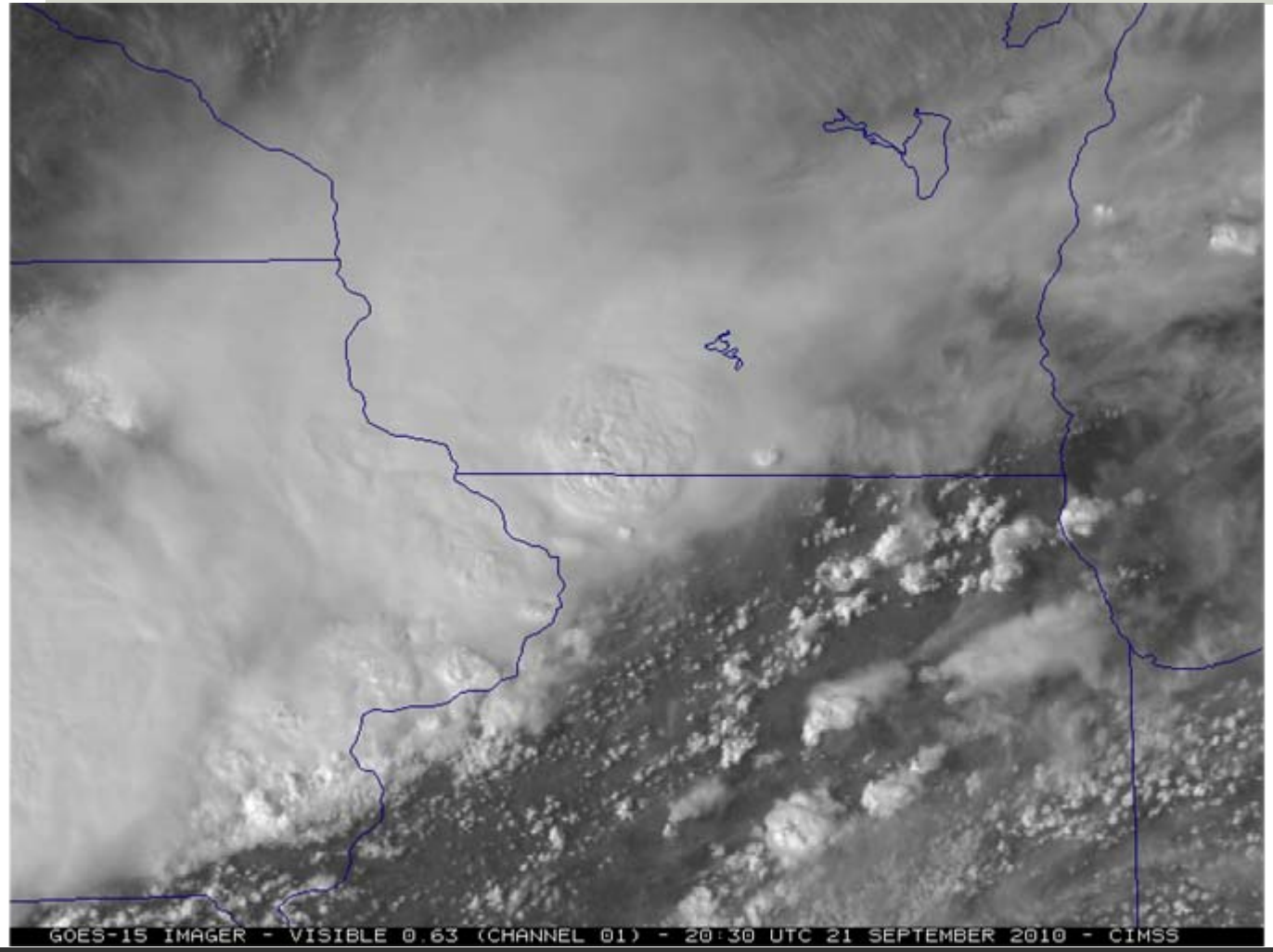
A large Mesoscale Convective System (MCS) initially developed over Nebraska and quickly grew in size as it propagated eastward across the Missouri River Valley region of the north-central US on 8 August 2010. AWIPS images of 1-km resolution POES AVHRR 0.63 µm visible and 10.8 µm IR channel data (above) revealed an impressive back-sheared anvil structure, along with well-defined overshooting tops and very cold cloud top IR brightness temperatures (as cold as -91º C)


POES Visible Satellite
Sun 23:58Z 08-Aug-10



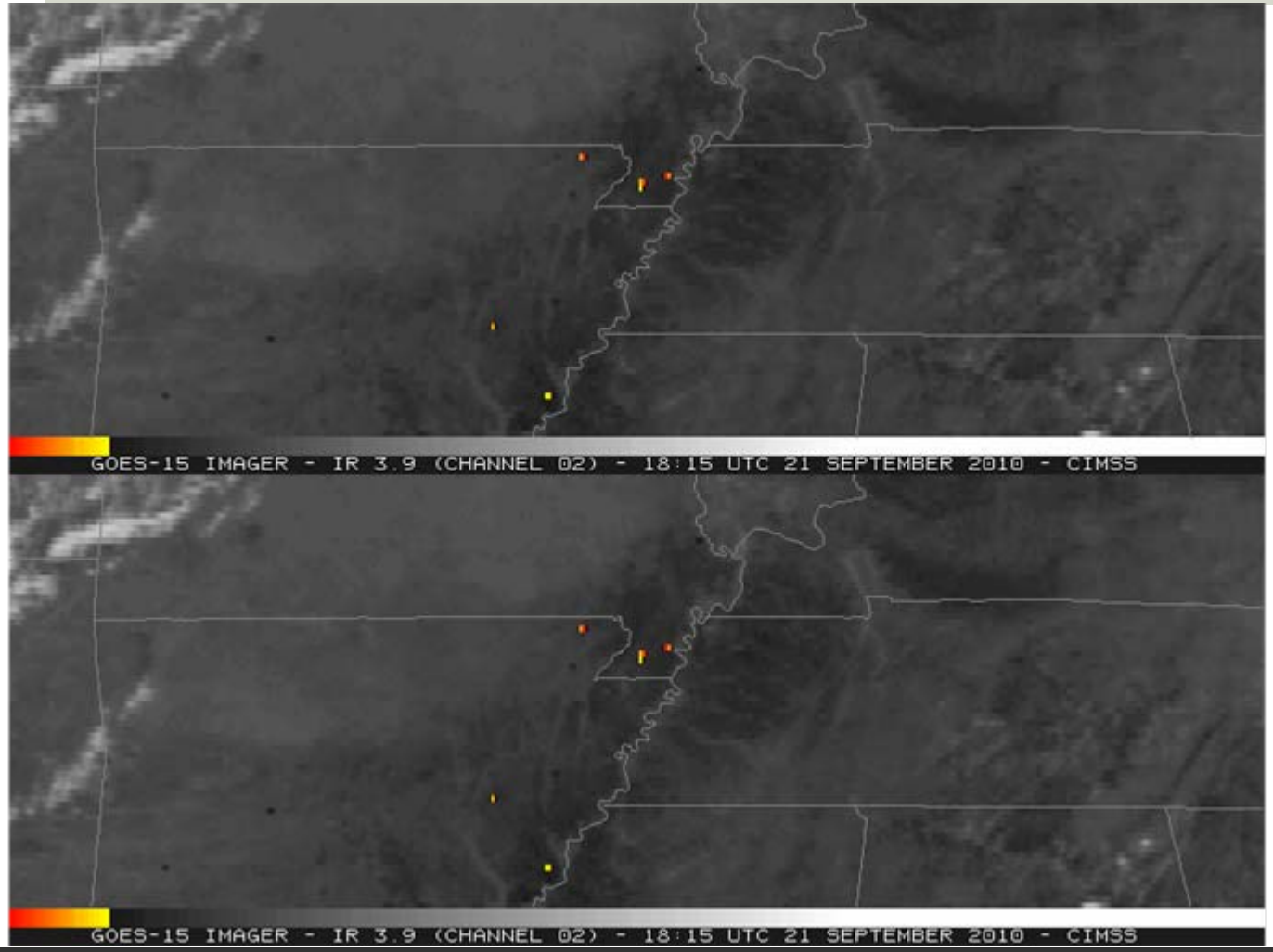

# 16 September 2010

McIDAS images of GOES-13 0.63 µm visible channel data on 16 September 2010 (above) showed a nice example of the role that a pre-existing convective outflow boundary can play in helping to act as a forcing mechanism for new convection — and also to help intensify existing strong convection that encounters the outflow boundary. Morning thunderstorms along the Texas/Oklahoma border region produced an outflow boundary that later moved southward and westward during the early afternoon hours.



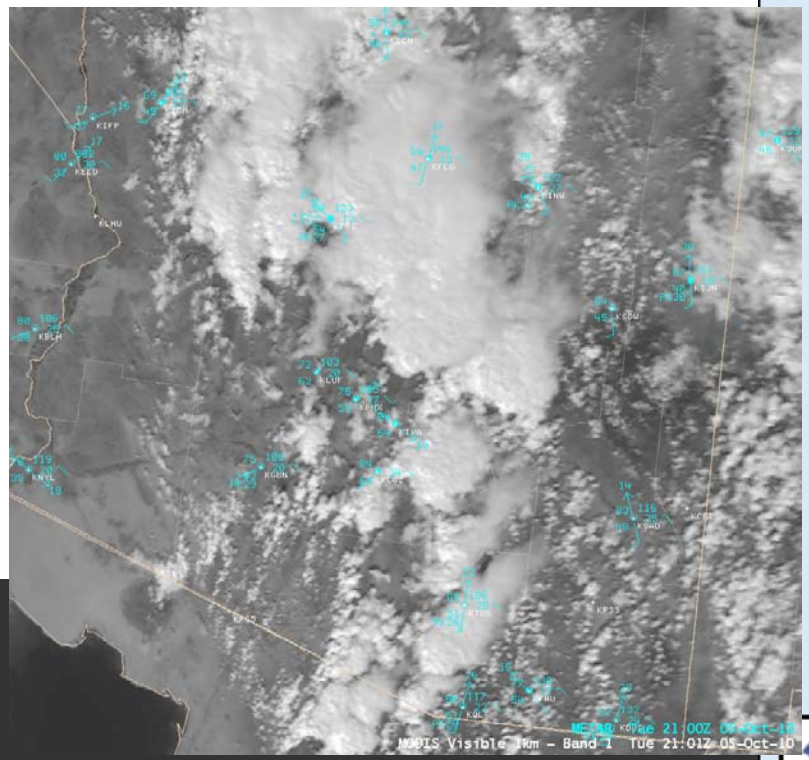

# 21 September 2010

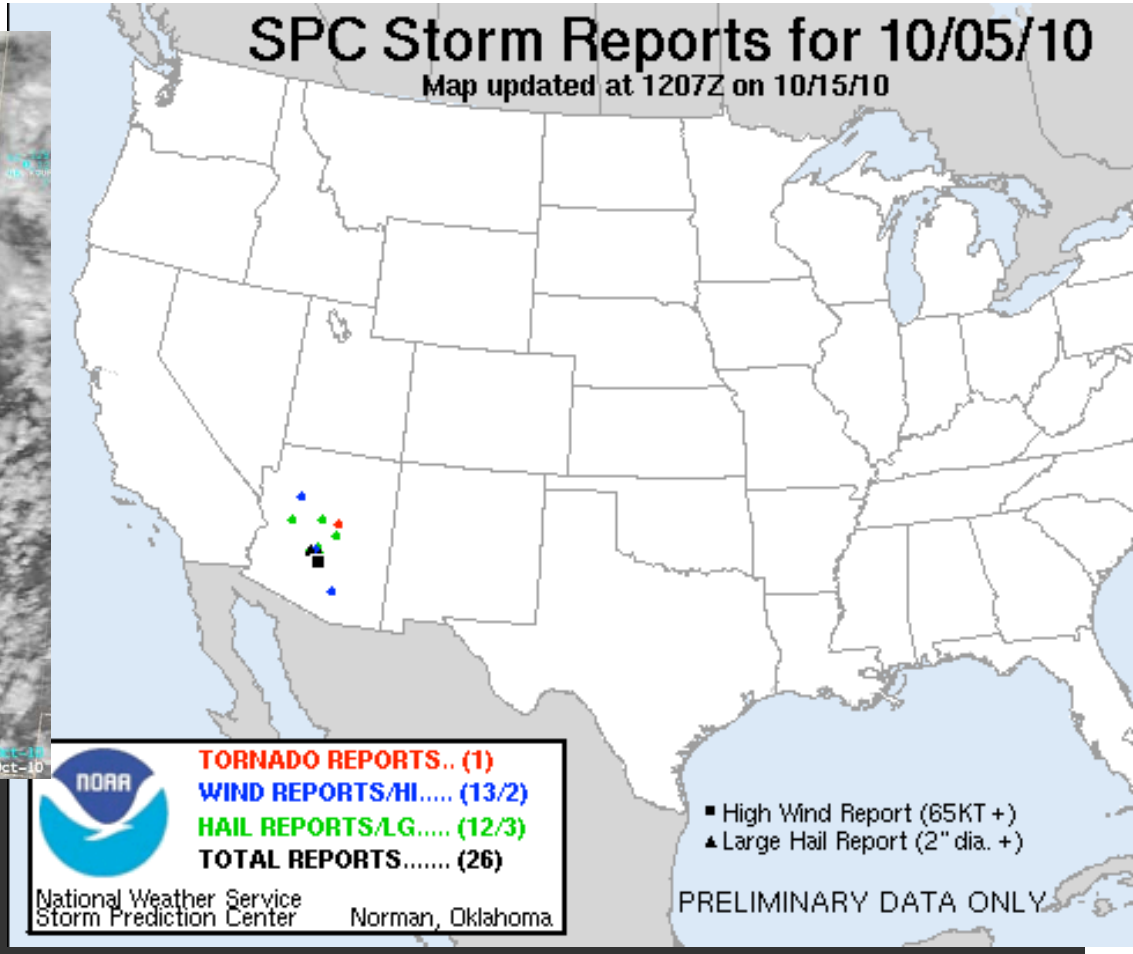
21 September 2010 was the final day of the GOES-15 Post Launch Science Test — and the satellite was placed into Super Rapid Scan Operations (SRSO) mode to provide images as frequently as every 1 minute over the Upper Midwest region. A set of SRSO 0.63 µm visible images (above) showed the evolution of clusters of severe thunderstorms with overshooting tops that were producing large hail and damaging winds across parts of Iowa, northern Illinois, and southern Wisconsin during the 20-22 UTC time frame.




# 21 September 2010

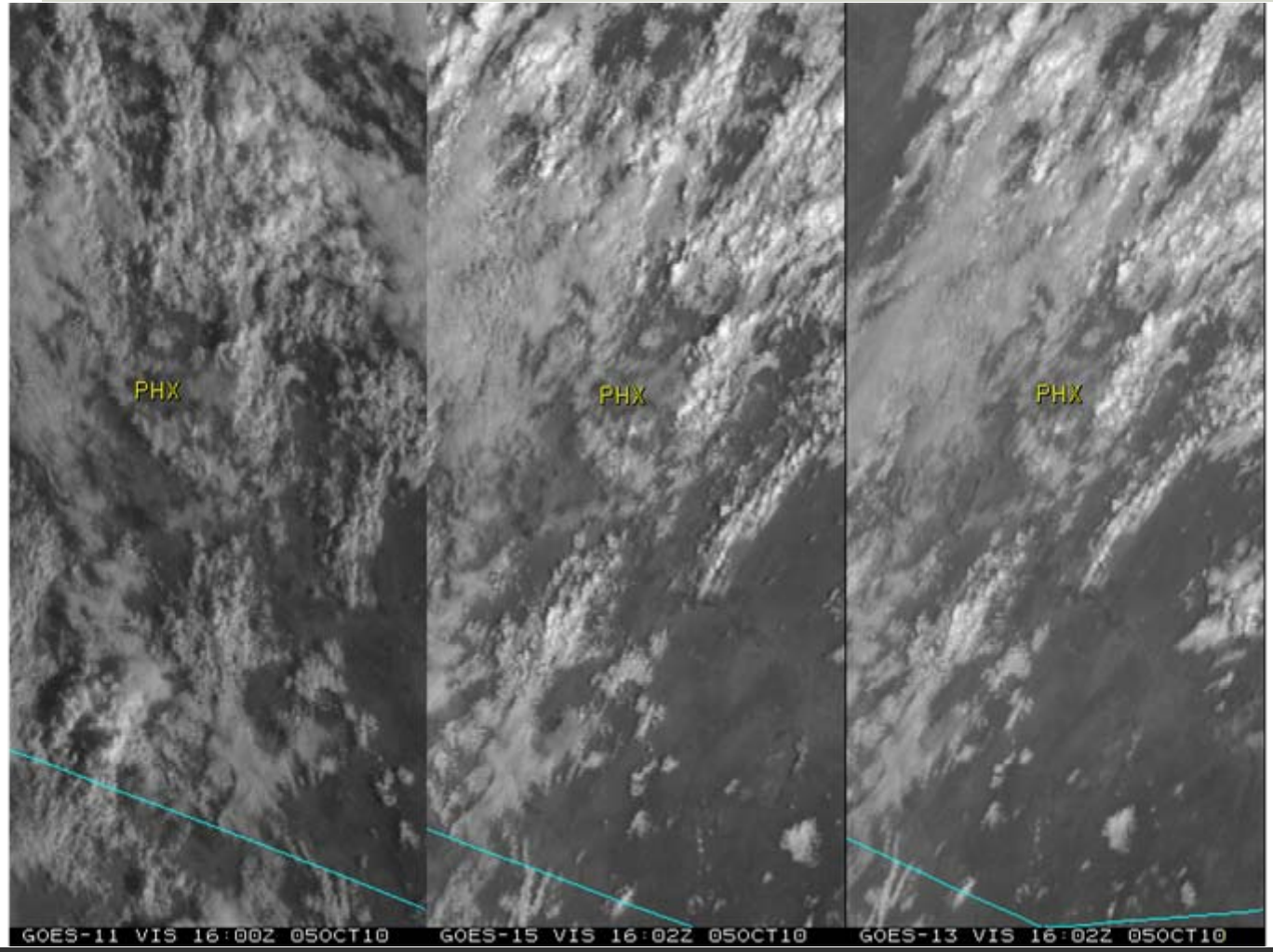
In addition to the severe convection, there were a number of small agricultural fires burning across parts of northern Arkansas into the Boothill of Missouri region and extreme southern Illinois. A comparison of GOES-15 3.9 µm shortwave IR images at 1-minute intervals (below; top panels) vs the "normal" operational 15-minute interval (below; bottom panels) demonstrates the improved ability to monitor the temporal variability of such small and often short-lived fires (which were denoted by the hotter yellow to red pixels).



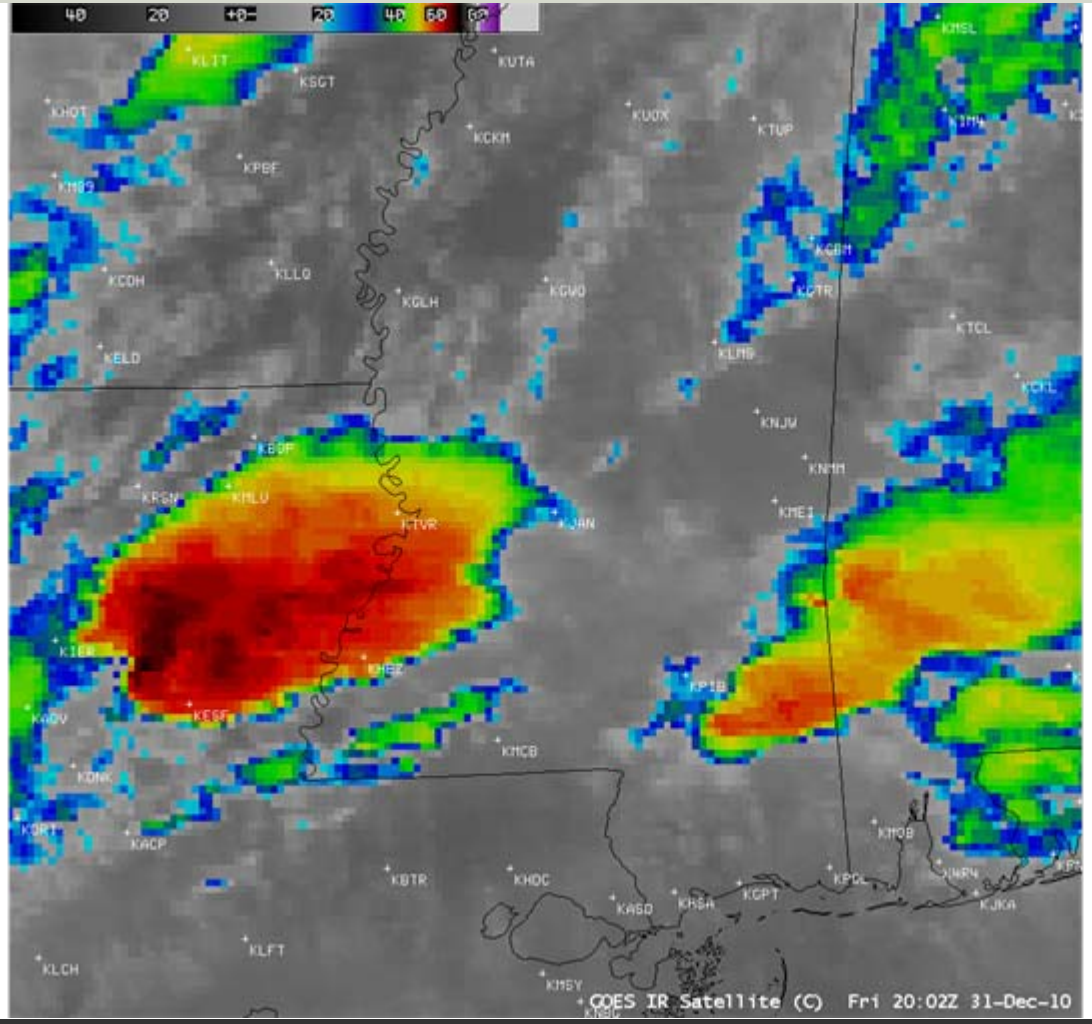

# 5 October 2010

Multiple rounds of severe thunderstorms moved northward across southern Arizona on 05 October 2010, producing hail as large as 2.5 inches in diameter, wind gusts as high as 75 mph, and rainfall in excess of 2 inches at some locations (SPC Storm Reports). According to a Phoenix Public Information Statement, the 2.5 inch diameter hail was some of the largest hail ever reported in Arizona.




# 5 October 2010

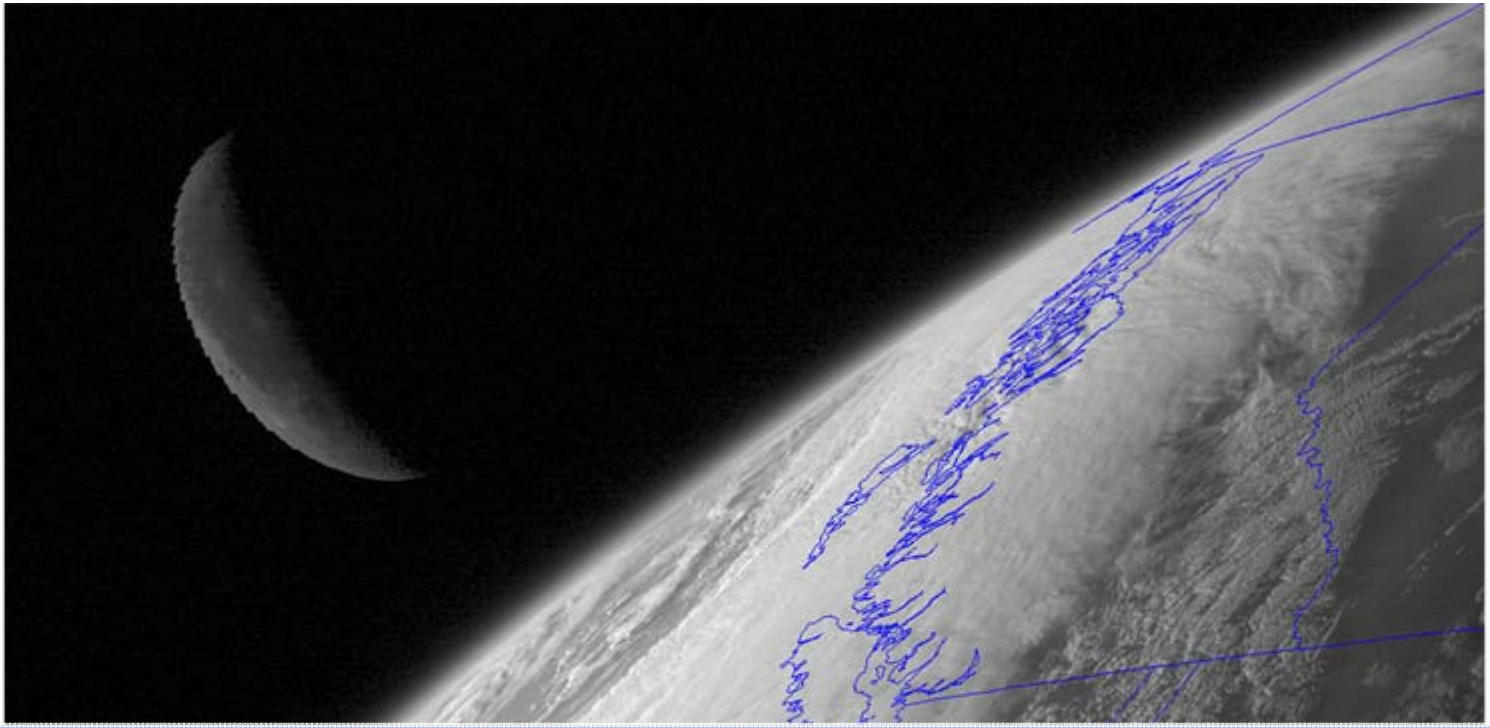
A 3-panel comparison of visible channel images from GOES-11, GOES-15, and GOES-13 (above; also available as a QuickTime movie) showed the large clusters of convection, some of which moved through the Phoenix area (station identifier PHX). After 18:30 UTC, the GOES-11 satellite was placed into Rapid Scan Operations (RSO) mode, allowing images as frequently as every 5-7 minutes (in contrast to the standard operational 15-minute image interval on GOES-15 and GOES-13).




# 31 December 2010

A tornado (which produced EF-2 damage at one point along its path) moved directly across the airport grounds and passed just south of the airport terminal at Jackson, Mississippi (station identifier KJAN) around 23:20 UTC on 31 December 2010 — being such a close call, it was cause for the staff at the National Weather Service forecast office at Jackson to shelter in place for several minutes while the tornado moved over the airport.

# Questions or Comments?



**http://cimss.ssec.wisc.edu/goes/blog**

**Contact Me: Jordan Gerth**, University of Wisconsin, Jordan.Gerth@noaa.gov

Thanks to Scott Bachmeier and Scott Lindstrom, CIMSS