An Observational Summary of Convective Storm-generated Winds

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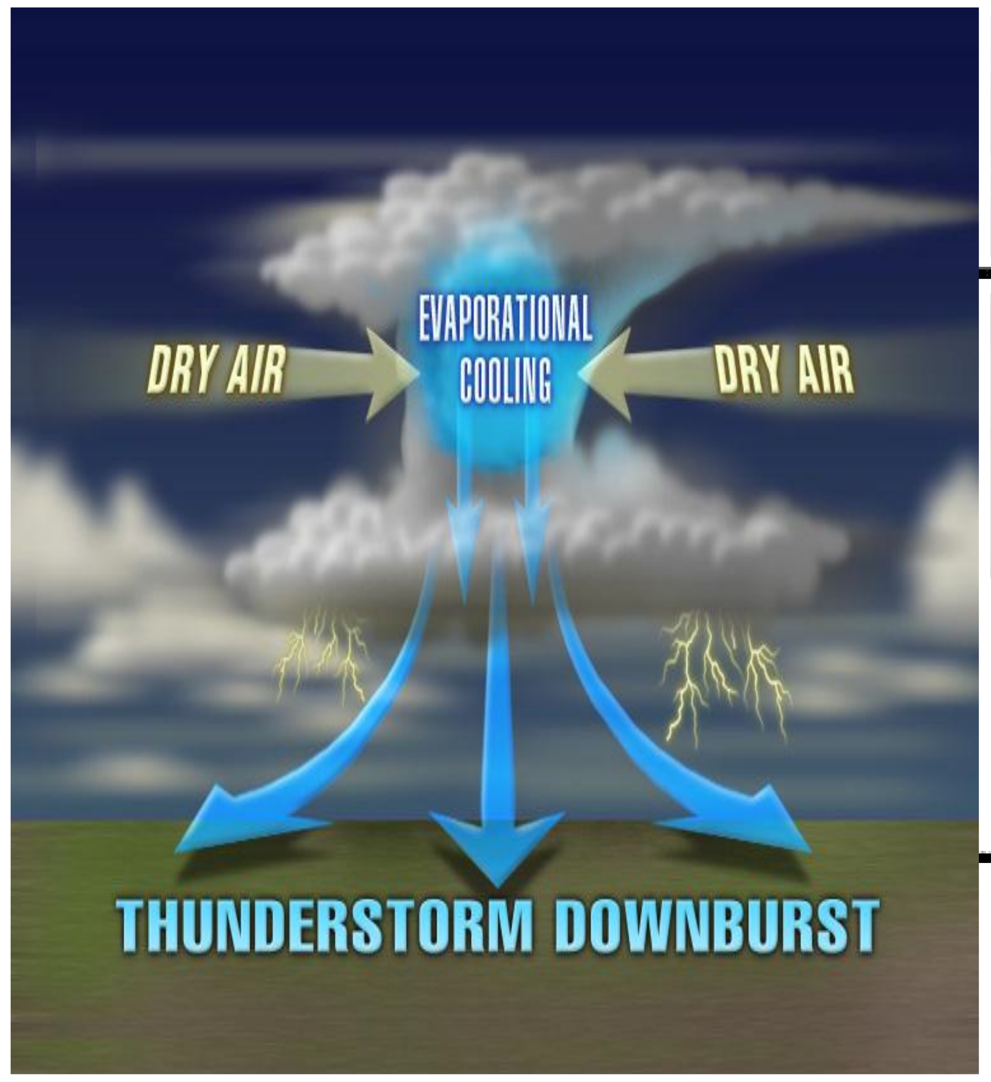
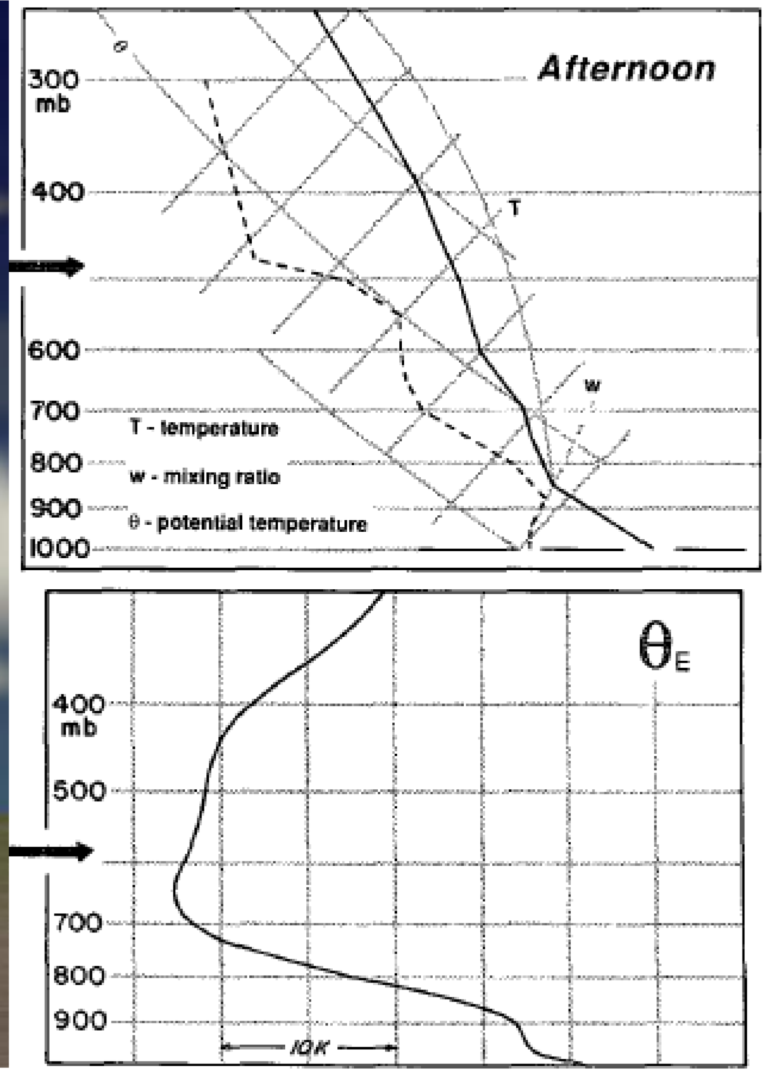
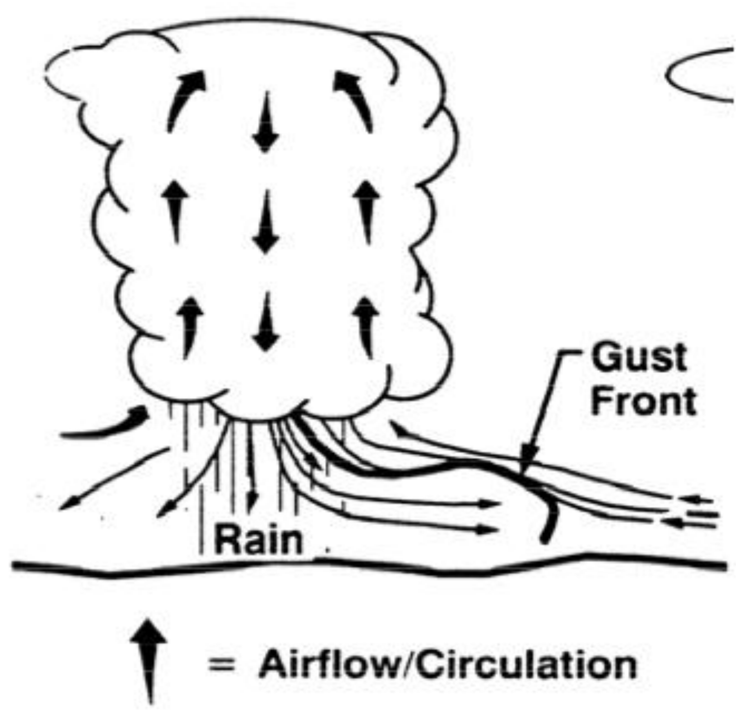
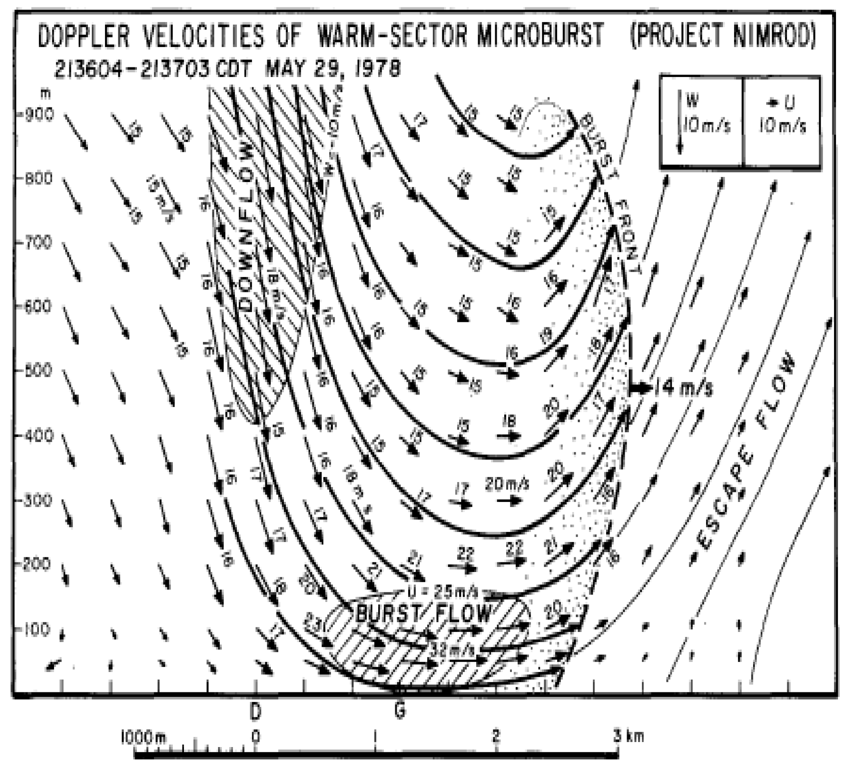
1. Introduction and Background





A favorable microburst environment is characterized by a mid-level dry air layer overlying a deep moist layer based at the surface. Downbursts are typically the result of the entrainment (ingestion) of mid-level dry air into the heavy rainfall core of a convective storm. Dry air entrainment results in evaporational cooling, the generation of negative buoyancy, and the acceleration of downdrafts toward the surface.





Convective storm downdraft winds can be classified according to different time and space scales:

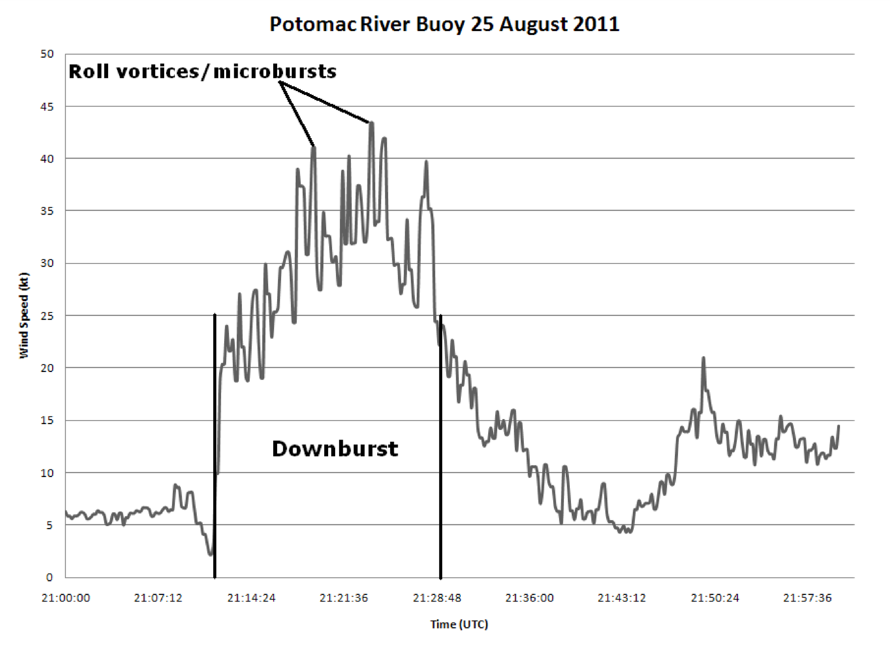
- **The gust front is a boundary that separates cold, downdraft air from warm, humid surface air. Typically dominated by strong horizontal winds.**
- **The downburst is strong downdraft that induces an outward burst of potentially damaging winds on or near the earth's surface. Composed of both vertical and horizontal components of wind.**
- **Macroburst: Outflow size > 4 km, duration 5-20 min.**
- **Microburst: Outflow size < 4 km, duration 2-5 min.**
- **Microbursts (or clusters of microbursts) can evolve into larger downbursts and gust fronts.**

2. Visual and In-situ Observation

Shelf cloud over Darwin Harbor (left) and roll cloud over Illinois (right) marking the location of a gust front.

Downbursts over central Oklahoma (left) and western Texas (right).

The visual appearance of wet-type downbursts is governed by 1) the size, concentration and distribution of raindrops; 2) resulting reflection, scattering, and diffraction of sunlight by rain drops; 3) the solar zenith (or elevation) angle; and 4) observer viewing perspective. A rain shaft containing a large number of large raindrops will typically appear darker due to the combined effects of scattering, reflection, and diffraction, as compared to a shaft composed of a large number of small raindrops. A volume of a large number of small raindrops enhances downdraft severity.



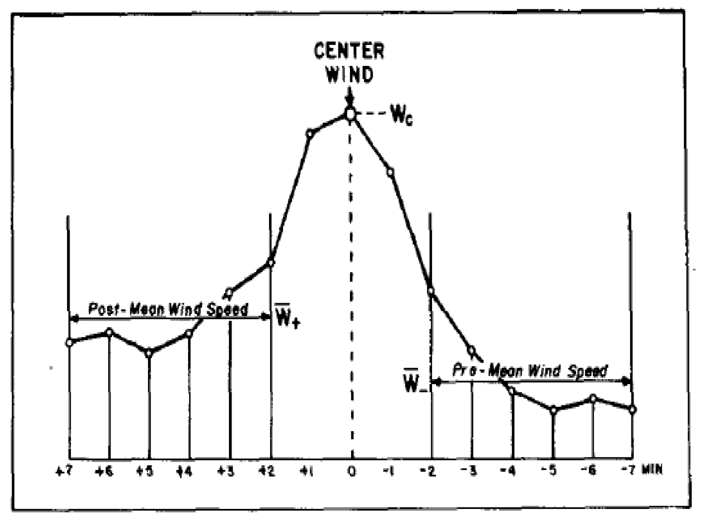
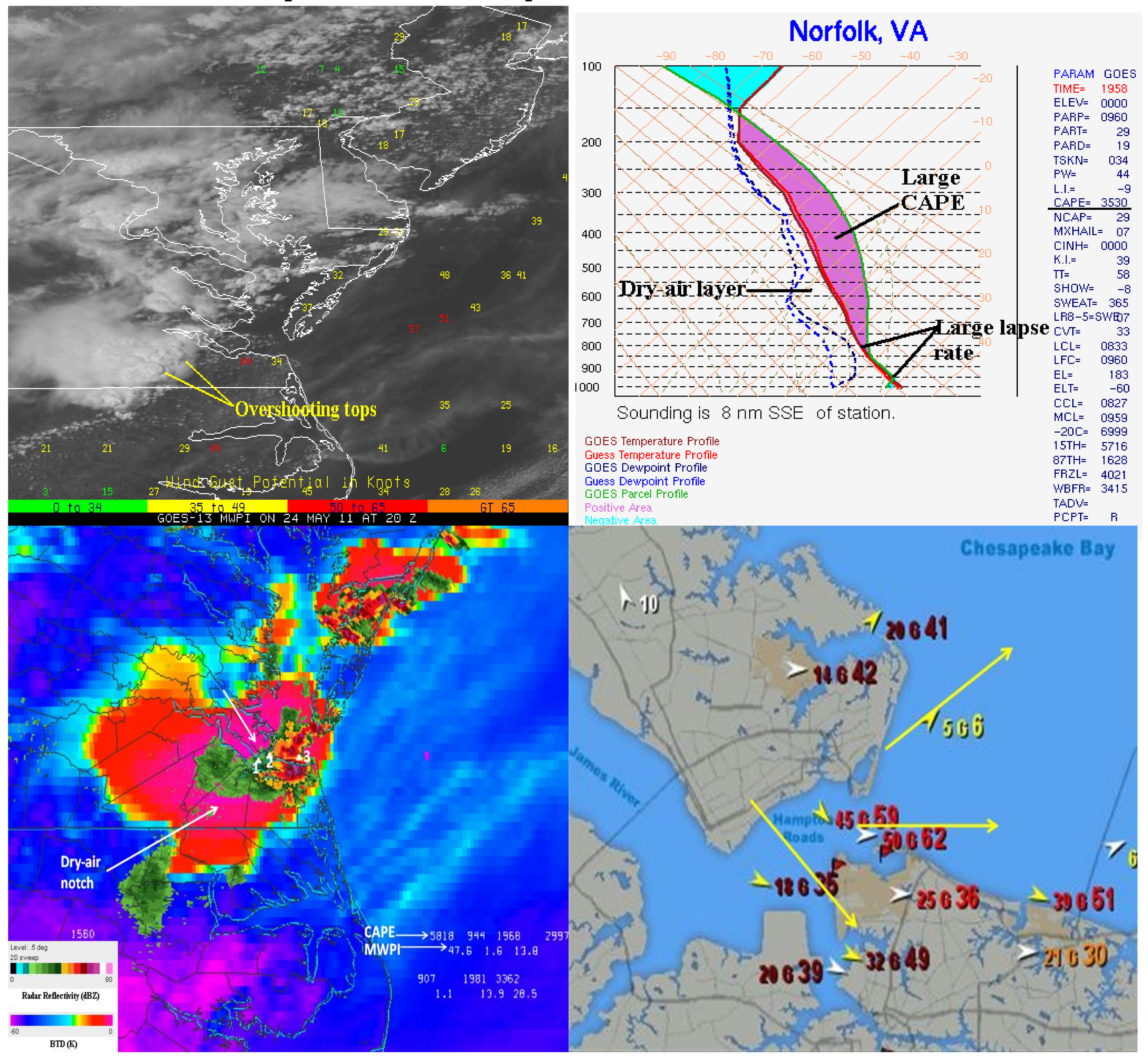


FIG. 2. A hypothetical microburst wind speed trace. The pre- and post-mean wind speeds are $\bar{W}_-$ and $\bar{W}_+$, respectively, and W_c is the center wind speed.

Comparison of a wind speed trace for a downburst event recorded by the Potomac River Buoy near Dahlgren, Virginia (left) compared to a hypothetical microburst wind speed trace (right).

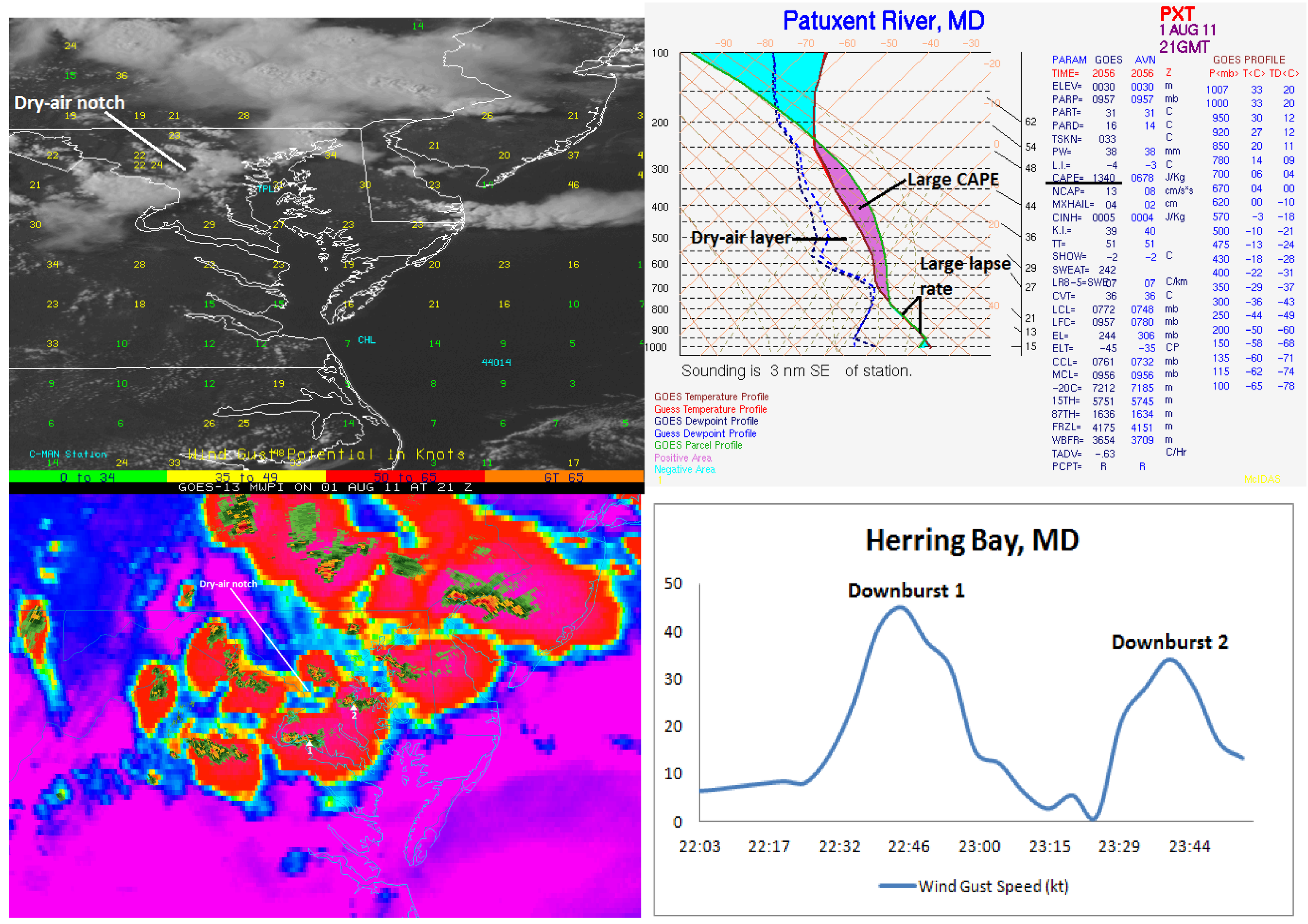
3. Case Studies and Product Examples

24 May 2011 Hampton Roads Downbursts



GOES MWPI product at 2000 UTC 24 May 2011 (top left), GOES sounding profile over Norfolk, Virginia at 2000 UTC (top right), GOES imager product at 2040 UTC (bottom left), and WeatherFlow surface observation plot at 2037 UTC showing the divergent nature of convective storm generated winds over the Hampton Roads area.

1 August 2011 Potomac-Chesapeake Downbursts



GOES MWPI product at 2100 UTC 1 August 2011 (top left), GOES sounding profile over Patuxent River, MD at 2100 UTC (top right), GOES imager product at 2232 UTC (bottom left), and wind histogram for Herring Bay, Maryland WeatherFlow station.