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Recent developments in microburst nowcasting using GOES

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1. INTRODUCTION

Recent testing and validation have found that the **Geostationary Operational Environmental Satellite (GOES) microburst products** are effective in the assessment and short-term forecasting of downburst potential and associated wind gust magnitude. Two products, the GOES sounder **Microburst Windspeed Potential Index (MWPI)** and a new two-channel GOES imager **brightness temperature difference (BTD) product** have demonstrated capability in downburst potential assessment (Pryor 2009; Pryor 2010). The GOES sounder MWPI algorithm is a **predictive linear model** developed in the manner exemplified in Caracena and Flueck (1988):

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

where Γ is the lapse rate in degrees Celsius (C) per kilometer from the 850 to the 670 mb level, and the quantity $(T-T_d)$ is the dewpoint depression (C).

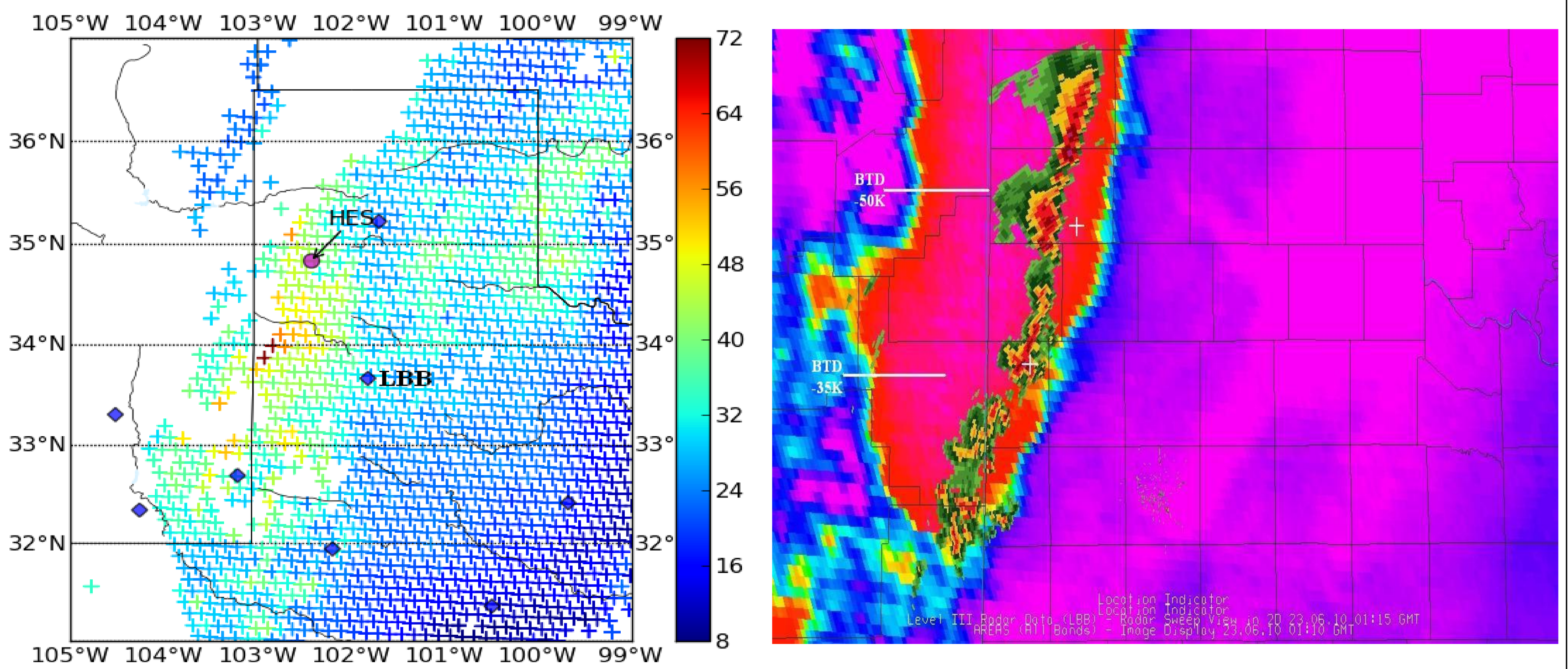

Figure 1. MWPI product image at 2200 UTC 22 June 2010 compared to a BTD image at 0110 UTC 23 June 2010 visualized by McIDAS-V. White lines represent the dry-air notches pointing to Hereford (northern white cross) and Muleshoe (southern white cross) West Texas Mesonet stations.

The MWPI algorithm, as shown in Figure 1, has been integrated into the **Graphyte Toolkit** as an executable **Python script**. The MWPI program reads GOES sounding profile data files in binary format, processes the data set, and generates output based on the above MWPI formula. A Python script, running in the Graphyte environment, produces an image with color-coded markers, representing relative wind gust potential. The output image, as visualized in Figure 1, can serve as a prototype for the GOES-R Microburst Windspeed Potential product.

In addition, it has been found recently that the **BTD between GOES infrared channel 3 (water vapor, 6.5μm) and channel 4 (thermal infrared, 11μm)** can highlight regions where severe outflow wind generation (i.e. downbursts, microbursts) is likely due to the **channeling of dry mid-tropospheric air** into the precipitation core of a deep, moist convective storm. Rabin et.al. (2010) noted that observations have shown that BTD > 0 can occur when water vapor exists above cloud tops in a stably stratified lower stratosphere and thus, BTD > 0 has been used a measure for intensity of overshooting convection. A new feature presented in this paper readily apparent in the BTD image in Figure 1 is a **"dry-air notch"** that signifies the channeling of dry air into the rear flank of a convective storm.

2. CASE STUDIES:
3 June 2010 Chesapeake Bay Downbursts

The 2100 UTC MWPI product image indicated elevated values over the entire Chesapeake Bay region downstream of the squall line developing over the Blue Ridge Mountains. The squall line moved eastward through the Maryland and Virginia piedmont and upper Tidal Potomac River between 2000 and 2130 UTC during the time of maximum surface heating when the lower troposphere was most unstable. Well-defined notches on the rear flank of the squall line signified the channeling of mid-tropospheric dry air into the storm precipitation cores, providing the initial energy for strong convective downdrafts. Near 2145 UTC, Potomac Light 33 recorded a gust to 39 knots followed by a gust to 41 knots near 2220 UTC at Kent Island. Note the orientation of a dry-air notch toward Potomac Light 33 station at 2132 UTC, just prior to the observation of a downburst. The 2100 UTC MWPI product in Figure 2 displayed index values of 20 to 24 in proximity to the locations of downburst observation. MWPI values of 20 to 24 correspond to wind gust potential near 40 knots.

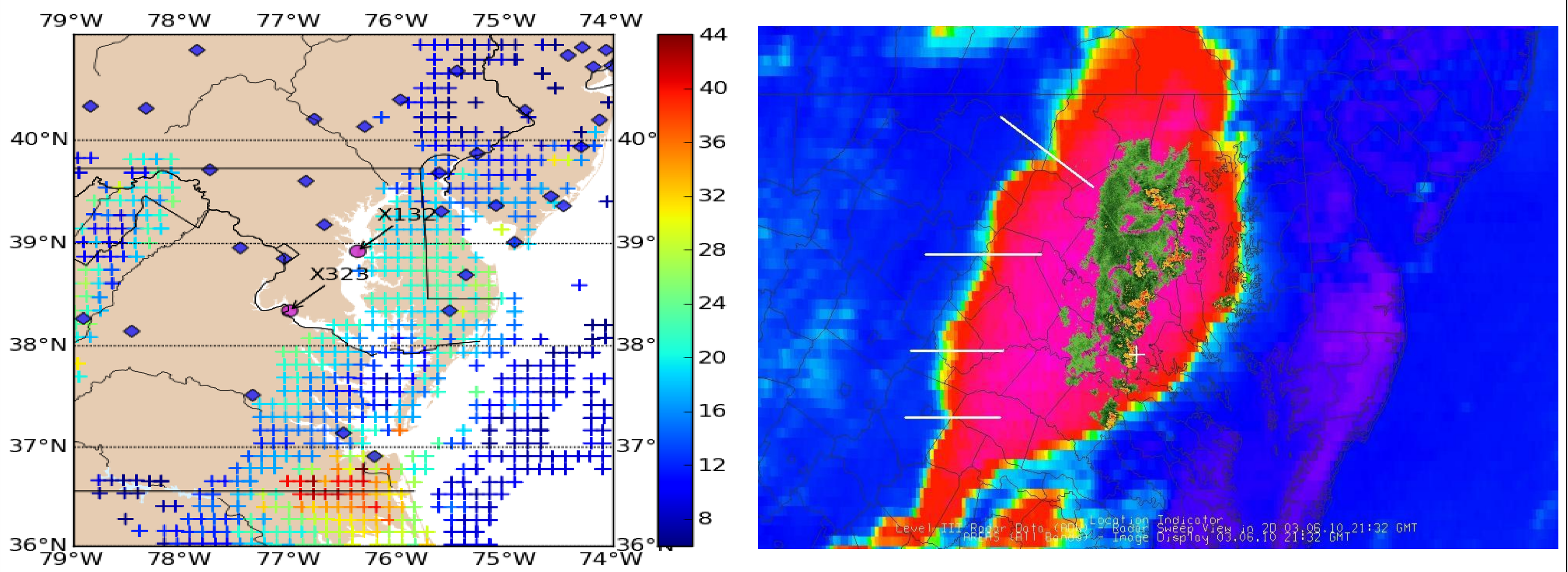

Figure 2. MWPI product image at 2100 UTC 3 June 2010 (left) and BTD image at 2132 UTC 3 June 2010 (right).

22 June 2010 West Texas Downbursts

The MWPI product performed especially well during the evening of 22 June 2010 over western Texas. Figures 1 and 3 show that the 2200 and 2300 UTC MWPI product images indicated elevated values near the Texas-New Mexico border, west of longitude 102° W, and a local maximum near Muleshoe, TX at 2300 UTC with index values of 40 to 45. A line of convective storms developed over eastern New Mexico and then tracked into western Texas after 0000 UTC producing a downburst wind gust of 43 knots at Muleshoe. The corresponding GOES sounding profile in Figure 3 displays a favorable classic "inverted V" profile that prevailed over western Texas.

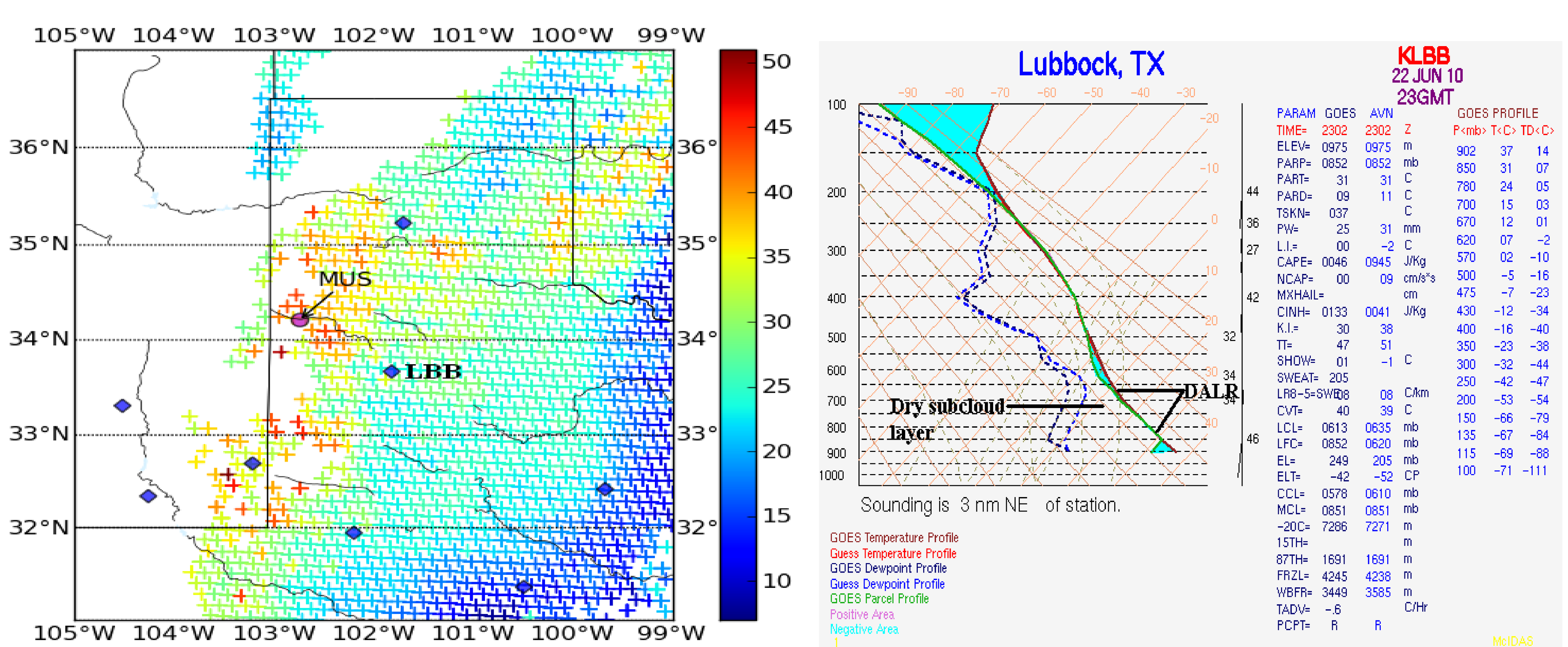

Figure 3. GOES MWPI product image at 2300 UTC 22 June 2010 compared to corresponding GOES sounding profile.

3. METHODOLOGY AND VALIDATION

The objective of this validation effort was to **qualitatively and quantitatively assess** the performance of the **GOES MWPI product** by employing classical statistical analysis of real-time data as illustrated in Figure 4. Data from the **GOES MWPI** product was collected over **Oklahoma and western Texas** for downburst events that occurred between **1 June 2007 and 1 September 2010** and validated against **surface observations** of convective wind gusts as recorded by **Oklahoma** and **West Texas Mesonet** stations.

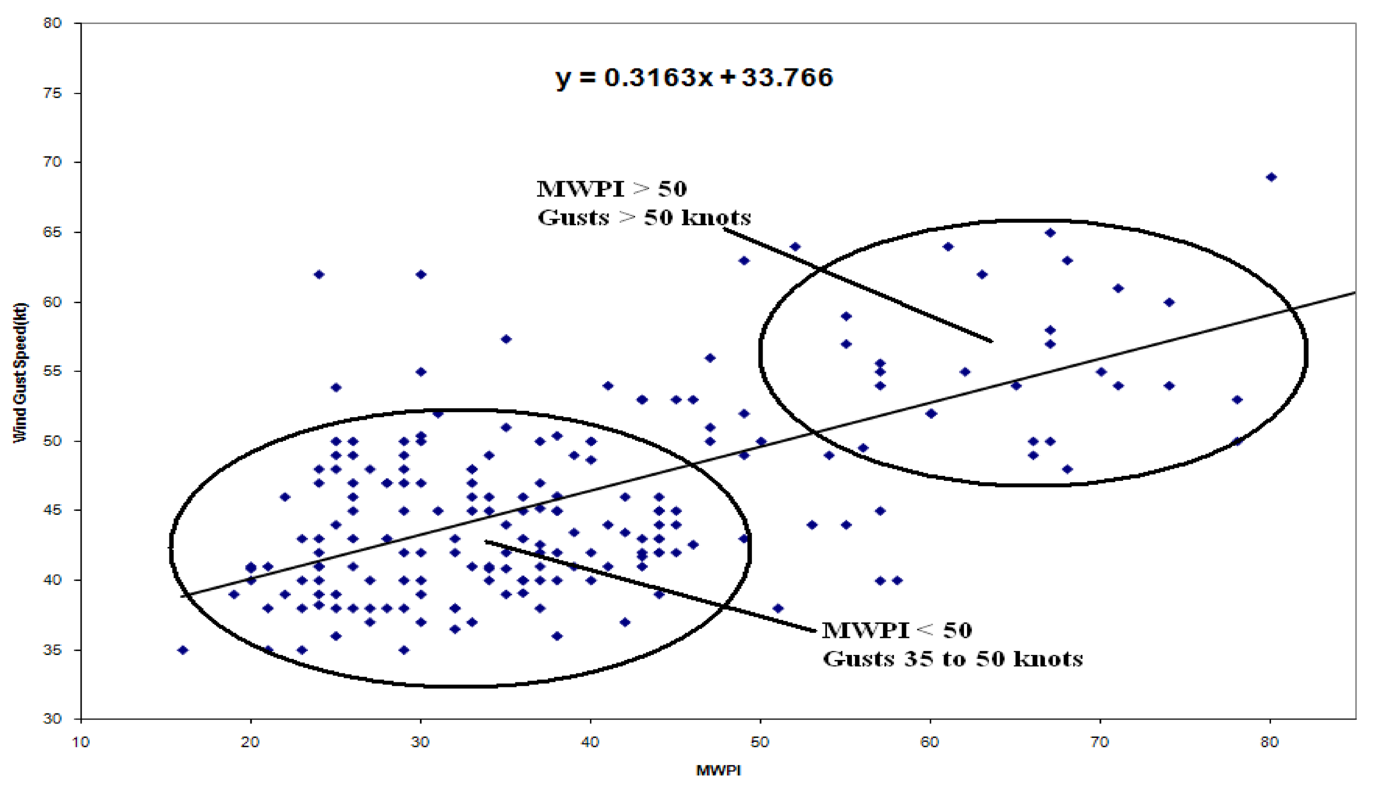

Figure 4. Statistical analysis of validation data over the Oklahoma and western Texas domain between June 2007 and September 2010: Scatterplot of MWPI values vs. measured convective wind gusts for 208 downburst events.

4. REFERENCES

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