JP6.12 Microburst Windspeed Potential Assessment: Progress and Developments

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1. INTRODUCTION

A diagnostic nowcasting product, the Microburst Windspeed Potential Index (MWPI) (Pryor 2008a), has been recently developed and validated. The GOES sounder-derived MWPI is designed to infer attributes of a favorable microburst environment: a convective boundary layer with a steep temperature lapse rate and low relative humidity in the surface layer. These conditions foster intense convective downdrafts due to evaporational cooling as precipitation descends in the sub-cloud layer and results in the generation of negative buoyancy. A concern pertaining to the GOES sounder products is the current temporal and spatial resolution (60 minutes, 10 km). A multispectral GOES imager product (Pryor 2008b) has been developed and experimentally implemented to assess downburst potential over the western United States with improved temporal and spatial resolution. The availability of the split-window channel in the GOES-11 imager allows for the inference of boundary layer moisture content. Wakimoto (1985) noted favorable environmental conditions over the western United States: (1) intense solar heating of the surface and a resulting superadiabatic surface layer; (2) a deep, dry-adiabatic convective boundary layer (Sorbjan 1989) that extends upward to near the 500mb level; (3) a well-mixed moisture profile with a large relative humidity gradient between the mid-troposphere and the surface.

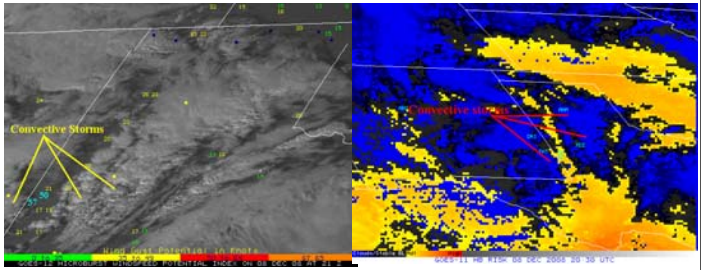

Figure 1. GOES sounder MWPI product at 2100 UTC 8 December 2008 (left) and corresponding GOES-11 imager microburst risk product at 2030 UTC 8 December 2008 (right).

The **Microburst Windspeed Potential Index (MWPI)** accounts for both updraft (**U**) and downdraft instability (**D**) in microburst generation and is defined as

$$MWPI \equiv \underbrace{\{(CAPE/100)\}}_{\mathbf{U}} + \underbrace{\{\Gamma + (T-T_d)_{850} - (T-T_d)_{670}\}}_{\mathbf{D}}$$

The **GOES-West (GOES-11) imager microburst algorithm** employs brightness temperature differences (BTD) between band 3 (upper level water vapor, 6.7µm), band 4 (longwave infrared window, 10.7µm), and split window band 5 (12µm). Band 3 is intended to indicate mid to upper-level moisture content and advection while band 5 indicates low-level moisture content. The GOES imager microburst risk (MBR) product is based on the following algorithm in which the output brightness temperature difference (BTD) is proportional to microburst potential:

$$MBR\ (BTD) = \{T5 - T3\} - \{T4 - T5\}$$

Both the GOES sounder MWPI and imager microburst risk products are predictive linear models developed in the manner exemplified in Caracena and Flueck (1988), consisting of a set of predictor variables that generates output of expected microburst risk.

2. CASE STUDIES:

Idaho Microbursts

During the afternoon of 30 and 31 August 2008, respectively, areas of convective storms developed over the mountains of extreme southern Idaho and northeastern Nevada and tracked northeastward through the Idaho National Laboratory (INL) complex. These events were of great interest due to the simultaneous availability of both GOES MWPI and imager microburst risk products two to three hours prior to the observed downbursts over the INL complex. As shown in Figure 2, both product images effectively characterized the pre-downburst environment. This case also proved to be efficacious in the comparison of different displays of the imager microburst product.

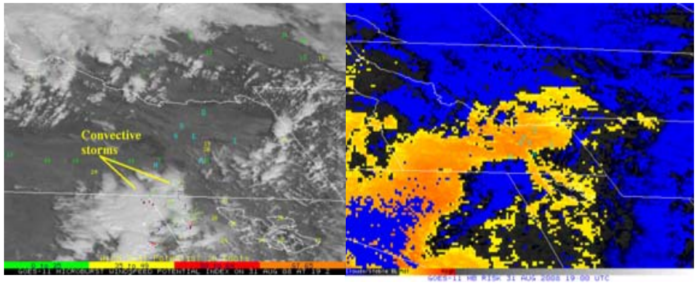

Figure 2. GOES sounder MWPI product (left) and GOES-11 imager microburst risk product (right) at 1900 UTC 31 August 2008 (right).

West Texas Downbursts

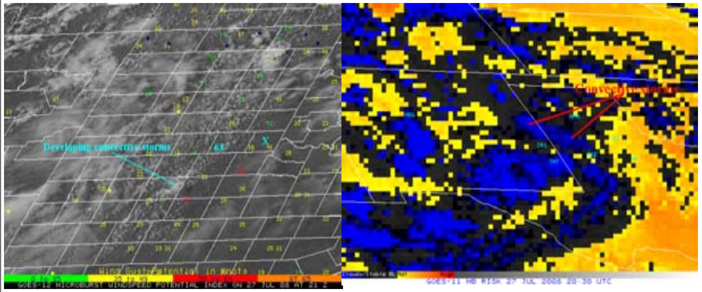
Figure 3. GOES MWPI product image at 2100 UTC 27 July 2008 (left) and corresponding GOES-11 imager microburst risk product.

During the afternoon of 27 July 2008, near 2300 UTC, a strong downburst, with an associated wind gust of 63 knots, occurred over western Texas in close proximity to elevated GOES MWPI values. The GOES MWPI product image, in Figure 3, indicated wind gust potential of 50 to 64 knots at 2100 UTC near Turkey West Texas Mesonet (Schroeder et al. 2005) station where the severe downburst was recorded two hours later. The ambient thermodynamic environment was featured strong static instability and a deep, well-mixed boundary layer that favored the development of intense convective downdrafts and resultant downburst generation. Strong downbursts also occurred elsewhere in the Oklahoma and Texas Panhandles. More recently, severe downbursts occurred over western Texas during the afternoon of 8 December 2008 (see Figure 1).

3. METHODOLOGY AND VALIDATION

Analysis of covariance between the variables of interest and surface downburst wind gust speed provided favorable results. As shown in Figure 4, the scatterplot of MWPI values vs. measured wind speeds effectively illustrated the strong correlation between MWPI values and wind gust magnitude, in which 54% of the variability in wind gust speed is coupled with variability in MWPI. Similar to the imager microburst product, the MWPI product is a linear predictive model (y=.3571x+31.436) that indicates relative convective wind gust potential that can be statistically related (or correlated) to surface wind gust speed.

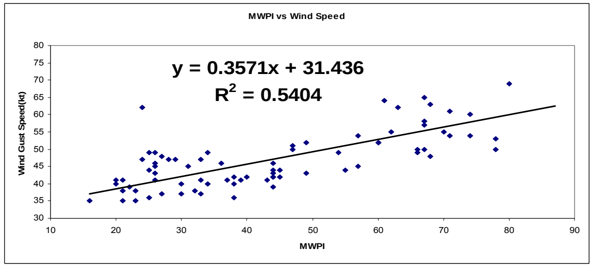

Figure 4. Scatterplot of GOES-12 sounder MWPI values vs. measured convective wind gusts for 78 downburst events over Oklahoma and western Texas that occurred during the 2007 and 2008 convective seasons.

4. REFERENCES

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