Comparison of the March 2, 2012 storm between polar and geostationary orbiters within AWIPS

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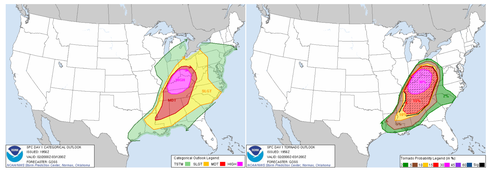
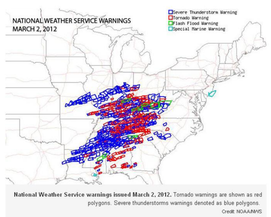
March 2, 2012 Storm Summary

On March 2, 2012 the Storm Prediction Center (SPC) issued a rare high risk of severe weather for central Tennessee and central Kentucky, which was later extended into central and southern Indiana and southern Ohio, with the potential for significant tornadoes, in advance of a deepening low pressure system developing over the Great Lakes.

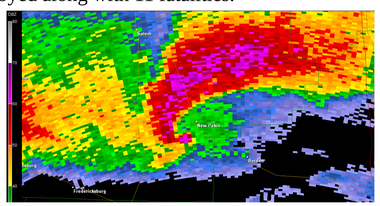


Credit: Storm Prediction Center, NOAA

The SPC issued multiple particularly dangerous situation (PDS) tornado watches in advance of a line of discrete supercells that formed along the Ohio River and pushed eastward. The following image from the National Weather Service (NWS) illustrates the volume of warnings issued on March 2nd, 2012.



While there were numerous severe weather reports, the most severe damage was from the storms which passed between Louisville, Kentucky and south of Cincinnati, Ohio. These storms resulted in an Enhanced Fujita scale (EF)4 tornado, which carved a 49 mi (79 km) path of damage from Fredericksburg, IN to Bedford, KY. In addition, there was a shorter EF1 tornado which passed to the south of Henryville, IN shortly after the EF4 struck. The most severe damage took place in New Pekin, Henryville, Marysville and Chelsea, IN, resulting in hundreds of homes being destroyed along with 11 fatalities.



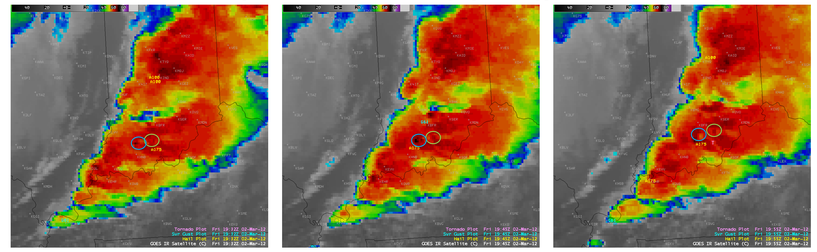
Credit: Louisville, KY NWS Weather Forecast Office (KLMK)

The first touchdown of the Southern Indiana EF4 tornado was approximately 1950Z (1450 EST) near New Pekin, IN, according to the Louisville, KY NWS Weather Forecast Office (WFO). This can be seen as the hook echo in the radar image above. Shortly before the tornado touched down there were 4 passes over the area by polar orbiting satellites, including NOAA-18, NOAA-19, Aqua and Suomi NPP, providing a unique look with three separate types of high resolution imagers at the developing storms as well as providing information that was unable to be seen from GOES.

Observations from the Satellite Perspective

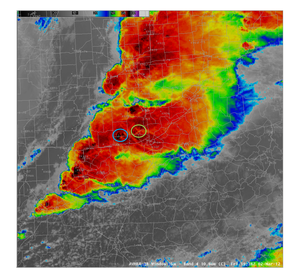
GOES

GOES-East (GOES-13) was in Rapid Scan Operations (RSO) for the duration of the severe weather outbreak. However, as can be seen in the sequence of images below, western supercell (circled in blue in each image) has a pronounced enhanced-V, had an approximate brightness temperature difference (BTD), of the overshooting top (~193K) minus the warm region (~203K), of ~10K. The eastern supercell (circled in green in each image), which spawned the EF4 tornado, can be seen in the GOES imagery, but is more subtle than the western supercell because its overshooting top is less apparent in the infrared imagery.



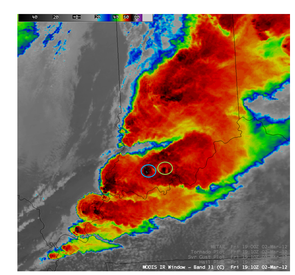
POES

The Advanced Very High Resolution Radiometer (AVHRR) on both NOAA-18 and NOAA-19, both part of NOAA's Polar Operational Environmental Satellite (POES) suite of satellites, observed the pair of supercells responsible for the severe weather in southern Indiana prior to the formation of the EF4 and EF1 tornadoes in the Henryville, IN area. As expected from the usage of the 1km imagery from AVHRR, more detailed features can be seen as compared to GOES. This includes the pronounced overshooting top and associated thermal couplet of the western supercell (circled in blue), which was responsible for several instances of hail and the EF1 tornado just south of Henryville, as well as the eastern supercell (green) which was responsible for the EF4 tornado.



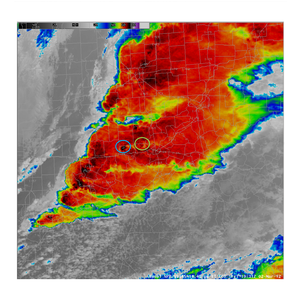
MODIS

Like the NOAA polar orbiters, the Moderate Resolution Imaging Spectroradiometer (MODIS) instrument on-board the Aqua NASA EOS satellite also observed the same pair of storms roughly 40 minutes prior to the formation of the EF4 tornado. As with AVHRR, both supercells (west, circled in blue, and east, circled in green) can be seen in the 1km imagery from MODIS (right). All four high-resolution polar imagers (NOAA-18, NOAA-19, MODIS and VIIRS) show similar temperatures for the western supercell (-76C for MODIS), while the lower resolution (4km) GOES imager was noticeably warmer (-67C a the time of the MODIS image).



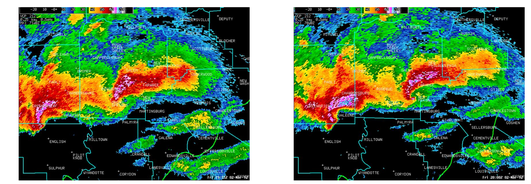
VIIRS

The Visible Infrared Imager Radiometer Suite (VIIRS), a scanning radiometer, on the Suomi NPP, overflew the storms in southern IN at approximately 1930Z, or approximately 20 minutes prior to the touchdown of the EF4 tornado associated with the eastern supercell (green). In this case the VIIRS I05 band data was remapped from its 0.375km native resolution to 1km for display in AWIPS. Even with the remapping and the loss of resolution, the eastern supercell shows a moderate enhanced-V, with a brightness temperature difference (BTD) between OT and warm region of ~10K. The western supercell (blue) BTD of ~25K.



Analysis

Both the western satellite feature, which has a clear enhanced-V signature in all of the images, and the eastern feature are associated with strong tornadic supercells. The western supercell had a BTD between the overshooting top and warm region of 10K in the GOES 4km imagery and greater than 20K in the polar 1km imagery. This robust enhanced-V signature is often associated with severe storms. Interestingly, it was the eastern storm, having the more subtle infrared satellite presentation, that was the one which formed the EF4 tornado that hit Henryville, IN. It should be noted that the overshooting tops of both storms can be seen in the visible (0.64 μm) imagery (not shown) from both GOES and the polar orbiters. Both supercells are easily seen on radar imagery, shown below (provided by the Louisville WFO)



Louisville, KY (KLMK) radar at 1955Z (left) and 2005Z (right)

While this case, as well as others, was well-sampled from surface-based observations, particularly ground-based radar, the evolution of cloud-top features as observed from satellites remains quite interesting. From a satellite perspective, the western supercell appears potentially "more" severe than the eastern supercell due to the more defined enhanced-V signature. However, as noted above, it was the eastern cell that produced the strongest (EF4) and longest lived tornado. While less noticeable in the low resolution GOES imagery, the higher resolution satellite imagery more clearly depicts the overshooting top associated with the eastern supercell.

VIIRS2AWIPS Conversion

A series of VIIRS granules are converted into AWIPS compatible NetCDF files by first aggregating them into an image swath with navigation for each channel of interest. Preprocessing enhancements are applied to the Day-Night Band. The swath is remapped to a grid, with the bow-tie gaps corrected. The gridded image is then rapidly scaled and packaged as AWIPS-compatible NetCDF with time and grid metadata. Gridded image sizes typically are 5000x5000 pixels for input swaths typically 3200x7000. The process has been demonstrated for the I-bands, M-bands and Day-Night band for CONUS-E, CONUS-W, HI national and AK regional domains. The VIIRS-to-AWIPS bridge is implemented as open-source software and will be available for download when pseudo-operational testing is complete.

Summary

- High resolution imagery shows the fine structure of these dramatic supercells. Other examples of severe weather being observed by VIIRS has continued through the 2012 severe weather season.
- By integrating polar satellite imagery into AWIPS, this provides the ability for forecasters to use high resolution imagery in their forecasts.
- Usage of data from direct broadcast (HRPT, IMAPP, CSPP) allows for timely distribution of polar data
- Because polar imagers do not have the temporal capability of current GOES, and current GOES does not have the spatial resolution of the polar orbiters, this emphasizes the need for higher spatial and temporal data, such as data coming from ABI on GOES-R.