

The Revere, MA Tornado of July 28, 2014: A Case for Improving Warning Performance Through a Better Understanding of Northeast Tornado Environments

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Takeaways:

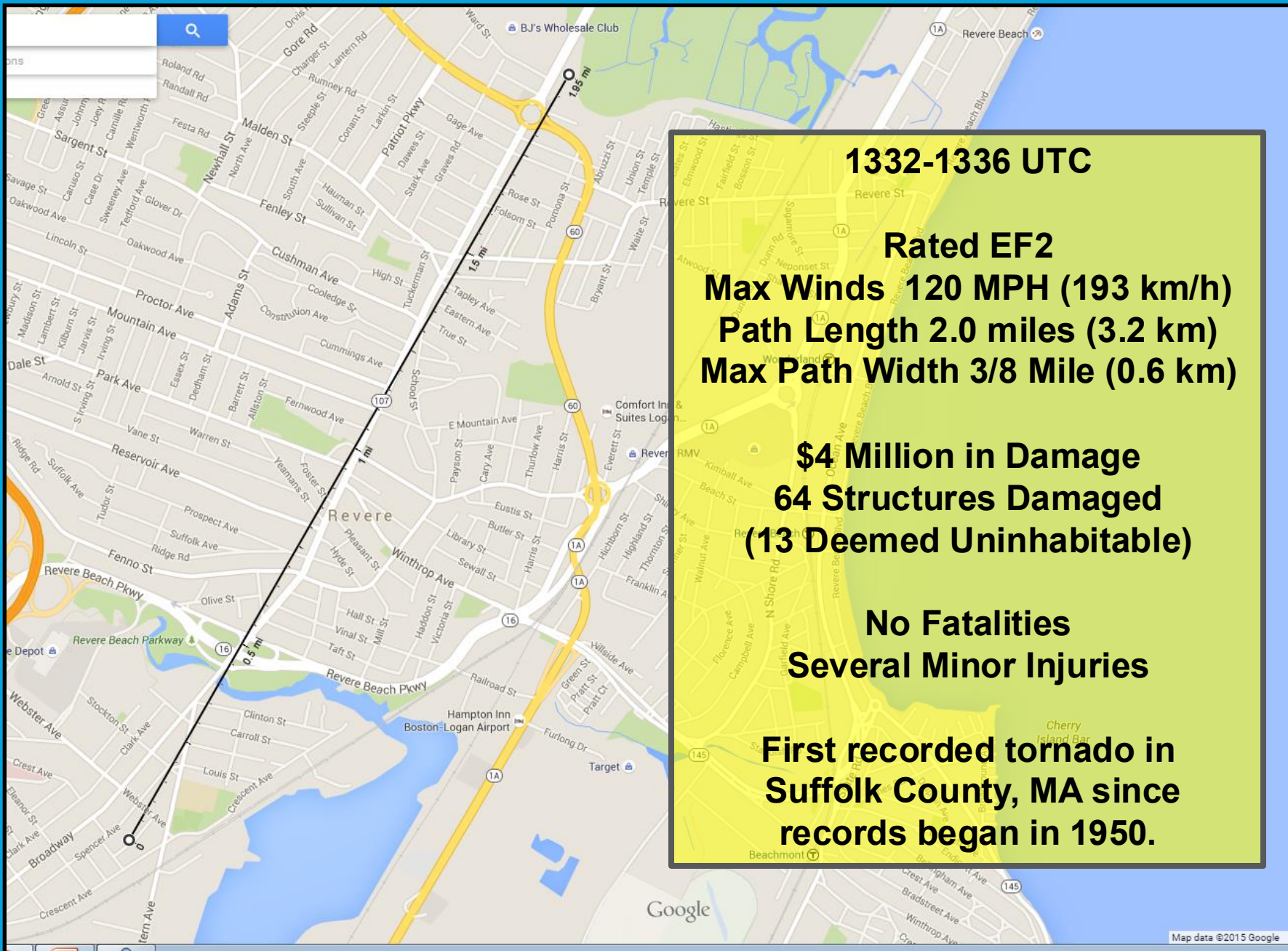
Northeast U.S. Tornadoes

- Typically weak and short-lived, last a few minutes
 - EF-0 and EF-1 are most common
- “Plains” supercell tornadoes are rare
 - June 1, 2011 Springfield EF3 Tornado
 - June 9, 1953 Worcester F4 Tornado
- Favorable conditions include:
 - 500 hPa closed low near Great Lakes
 - Surface based CAPE 500-1500 J/kg
 - 0 to 6 km shear 18 m/s (35 kt) or greater
 - 0 to 1 km helicity near 100 m^2/s^2 or greater
 - “Tropical” air mass (low LCL)
 - Low level boundary nearby

Takeaways:

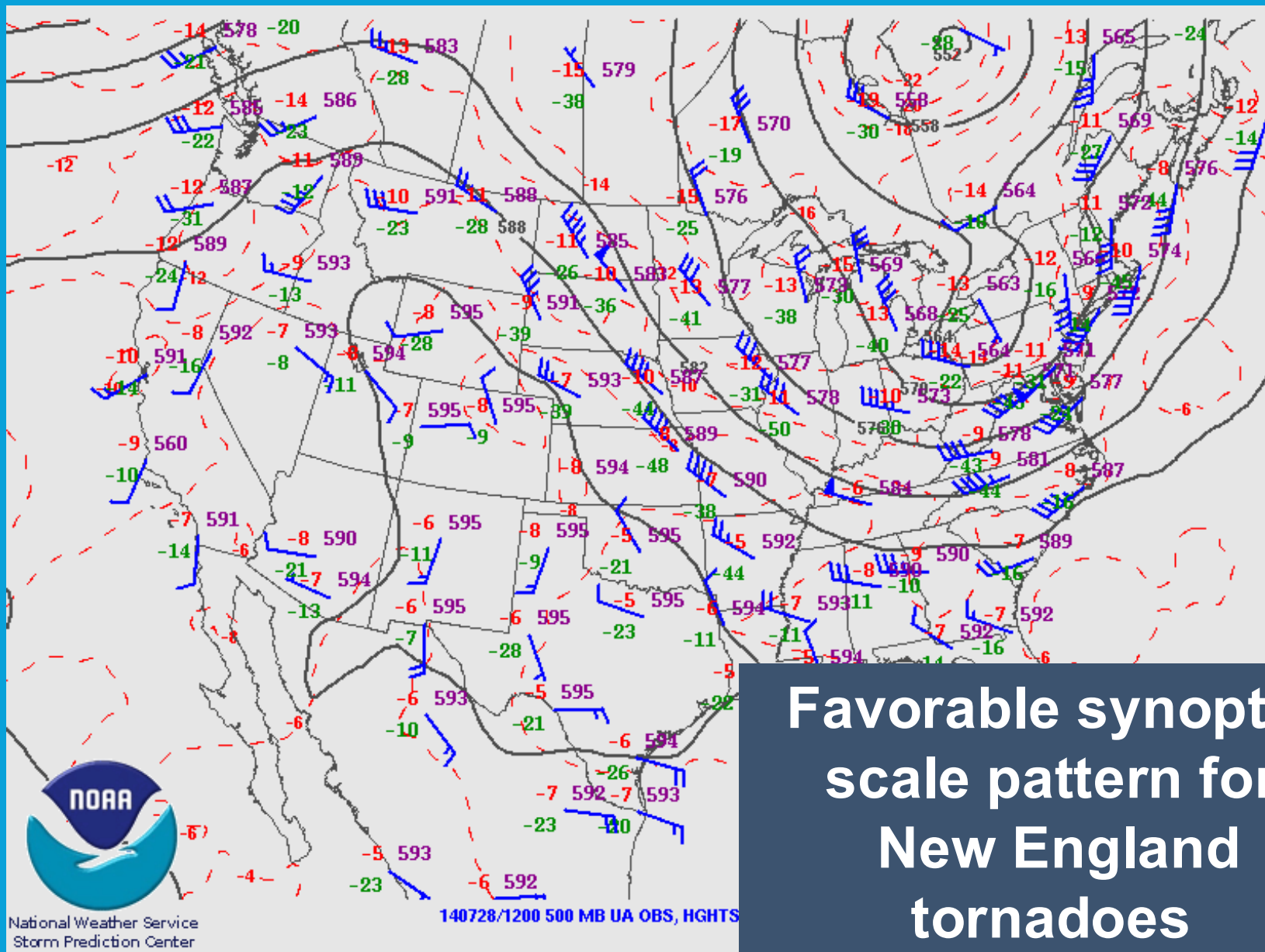
July 28, 2014 Operations

- **Planning:**
 - Severe weather was not expected in the morning
 - Augmented staffing was in place for the afternoon
- **Tactical:**
 - No Tornado Warning was in effect for Revere
 - Severe Thunderstorm Warning expired 2 minutes before tornado touched down
 - No damage reports were received while warning was in effect
 - As a result, flash flooding became the primary focus as storms approached Boston
 - Made it challenging to focus on tornado potential



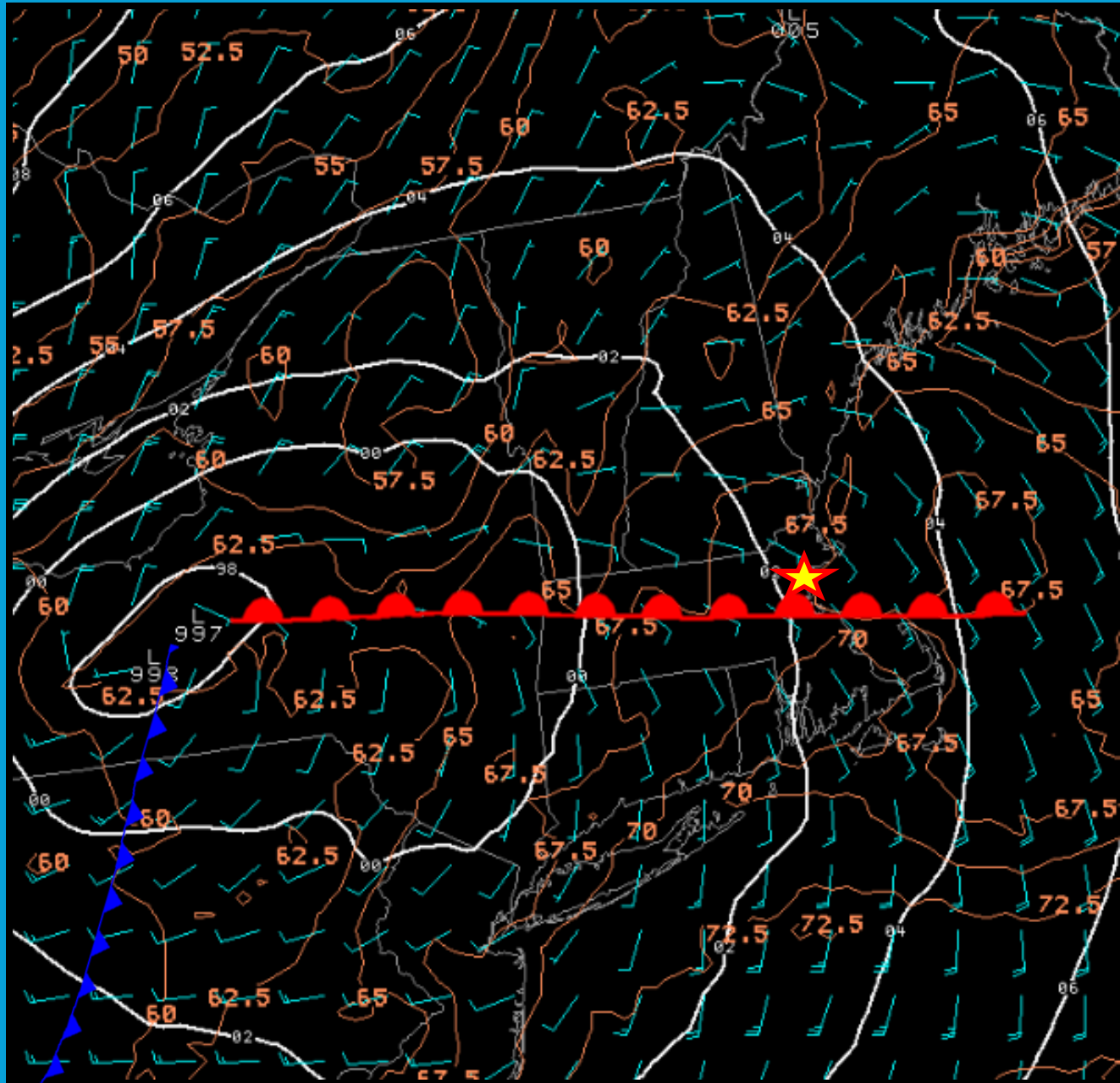


500 hPa Analysis: 12 UTC July 28, 2014



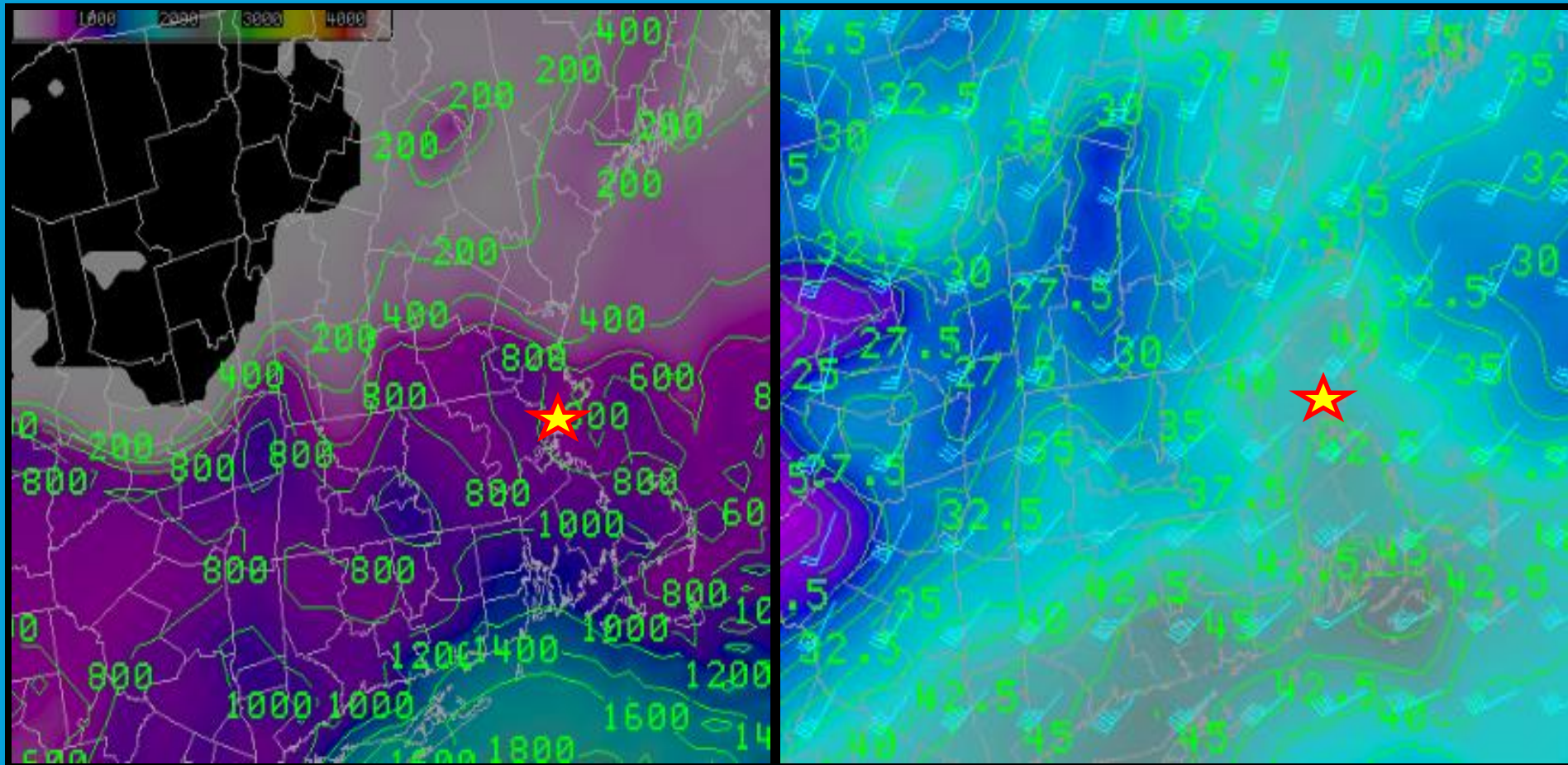
Favorable synoptic scale pattern for New England tornadoes

Surface Analysis: 12 UTC July 28, 2014



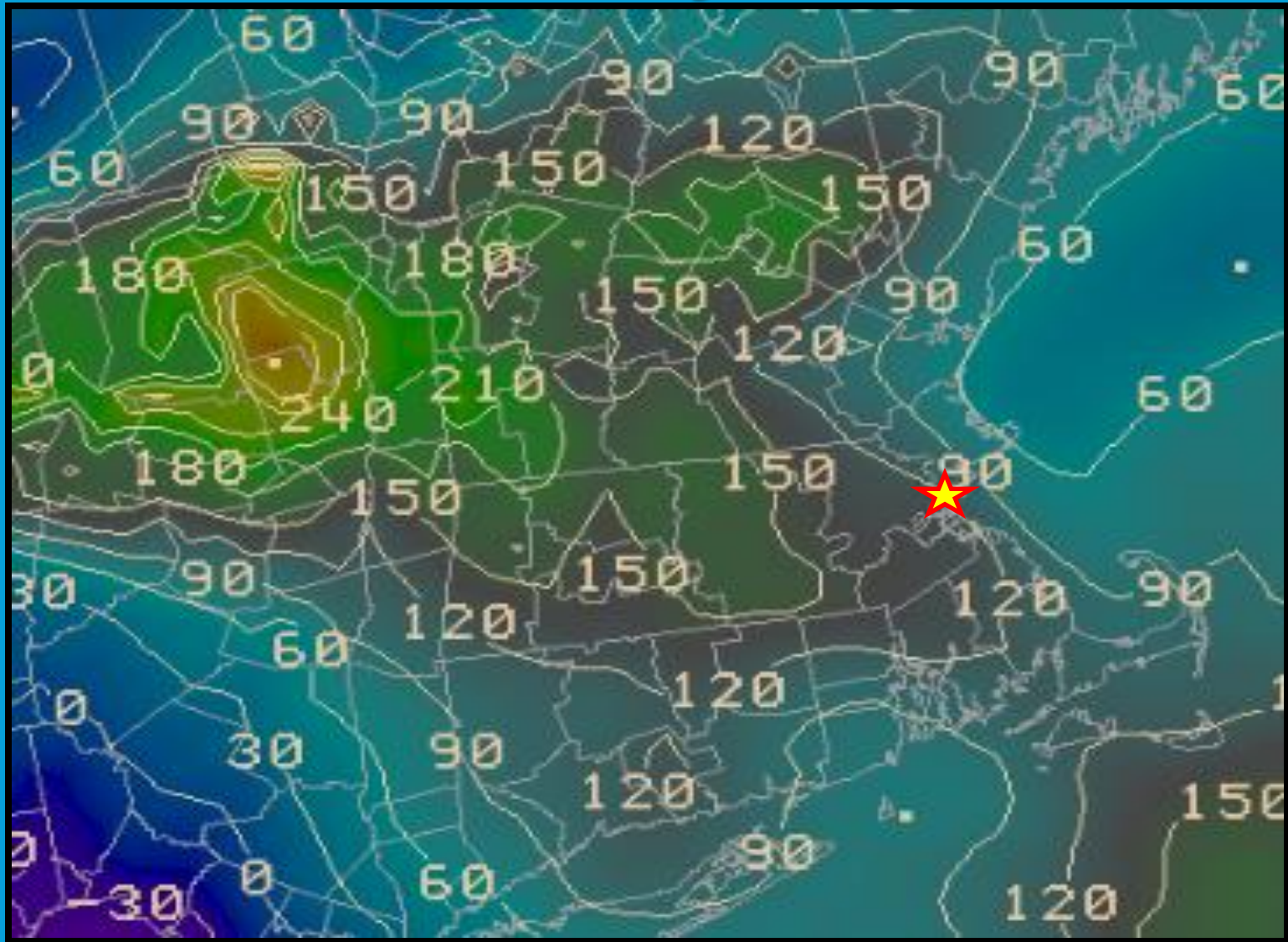
Surface Based CAPE Valid 15 UTC

0 to 6 km Shear Valid 15 UTC



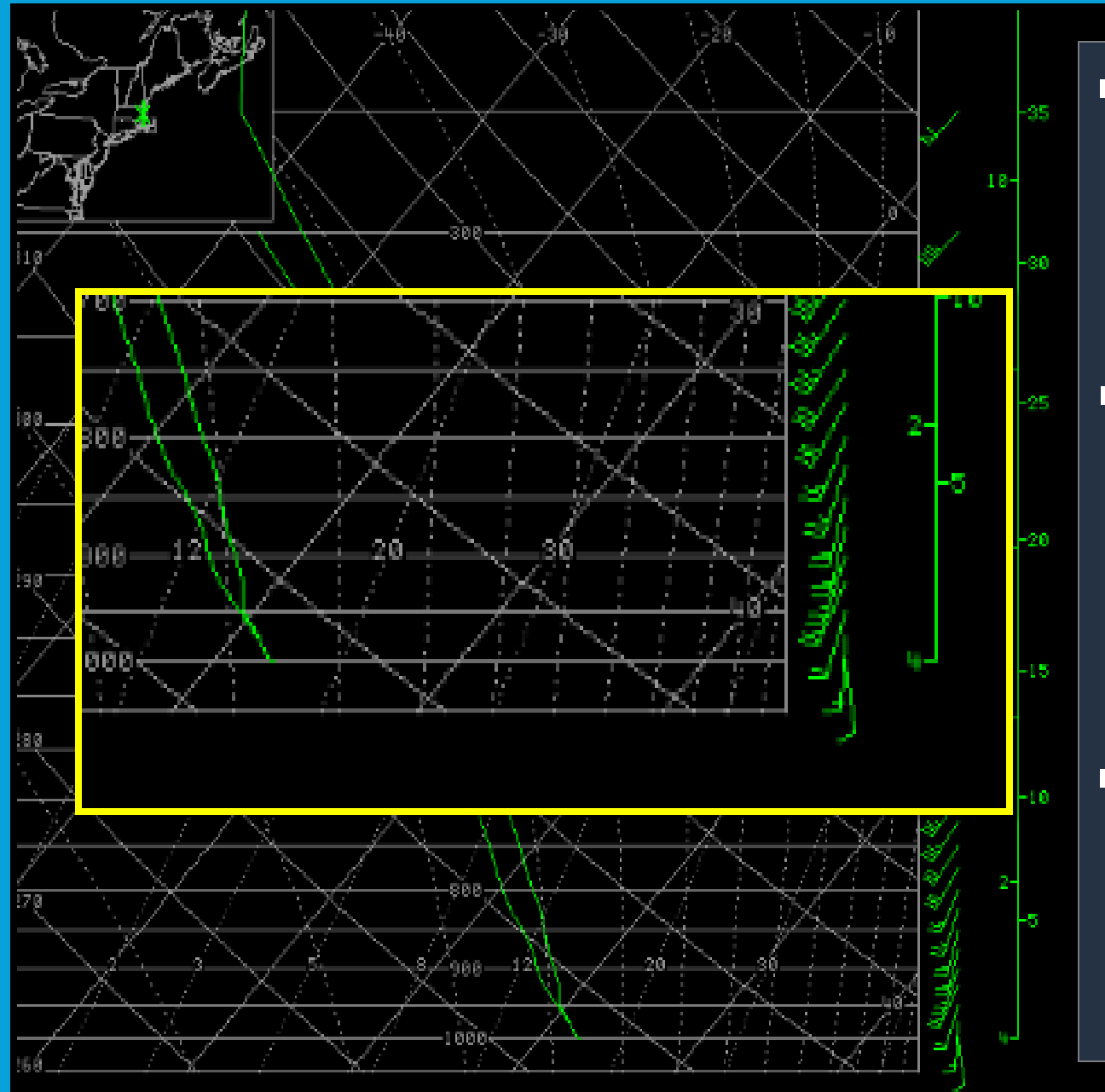
06 UTC NAM Forecasts: July 28, 2014

0 to 1 km Helicity Valid 15 UTC



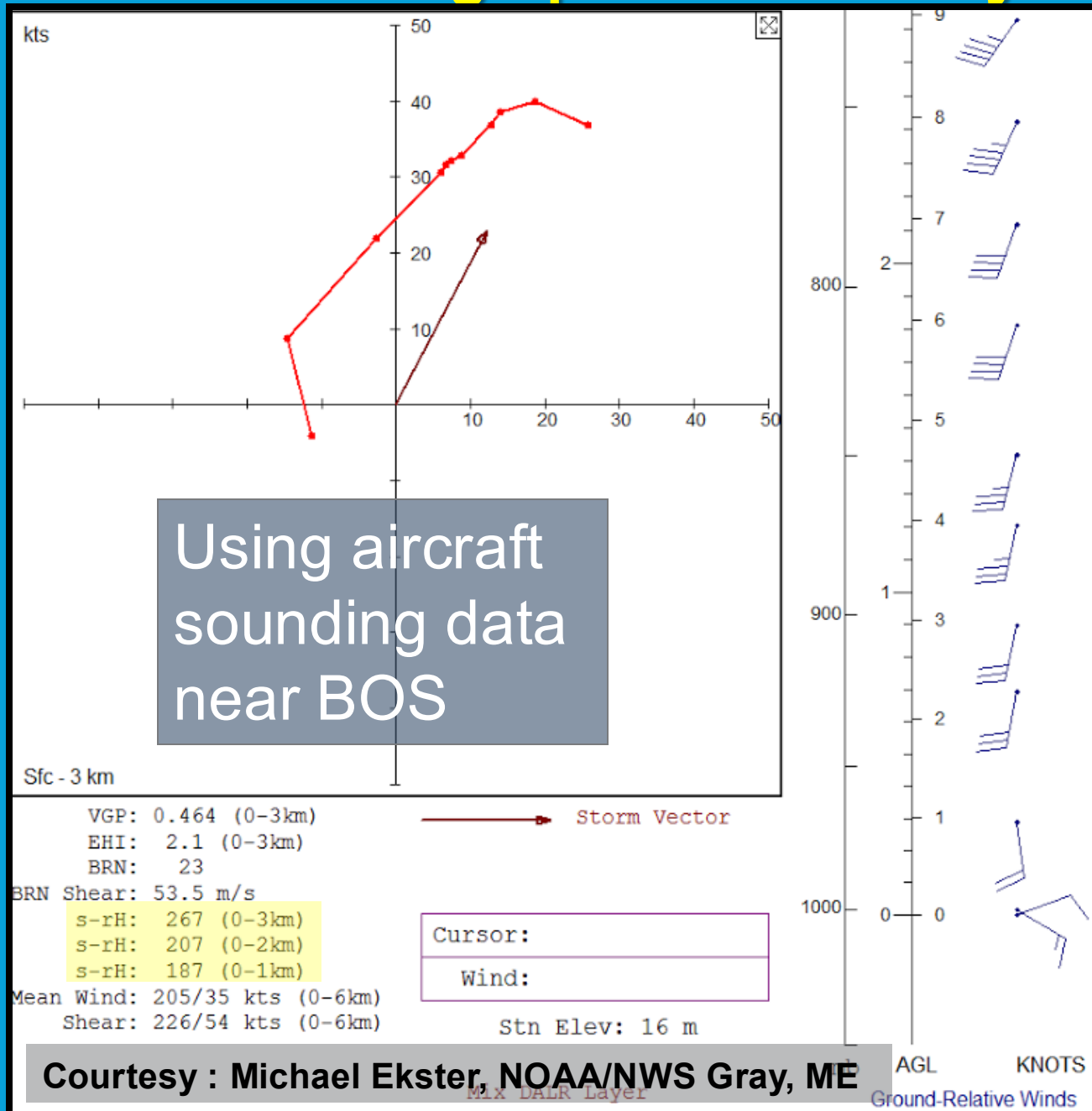
06 UTC NAM Forecast: July 28, 2014

NAM Sounding Near Revere, MA: 12 UTC July 28, 2014



- Strong Winds through the profile
- Nearly saturated boundary layer, results in low LCL
- Winds veering with height, especially in the lowest 1 km

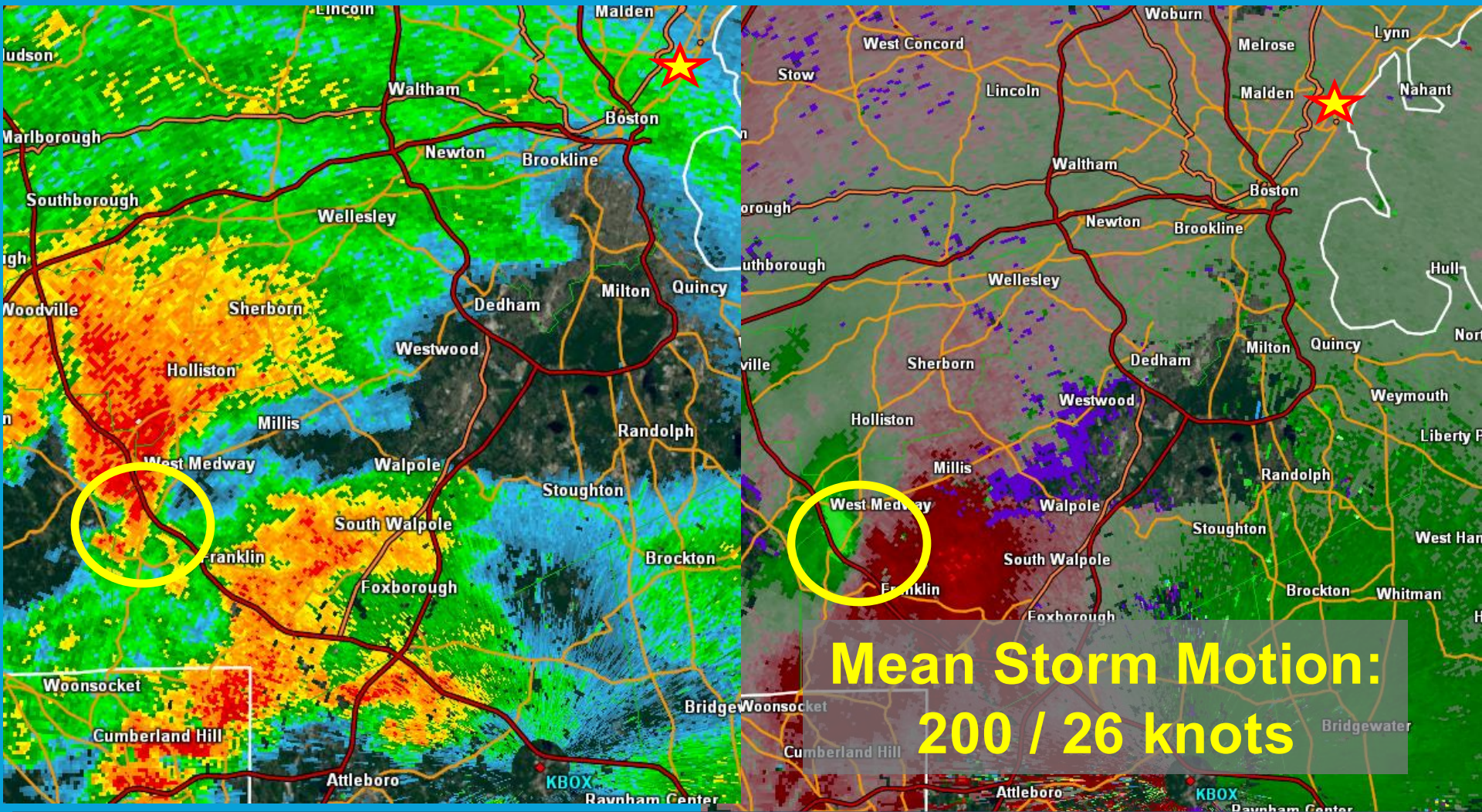
Revere Modified Hodograph: 12 UTC July 28, 2014



Courtesy : Michael Ekster, NOAA/NWS Gray, ME

0.5 REF 1228 UTC

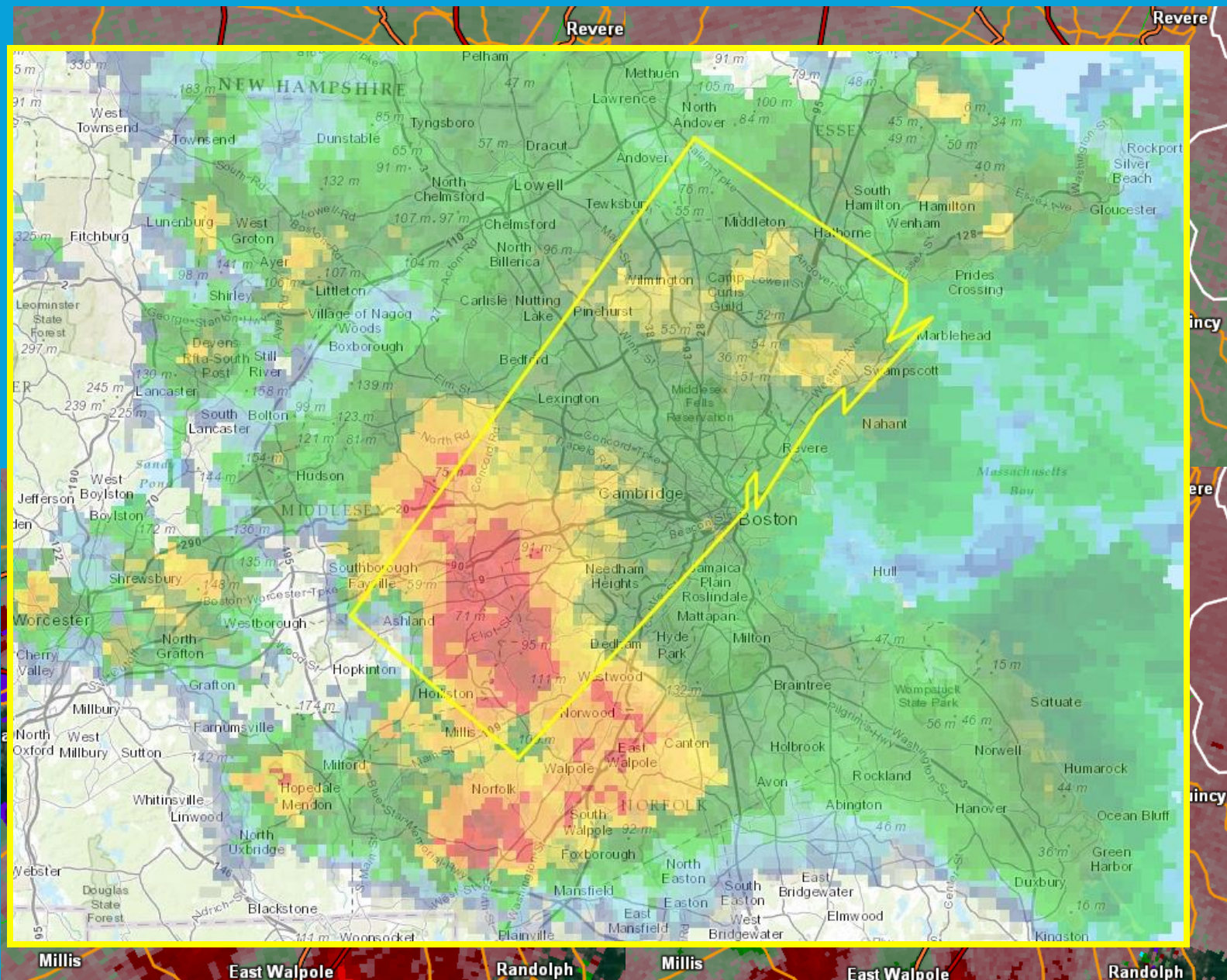
0.5 SRM 1228 UTC



Mean Storm Motion:
200 / 26 knots

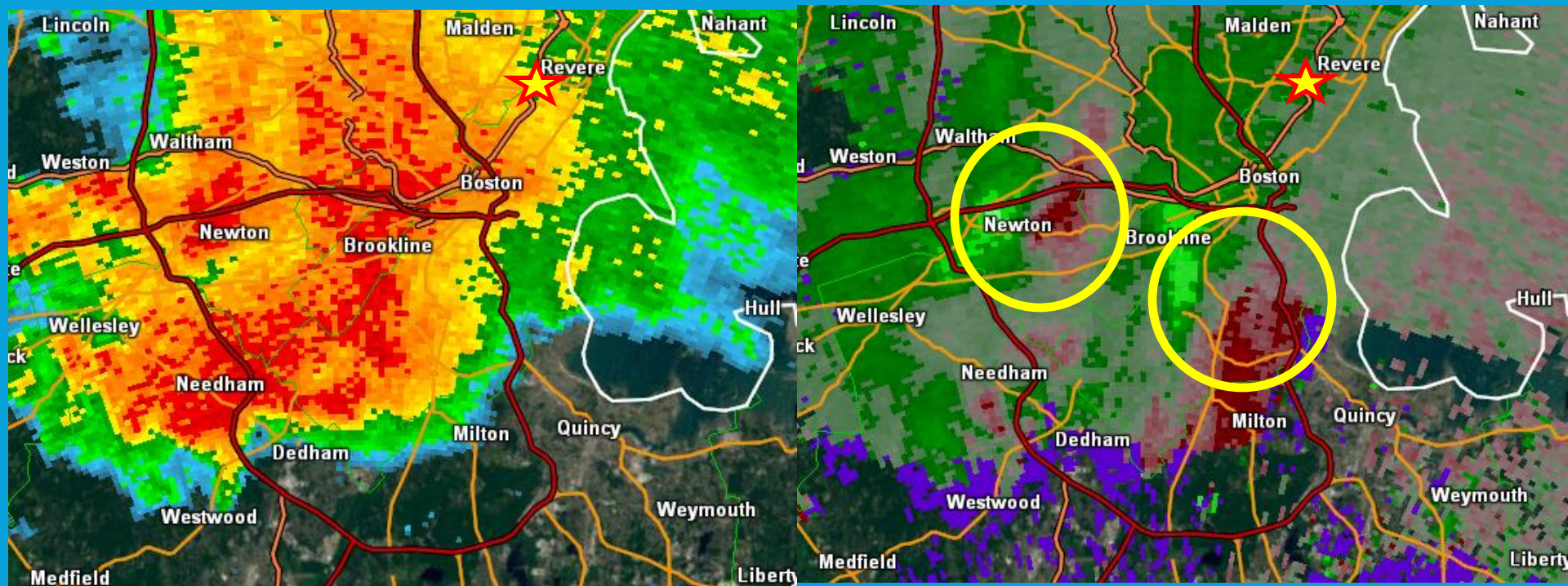
- Over 1 hour before tornado in Revere
- Rotational velocity 25 kt but broad
- Forecaster monitoring for possible Warning

Lower Elevation SRM 1252 UTC



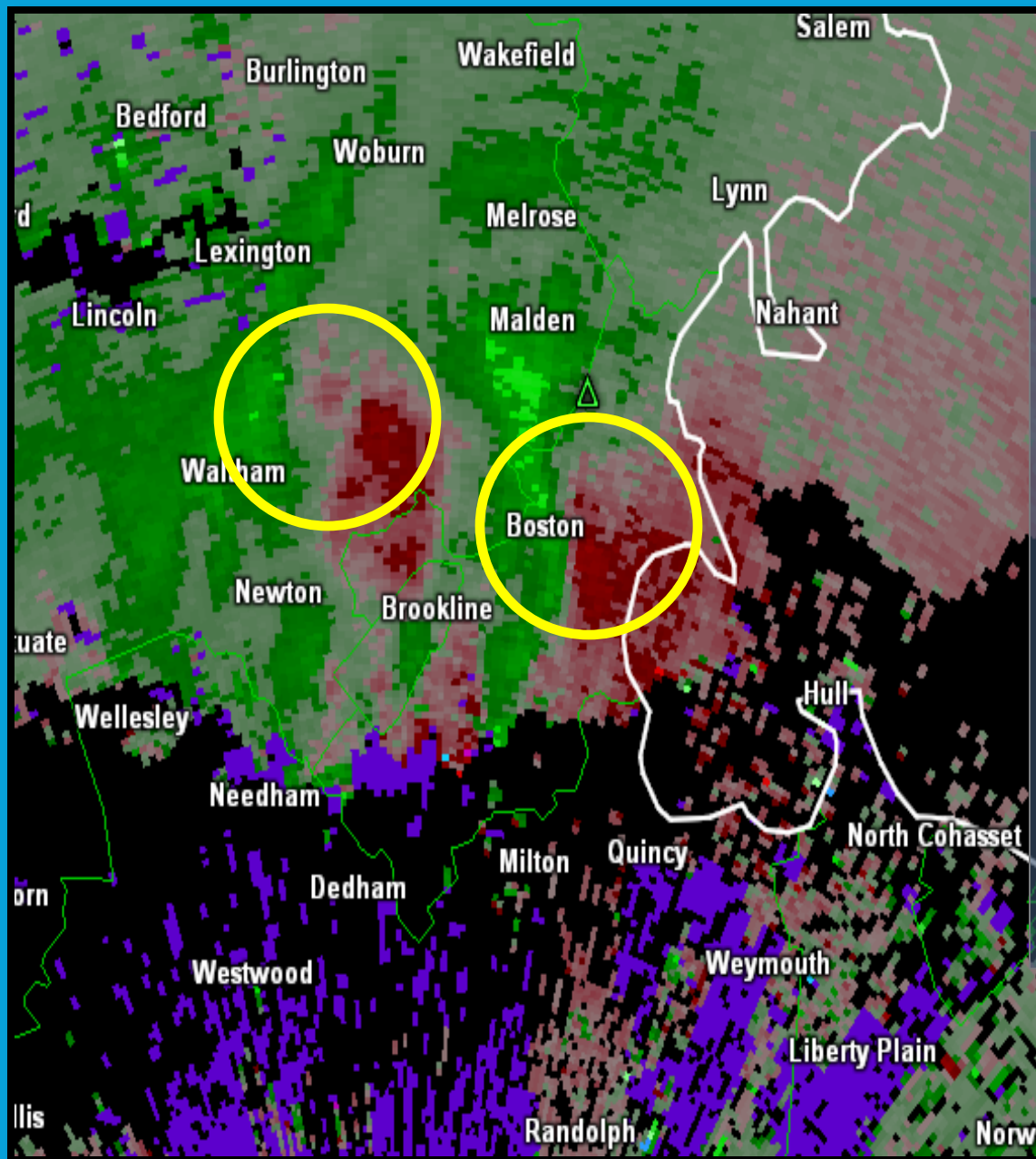
0.5 REF 1315 UTC

0.5 SRM 1315 UTC



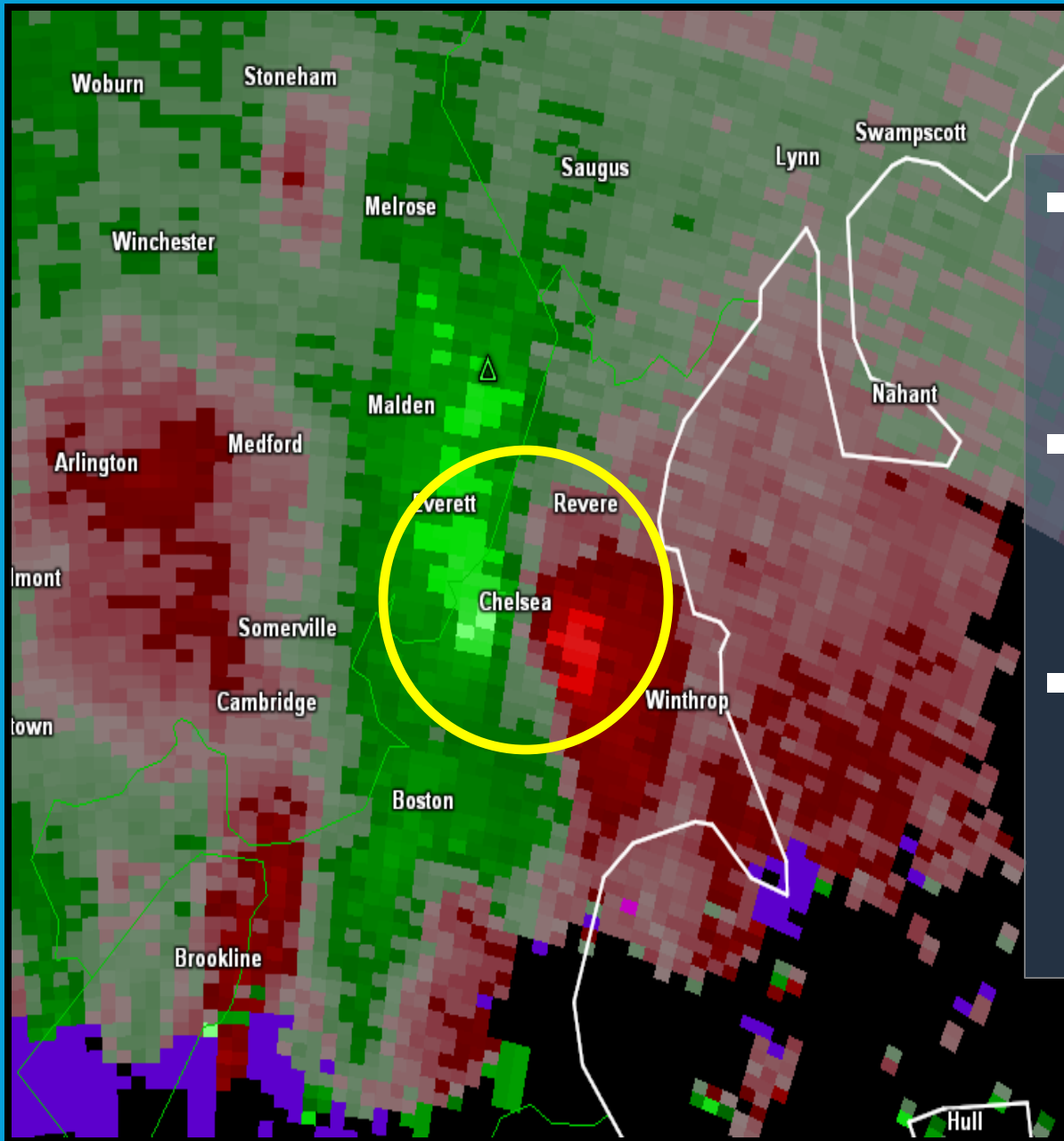
- Two distinct circulations west of Boston
- Cell merger appears to be a driving force in tornado development 15 minutes later

0.5 Degree SRM: 1325 UTC



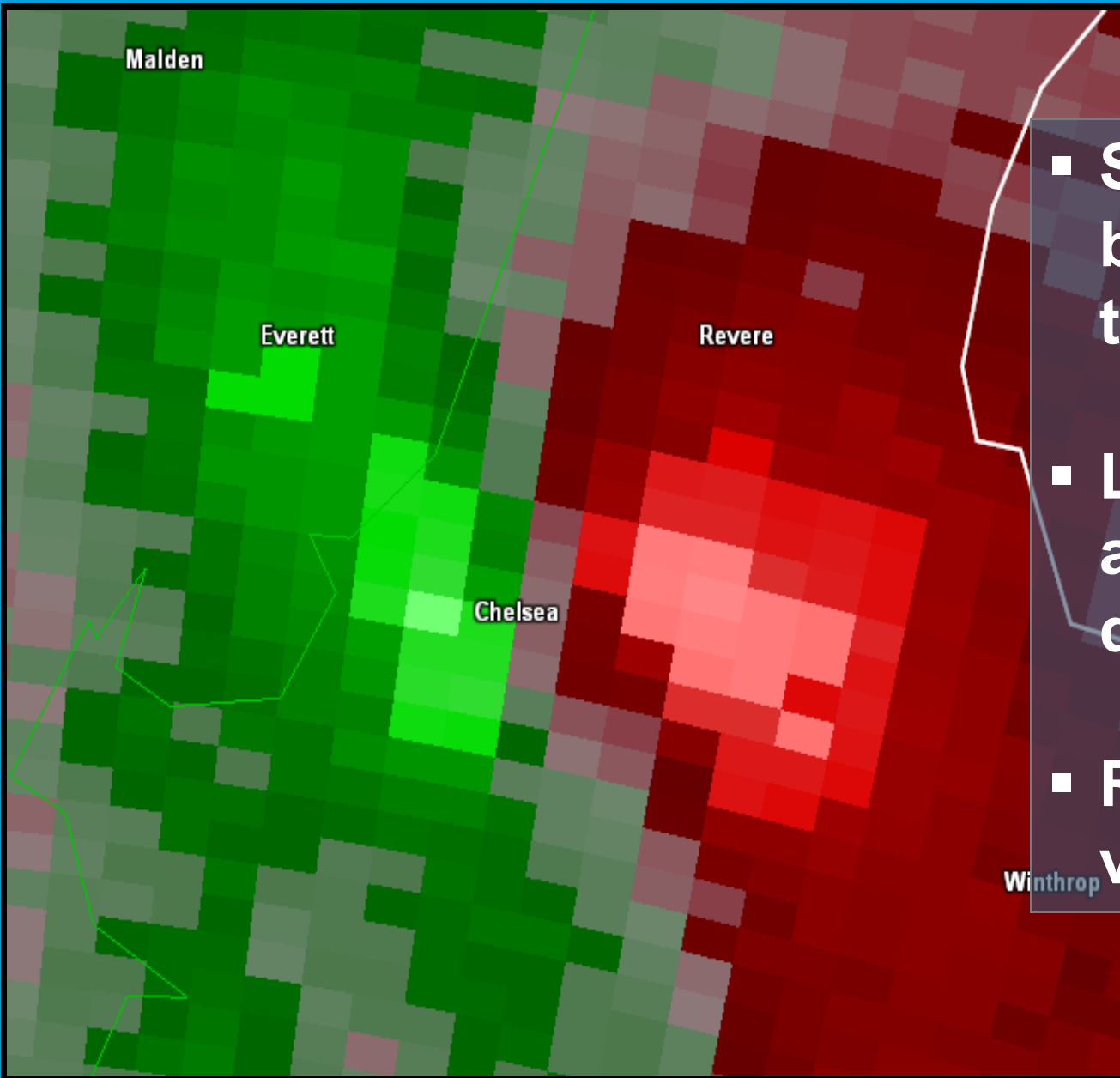
- 7 Minutes before tornado in Revere
- Very broad weak rotation near Boston
- Second couplet near Waltham

0.5 Degree SRM: 1329 UTC



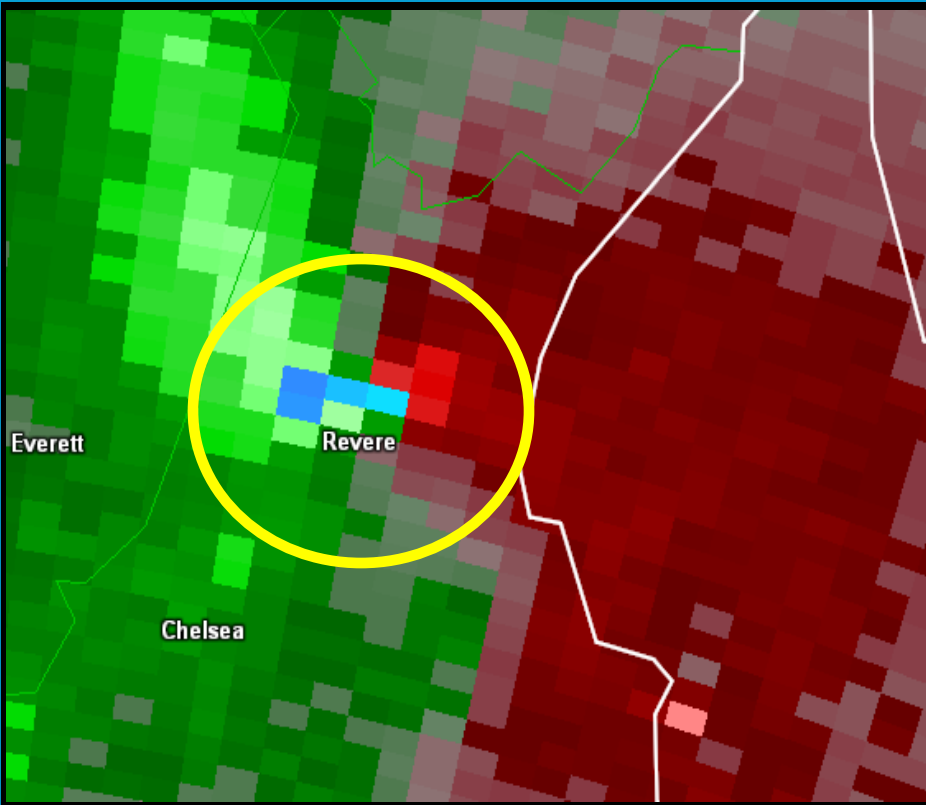
- 3 Minutes before tornado
- Rotational velocity >30 kt
- Fairly symmetrical rotation, nearly “gate-to-gate”

0.9 Degree SRM: 1329 UTC

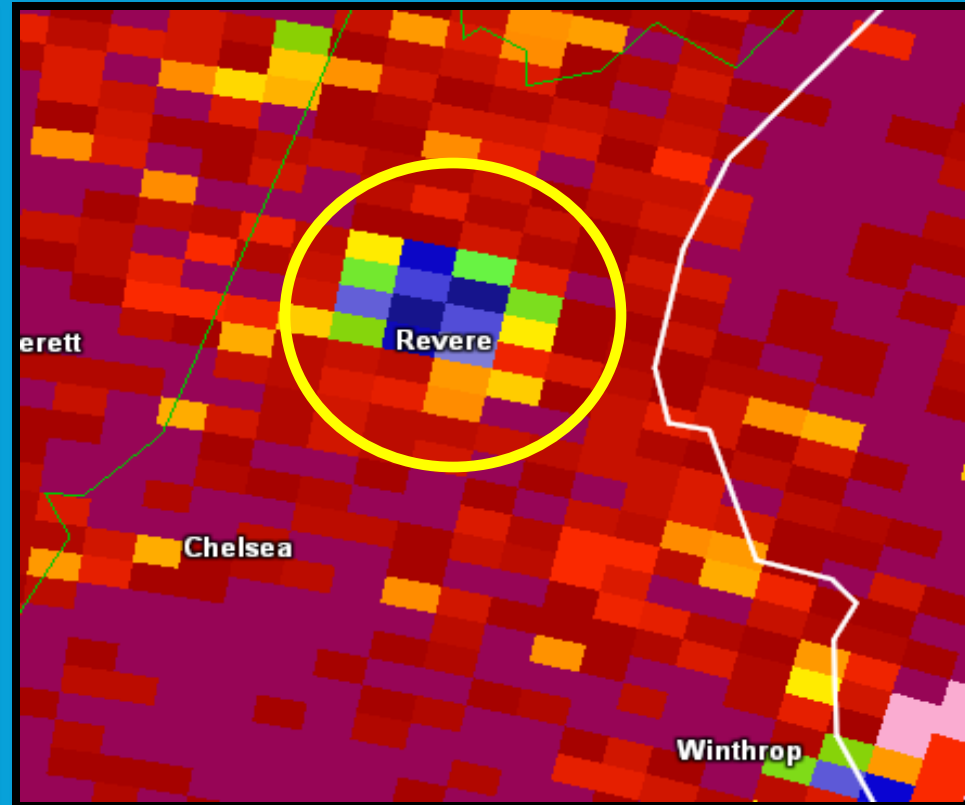


- Still 3 minutes before touchdown
- Looking just above 0.5 degree slice
- Rotational velocity 37 kt

0.5 SRM: 1334 UTC

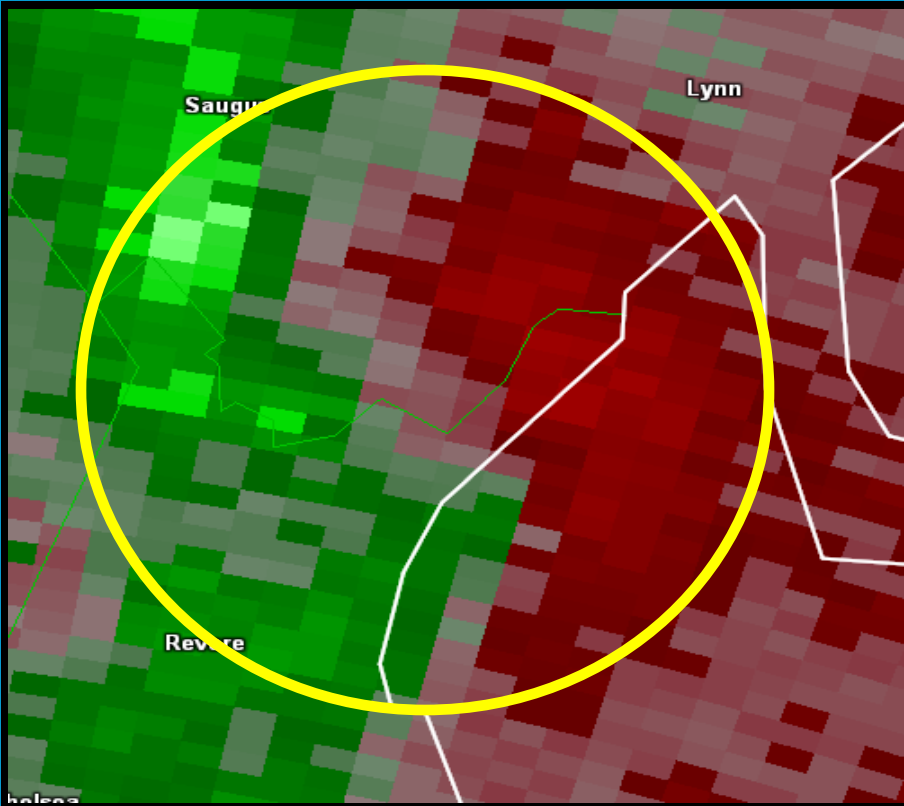


0.5 CC: 1334 UTC

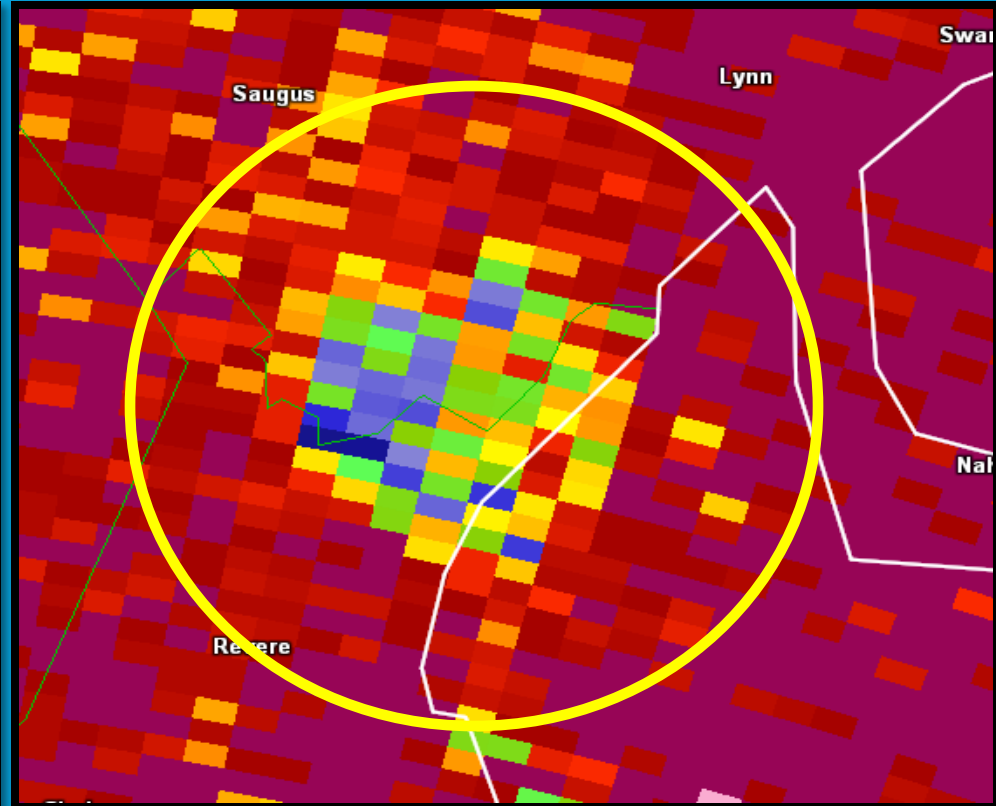


- Gate-to-gate Rotational Velocity of 40 knots
- Correlation Coefficient well below 0.8 co-located with rotational couplet
- Tornadic Debris Signature

0.5 SRM: 1339 UTC

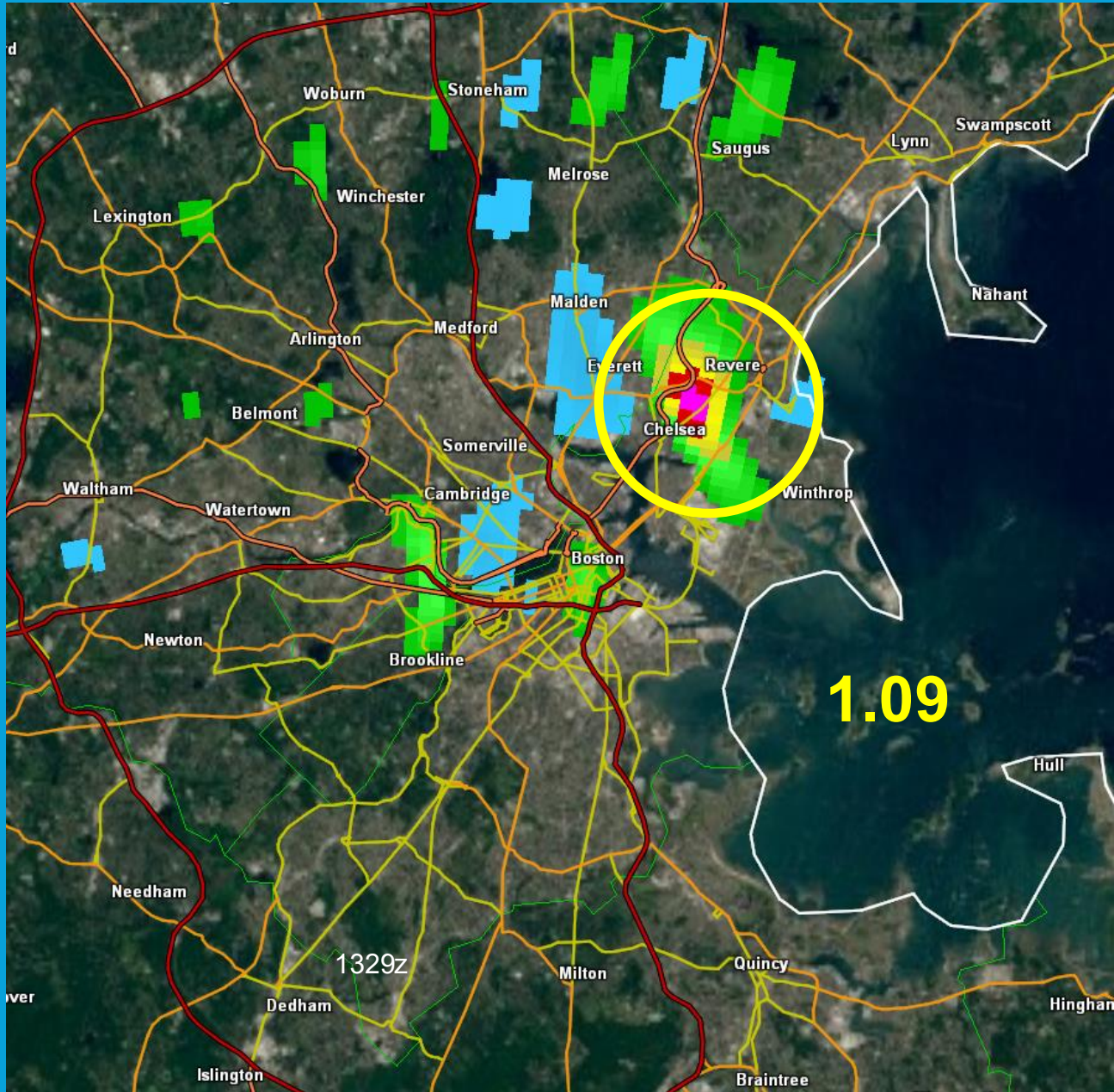


0.5 CC: 1339 UTC



- Shear weakened considerably
- Tornado had lifted by this time
- CC still suggests debris lofted by tornado

1.3 NROT: 1329 UTC



0.5 NROT: 1334 UTC



Lessons Learned

■ Changes to Operations

- Two warning forecasters for severe weather
- Incorporation of near storm environment & NROT
 - Anticipate how storms will evolve
- Strategy: Detection & Lead Time
- Radar color curves enhance critical thresholds
 - 25kt Rotational Velocity

■ Success Story

- June 23, 2015 Wrentham EF-0 tornado warned with 19 minutes of lead time.

Future Work

- **NOAA Hollings Student (Summer 2016)**
 - Update database of mesoscale environments and radar signatures from past events (2012-2015)
 - Update Warning Decision Making guidelines
 - **Improve warning detection and lead time**