**The Tennessee Floods of May 2010: A Satellite Perspective--Part III**

*Introduction to Series III*

An unprecedented multi-day heavy rainfall and flash flooding event occurred last year in early May over Tennessee and surrounding states. A sequence of NOAA Blended Total Precipitable Water (BTPW) and Percent of Normal product images of the "big picture" history and evolvement of deep low level moisture sources leading to the event was shown in Part I. Part II discussed and compared the use of the GOES 6.7µ Water Vapor (WV) channel and BTPW product for analyzing various moisture and lifting mechanisms that contributed to this event, reinforcing the need to incorporate satellite imagery and their applications into the analysis and forecast process to help further improve the forecasts of the location and amount of heavy precipitation; lead time for the issuance of flash flood watches and warnings. In this month's concluding article of the series, Part III will show how BTPW and GOES WV satellite data can both supplement and complement initial computer model standardized anomaly information to gain a better perspective of the potential magnitude/historic aspects of the May 2010 heavy rainfall/flash flood event.

*Discussion*

NOAA/NESDIS operational satellite analysts make use of Blended Total Precipitable Water (BTPW) products and GOES 6.7µ WV to analyze heavy rainfall and the potential for flooding. The NOAA/NESDIS operational unified BTPW product is produced with the blending and merger of TPW products produced from various sensors on polar-orbiting and GOES satellites and ground-based Global Positioning System (GPS) equipment (Forsythe, et.al., 2009; Kusselson, et.al., 2009). The BTPW Anomaly or Percent of Normal product takes the current BTPW product and compares it with a 1988-1999 climatology of DMSP SSM/I TPW over the ocean and a mix of radiosonde/TIROS Observational Vertical Sounder (TOVS) soundings over land (conversation with John Forsythe of CIRA/Colorado State University, 2006). By accessing the BTPW products and anomalies, forecasters can use this data to forecast the development and evolution of potential heavy rainfall events. They also may be of considerable value when predicting a heavy or near record rainfall event. The ability to monitor these plumes hour by hour from the BTPW and Percent of Normal products could be of considerable value in the forecast process. GOES 6.7µ water vapor imagery can provide a subjective way to analyze the intensity of a middle and upper level trough approaching an area of concern. NCEP Hydrometeorological Prediction Center (HPC) operational forecasters make use of standardized anomalies to evaluate deterministic numerical weather prediction forecasts. The anomaly data are computed from a 62-year daily climatology (1948-2009) derived from the NCAR/NCEP reanalysis dataset (Kalnay et.al., 1996). The forecast model output is interpolated onto the reanalysis 2.5 grid, and a 15-day centered average for each time in the daily climatology is used in the computation of the anomalies. The anomalies are quantified as standard deviations (SDs) from normal, meaning SDs were used to compute standardized anomalies as described in Hart and Grumm (2001). The Second Forum on the Future Role of the Human in the Forecast Process identified the need for forecasters to be able to recognize the problem of the day and to discern anomalous, relatively rare weather situations which may necessitate deviating from model guidance (Stuart et al. 2007). The use of standardized anomaly (SA) fields can aid in the prediction of anomalous weather situations. Grumm and Hart (2001) and Stuart and Grumm (2006) have shown that SAs can be used to help forecasters identify significant anomalous weather events.

Satellite and SAs can play a powerful tool in assessing the potential for heavy precipitation/flash flooding. Matching the right satellite and SA product so that they complement and supplement each other and further help forecasters in trying to pinpoint heavy rainfall and flash flood concerns can be challenging. In Figure 1 , BTPW products and GOES WV satellite products in the top row were matched with initial GFS model SA analysis information that could subsequently provide added value to the forecaster in identifying areas of heavy rainfall and potential flash flooding. Different satellite products were matched with SA products, but forecasters should not feel obligated to just use the below matched satellite products (top) with the SA directly below it. Mixing and matching is encouraged if it helps the forecaster hone in better on the heavy rain/flash flood problem of the day.

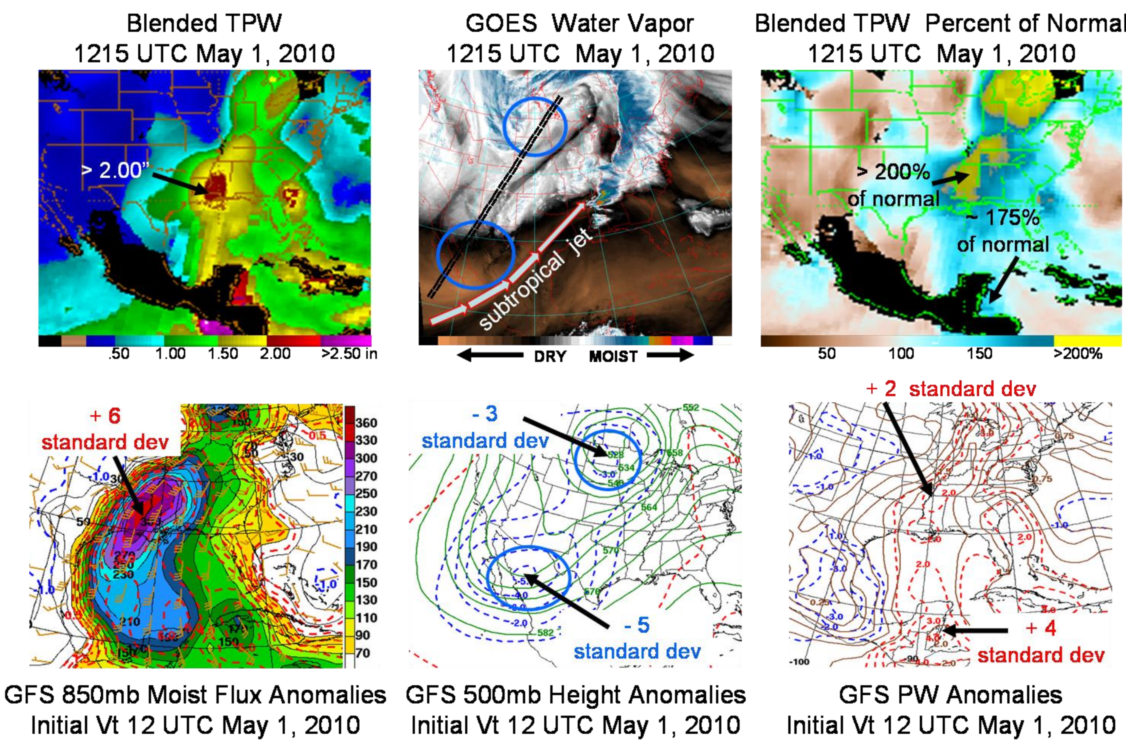


**Figure 1 - The individual satellite products/imagery (top row) complement and supplement the particular GFS initial analysis standardized anomalies (bottom row) for 1200 UTC May 1, 2010: Blended TPW (top left) and model 850mb moisture flux anomalies (bottom left); Analyzed GOES 6.7µ Water Vapor image (top middle)**

**and model 500mb height anomalies (bottom middle); Blended TPW Percent of Normal (top right) and model precipitable water anomalies (bottom right).**

BTPW was matched with 850 mb moisture flux anomalies to get a clearer sense of the anomalous efficiency of transporting a concentrated area of moisture (the plume) and hopefully help further improve the lead time and location of the significant heavy rainfall and flash flooding event. GOES WV was matched with model 500 mb height anomalies to get a sense of the forcing mechanisms and anomalous heights that would drive the efficient squeezing of moisture from the atmosphere to the ground to increase that heavy rain and flooding potential. Lastly, BTPW Percent of Normal was matched with model PW anomalies to further confirm whether the event was going to be abnormal and by how much compared with satellite and reanalysis climatology, respectively. Since the BTPW products and GOES WV imagery are updated hourly and half hourly, respectively, their greatest value is providing information between the initial run times of the GFS model SAs. Forecasters are encouraged in the future to mix these and other satellite products with SA analysis parameters to increase their confidence in forecasting significant anomalous events like this one centered in Tennessee in May, 2010.

**References:**

Forsythe et. al, 2009: Increasing the land coverage of blended multisensor total precipitable water (TPW) products for weather analysis, *AMS 89th Annual Meeting, 16th Satellite Meteorology and Oceanography Conference*,. January 11-15, 2009, Phoenix, AZ.

Grumm, R. H. and R. Hart, 2001:Standardized anomalies applied to significant cold season weather events: Preliminary findings. Wea Forecasting, **16**, 736-754.

Hart, R. E. and R. H. Grumm, 2001: Using normalized climatological anomalies to rank synoptic-scale events objectively. *Monthly Weather Review*, **129**, Issue 9, 2426-2442. 2001.

Kalnay et. al, 1996: The NCEP/NCAR 40-year reanalysis project. *Bull. Amer. Meteor.Soc.*, **77**, No. 3, March 1996.

Kusselson, et. al, 2009: An Update on the operational implementation of blended total precipitable water (TPW) products, *AMS 89th Annual Meeting, 23rd Conference on Hydrology*, January 11-15, 2009, Phoenix, AZ.

Stuart, et. al, 2007: Maintaining the role of humans in the forecast process: Analyzing the psyche of expert forecasters. *Bull. Amer. Meteor. Soc.*, **88,** 1893–1898.

Two sources of NCEP Real-time Standardized Anomaly data
http://www.hpc.ncep.noaa.gov/training/SDs/
http://www.atmos.albany.edu/student/tomjr/images/predict/pw/forecast.html

Satellite Image Resources

Blended TPW Products: http://www.osdpd.noaa.gov/bTPW
GOES-EAST WV loop: http://www.ssd.noaa.gov/PS/PCPN/DATA/RT/na-wv-loop.html
GOES-WEST WV loop: http://www.ssd.noaa.gov/goes/west/nepac/loop-wv.html