

**August 4, 2015:**  
***Two Rare High End Severe Weather Events  
Inside 12 Hours In  
Southern New England***

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# Overview

## ***First Event:***

### **Rhode Island and Southeast MA 6:00-8:30 am**

- Widespread damaging wind gusts of 60 to 80 mph
- Rhode Island hardest hit, including Cranston and Providence
  - Roads/rail blocked by fallen trees making for a horrific rush hour
  - 25 percent of Rhode Island lost power (over 121,000 people)
  - *More power outages in RI than Hurricane Sandy!*
  - 10 minor injuries at Burlingame Campground in Charlestown, RI

## ***Second Event:***

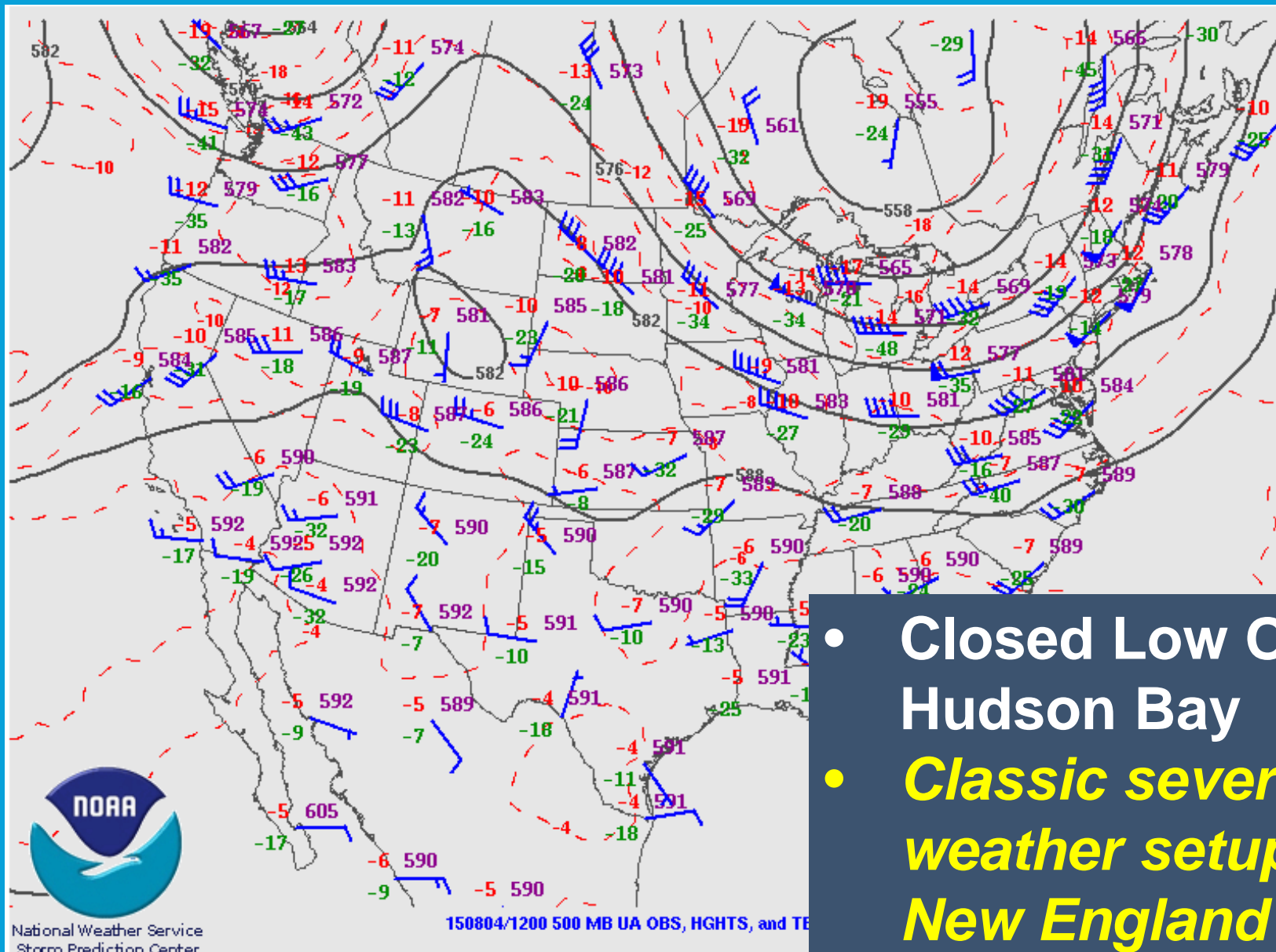
### **Massachusetts (along/north of Mass Pike) 12:30-4:30 pm**

- Reports of golf ball to 2 inch diameter hail
  - 2" diameter hail in Boston (largest reported in Suffolk County)
- Wind gusts of 50-60 mph
  - Some tree damage and isolated power outages
- No injuries reported

# Damage in Rhode Island

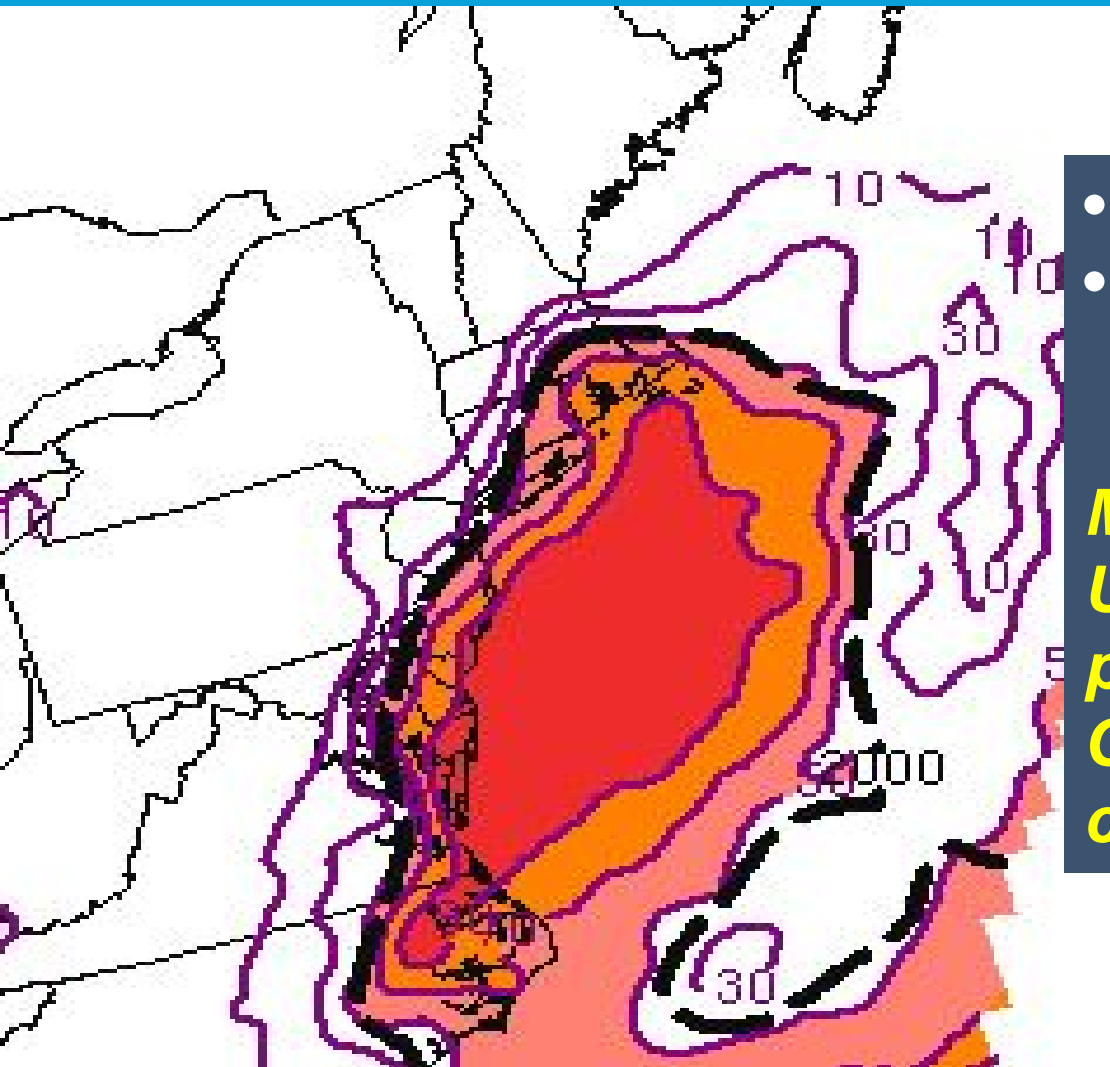


# 500 mb Analysis: 12 UTC August 4<sup>th</sup> 2015



- Closed Low Over Hudson Bay
- **Classic severe weather setup for New England**

# SPC SREF: Mean Probabilities of MUCAPE Exceeding 2000 J/KG



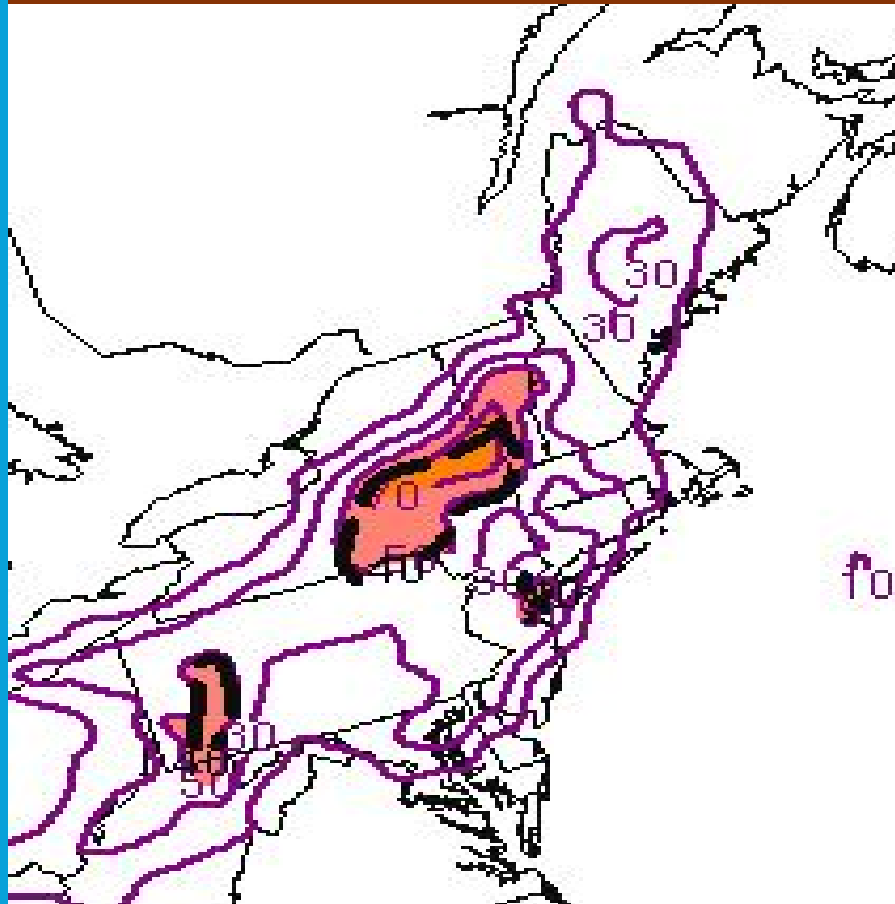
- Valid 09z August 4
- 70 to 90 percent in RI and southeast MA

*MUCAPE (Most Unstable CAPE) better predictor than surface CAPE for nighttime convection*

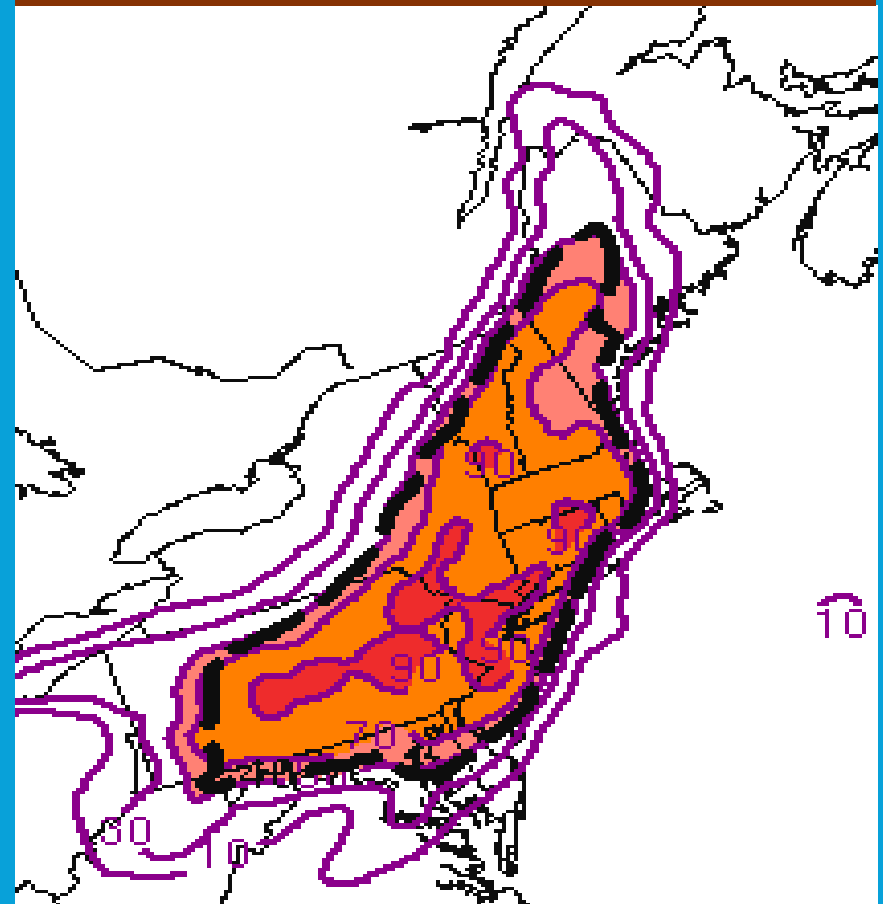
15 Hour Forecast from SREF

# SPC SREF: Mean Probabilities of 0-6 km Bulk Effective Shear Exceeding 40 Knots

09z August 4<sup>th</sup> 2015



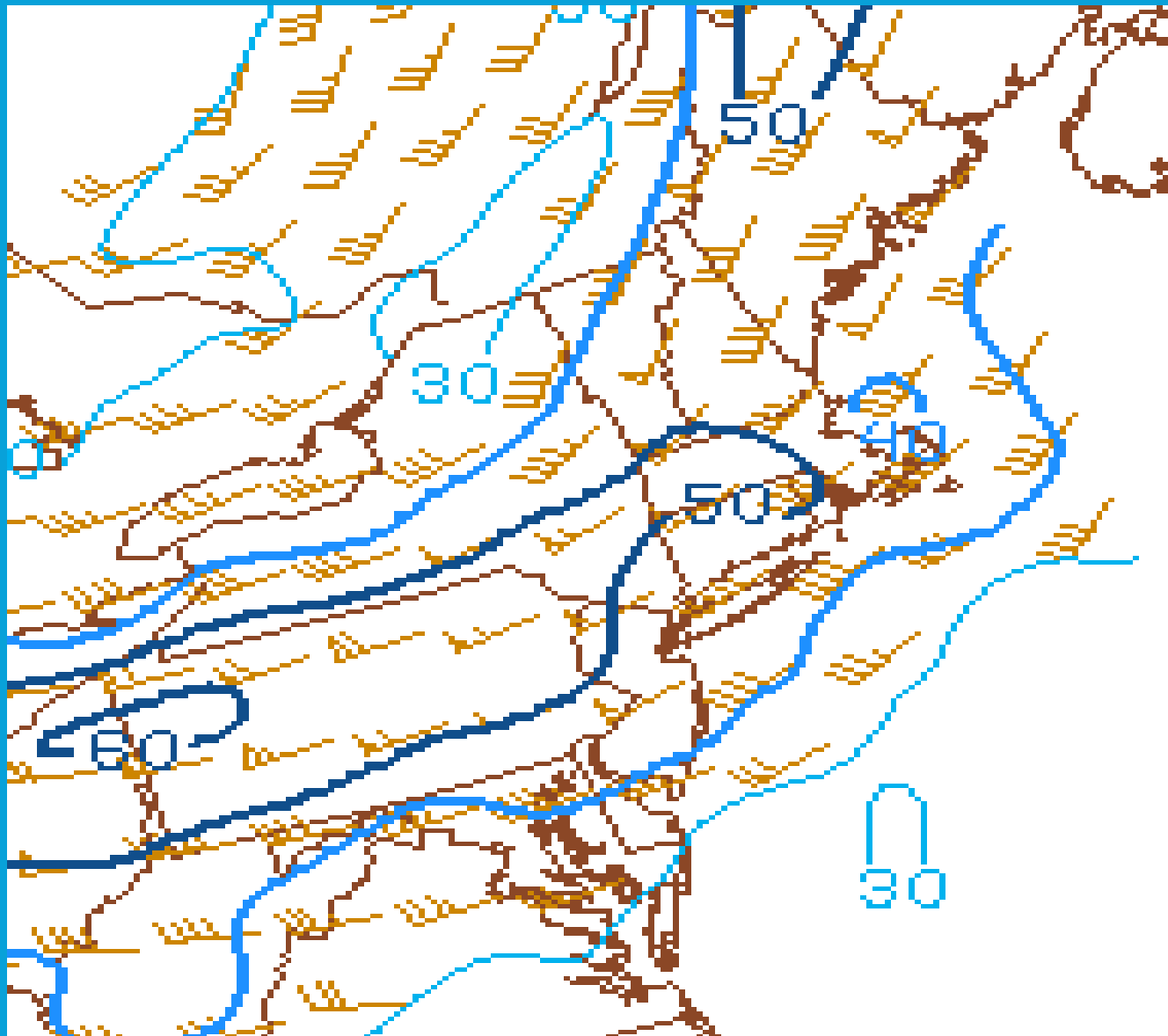
12z August 4<sup>th</sup> 2015



Probabilities rapidly increase  
in response to approaching shortwave

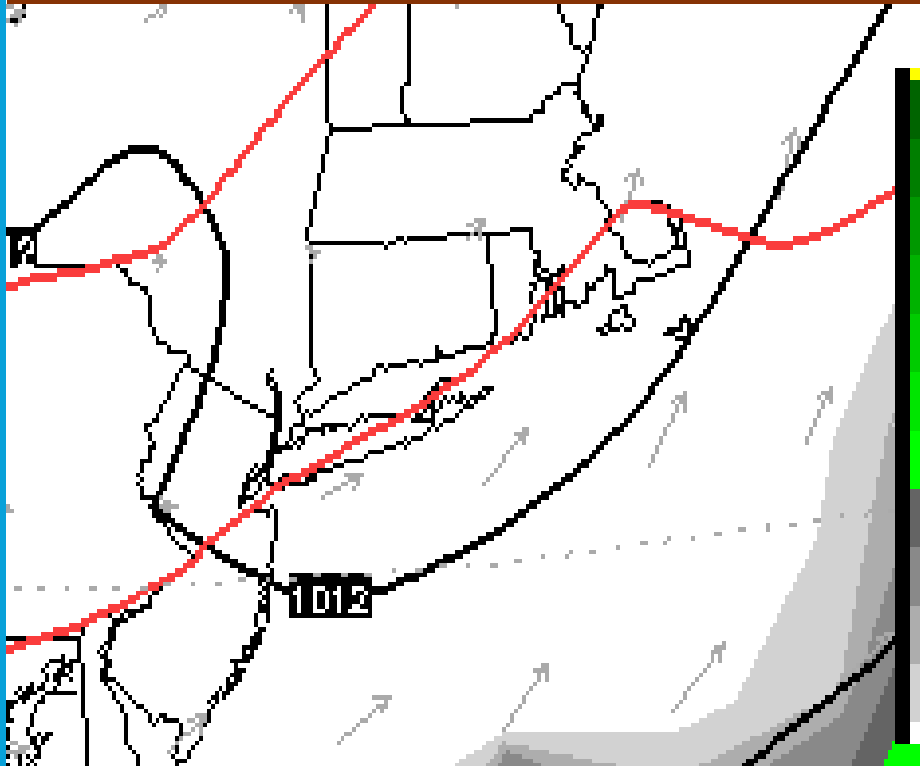
# SPC Mesoanalysis: 11z

## Strong 0-6 km Shear

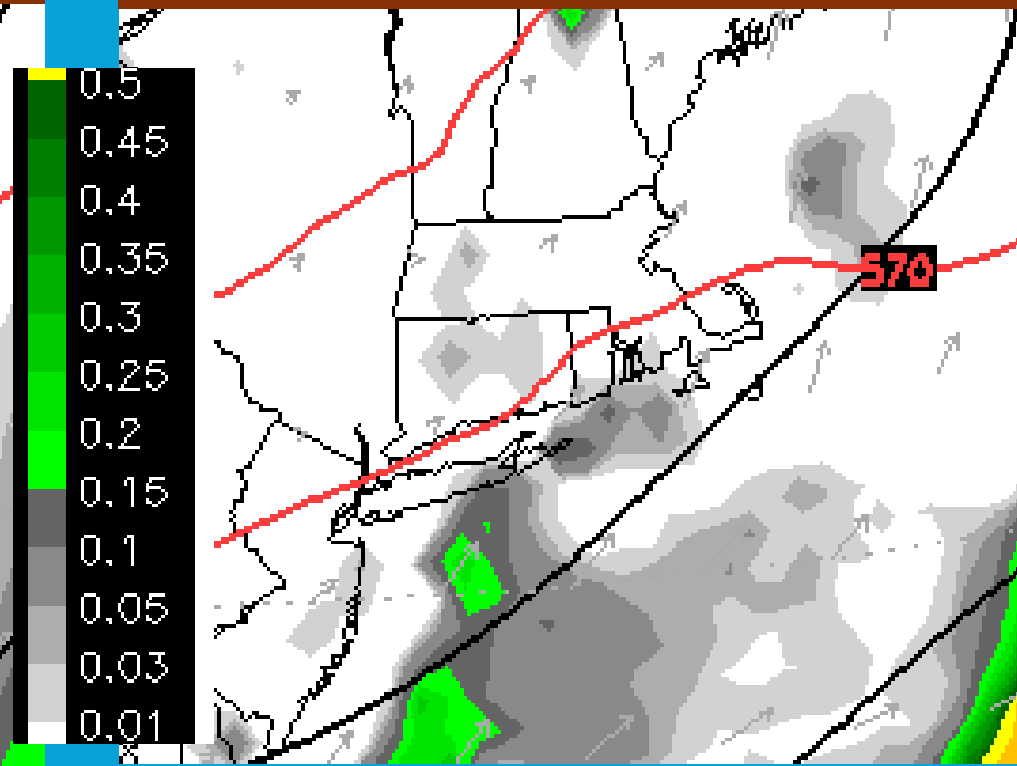


# Forecaster Uncertainty: Several Models Forecasting a Shutout Inside 36 Hours

ECMWF QPF 06z to 12z



GFS QPF 06z to 12z

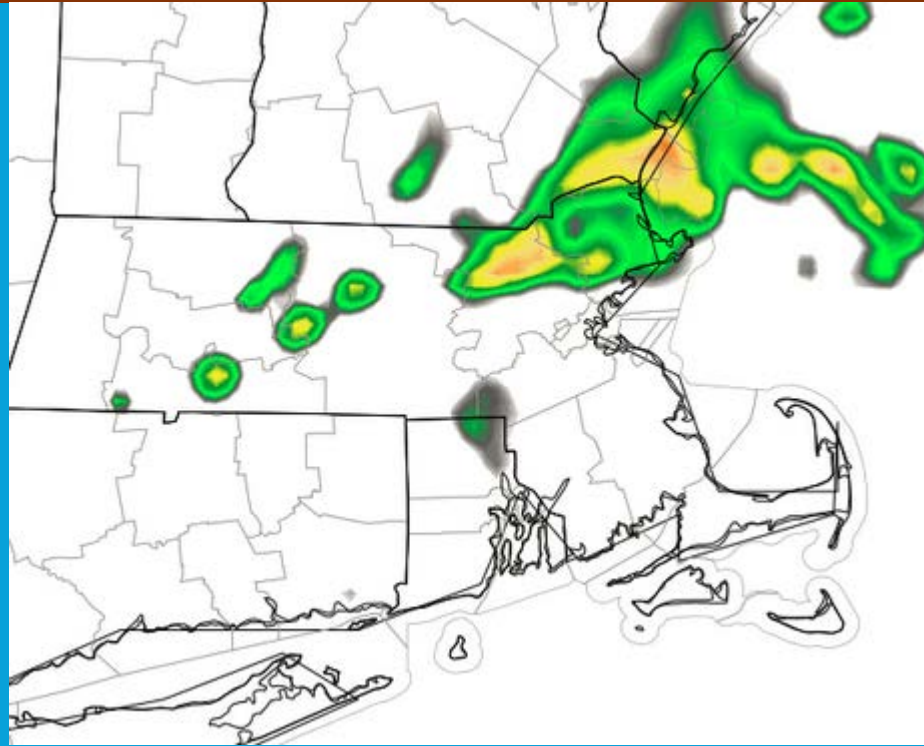


- Need some type of forcing to ignite potentially potent environment.
- GFS/ECMWF suggest there is not enough of a trigger.
- ***How do you handle this as a forecaster ?***

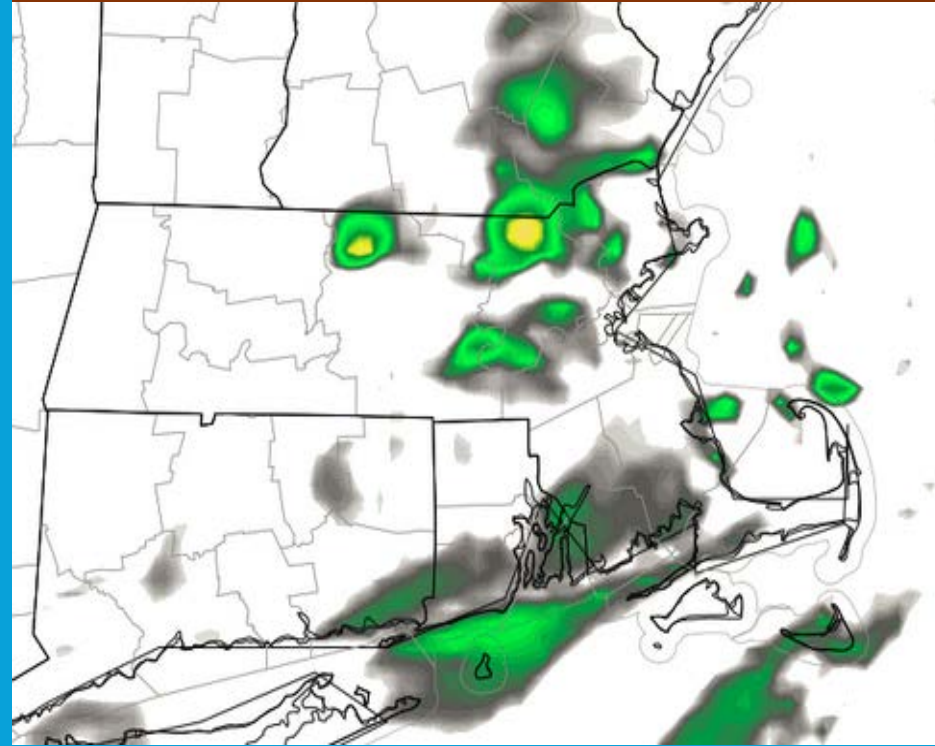


# High Resolution Guidance

12z Aug 3 ARW Valid 10z Aug 4



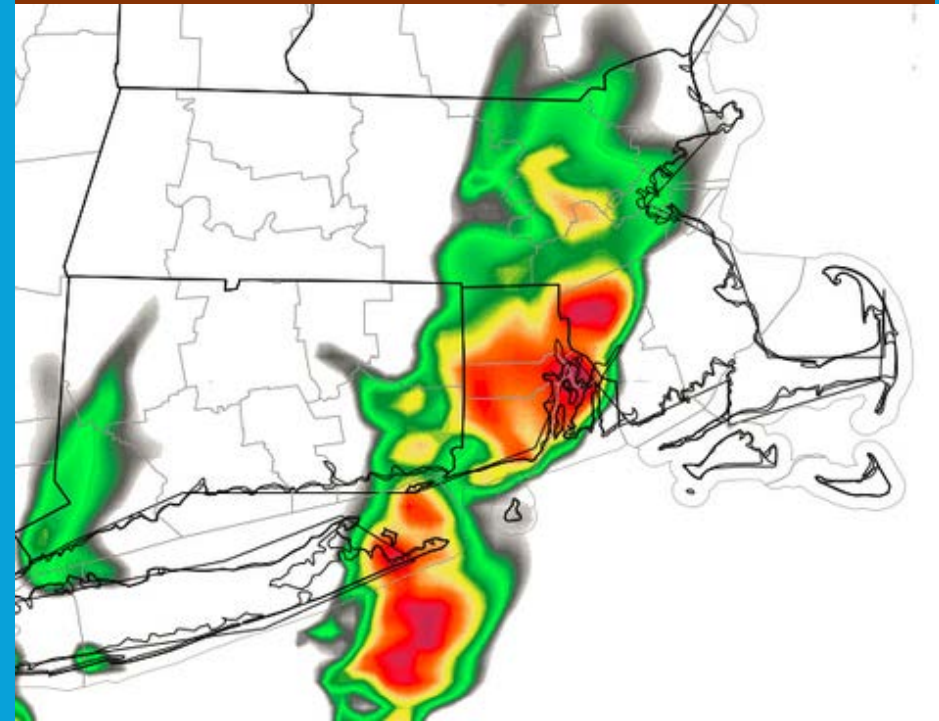
12z Aug 3 NMM Valid Aug 10z Aug



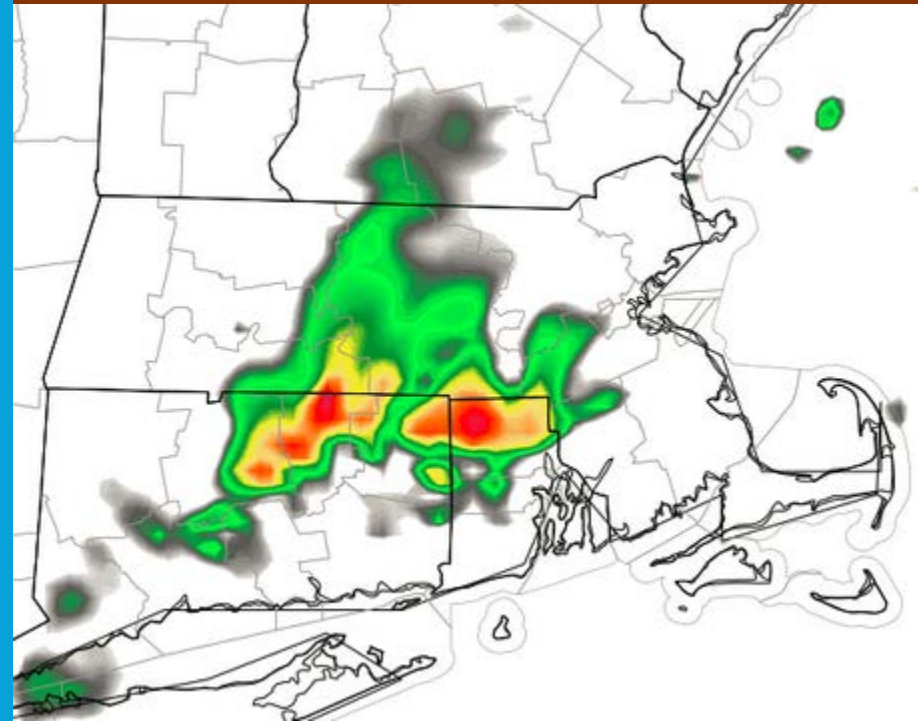
- 22-Hour Simulated Reflectivity From 4 km ARW/NMM not impressive
- Few showers/isolated thunderstorm in Northeast MA
- Little if anything farther to the south

# High Resolution Guidance 12 Hours Later

00z Aug 4 ARW Valid 09z



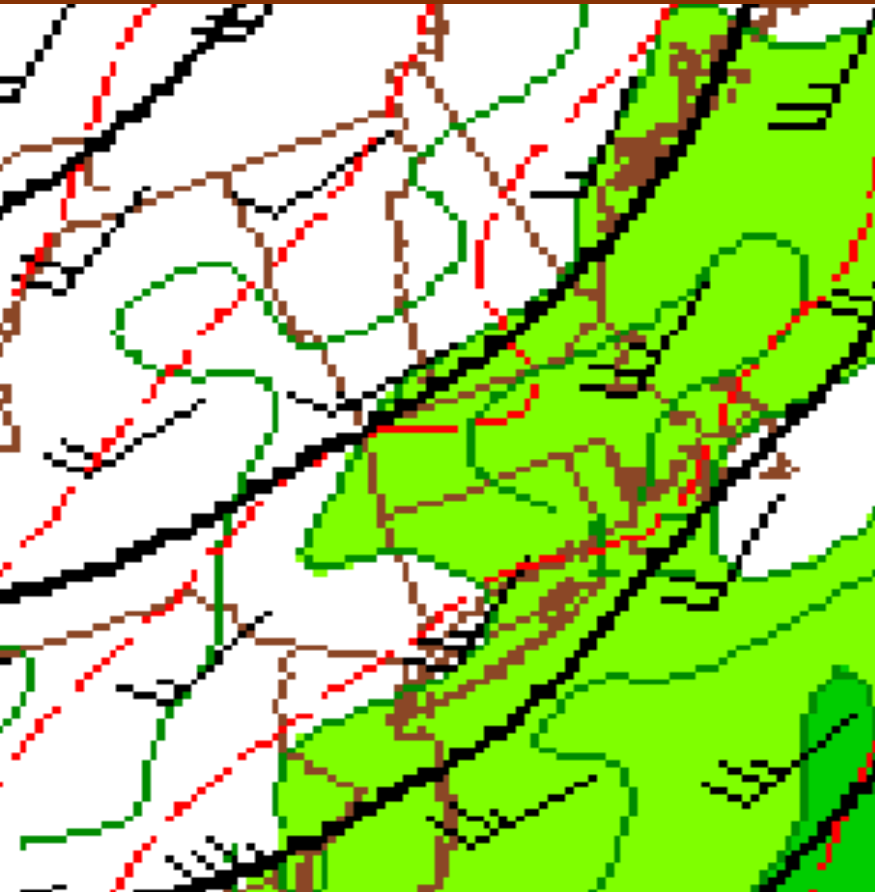
00z Aug 4 NMM Valid 09z



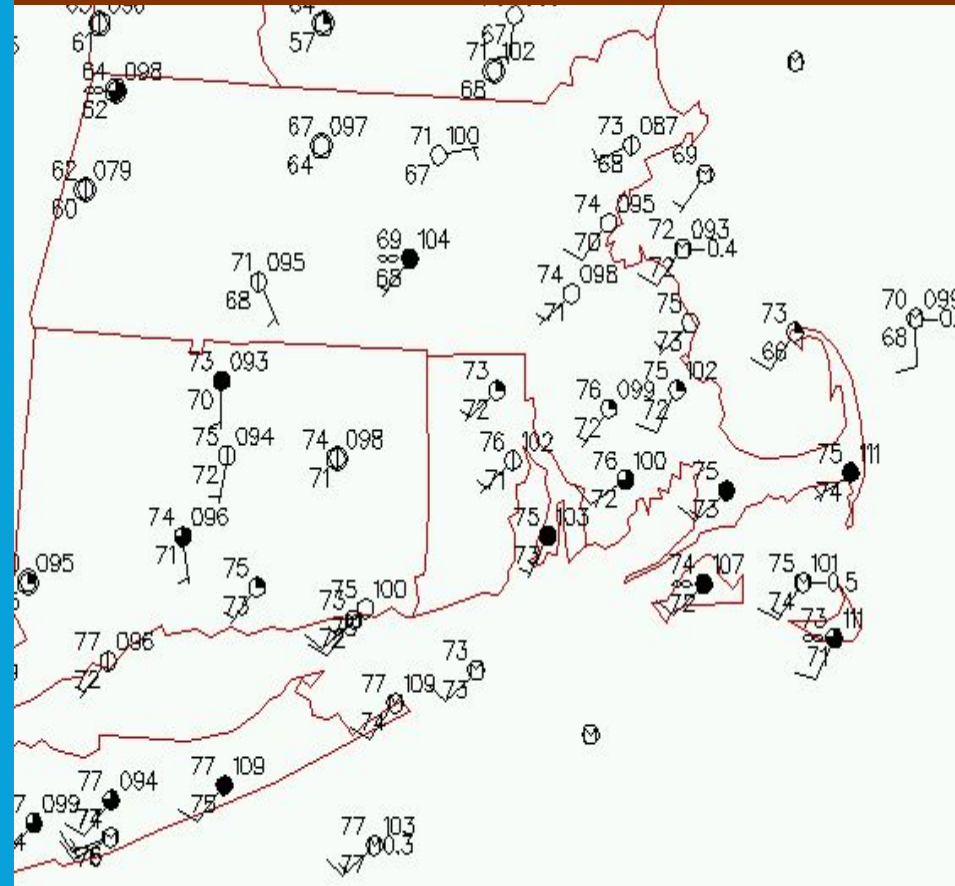
- 9 Hour Simulated Reflectivity shows better activity
- 4km NMM better, but not as impressive as the ARW
- ***What is causing this change?***

# Low Level Jet and Decoupled Boundary Layer

850mb LLJ of 25 Knots at 08z



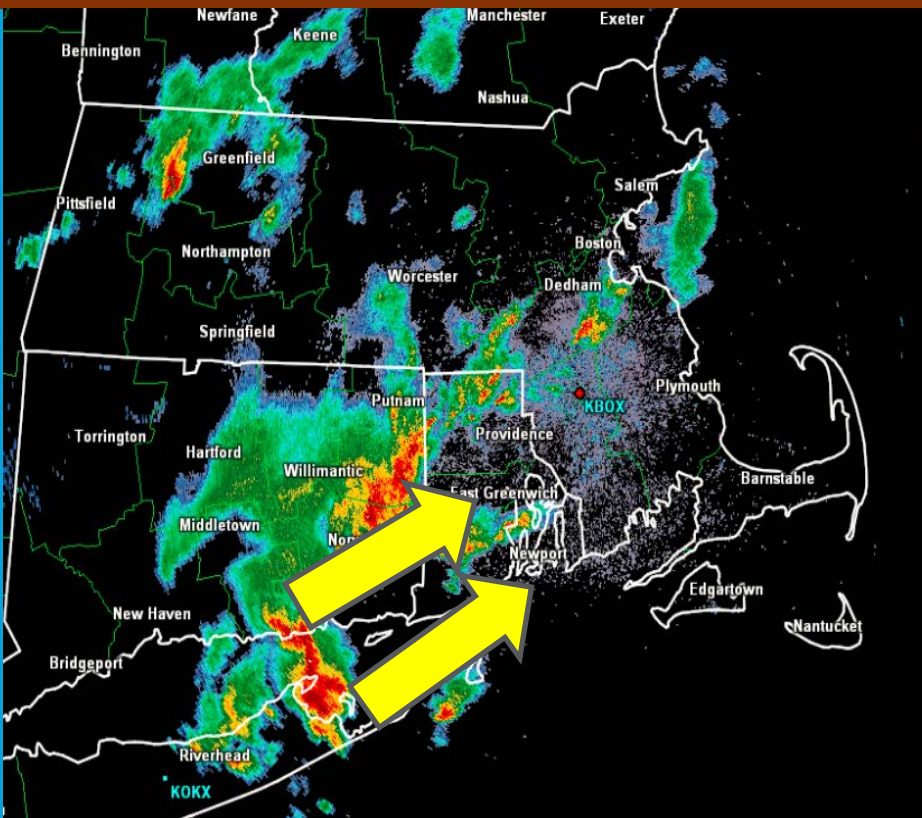
Weak Surface Winds at 08z



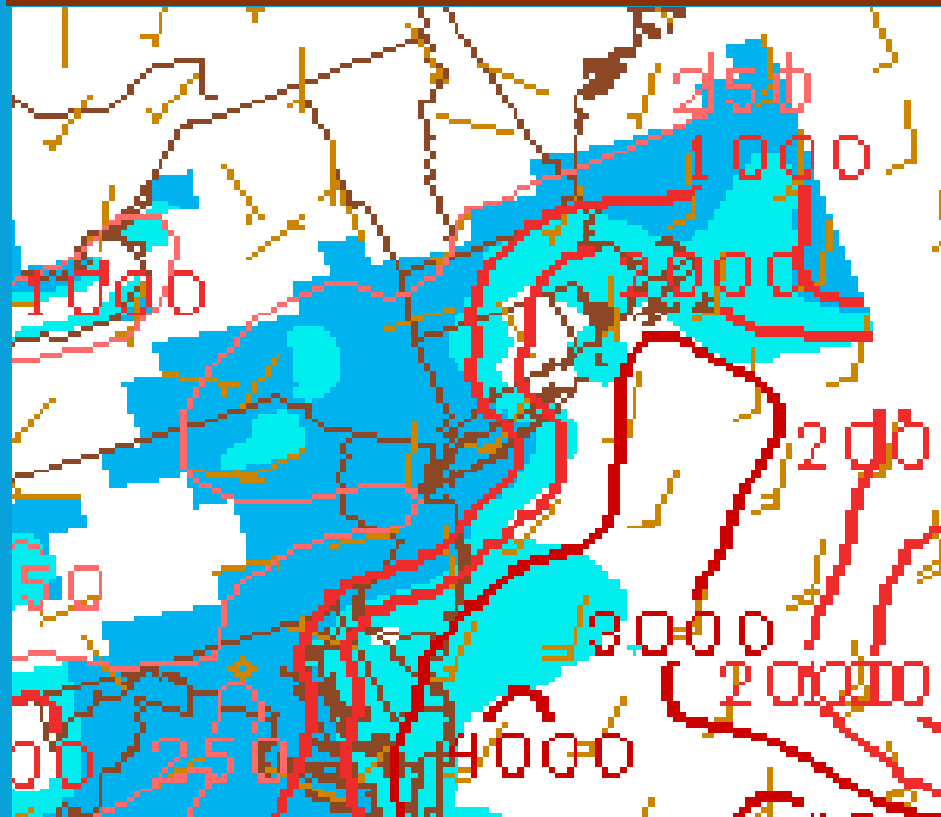
- **Low Level Jet overruns cooler decoupled boundary layer**
  - Sets up mesoscale boundary.
- **Models can struggle with this setup**
  - Often see a “Sunrise Surprise.”
  - But MUCAPE/shear usually less impressive.

# Radar Imagery

Radar Imagery at 0958z



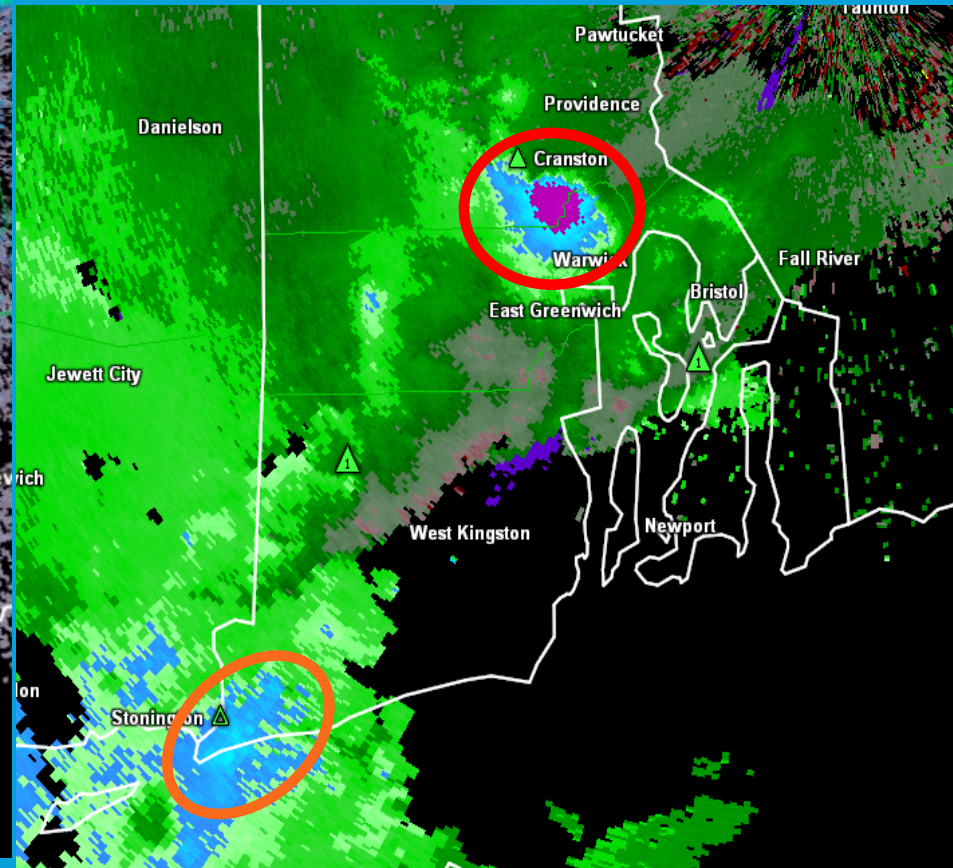
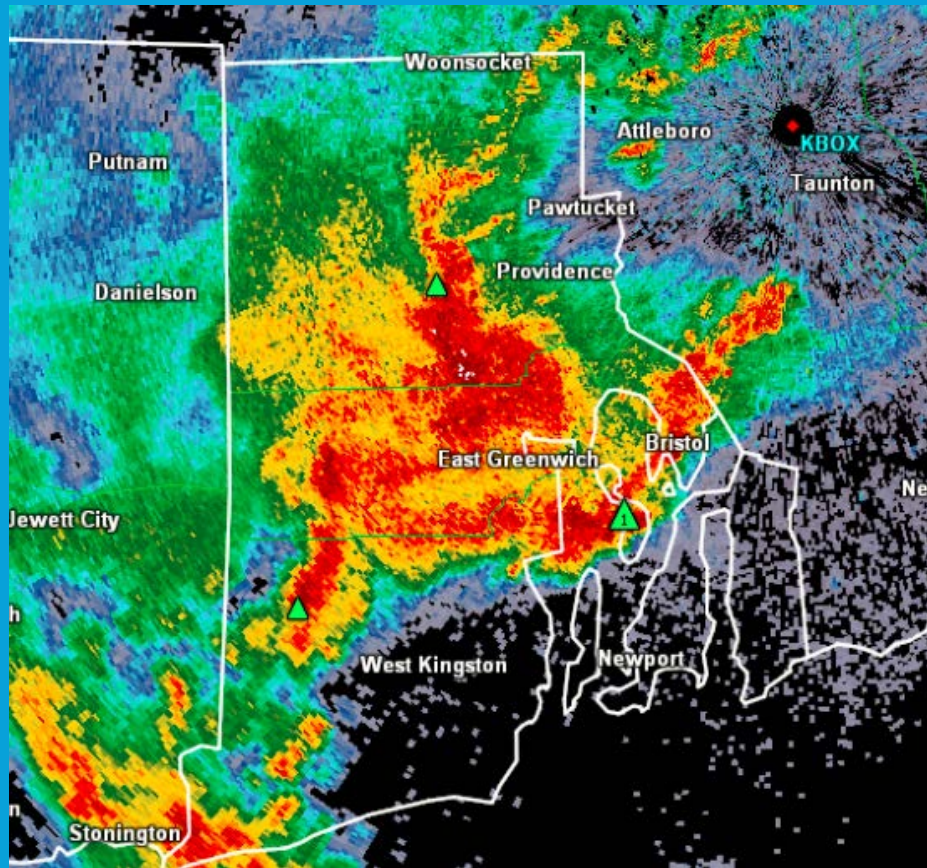
Storms moving into 2-3K of MUCAPE



- Storms formed on LLJ, moved into more favorable environment.
- 2000 to 3000 J/kg of CAPE across southeast New England
- Storms became surface based

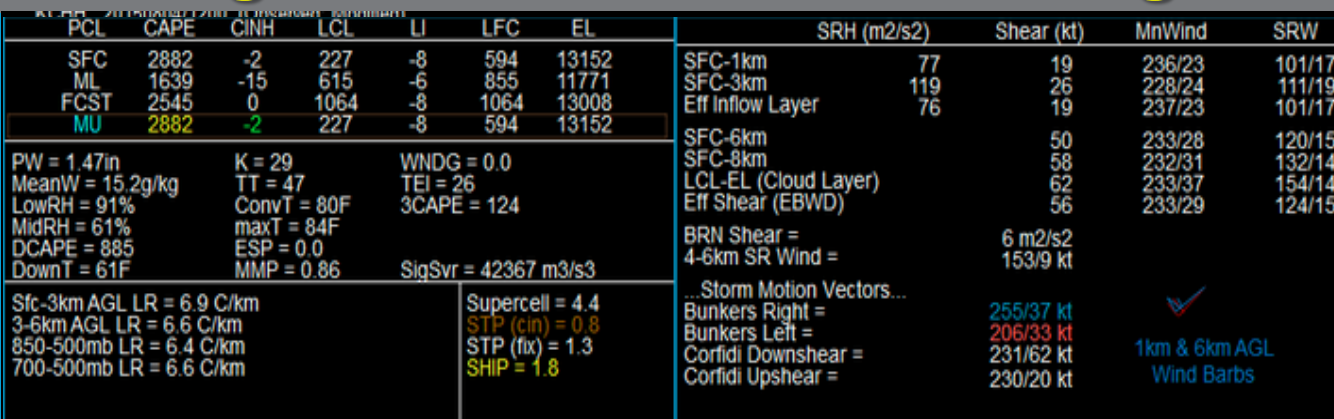
# 0.5 REF 1124 Z

# 0.5 VEL 1124 Z



- 70 to 80 knots just off the ground in Cranston, RI
- 60 to 70 knots across Southwest RI
  - Produced 83 mph gust at Charlestown, RI injuring 10 campers.

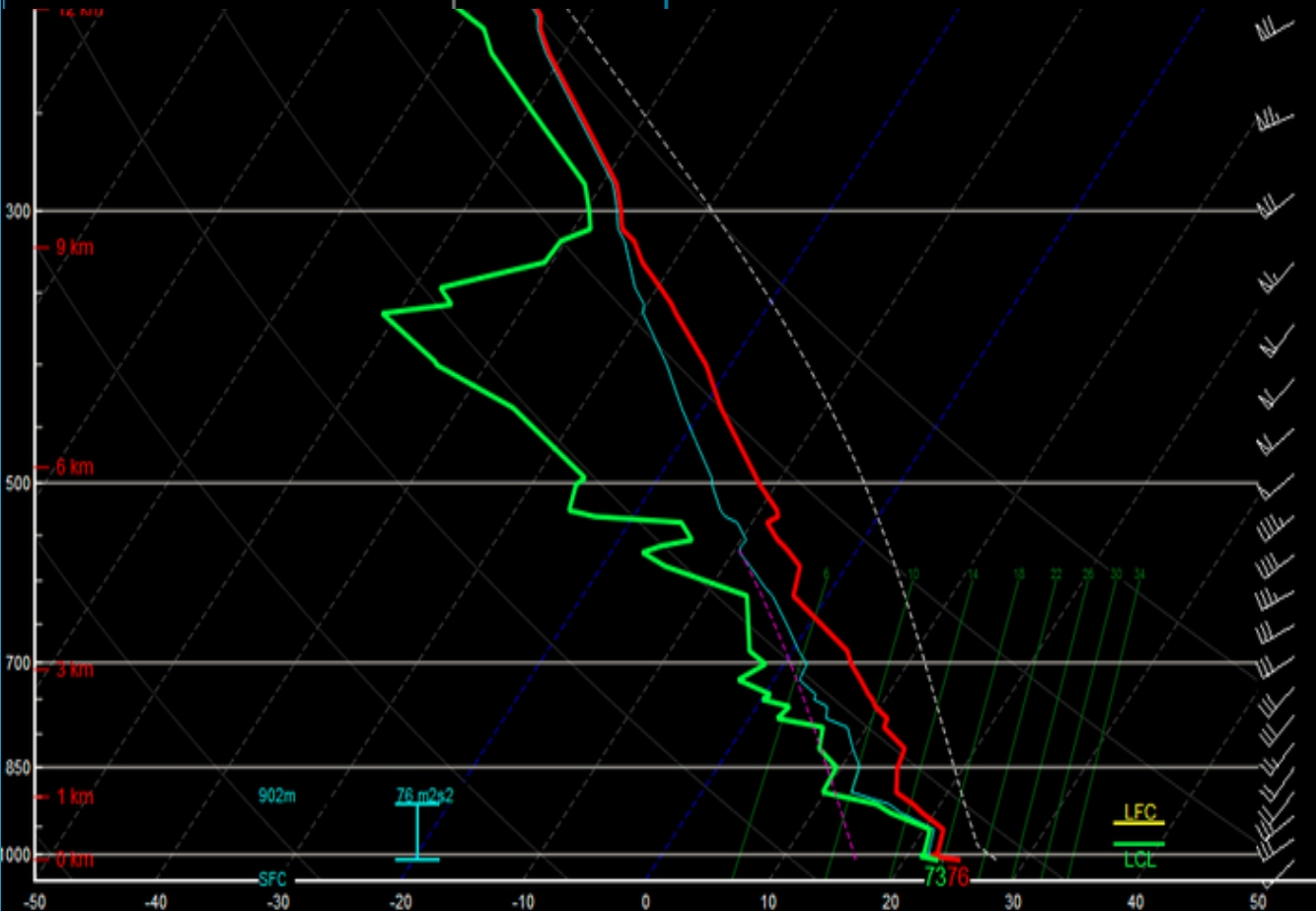
# August 4<sup>th</sup> 12z CHH Sounding Modified for PVD



Modified using PVD temperature (76) and dewpoint (73) at time of the event

Courtesy of Ryan Hanrahan

- Surface CAPE: 2882 J/kg
- Effective Deep Layer Shear: 56 knots



# Lessons Learned from the Early Morning Event

Highly anomalous environment *may* result in a highly anomalous event, but a trigger is still needed.

- In this case, mesoscale boundary formed from low level jet and decoupled boundary layer

## Utilize SPC SREF guidance

- Probabilistic approach
- Important to communicate uncertainty in these situations

## Model QPF should be considered

- Not always the determining factor on what will unfold.

## Round 2: Unusually Large Hail and Damaging Winds

- All storms stayed to the north of the Connecticut and Rhode Island border.
- Hardest hit area along and north I-90 (Massachusetts Turnpike)
  - Several reports of golf ball sized hail
  - 50 to 60 mph wind gusts.
- Bulk of the area that was hit earlier in the morning was not affected by the afternoon activity.
- No tornadoes occurred during the afternoon, despite impressive radar signatures.



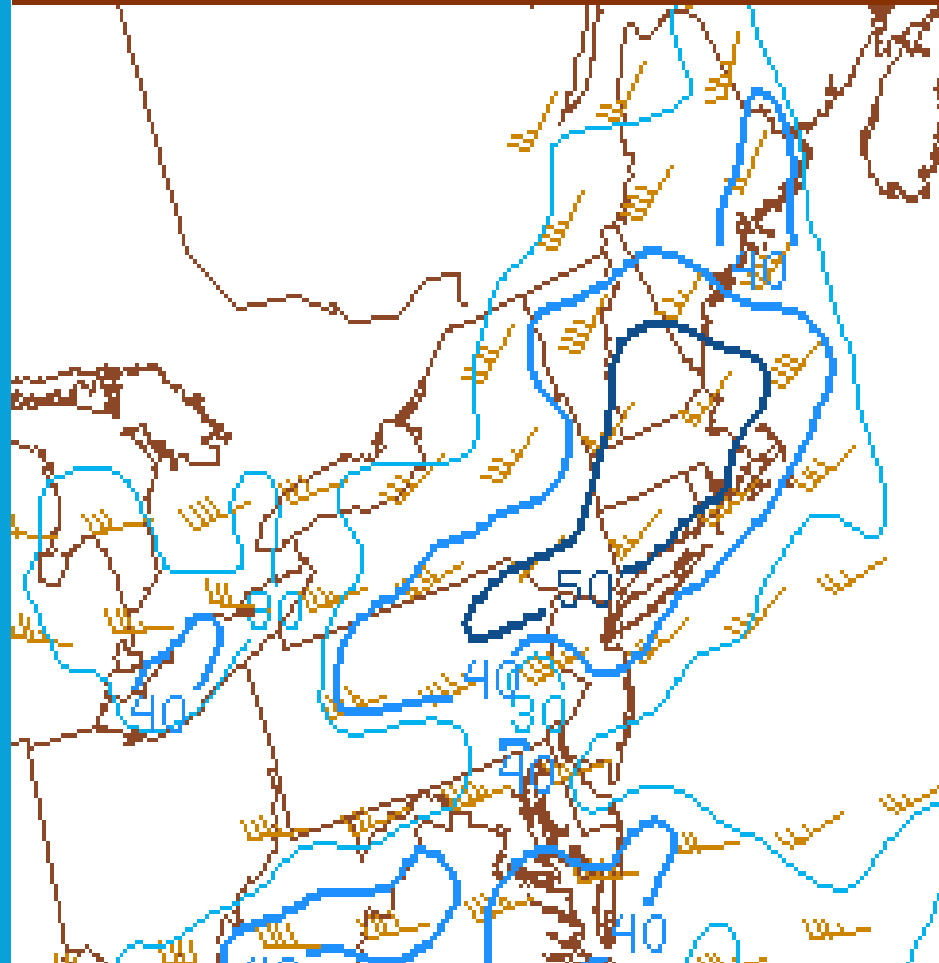
# Pictures from Boston Hail Event



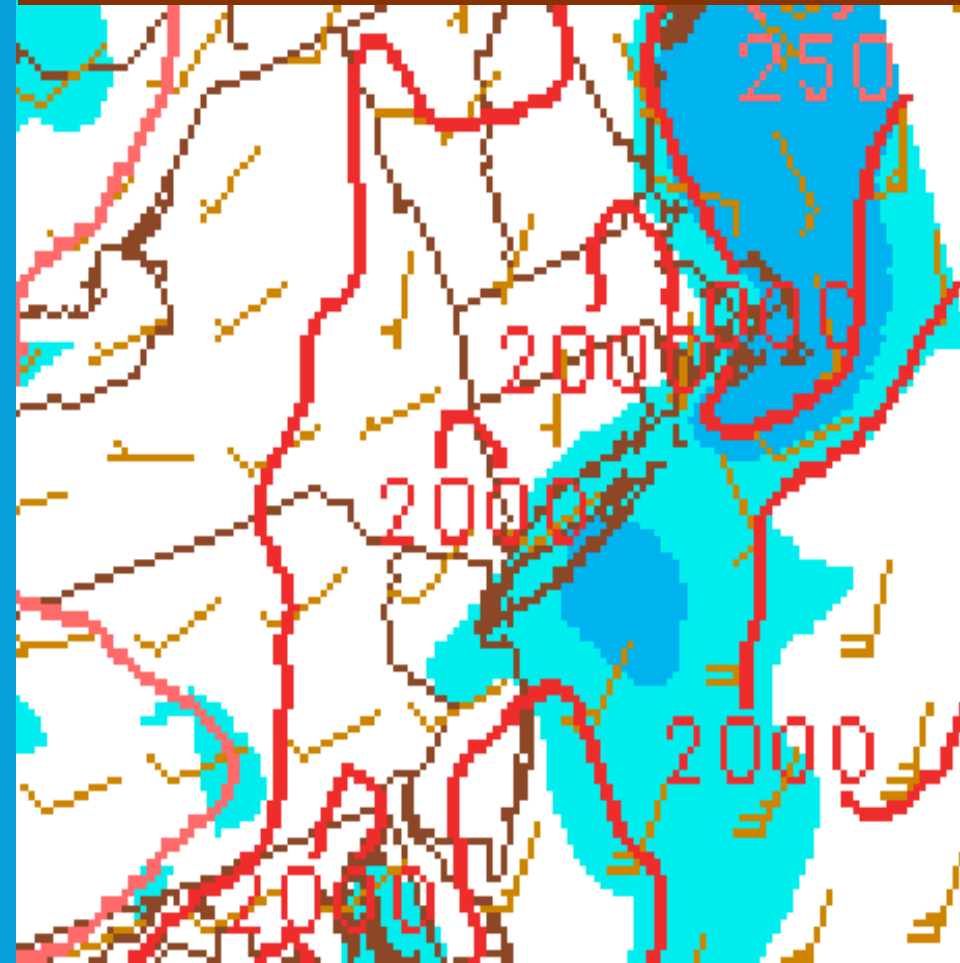
These pictures were taken in Brighton, MA courtesy of Rachel Rumely

# SPC Meso-Analysis: Effective Bulk Shear and MLCAPE at 19z

Bulk Shear Values 50 to 60 Knots

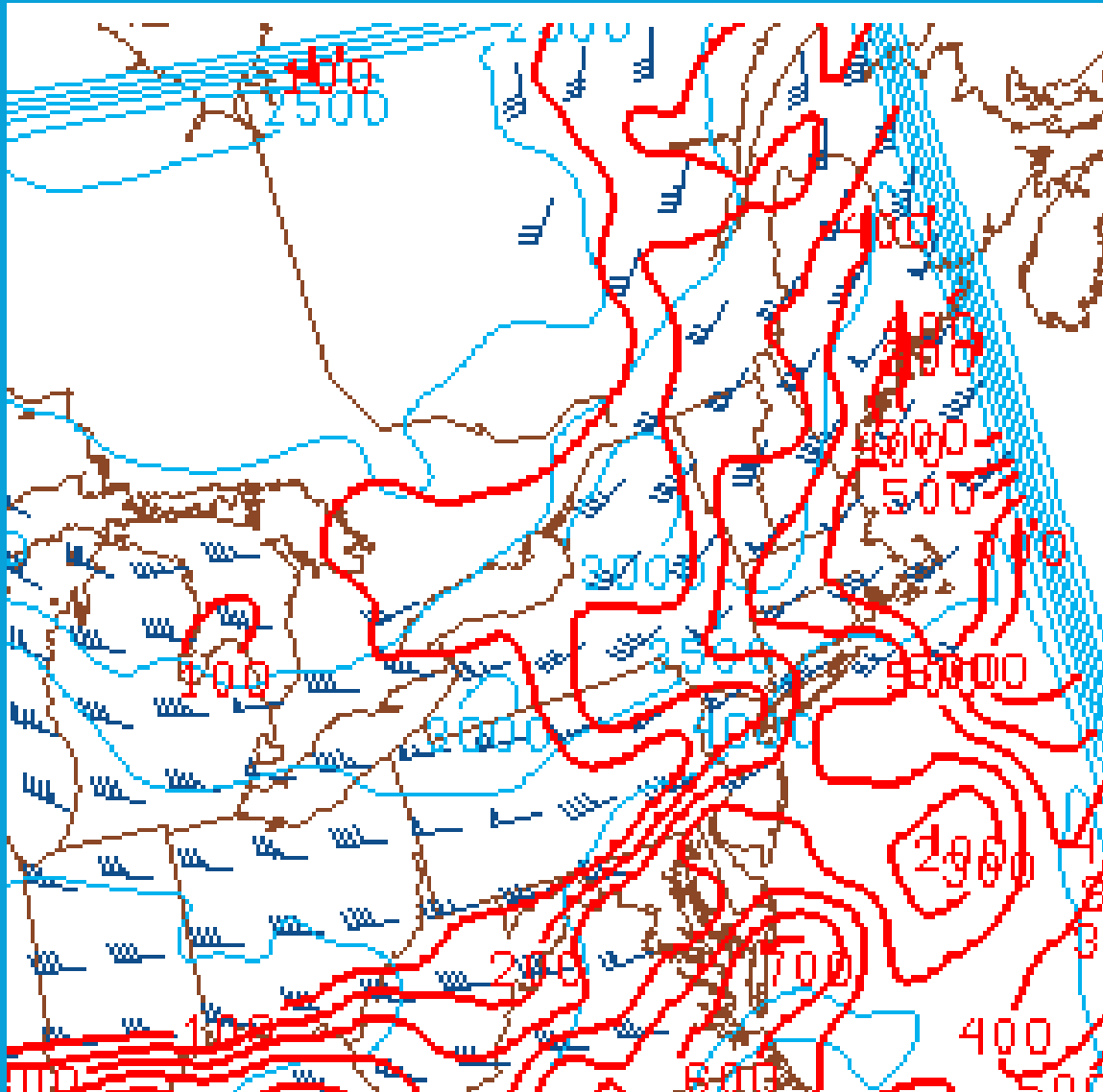


MLCAPE 1500 to 2500 J/kg



High Cape and High Shear in Place for the Entire Region

# SPC Meso-Analysis: “Hail CAPE” at 19z



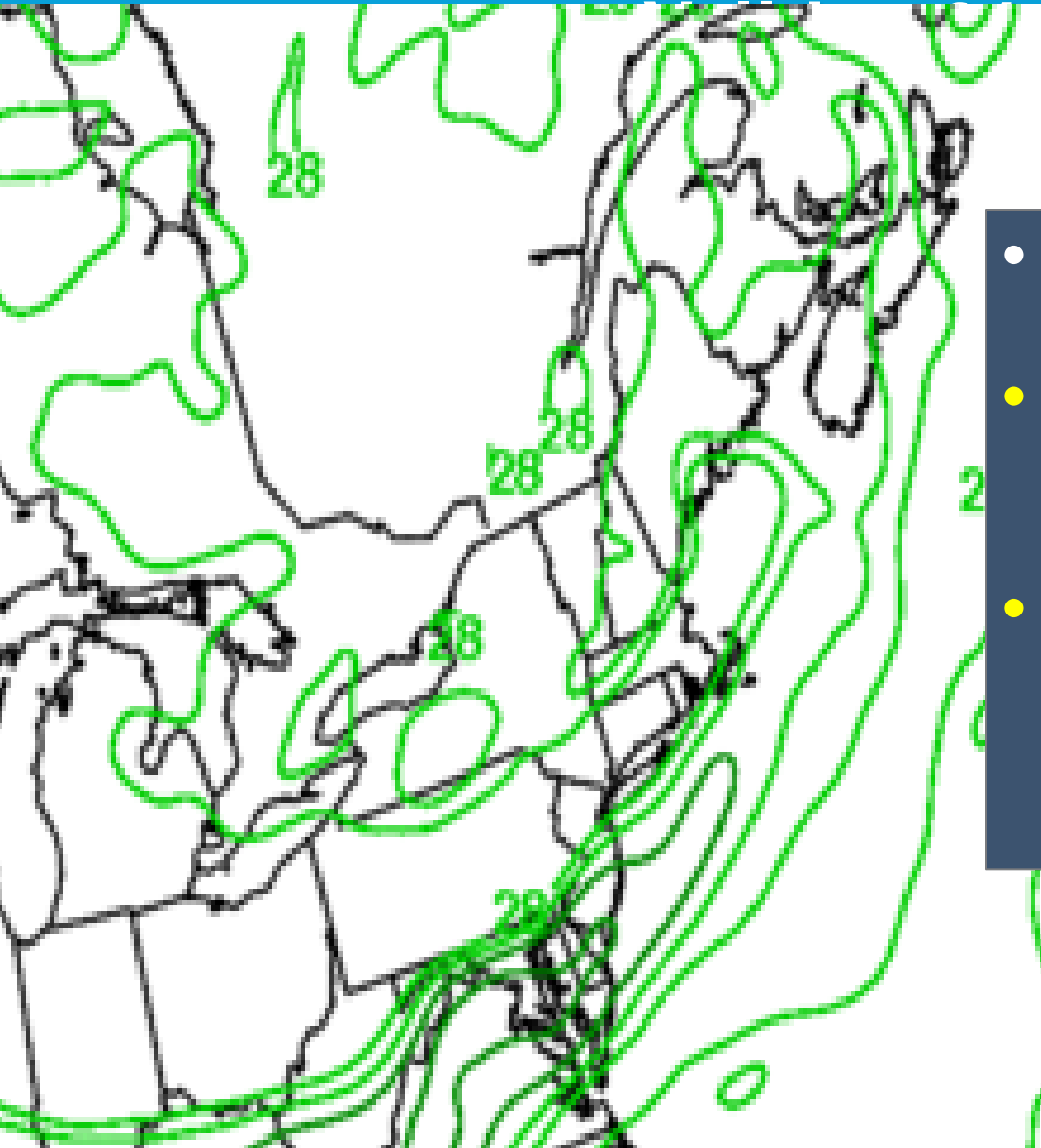
Values  $> 400$  J/kg  
in the  $-10$  to  $-30$ C  
layer bring the  
potential for very  
large hail

In this case,  
values were  
between 400 and  
550 J/kg!

# Forecast Uncertainty During the Afternoon

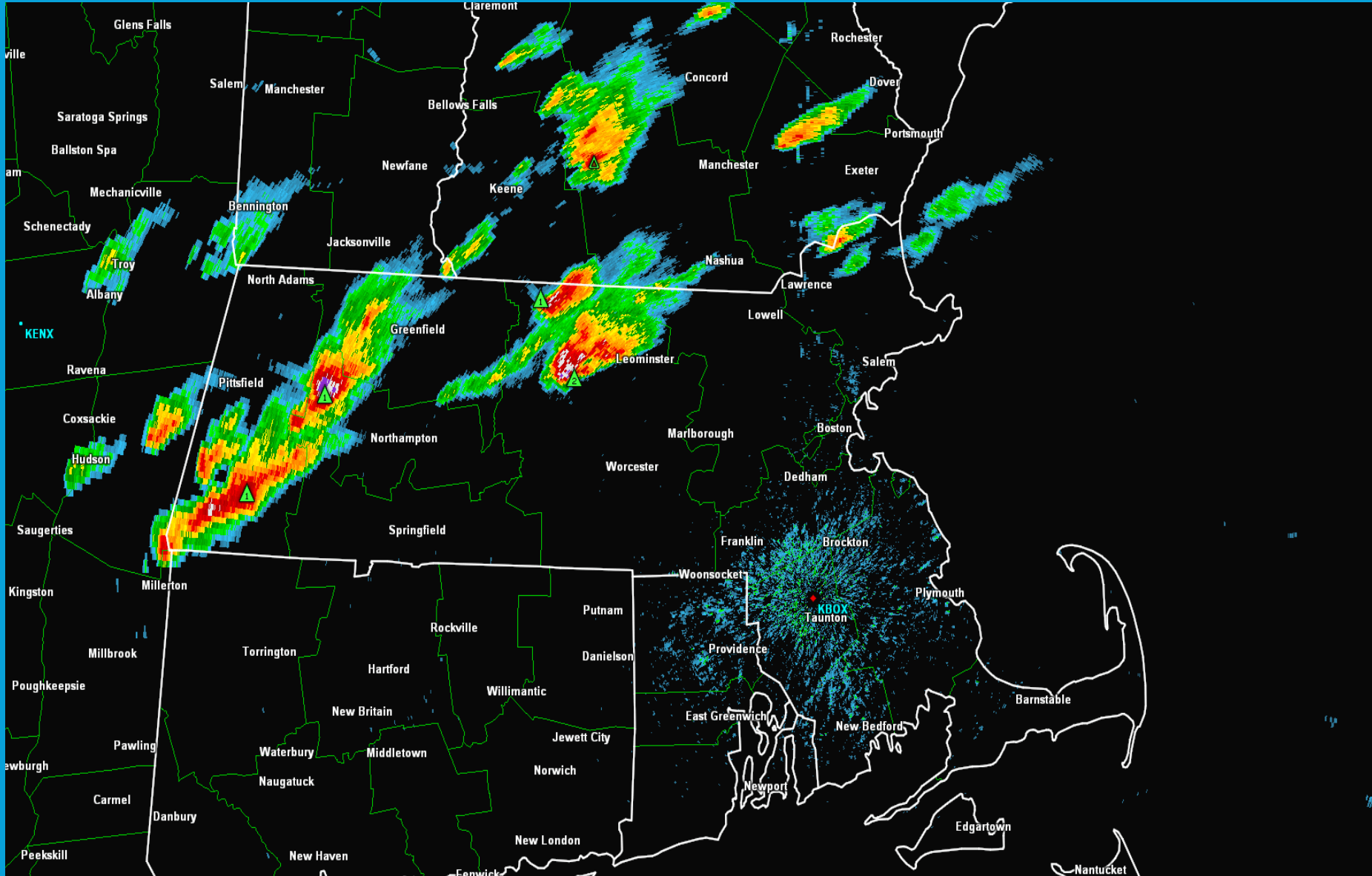
- Anomalously High CAPE/High Shear in place with 6.5C/km mid level lapse rates
  - **Very cold aloft with >400 J/kg of Hail CAPE**
- Approaching Shortwave/Cold Front would be the potential trigger for another round of high end severe weather
- Biggest uncertainty was amount of mid level dry air that would work into the region behind earlier convection.
  - **Some mid level dry air can increase lapse rates and promote risk for severe wind and hail.**
  - **Too much mid level dry air will cutoff thunderstorm updrafts and prevent severe weather.**
  - ***It's a very delicate balance!***

# Another Look at Moisture: K Index



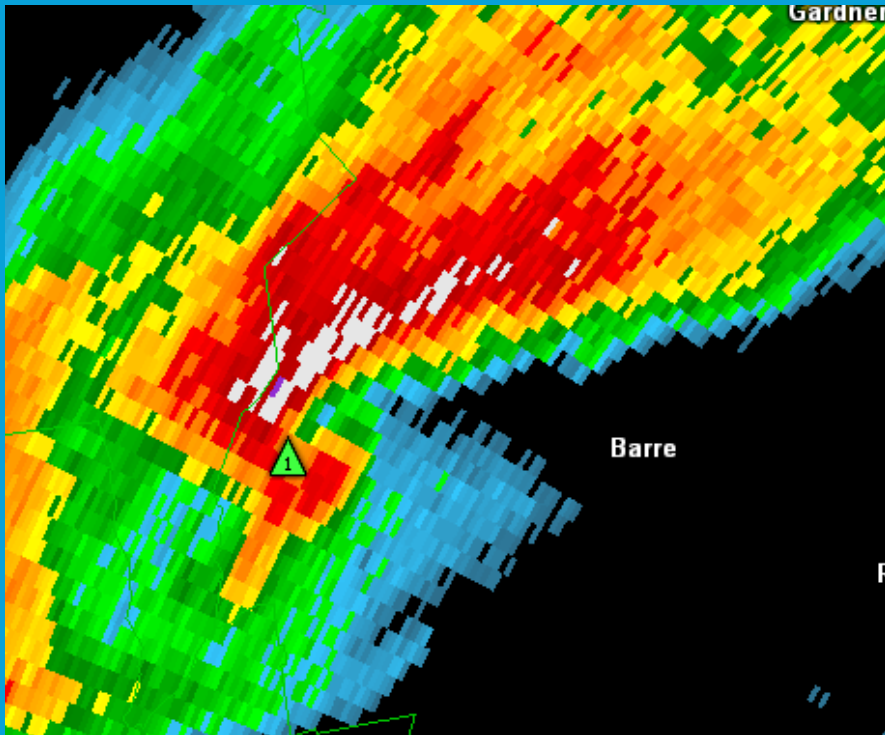
- “Higher” values near & north of the MA Pike
- ***Just enough mid level dry air prevented storms to the south***
- ***Helped in large hail and strong wind production across Northern MA***

# Radar Loop from the Afternoon Storms

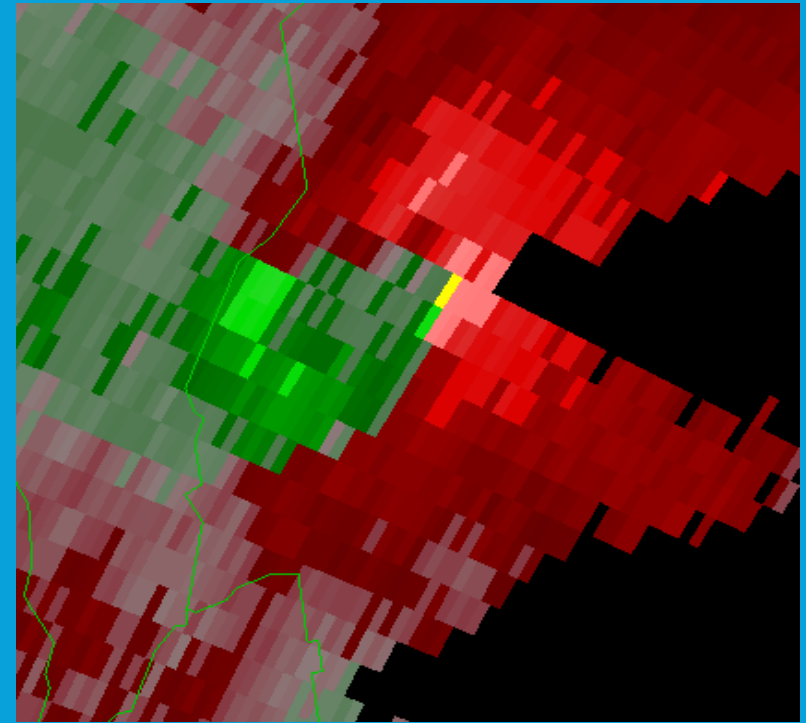


# A Few Storms in Northern Massachusetts Prompt Tornado Warnings

0.5 REF: 1937 Z

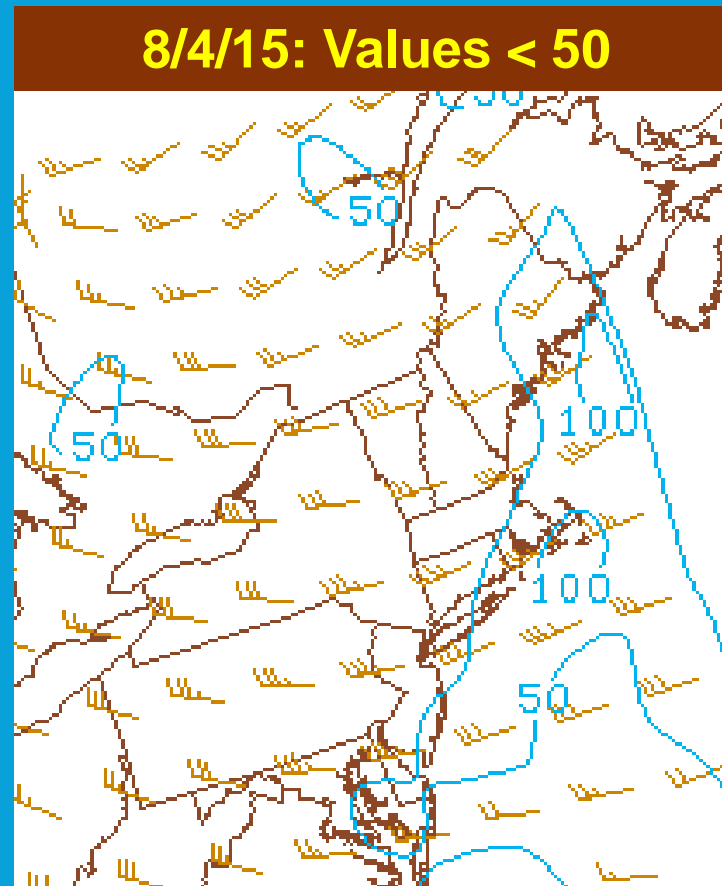


0.5 SRM: 1937 Z



- Classic Hook Echo
- Gate-to-gate shear: 67 knots (7K feet from radar)
- Tornado Warning was issued but no tornadoes confirmed on damage survey

# No Confirmed Tornadoes in Southern New England



- Low level helicity less than 100, likely prevented tornadoes.
- Dry air at low levels was likely also a factor



# Summary of Two High End Severe Weather Events

## Favorable Environment in Place

- Anomalous instability
- Deep shear/moisture
- Mid level lapse rates near 6.5C/km.

## Round 1

- *Trigger: Mesoscale boundary from increasing shear/low level jet across southeast New England*
- Widespread 60 to 80 mph wind gusts

## Round 2

- *Trigger: Shortwave/cold front which brought very large hail to Northern MA*
- Mid levels dried out too much across CT/RI
- Lack of 0 to 1 KM helicity and dry air at lower levels were probably the reasons we did not have any confirmed tornadoes