AN OBJECTIVE NEAR-CASTING TOOL THAT USES THE GOES SOUNDER TO PREDICT SEVERE CONVECTION

Robert M. Aune[(1)] *and Ralph Petersen*[(2)]

[(1)]Advanced Satellite Products Branch (ASPB), NOAA/NESDIS
1225 West Dayton Street
Madison, Wisconsin - USA

[(2)]Cooperative Institute fore Meteorological Studies (CIMSS)
1225 West Dayton Street, University of Wisconsin,
Madison, Wisconsin - USA

1. INTRODUCTION

Satellite instruments of the future will improve atmospheric measurements in both time and space. Although these observations are expected to improve numerical weather prediction (NWP) guidance at 48 hours and beyond, a significant benefit will come from using the data in objective near-casting systems that assist forecasters in identifying rapidly developing, extreme weather events one to six hours in advance. These systems will have to detect and track extreme variations in the atmosphere, and be able to incorporate large volumes of high-resolution asynoptic data. They will have to be computationally efficient and will most likely use numerical approaches different from current numerical weather prediction models. High temporal resolution will be required which can best be provided by a geosynchronous platform. A new objective near-casting approach has been developed at the Cooperative Institute for Meteorological Satellite Studies (CIMSS) that uses LaGrangian trajectories of retrieved parameters provided by the Geostationary Operational Environmental Satellite (GOES) sounder. Observations are projected forward in time six hours and saved hourly. Datasets from the previous six sounder scans are combined with the current scan to produce an analysis. This operation is performed at two layers in the vertical. The system is designed to detect and track intense vertical and horizontal variations in the atmosphere that can lead to an outbreak of severe weather. Tests of the system have identified atmospheric details associated with the onset of significant weather events up to 6 hours in advance. Using full resolution derived products from current GOES sounders to update and enhance current operational forecasts, the LaGrangian system captures and retains details (maxima, minima and extreme gradients) important to the development of convective instability, even after IR observations are no longer available due to cloud development.

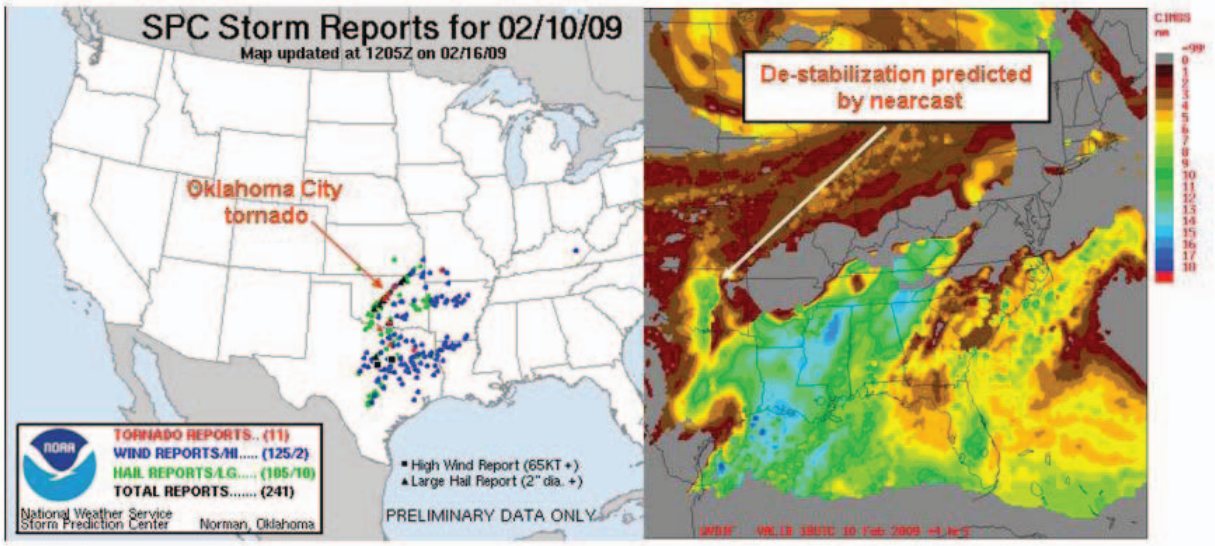
2. THE CIMSS NEAR-CASTING MODEL

A simple trajectory model was designed to project GOES sounder observations forward in time. The trajectories are forced using winds and heights from the National Weather Service's Rapid Update Cycle (RUC) model to steer the observations at multiple levels. Two layers of precipitable water retrievals from the GOES-12 sounder were used in the initial tests. The retrieval uses the three water vapor channels: channels 10 (7.4 microns), 11 (7.0 microns), and 12 (6.5 microns) to define the distribution of water vapor in the atmosphere at different levels [1]. Such a multi-layer description of the atmospheric water vapor is not possible with the single water vapor channel on the GOES imager. Multiple channels of the GOES sounder are required. This system can predict areas of destabilization (convective potential) if "low" level moisture moves underneath "upper" level drying. The fields are presented as moisture change with height. If a region shows the moisture change with height increasing with time, then that region is becoming more convectively unstable. More recently, equivalent potential temperature (thetaE) retrievals were used with good results. ThetaE is a more comprehensive indicator of atmospheric destabilization.

3. REAL DATA TESTS USING DERIVED PARAMETERS FROM GOES

Real data tests are currently being conducted at CIMSS - with the goals of identifying details of the environments associated with the onset of significant weather events several hours in advance. The tests use full resolution (10 km) derived layer products from the GOES-12 sounder. Initial tests are focusing on the use of multi-layer GOES Derived Products (DPs) such as precipitable water and thetaE. The objective of these tests is to provide forecasters 3 to 6 hour near-casts of the DP fields updated every hour. Initial testing of the LaGrangian near-casts focuses on the optimal approaches for providing rapid updates to the user. Individual air parcels are assigned to each GOES-DP data location and marched forward in time at 15 minute intervals. The system has been successful at identifying severe weather three to six hours in advance. An example of a two-layer precipitable water near-cast is shown in Figure 1. A 4-hour near-cast of layered precipitable water differences, low layer minus upper layer, valid 22 UTC February 10, 2009 indicates an area of de-stabilization in central Oklahoma. Severe weather reports are shown on the left. For this case, forecasters found the product useful because guidance was favoring severe thunderstorm development in eastern Oklahoma.

Figure 1



4-hour nearcast of de-stabilization (mm differences) near Oklahoma City valid 22UTC Feb 10, 2009. Multi-layer moisture information from multiple GOES-12 sounder scans are used to identify regions of drying aloft and low-level moistening.

4. FUTURE DIRECTIONS

The approach holds promise for extending the utility of GOES derived products (which currently are not used in NWP models over land) from observational data into objective tools that can be used in anticipating details about the timing and location of convection 3-6 hours in advance, even after the IR observations themselves may no longer be available in the areas of severe weather due to cloud development. In the future we will be working toward optimizing wind level selection to match satellite channel weighting and running the trajectories on isentropic surfaces. We need to improve the accuracy of the products by including 'data aging' and 'continuous successive image merger' algorithms to combine coincident output from successive near-cast runs into single images. We are also considering integrating observations from other observing systems. In addition we are assessing how a hyper-spectral sounder would improve the system.

11. REFERENCES

[1] Menzel, W. P., F. C. Holt, T. J. Schmit, R. M. Aune, A. J. Schreiner, G. S. Wade, and D. G. Gray, "Application of GOES-8/9 Soundings to Weather Forecasting and Nowcasting", *Bulletin of the American Meteorological Society*, Vol 79, pp. 2059-2077, Oct. 1998.