Microburst nowcasting applications of GOES

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1. INTRODUCTION AND BACKGROUND

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 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 displays product imagery that describes a significant downburst event that occurred over southeastern Virginia during the afternoon of 24 May 2011, when a multicellular convective storm developed over the southern piedmont of Virginia and tracked rapidly eastward toward the lower Chesapeake Bay. Between 2000 and 2100 UTC, as the convective storm passed over the Hampton Roads, one of the busiest waterways in the continental U.S., numerous severe wind gusts were recorded by WeatherFlow and Physical Oceanographic Real-Time System (PORTS) stations. GOES MWPI imagery indicated a general increase in wind gust potential over the Hampton Roads area during the afternoon hours, between 1700 and 2000 UTC. The increase in both convective and downdraft instability was reflected in the Norfolk, Virginia GOES sounding profile as a marked increase in CAPE and an elevation and increasing amplitude of the mid-tropospheric dry-air layer. By 2000 UTC, the MWPI product indicated the highest wind gust potential, up to 64 knots, over Hampton Roads, where wind gusts of 57 to 67 knots were recorded by WeatherFlow and PORTS stations during the following hour.

In addition, a comparison study between the GOES-R **Convective Overshooting Top (OT) Detection** and MWPI algorithms has been completed for cases that occurred during the 2007 to 2009 convective seasons over the southern Great Plains. The OT detection algorithm (Bedka et al. 2010) is a pattern recognition-based technique that employs **brightness temperature (BT)** data from the GOES thermal infrared channel. Output OT detection algorithm parameters that include **cloud top minimum BT** and a **BT difference** between the overshooting top and surrounding convective anvil cloud have been compared to MWPI values and measured downburst wind gusts. Close correspondence between the location of overshooting tops, proximate MWPI values, and the location of observed downburst winds are evident in Figure 2. Favorable results of the comparison study, shown in Figures 3 and 4, include a statistically significant negative correlation between the OT minimum temperature and MWPI values and associated measured downburst wind gust magnitude. The negative functional relationship between the OT parameters and wind gust speed highlights the importance of updraft strength, realized by large CAPE, in the generation of heavy precipitation and subsequent intense convective downdraft generation. Figure 4 demonstrates that storms with a significant BT minimum are more often severe than those with a more spatially uniform BT distribution. Severe weather frequency is also shown to increase with OT magnitude.

2. CASE STUDIES AND VALIDATION RESULTS

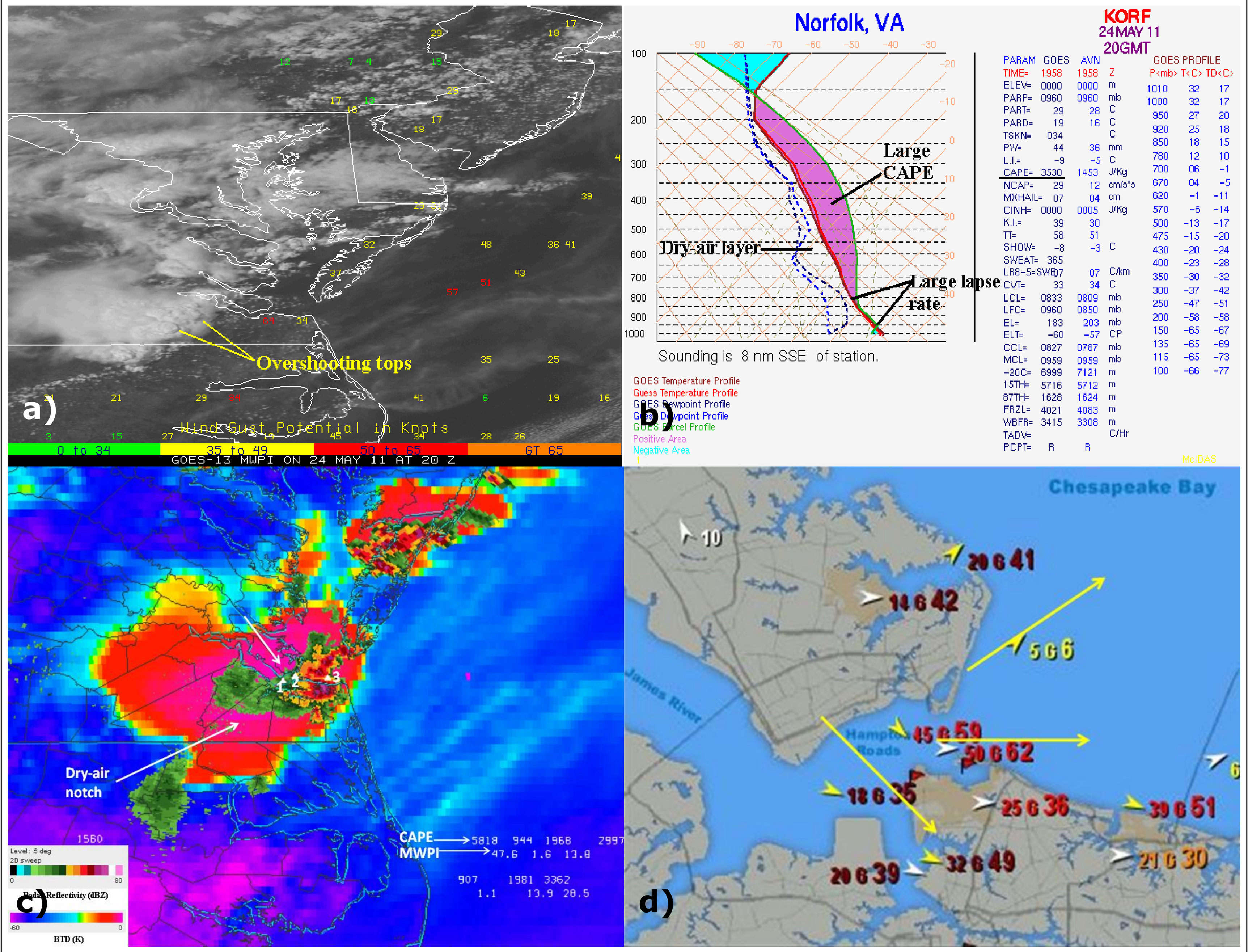

Figure 1. a) GOES MWPI product at 2000 UTC 24 May 2011 overlying visible imagery compared to b) a GOES sounding profile over Norfolk, Virginia at 2000 UTC; c) composite GOES BTD-NEXRAD-MWPI image at 2040 UTC, and d) WeatherFlow surface observation plot at 2037 UTC 24 May 2011.

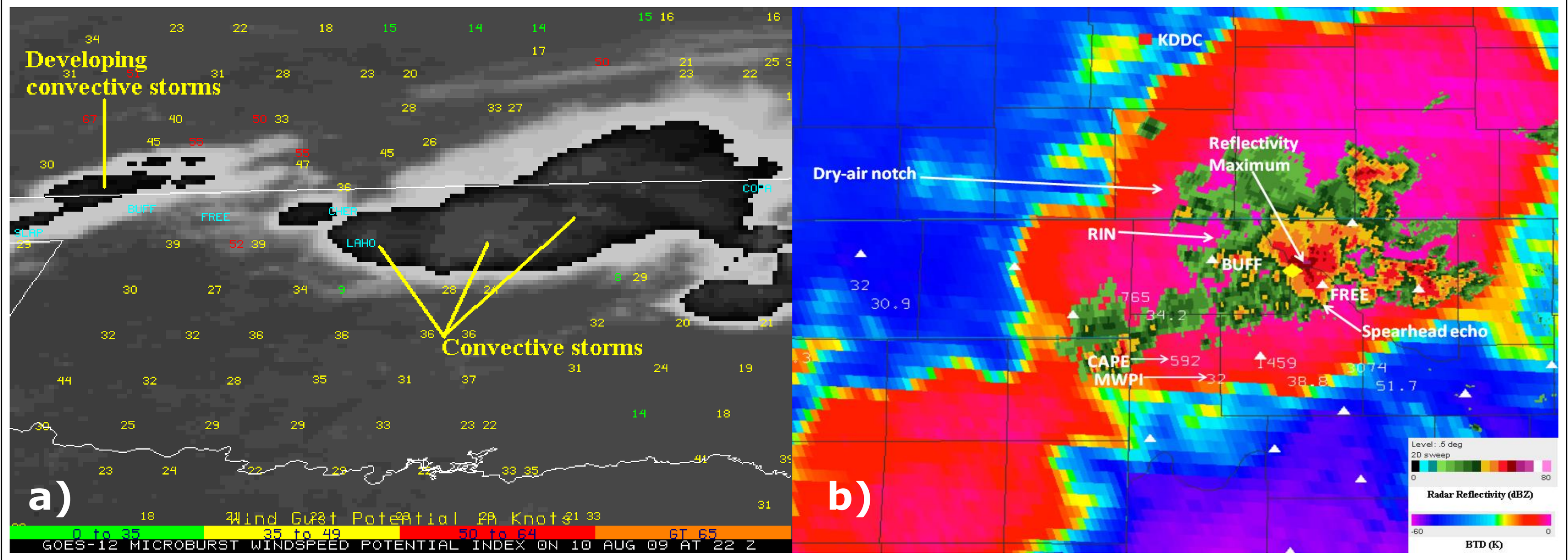

Figure 2. a) GOES MWPI product at 2200 UTC and b) composite BTD-NEXRAD-MWPI product at 2332 10 August 2009. The overshooting top, as indicated by the Bedka algorithm, is marked with a yellow triangle. The location of the Dodge City RAOB is marked with a red square.

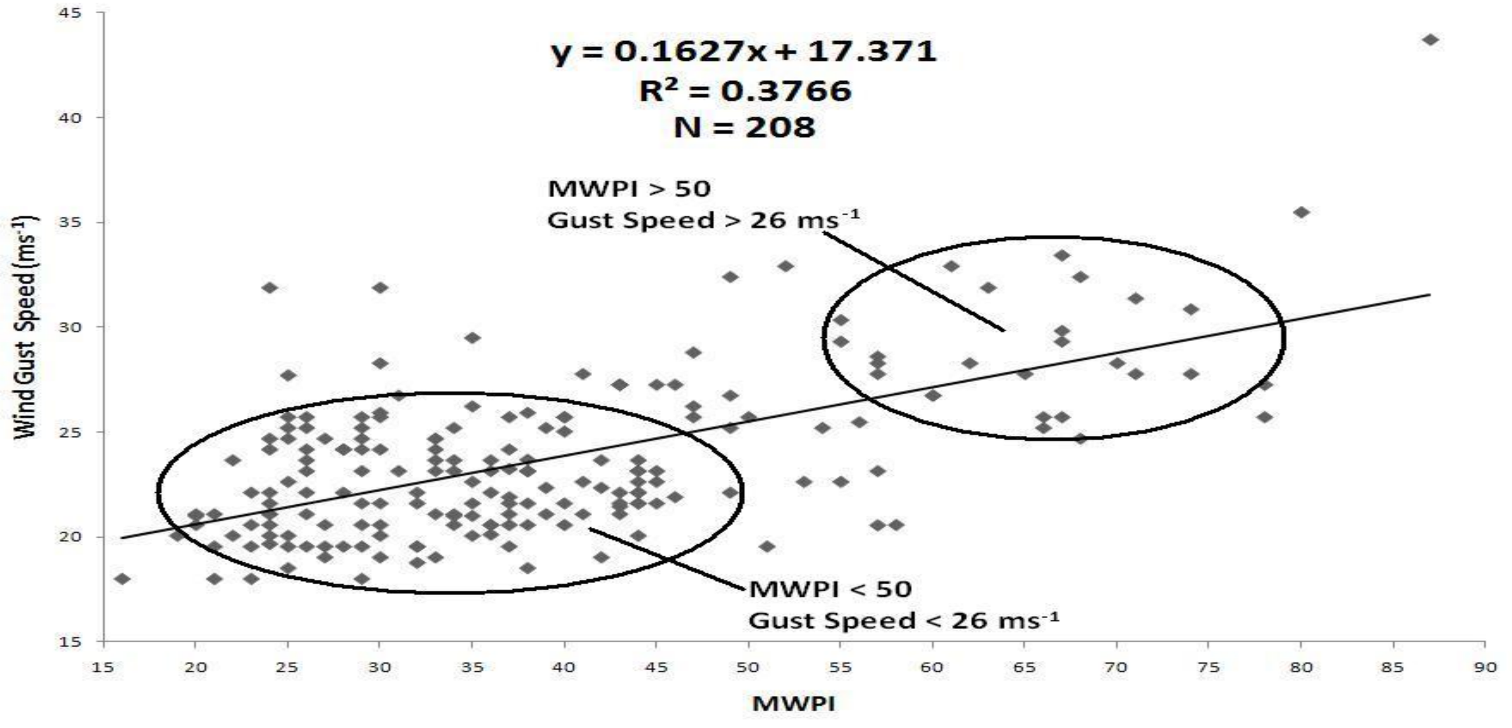

Figure 3. Statistical analysis of validation data over the Oklahoma and western Texas domain between June 2007 and September 2010: Scatterplot of MWPI values vs. measured convective wind gusts for 208 downburst events.

3. INTERCOMPARISON RESULTS

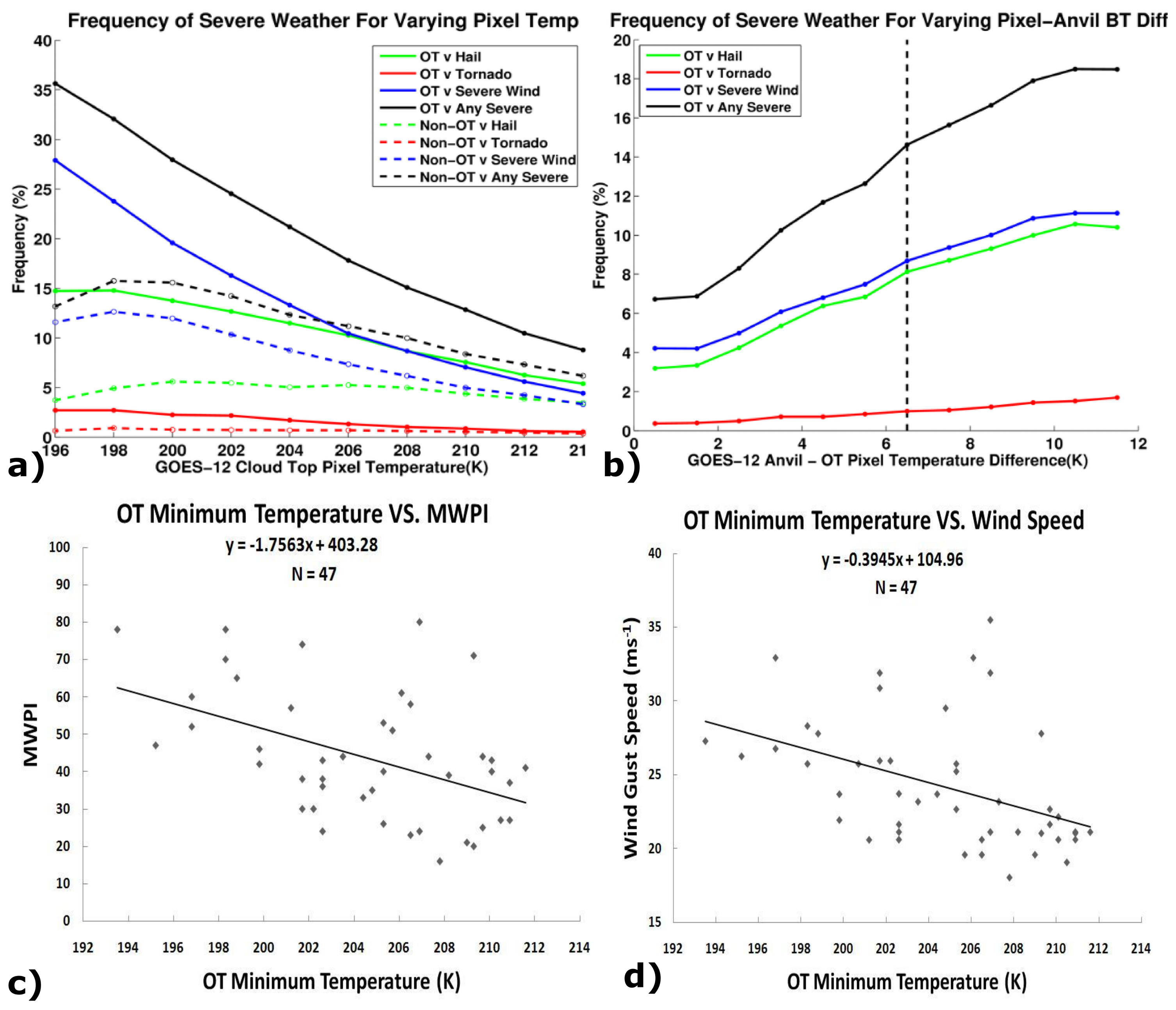

Figure 4: a) The frequency of severe weather for OTs (solid lines) and non-OT cold pixels (dashed lines) with varying IRW BT for each of the severe weather categories during the 2004-2009 warm seasons. b) Frequency of severe weather with varying BT difference between a pixel and the mean surrounding anvil temperature for each of the severe weather categories. The dashed line delineates the 6.5 K criteria required for a pixel to be considered an OT. c) Scatterplot of OT minimum BT vs. GOES MWPI values. d) Minimum BT vs. measured downburst wind gust speed (bottom) for 47 cases that occurred between 2007 and 2009.

4. REFERENCES

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