P12.5 OVERVIEW AND SYNOPTIC ASSESSMENT OF THE 28 APRIL 2002 LA PLATA, MD TORNADO

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1. INTRODUCTION

During the evening of 28 April 2004 a rare and devastating F4 tornado tracked across the Mid-Atlantic in southern Maryland. Though F4 tornadoes are uncommon, even more rare with this event was its location well outside of the climatologically favored area of the country for violent tornadoes. In the tornado record, only six tornadoes of this magnitude have been recorded further north and east – most notably the Worchester Massachusetts event of 1953.

This storm was the seminal event of an atypical alignment of meteorological conditions that had developed over the region that day. Several parameters came together that day in such a way to allow for the development and maintenance of a long-lived supercell. These conditions allowed that supercell to track 300 miles across West Virginia and Virginia, before triggering a long lived significant tornado that crossed 64 miles through four counties in southern Maryland that evening. This paper will provide an assessment of the synoptic conditions across the Mid-Atlantic region on 28 April 2002. Companion papers by Rogowski and Zubrick (2004) and Manning and Zubrick (2004) address the mesoscale environment and radar characteristics, respectively.

2. SYNOPTIC PATTERN

April and May are the most common months for tornado development in the Mid-Atlantic. This is largely due to the combination of strong dynamics, and resultant shear, from spring storms under the retreating westerlies, and the instability produced by strengthening insolation warming the low-levels under a middle and upper atmosphere. On 28 April 2002, strong atmospheric shear and instability combined to allow supercells to form.

In the upper levels, a strong 500 hPa trough was located over the lower Great Lakes region (Fig. 1).

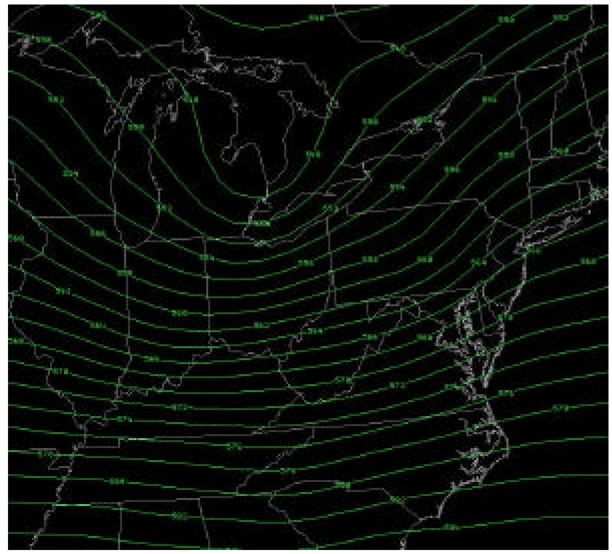

Figure 1. 500 hPa Height (dm) 1200UTC 28 April 2002.

An advancing surface cold front (Fig. 2), helped create convection throughout the Ohio valley, the Appalachians, and the Mid-Atlantic.

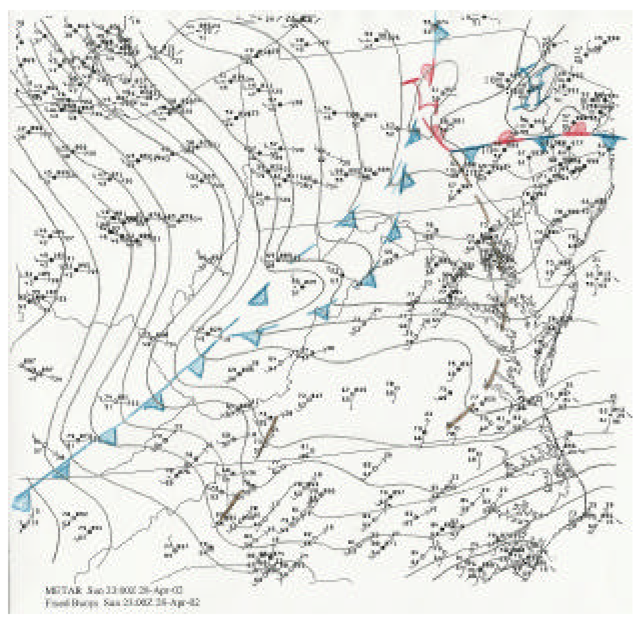

Figure 2 - 2300 UTC Mid-Atlantic surface analysis.

At 200 hPa, a strong 80-knot jet was advancing ahead into New England, while a stronger pair of 110 knot jet streaks over the center U.S. In

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between these jets was the Mid-Atlantic, in the prime spot for upward motion from a coupled jet structure. The left exit region of the cross country coupled with the right entrance region of the New England jet to produce strong divergence over the Mid-Atlantic. A line of enhanced potential vorticity at 400 hPa located over western Pennsylvania and northern West Virginia during the morning of the 28th (not shown) swept across the Mid-Atlantic during the afternoon and provided upper-level support for convection.

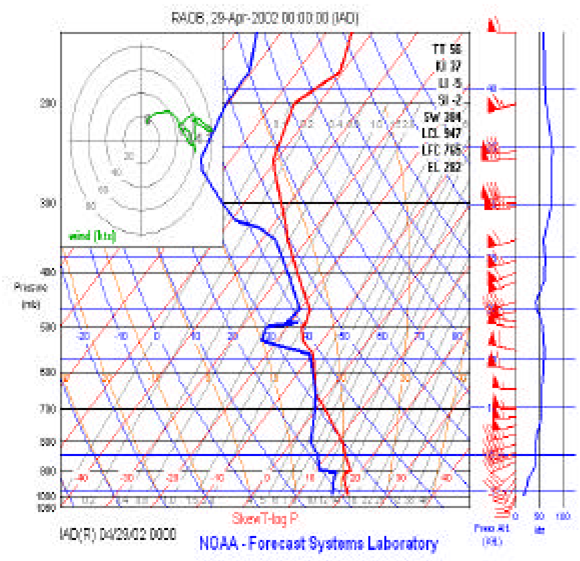

Figure 3. 0000UTC 29 April 2002 Dulles IAD raob.

At the middle levels, 60 to 75 knot winds and relatively dry air allowed for strong rear flank down drafts and strong shear for supercell development. The 00Z rawinsonde observation from Dulles Airport reported a large layer of 50 to 75 knot winds from 750hPa through 400hPa. (Fig. 3). Inspection of visible satellite imagery shows rapid clearing between 1600 and 1800 UTC (Figures 4 and 5). At 1800 UTC, the supercell is just west of Elkins (EKN) in east-central West Virginia. Strong mid-level drying was evident between 1500 and 1800 UTC in water vapor imagery (not shown).

While the upper and middle levels allowed for strong convection on 28 April, the lower levels contained some of the most impressive data that allowed for violent tornadic development. First, local wind profiler data showed that a low-level jet, driven by the advancing cold front, strengthened from 35 knots to 50 knots below 850 hPa during the afternoon (between 1600 and 2200 UTC) over lower southern Maryland. This southerly surge of air raised dew points into the middle 60s and dramatically increased the low-level shear.

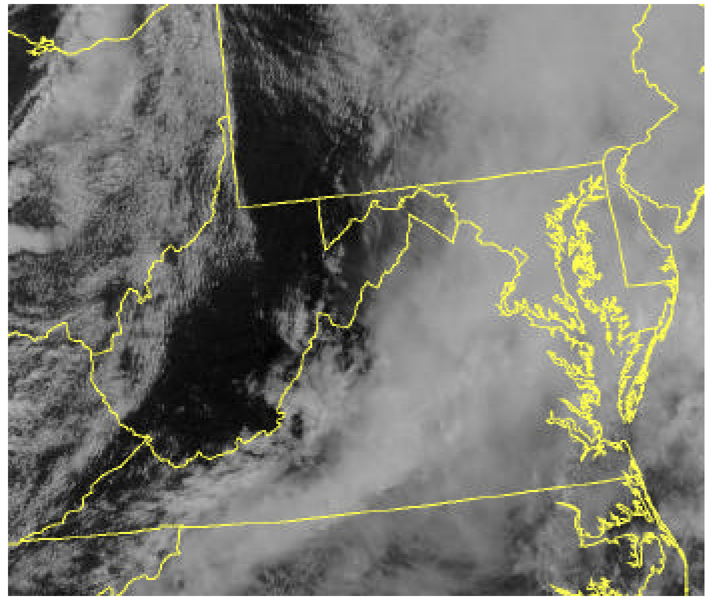

Figure 4. GOES Visible 1602 UTC 28 April 2002

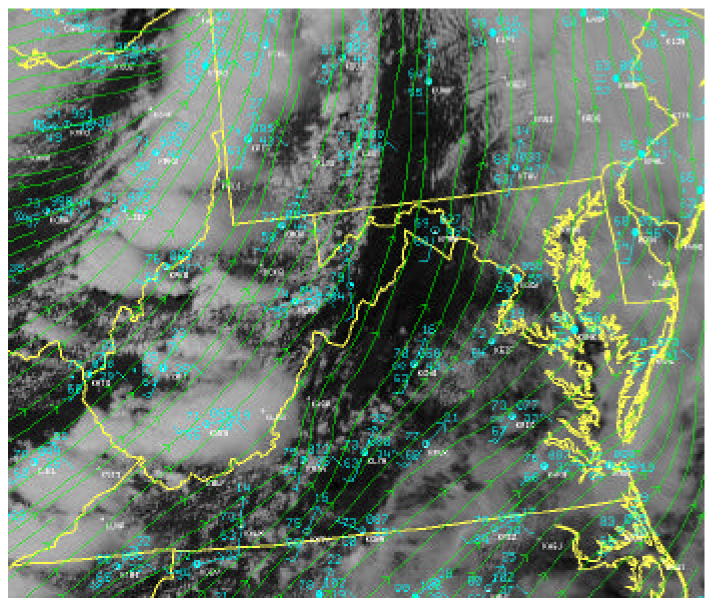

Figure 5. GOES Visible 1800 UTC 28 April 2002 with surface streamlines; observations.

A wind profiler located at Fort Meade, Maryland about 50 km north of La Plata, MD, recorded the development of the low-level jet. (Fig. 6).

With this low-level jet, two integral events occurred – both the instability and the shear increased to levels necessary for violent tornado development. The six-hour forecast from the 18z Eta valid 0000 UTC 29 April 2002, had a axis of high instability exactly aligned with the path of the mesocyclone (Fig. 7). Along that axis, convective available potential area (CAPE) reached 1800 to 1900 joules per kilogram. This high instability combined with the increasing shear due to the developing low-level jet to produce extraordinarily high values of the energy helicity index (EHI), which reached values of between 4 and 6 at 00z 29 Jul 2004 centered over southern MD.

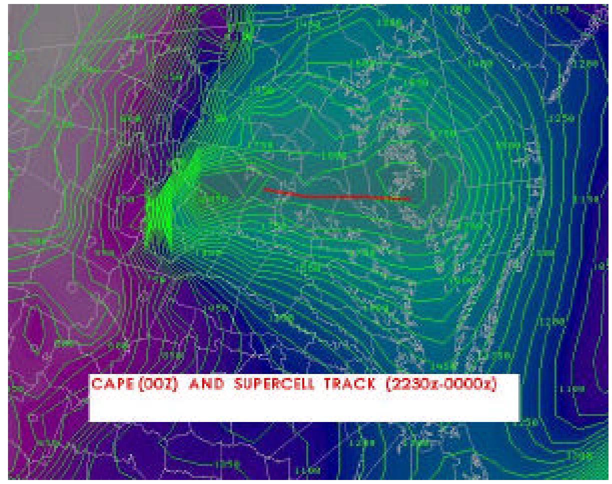

Figure 6. 6hr forecast CAPE - 1800 UTC run of the Eta 28 Apr 2002 valid 0000 UTC 29 Apr 2002.

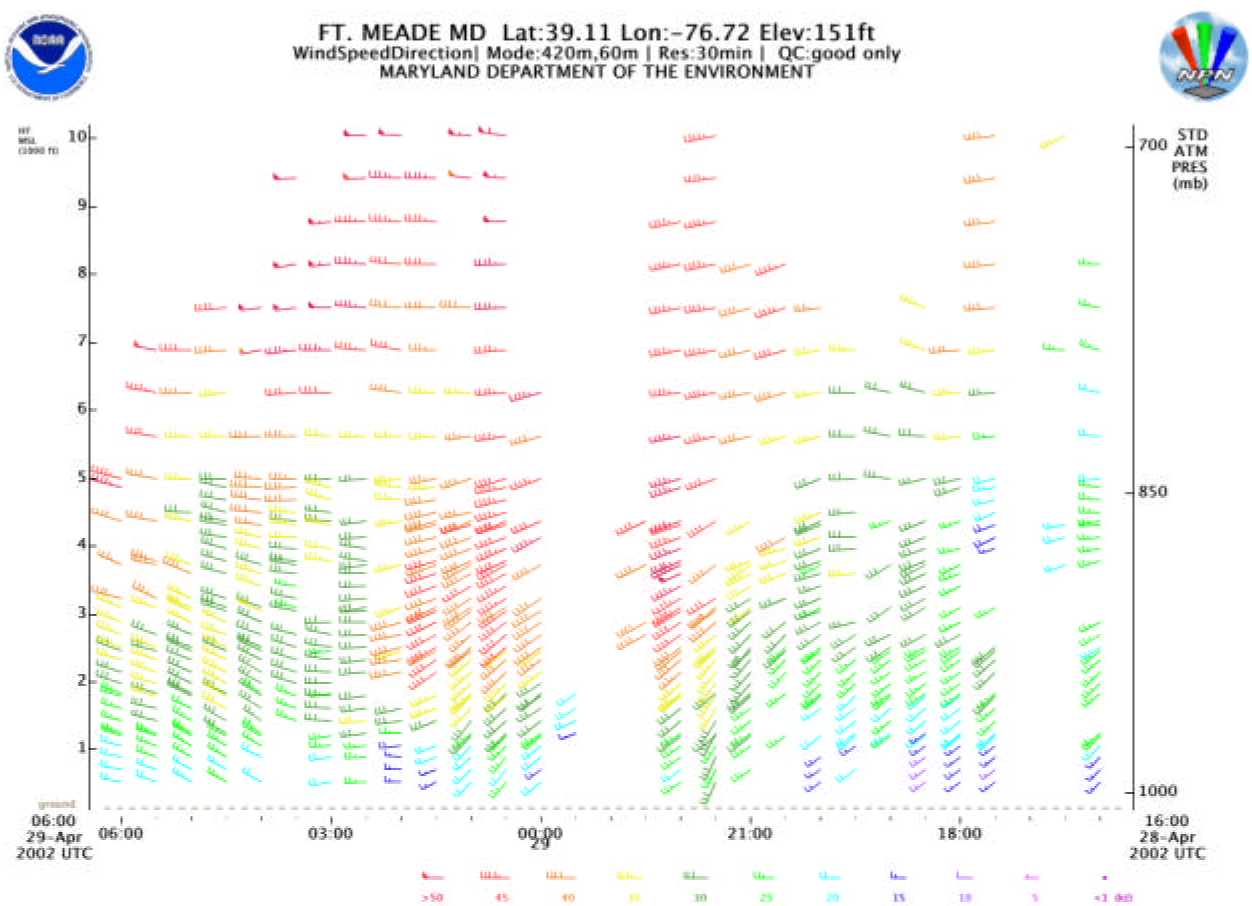

Figure 7. Ft. Meade, MD Wind Profiler (kts) 0-10 kft, 1600 UTC 28 Apr 2002 - 0600 UTC 29 Apr 2002

3. OBSERVATIONAL AND MODEL DATA

Observations matched up well with model data, particularly the Eta and RUC model forecasts from 1200 UTC 28 April 2002. The developing low-level jet forecast by the 12Z RUC and Eta models (not shown) was observed in both the 0000 UTC 29 Apr 2002 RAOB at Dulles Airport, Virginia (Fig. 3) and the wind profiler at Fort Meade, MD (Fig. 6).

At upper levels, the double jet structure evident in the ACARS observations was oversimplified in the models to a broad, single jet. This however did not adversely affect the divergence area that was correctly placed over the Mid-Atlantic between the exit region of the broad Plains jet and the entrance region of the New England jet.

Observed 500 hPa temperatures from the IAD-Dulles RAOB at 0000 UTC 29 April 2002 was incorrectly measured at 17 degrees C. Inspection of the temperature trace shows a small 100mb layer depression of temperature centered at 500 hPa. (Fig. 3) The base of this depression is collocated with a quick depression of dew point temperatures above the freezing level. This is a classic "wet bulb effect" error that is created by moisture freezing on the sensor after evaporational cooling. A more representative value of 14C was obtained from an ACARS ascent sounding obtained from a flight out of IAD about one hour before the rawinsonde time (not shown).

4. EVENT OVERVIEW

With decent synoptic parameters in place for strong convection, a moderate risk area was issued by the Storm Prediction Center. The La Plata storm began as a shower on the Kentucky and West Virginia border near Huntington, West Virginia at 1715 UTC. That shower developed into a thunderstorm that crossed through central West Virginia and passed 10 miles north of Charleston, West Virginia around 1800 UTC (see Fig. 5).

Shortly after 1800 UTC, the thunderstorm split into left- and right-movers about 15 km northeast of Charleston, WV. The left mover initially was the dominant storm and passed over the eastern continental divide into Grant County in West Virginia in the eastern panhandle. There it produced nickel-sized hail. However, this storm diminished quickly as it moved into slightly more stable air left over earlier morning stratiform precipitation and mid- and high-level cloud decks.

However, the right mover tracked under mostly clear skies during its early and middle life. It maintained itself through West Virginia, and crossed the eastern continental divide into Pendleton County in West Virginia. It was at this point that the storm began to intensify and develop a persistent mesocyclone.

As the storm moved east through northern Rockingham County, Virginia, then into southern Shenandoah County, it produced a F2 tornado just south of Mount Jackson, Virginia at 2055 UTC. Here it destroyed 3 houses, 19 barns, and damaged 27 other residences. An elderly couple was injured. It also flipped a tractor-trailer over the road on Interstate 81 near Mount Jackson.

As it continued east, the storm's mesocyclone fluctuated (or cycled) in size and intensity, as described by Manning and Zubrick (2004). As the storm crossed a mountain ridge just east of Mount Jackson, no further damage was reported (or surveyed) for nearly 75 miles to the western shore of the Potomac River. During this time, the storm maintained supercell characteristics as it moved east across northern Virginia, with only minimal-size hail (20-45 mm diameter) reported at several locations. The storm's forward flank downdraft region (heavy precipitation) crossed the Potomac River into lower southern Maryland (Charles county) at 2235 UTC (Fig. 8). The storm's strengthening mesocyclone crossed the Potomac River by 2250 UTC.

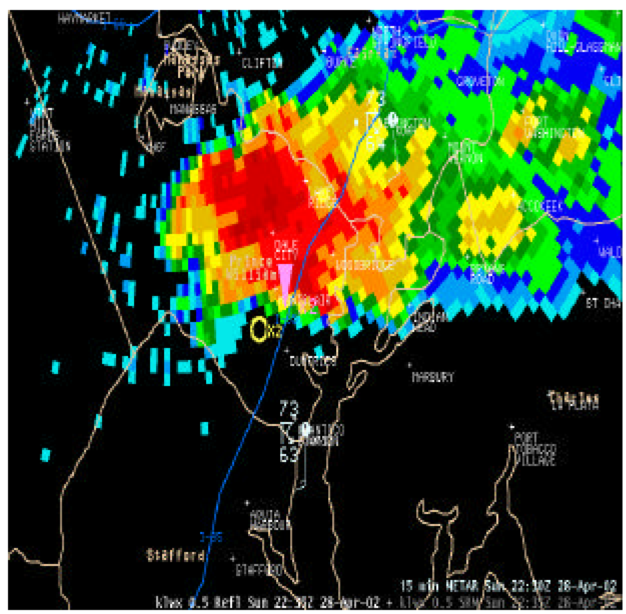

Figure 8. 2235 UTC KLWX 0.5 degree base reflectivity 28 April 2002.

A short distance from the shoreline, the La Plata tornado made touchdown near Marbury, Maryland at 2256 UTC (Fig. 9). Initially F1, the tornado strengthened as it neared of La Plata, producing F3 damage in the western suburbs of the town.

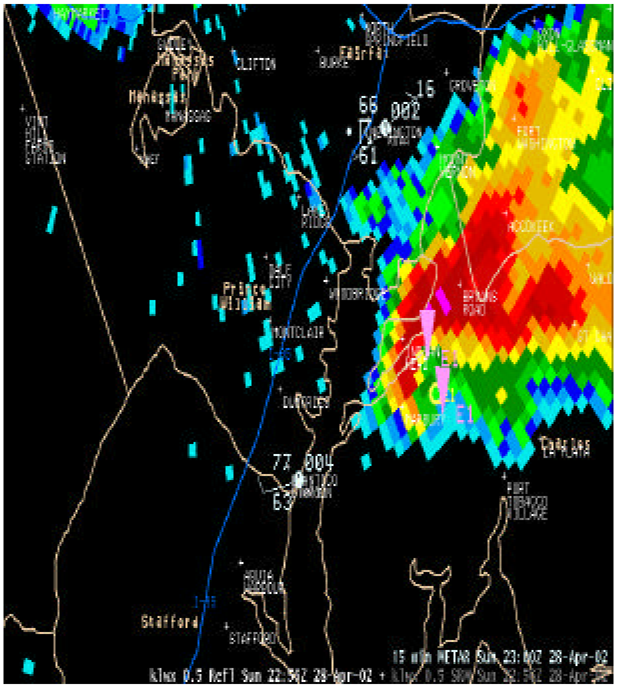

Figure 9. as in Fig. 8 except 2256 UTC.

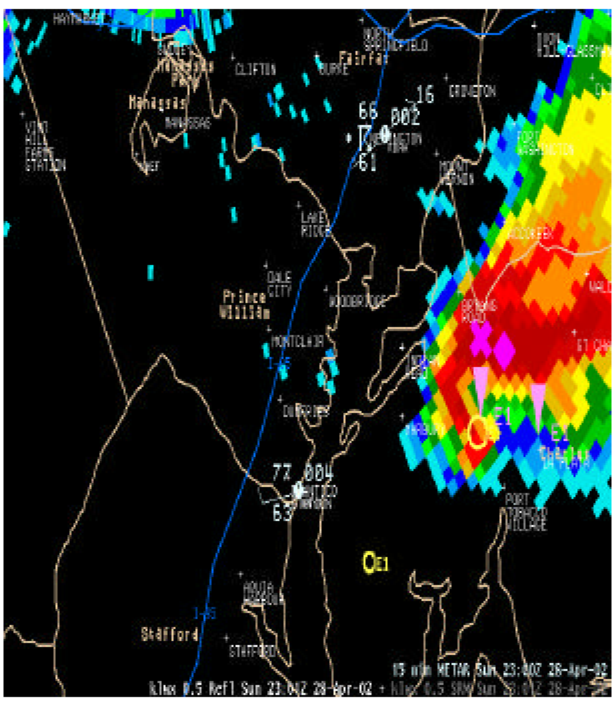

Figure 10. as in Fig. 8 except 2301 UTC.

A secondary vortex formed a quarter mile south of the first in the western outskirts of La Plata, then the two converged on the town and crossed between 2302 and 2307 UTC. Damage across the town was widespread F2 and F3 damage, with isolated areas in central La Plata rated as F4 damage. The secondary tornado dissipated just east of La Plata, while the primary continued through eastern Charles County as a F1 with pockets of F2 and F3 damage (Fig. 10).

The tornado crossed into Calvert County at 2330 UTC as an F1. However, it quickly diminished to an F0 two miles inside the county, which it remained through the rest of the county and across the Chesapeake Bay. It moved over the Calvert county shoreline, and over the Chesapeake Bay, just north of the Calvert Cliffs Nuclear Power Plant. A secondary vortex formed briefly as the storm traveled over the Bay.

Once over the Bay and onto the eastern shore of Maryland at 2358 UTC, the storm passed through the Blackwater National Wildlife Refuge area in Dorchester county as a F0 with isolated areas of F1 through F3 damage. The storm also produced softball sized hail (57 mm) three miles southwest of Bucktown, Maryland at 0010 UTC 29 April 2002.

The tornado continued on through the wildlife refuge, and crossed over the Nanticoke River into Wicomico County at 0026 UTC. In Wicomico County it produced F0 to F1 damage, before dissipating near Royal Oak, Maryland at 0030 UTC.

The total effects were impressive for a Mid-Atlantic tornado. The La Plata tornado produced a continuous 64 mile track of damage through four Maryland counties. (Fig. 19) Three deaths were directly attributed to the storm, one man in Charles County, and another couple killed in Calvert County. All fatalities were while the victims were in their homes. Another 122 people were injured. There was over $100 million in property damage, with 344 homes and businesses destroyed.

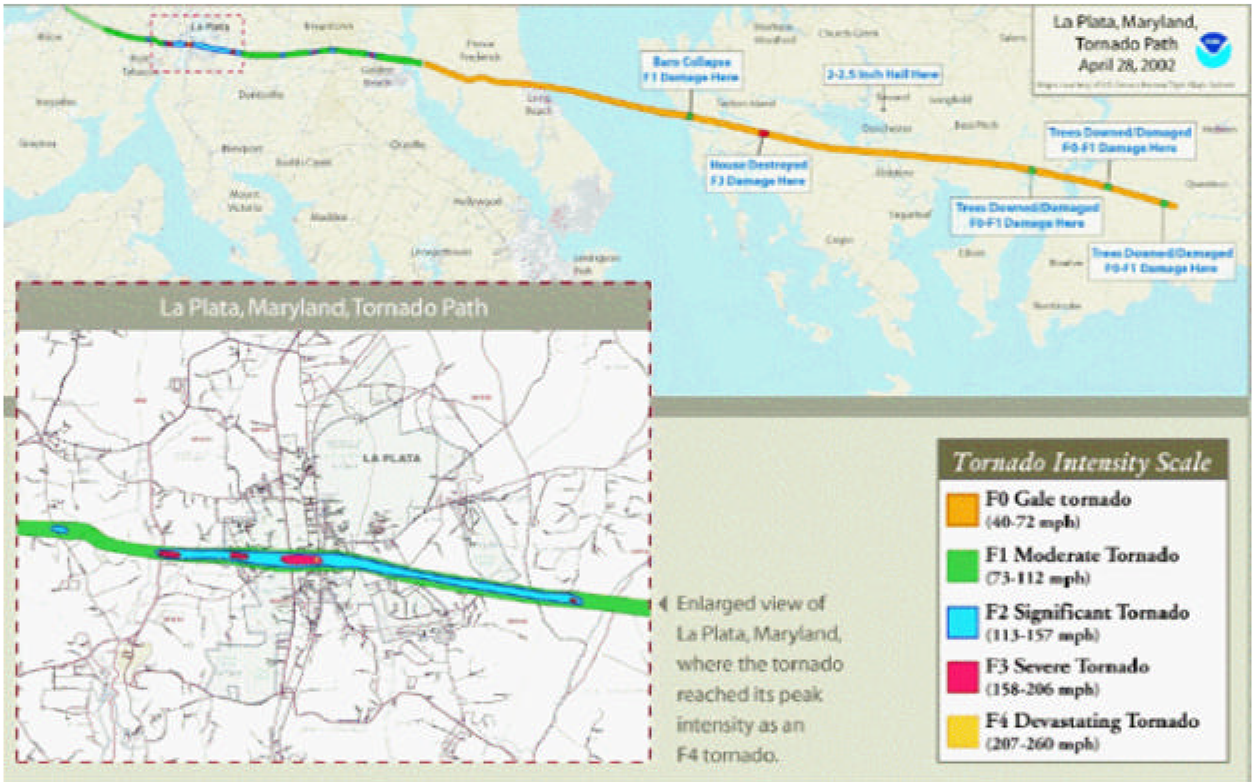

Figure 11. La Plata MD-southern Maryland tornado path 28 April 2002 (U.S. Dept. Commerce 2002).

5. SUMMARY

The La Plata tornado of 28 April 2002 was an uncharacteristically violent, and long-lived tornado for the Mid-Atlantic. On that day, a combination of a strongly-sheared wind profile and decent instability over lower southern Maryland provided an environment conducive to severe weather. This combination was well-forecast by the high resolution models of the Eta and the RUC. A coupled jet structure in the upper levels, dry air in the middle levels, a developing low-level jet, and humid low-levels all set the stage to allow a mesocyclone to spawn a strong F4 tornado; one of the strongest recorded this in the Mid-Atlantic region in many years (since the June 2, 1998 Frostburg, MD, F4 tornado).

6. REFERENCES

Manning, D.R., and S.M. Zubrick, 2004: Doppler radar analysis of the 28 April 2002 La Plata, MD tornadic supercell. *Preprints, 22st Conf. on Severe Local Storms*, Hyannis Port, MA, Amer. Meteor. Soc., (paper 13.5 elsewhere in this volume).

Rogowski, S. J., and S.M. Zubrick, 2004: Analysis of the 28 April 2002 La Plata, MD tornado mesoscale environment. *Preprints, 22st Conf. on Severe Local Storms*, Hyannis Port, MA, Amer. Meteor. Soc., (paper 12.4 elsewhere in this volume).

U.S. Dept. of Commerce, NOAA/NWS Assessment: La Plata, Maryland, Tornado Outbreak 28 April 2002, Silver Spring, MD (September 2002), [*http://www.nws.noaa.gov/om/assessments/laplata.pdf]*.