WFO Taunton Storm Series Report
2009-01:

Analysis of the December 11-12, 2008
Destructive Ice Storm across
Interior Southern New England

Ice storm damage in Fitchburg, MA.
(Photo courtesy of Maurice Boudreau)

Foreword

The objective of the National Weather Service Forecast Office (WFO) Taunton Storm Report Series is to provide a concise summary of a significant meteorological event that impacted the WFO Taunton County Warning Area (CWA). The WFO Taunton CWA includes all of Massachusetts except for Berkshire County; all of Rhode Island; Cheshire and Hillsborough Counties in southwest New Hampshire; and Hartford, Tolland and Windham Counties in northern Connecticut.

Use of the series is intended for training and WFO Taunton historical documentation only. Official storm reports can be found in Storm Data, published by the National Oceanic and Atmospheric Administration, National Climatic Data Center.

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Taunton, MA
March, 2009

1. Introduction

A destructive ice storm affected interior southern New England on 11-12 December 2008. Widespread ice accumulations of 0.50 to 1.00 inch, with locally up to 1.50 inches, were observed across interior portions of northern Massachusetts and southern New Hampshire (Figure 1). The hardest hit areas in the WFO BOX County Warning Area (CWA) were the higher terrain of north central Massachusetts and southern New Hampshire. Large amounts of ice accumulated on wires and trees, resulting in numerous downed trees and power outages. Media reports indicated that up to 500,000 people were without power at the height of the storm. The power outages were so extensive that it took weeks in some areas for power to be restored. Although the 1998 ice storm impacted a larger area from northern New England into southeast Canada, this event appears to have had a larger impact across the WFO BOX CWA.

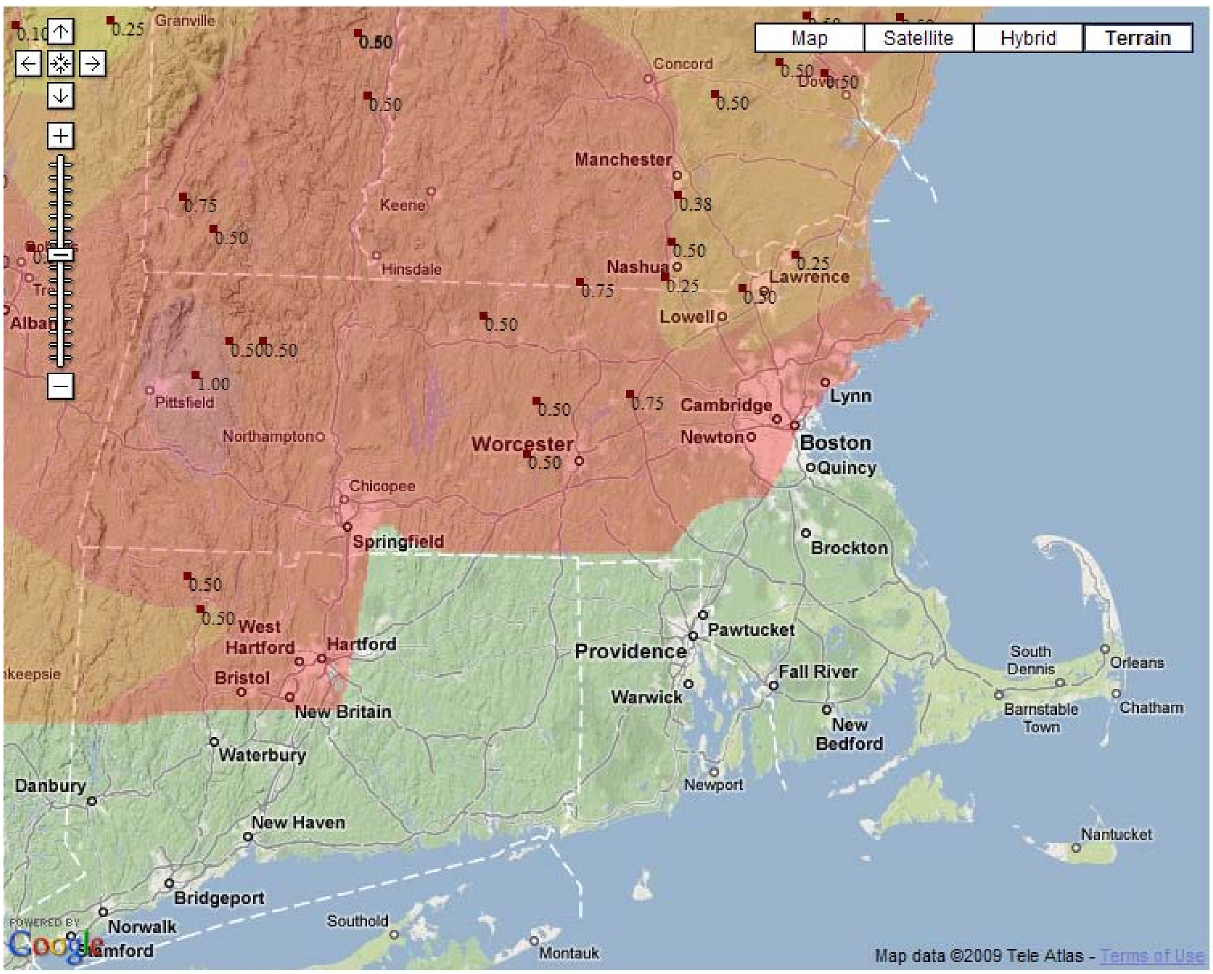

Figure 1. Observed ice accretion (inches), December 11-12, 2008. Orange shading indicates 0.25" of ice, red shading indicates 0.50" of ice, and purple shading indicates 1.00" of ice

Closer to the coast, between 2 and 4 inches of rain fell on average, resulting in flooding of smaller streams and urban areas (Figure 2).

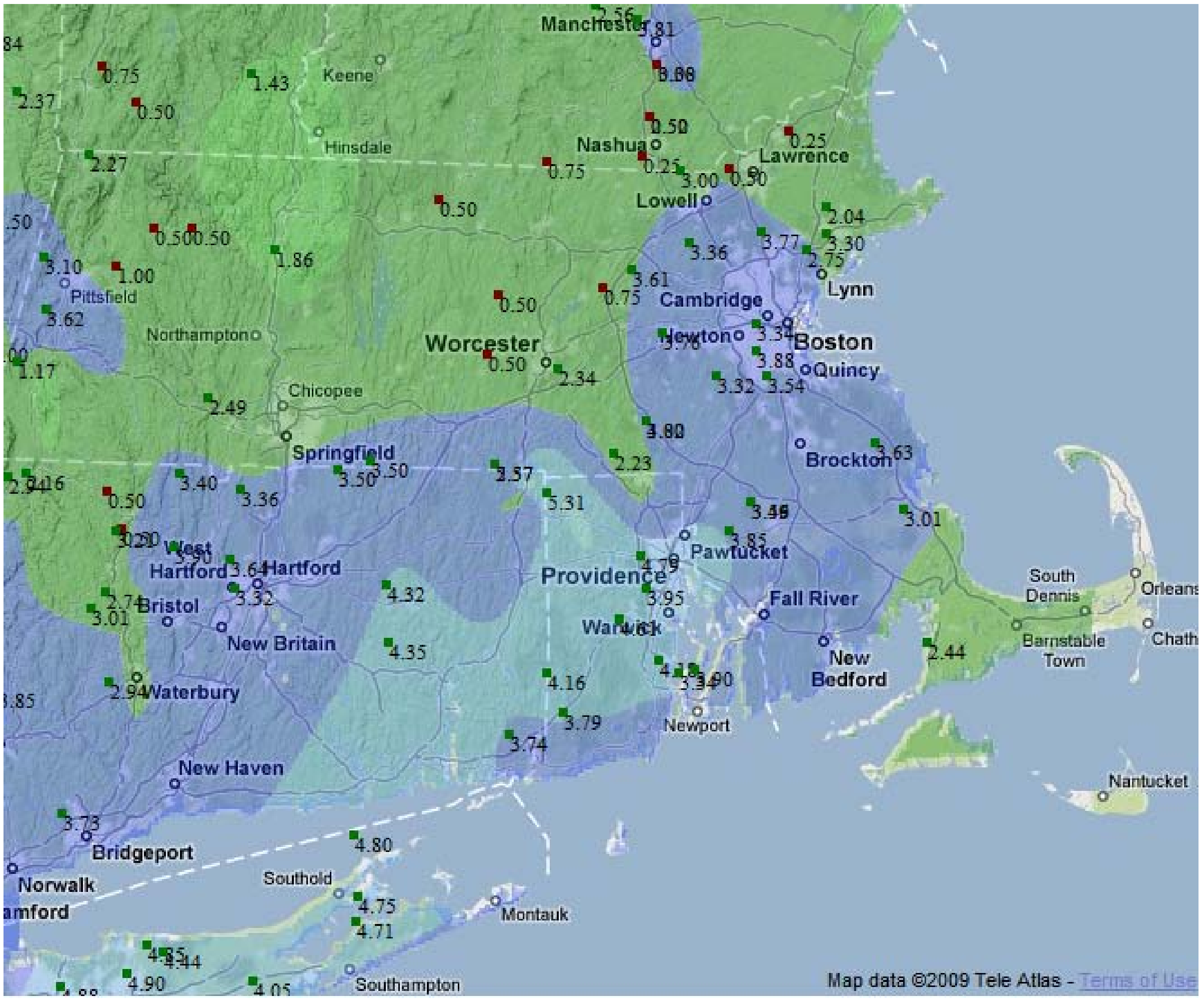

Figure 2. Observed precipitation totals (inches), December 11-12, 2008

This paper will describe how several meteorological ingredients came together to produce a rare destructive ice storm. Special focus is given to one of the more unusual aspects to this destructive ice storm compared to others. In most cases when rainfall rates are high, surface temperatures below 30F are required for a considerable amount of ice accretion and subsequent damage. In this event, heavy freezing rain produced significant icing with temperatures between 29F and 32F, and resulted in a destructive ice storm.

2. Synoptic Overview and Performance of Model Guidance

Numerical model guidance did an excellent job in advertising the potential for a significant ice storm across interior southern New England on December 11th and 12th. WFO BOX forecasters mentioned the potential for a significant winter storm in the Hazardous Weather Outlook issued in the early morning of December 8th. As the event drew closer, a Winter Storm Watch was issued during the afternoon of December 9th. Forecasters specifically mentioned the potential for ice accretions in excess of one half inch. The Watch was later converted to Winter Storm and Ice Storm Warnings on the afternoon of December 10th. In the warning statements, forecasters mentioned ice accretions between one half and one inch with dangerously higher amounts. The statements also discussed the potential for widespread and extended power outages.

Several synoptic and mesoscale features came together to create a significant ice storm across interior southern New England. Unseasonably mild weather was observed on December 10th as high temperatures climbed to between 55F and 60F. However, at the same time, temperatures had already fallen into the teens in southeast Canada, behind a strong cold front (Figure 3).

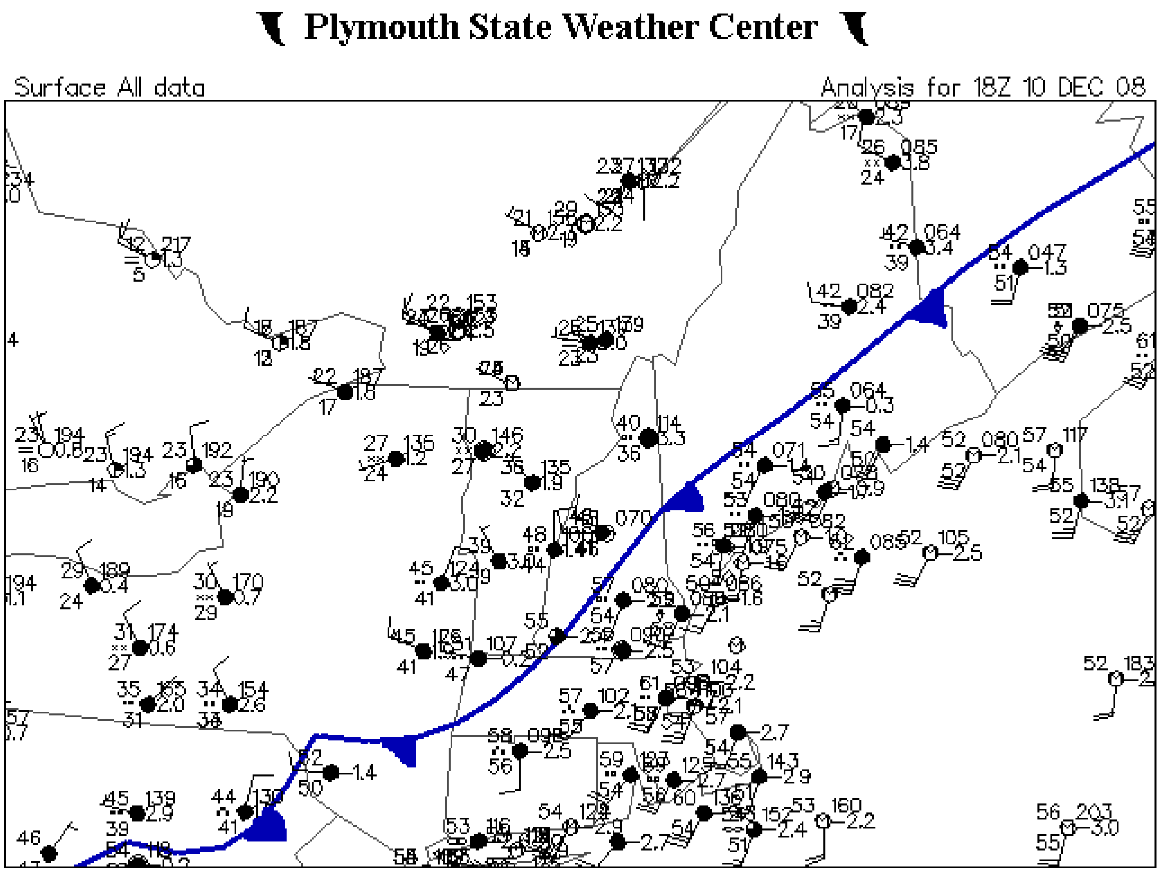

Figure 3. Surface weather plot valid at 18z December 10th, 2008. Despite temperatures between 55F and 60F in southern New England, a strong cold front sent readings below freezing in northern New York and northern Vermont. Courtesy of Plymouth State Weather Center.

The cold front was expected to move through the region that evening, allowing the shallow cold air to penetrate into southern New England. A 1027 mb high pressure system over northern New England would maintain a northeast flow of subfreezing air from the surface to 950 mb. The 12z model runs of the GFS and NAM on December 10th depicted this scenario quite well, as both models showed 2-meter temperatures falling to around 32F across interior southern New England by the early morning hours of December 11th.

Despite the shallow cold air working down from the north, model guidance indicated an unusually strong and moist southerly 850 mb low level jet increasing to 80 knots during the early morning hours of December 12th (Figure 4). This transported anomalously high values of precipitable water northward (+2 to +3 SD into southern New England and as much as +5 SD offshore, Grumm et al, 2009), with values forecast to increase to 1.5 inches during the peak of the storm overnight (Figure 5). NCEP models picked up on this quite well, forecasting between 2.00 and 3.50 inches of precipitation across much of the region (Figure 6).

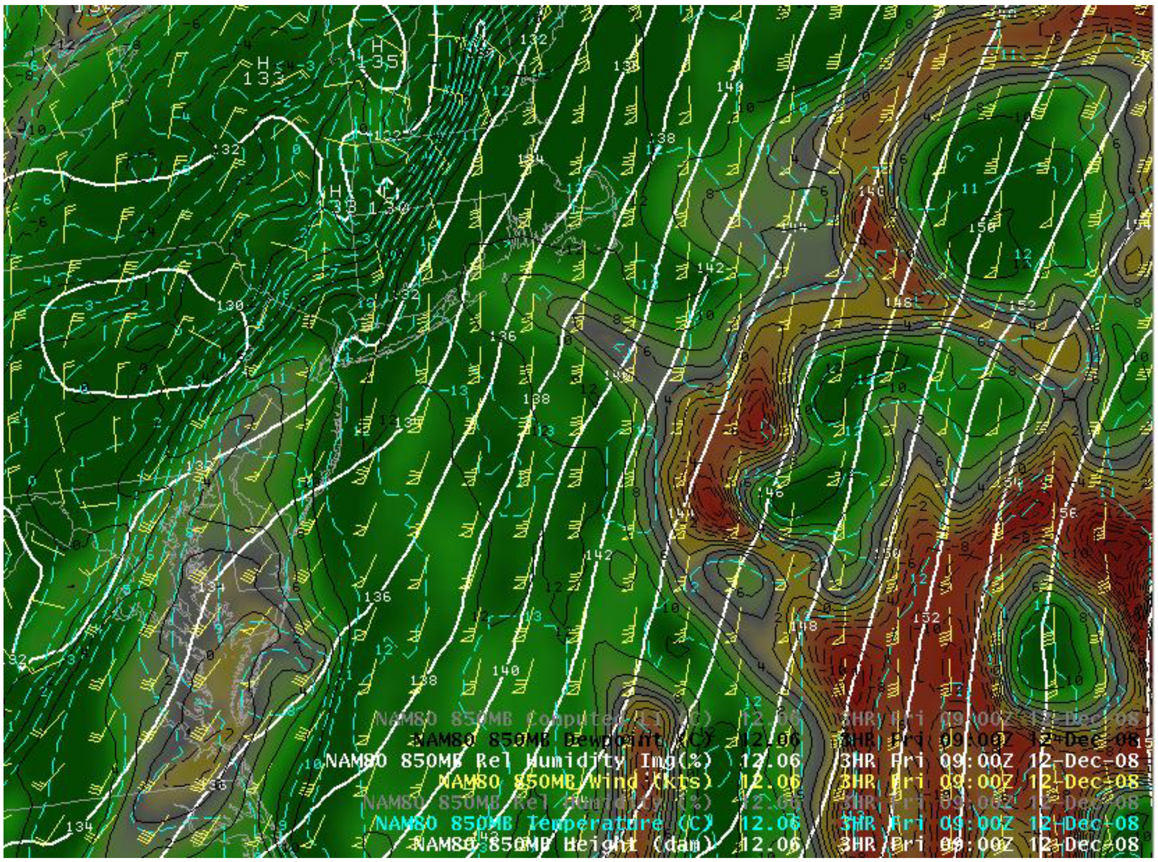

Figure 4. NAM 850 mb forecast of geopotential height, temperature, wind, and relative humidity (image), valid 09z December 12, 2008. Winds were expected to increase to 80 knots across much of southern New England, helping to transport copious amounts of moisture northward over the shallow cold surface air.

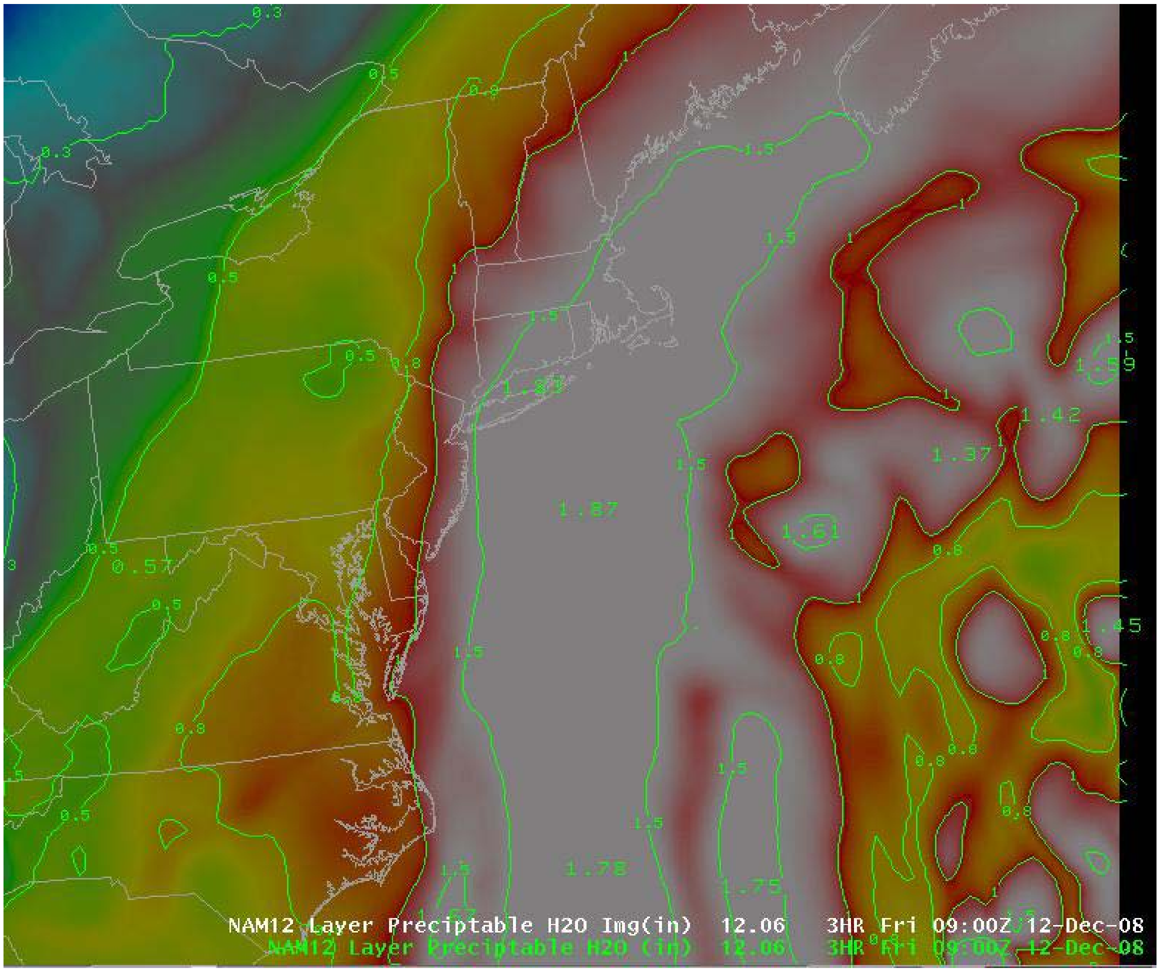

Figure 5. NAM forecast of precipitable water, valid at 09z December 12, 2008. Values were expected to reach between 1.25 and 1.50 inches across interior southern New England.

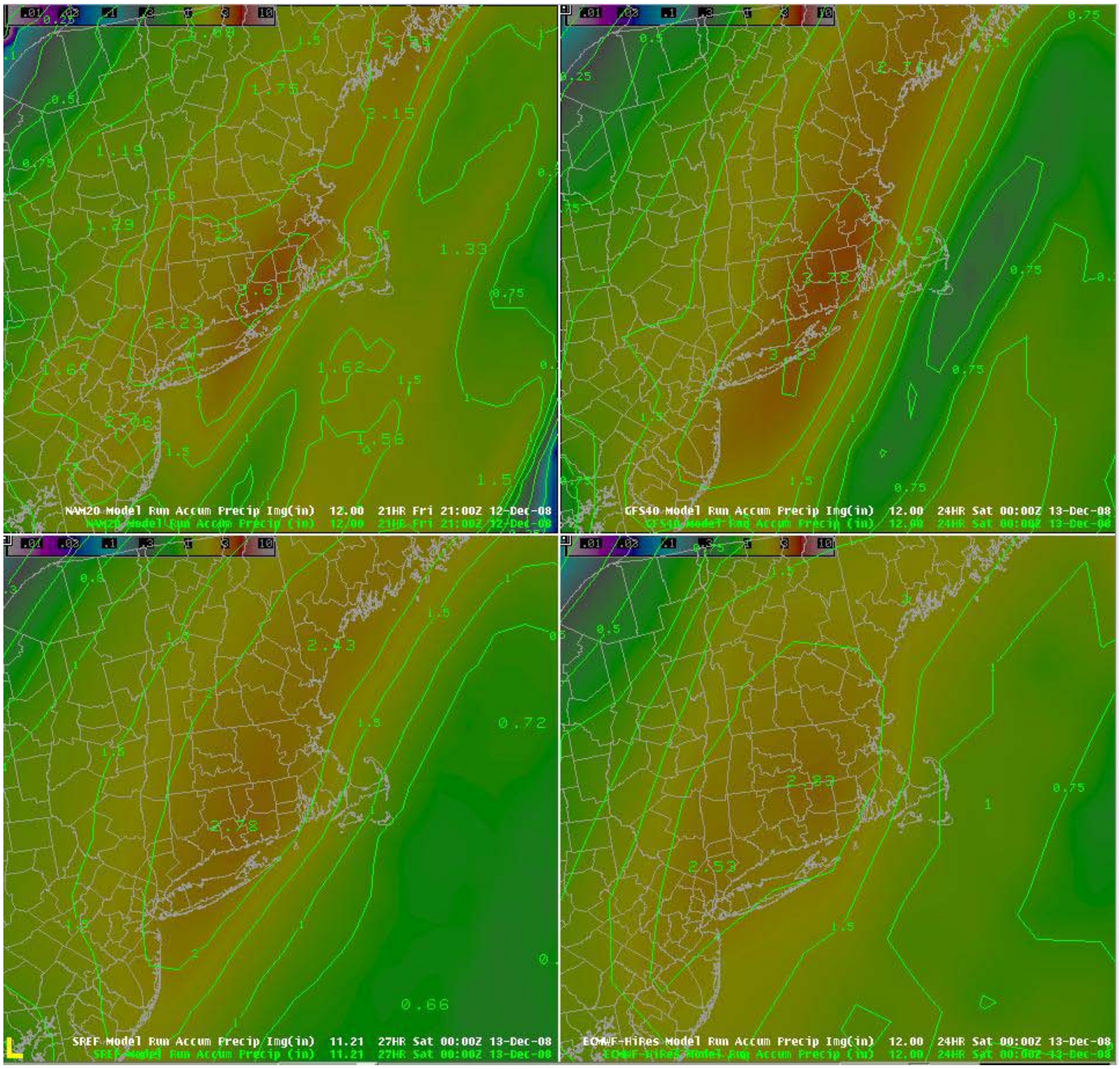

Figure 6. Run-accumulated precipitation forecasts from 00z December 12, 2008 NAM (top left), GFS (top right), SREF (lower left), ECMWF (lower right). All models had between 2 and 3.50 inches of QPF across southern New England.

Another important aspect of this storm was the dry air over southeast Canada and northern New England. Surface dew points dropped into the single digits and teens in this region by the early morning hours of December 11th. Persistent northeast winds at the surface brought these low dew points into southern New England that afternoon, and kept surface temperatures at or just below freezing across the interior (Figure 7). This was a precursor to the destructive ice storm that would occur that night. In fact, many upslope (northeast facing) locations in Worcester County saw significantly more icing than surrounding areas.

It is also noteworthy that the push of drier air was much weaker along the east slopes of the Berkshires in western Massachusetts. Since temperatures were near freezing, it is not surprising that portions of western Massachusetts, including the Berkshires, were not impacted as much as other portions of the CWA.

The timing of the storm was another significant factor. Even though the December sun angle is quite low, enough solar radiation can still penetrate through the clouds to prevent significant ice accumulation with marginal (near freezing) temperatures. At night, this compensating effect is lost, leading to potentially greater ice accretion.

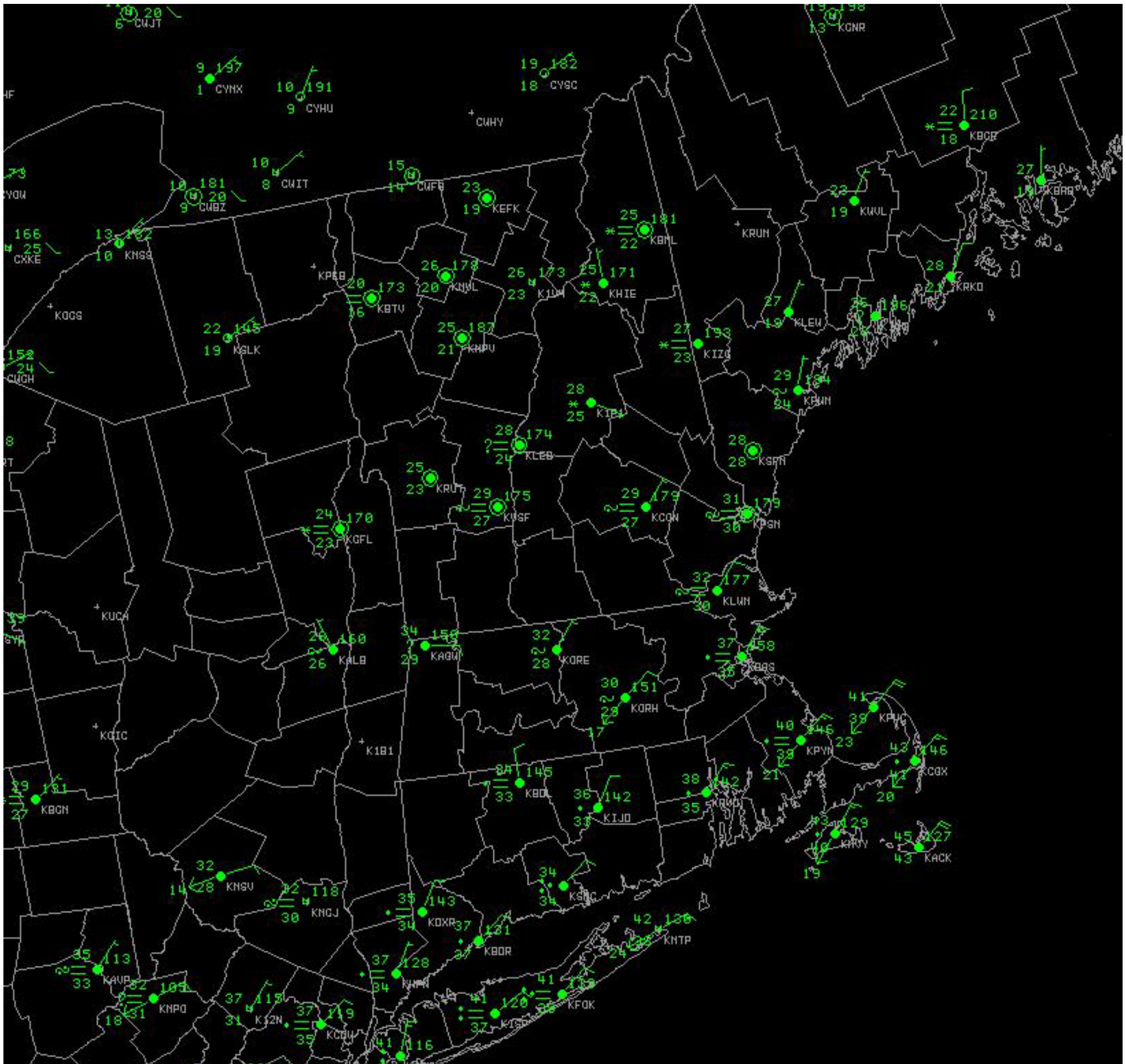

Figure 7. Surface weather plot valid at 22z on December 11th, 2008. Northeast surface winds across interior southern New England maintained a flow of drier air from southeast Canada and northern New England.

Over the past few years, WFO BOX forecasters have integrated ensemble data into operations, to use a probabilistic approach to potentially high impact weather events, as well as to gauge confidence in operational model runs. In this case, SREFs gave high probabilities of freezing rain (Figure 8), surface temperatures below freezing (Figure 9), and precipitation totals in excess of 2 inches (Figure 10).

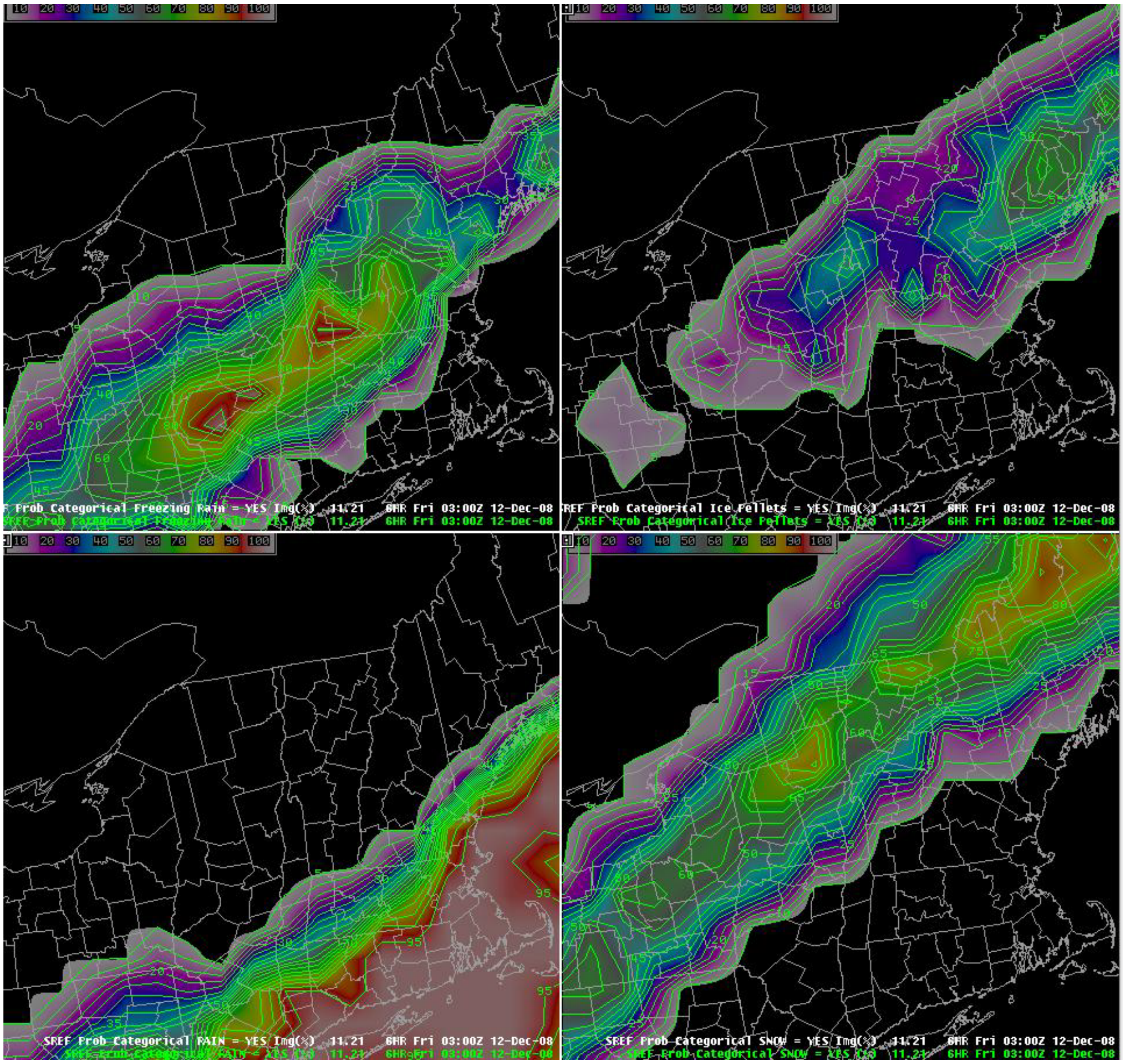

Figure 8. SREF probabilities of freezing rain (upper left), ice pellets (upper right), rain (lower left), and snow (lower right) valid 03z December 12, 2008. Probabilities of freezing rain are quite high across interior southern New England, while probabilities of other precipitation types are much lower.

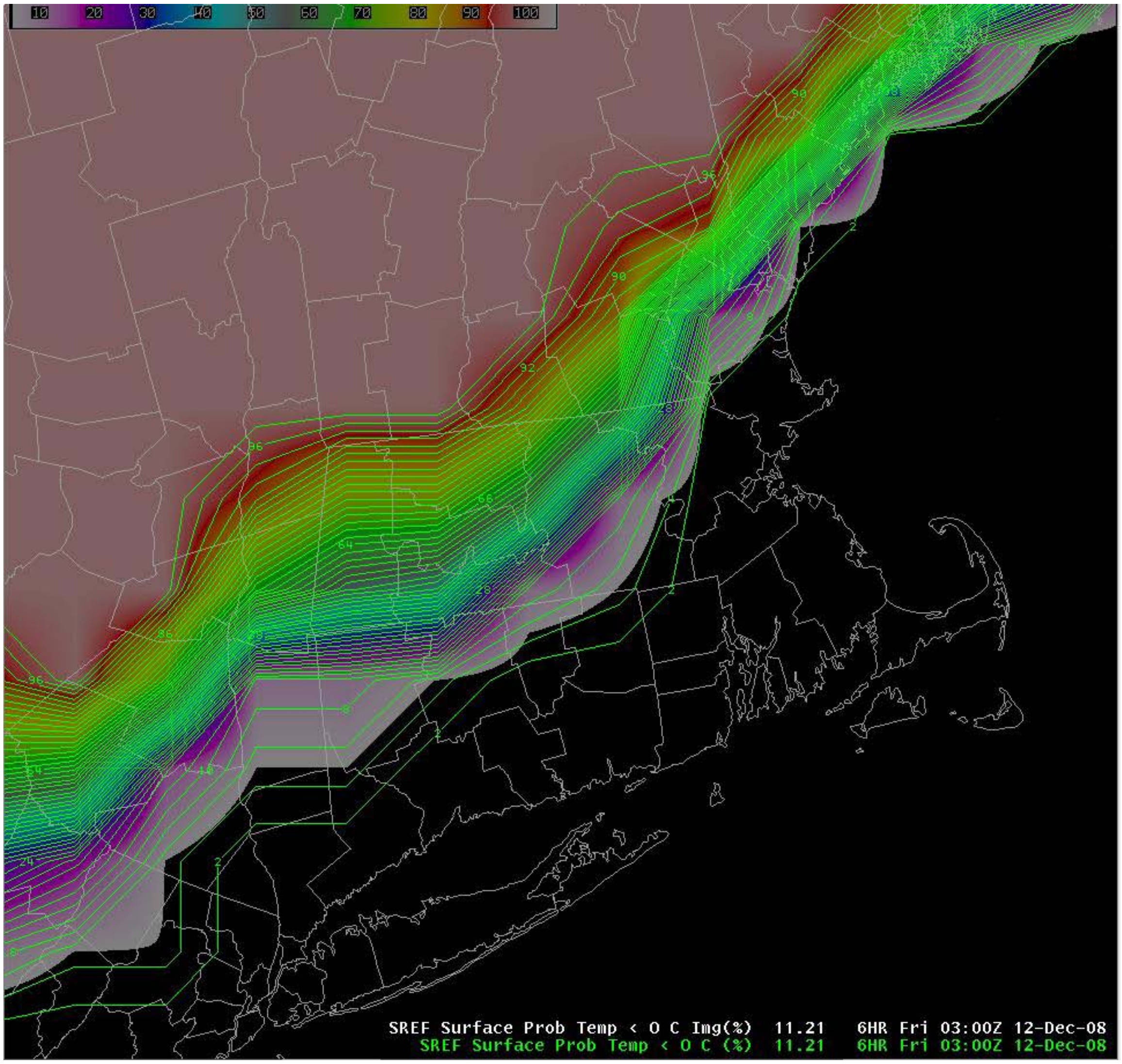

Figure 9. SREF probability of surface temperature below freezing, valid 03z December 12, 2008.

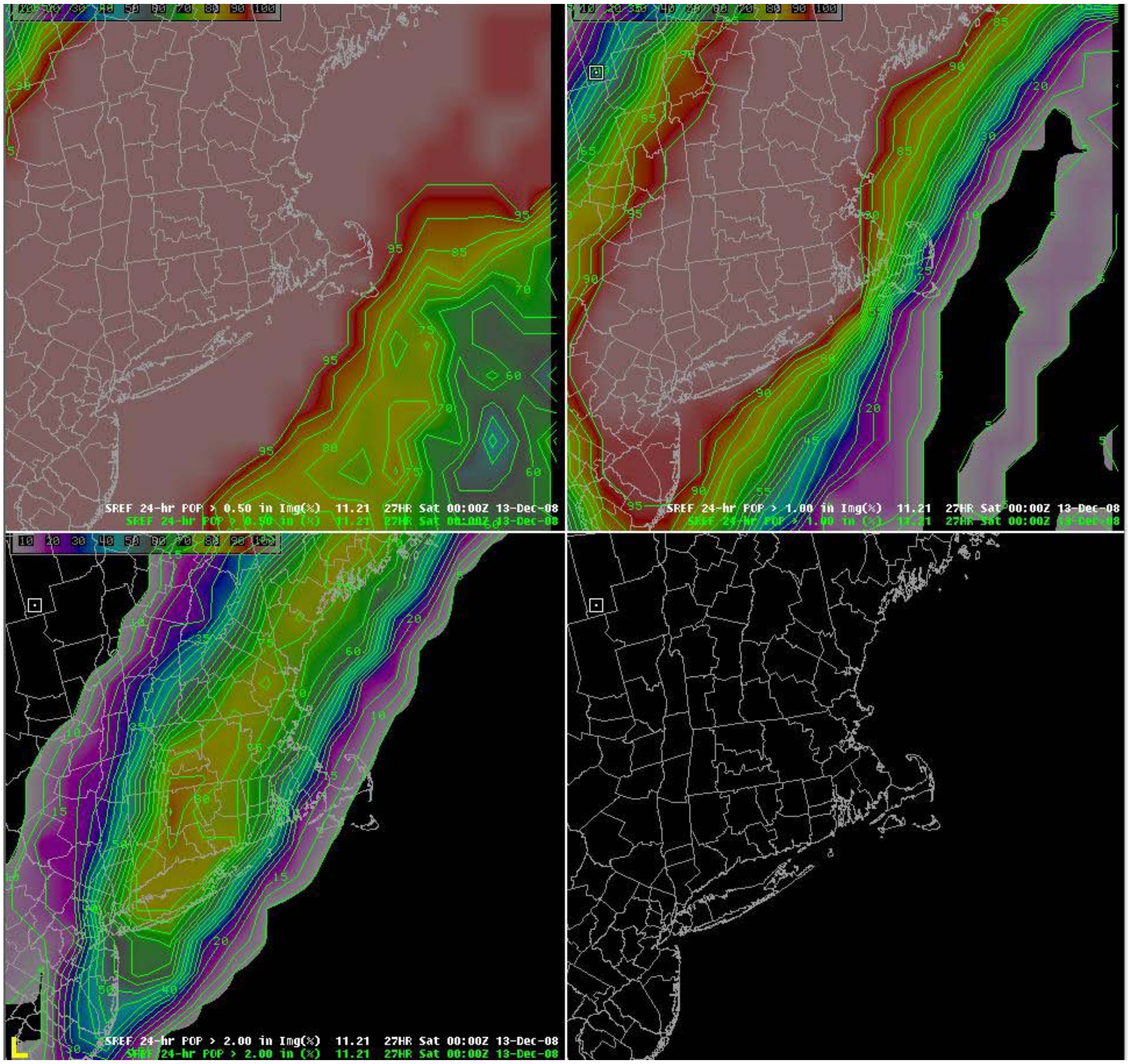

Figure 10. SREF 24-hour probabilities of greater than 0.50 inch (upper left), 1.00 inch (upper right), and 2.00 inches (lower left). Probabilities of more than 2.00 inches are rather high and support NCEP operational model runs, giving forecasters more confidence in a significant event.

Numerical models also indicated the development of a secondary coastal low pressure system and tracked it across far southeast Massachusetts during the early morning hours of December 12th. The secondary low pressure system prevented the shallow cold air from being eroded in the interior, by maintaining northerly winds at the surface (Figure 11).

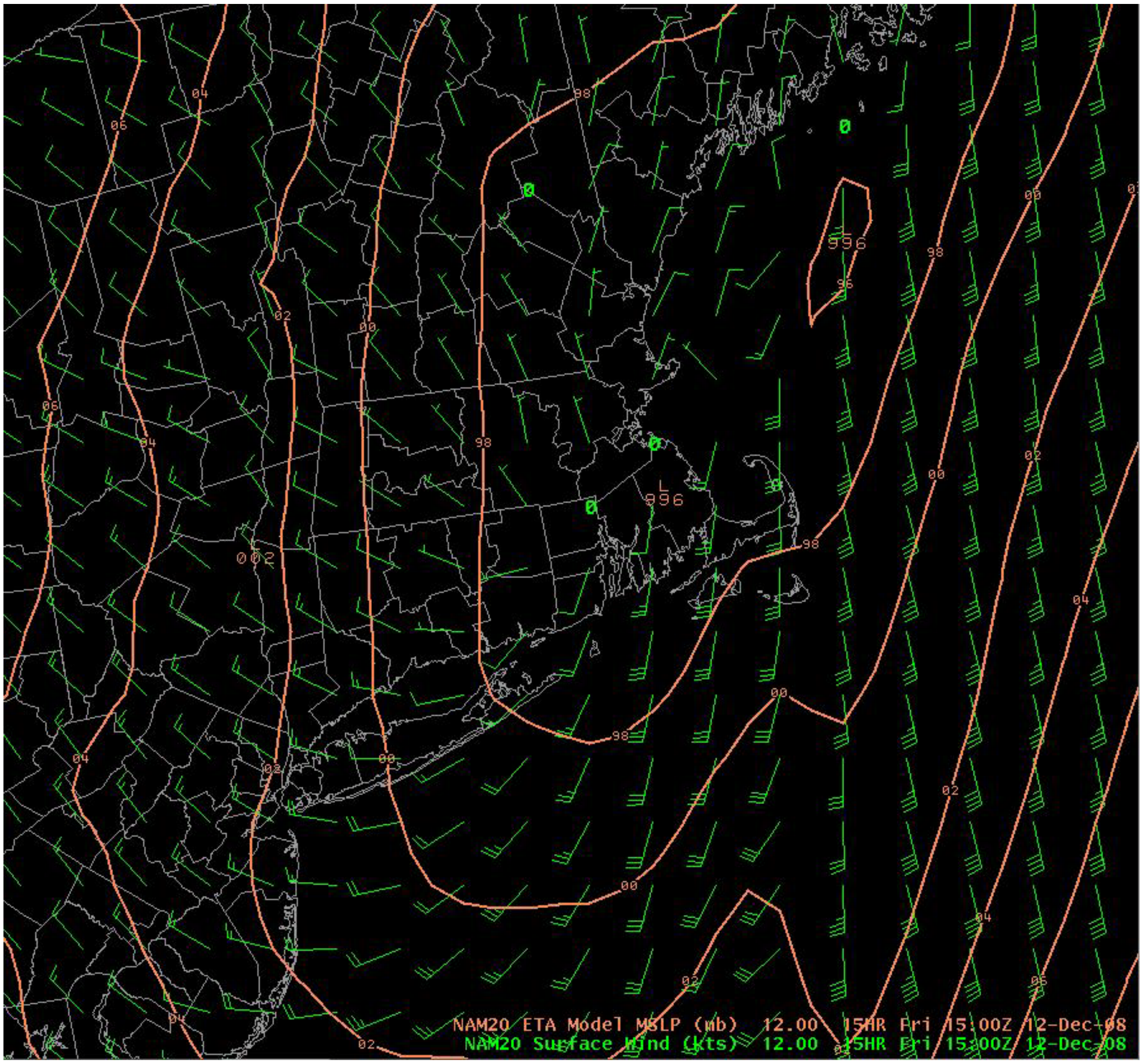

Figure 11. NAM forecast of sea level pressure and surface winds, valid 15z December 12, 2008. The surface low tracking across southeast Massachusetts maintained northerly surface winds across the interior, locking in shallow cold air for much of the event.

Model forecast soundings showed a classic signature for freezing rain across the interior as well. The NAM forecast sounding for Orange, MA (Figure 12) at 04 UTC December 12th indicates a nearly saturated ice crystal-producing layer (-10C isotherm), an elevated warm layer of around +4C, and a near-surface cold layer around -4C.

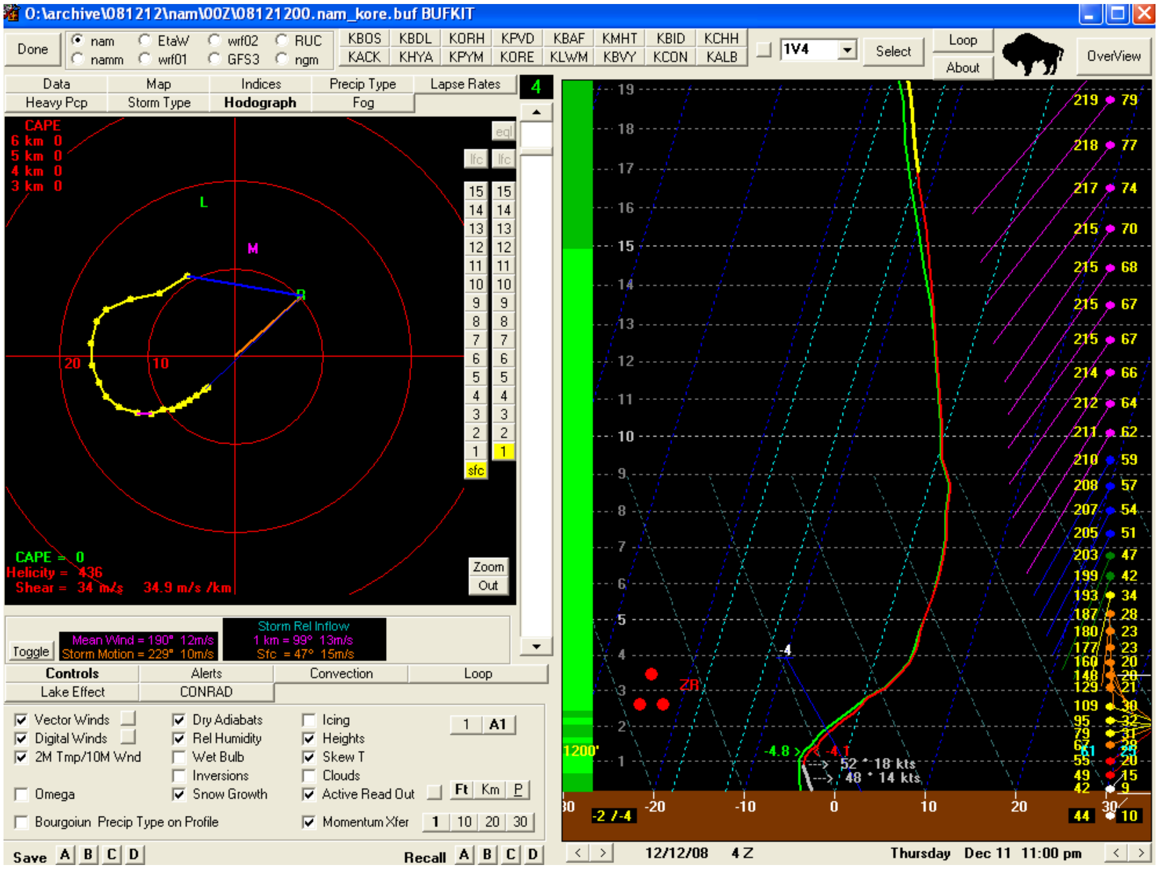

Figure 12. NAM 4-hour forecast sounding for Orange, MA valid 04 UTC December 12th, 2008. Note the elevated warm layer of +4C and the near-surface cold layer of -4C.

3. Verification and Service Assessment

Verification scores for this high impact storm are outlined in Figure 12. It should be noted that WFO BOX forecasters mentioned the potential for a significant ice storm as early as December 8th in the early morning Hazardous Weather Outlook, providing a heads up of nearly 4 days in advance.

Type	POD	FAR	Average Lead Time
Watches	0.85	0.08	43 hours
Warnings	1.00	0.06	18 hours

Figure 12. Verification scores for Watches and Warnings, December 11-12, 2008

WITI (Weather Impact Traffic Index) scores for Logan Airport in Boston (KBOS) are shown in Figures 13 and 14. WITI is a product used to measure weather impact on air traffic across the 35 major airports. Weather has been identified as the most significant cause of delays and air traffic problems across the National Airspace System (NAS). WITI is similar to a financial market index or performance index; it is a composite measure of the "front-end" impact of weather and traffic demand on the NAS. The WITI metric gives a high-level assessment of the NAS performance and can provide an important “system heartbeat” indicator. A very strong correlation has been found between WITI index scores and aviation delays.

WITI software uses data from national weather products and air traffic schedules to determine the combined impact of weather and traffic demand. WITI is comprised of three major components: en-route, terminal, and queuing. E-WITI quantifies the impact of en-route convective weather, T-WITI quantifies the impact of terminal weather, and Q-WITI reflects the non-linear (queuing) effect of insufficient airport capacity (especially when it is degraded due to inclement weather) vs. scheduled traffic demand.

Each WITI component can be computed using actual or forecast weather. The forecast WITI metric is designated as WITI-FA (for Forecast Accuracy). WITI scores are re-scaled so that on the new normalized scale, the three-year seasonal average (April-September 2004-2006) is equal to 100. That means that a “normal” day in the NAS, with average weather impact, has a score of around 100. The further above 100 the WITI score is, the greater the impact of weather. A WITI score below 100 indicates a day less impacted by weather. It should also be noted that days with lower traffic demand, including weekends, will typically have lower WITI scores.

For purposes of this study, only T-WITI scores were assessed for Logan International Airport in Boston (KBOS), since it only focused on weather impact in the terminal area.

Although not directly affected by freezing rain, gusty northeast winds combined with rain, low ceilings, and poor visibilities to have had a significant impact on Airport Arrival Rates, especially on December 12th.

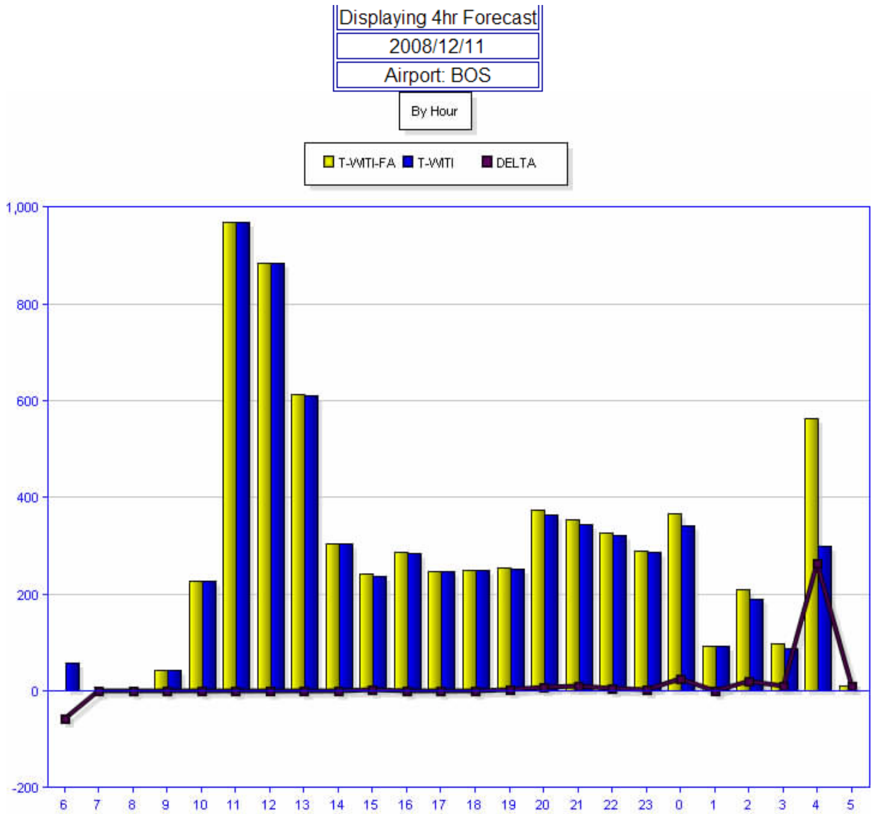

Figure 13a. KBOS T-WITI, December 11th, 2008

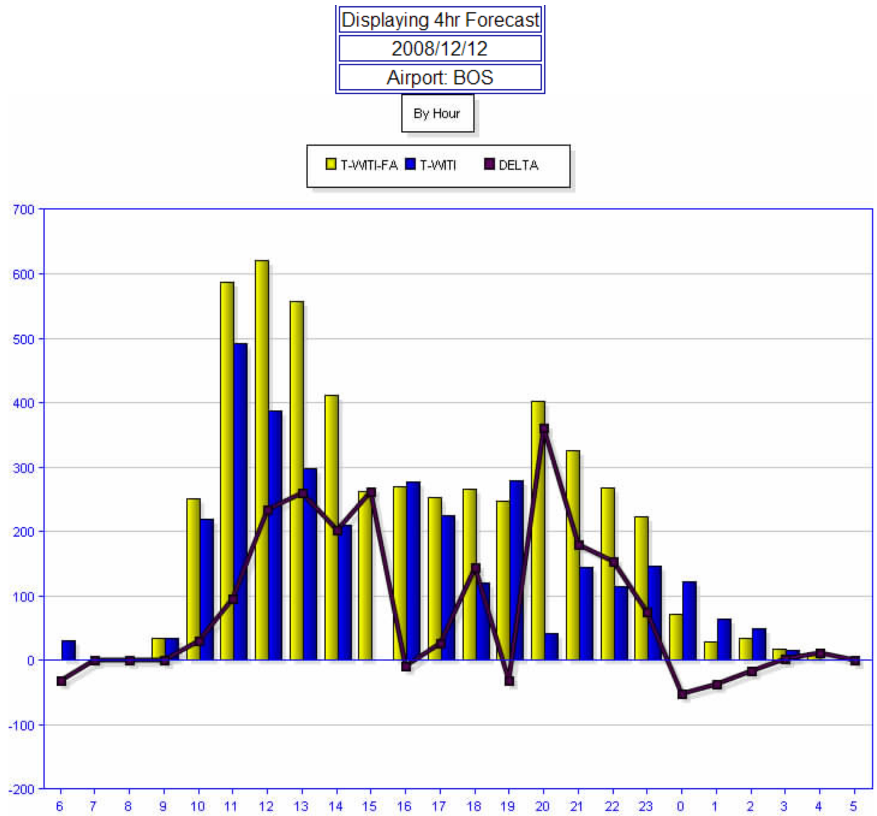

Figure 13b. KBOS T-WITI, December 12th, 2008

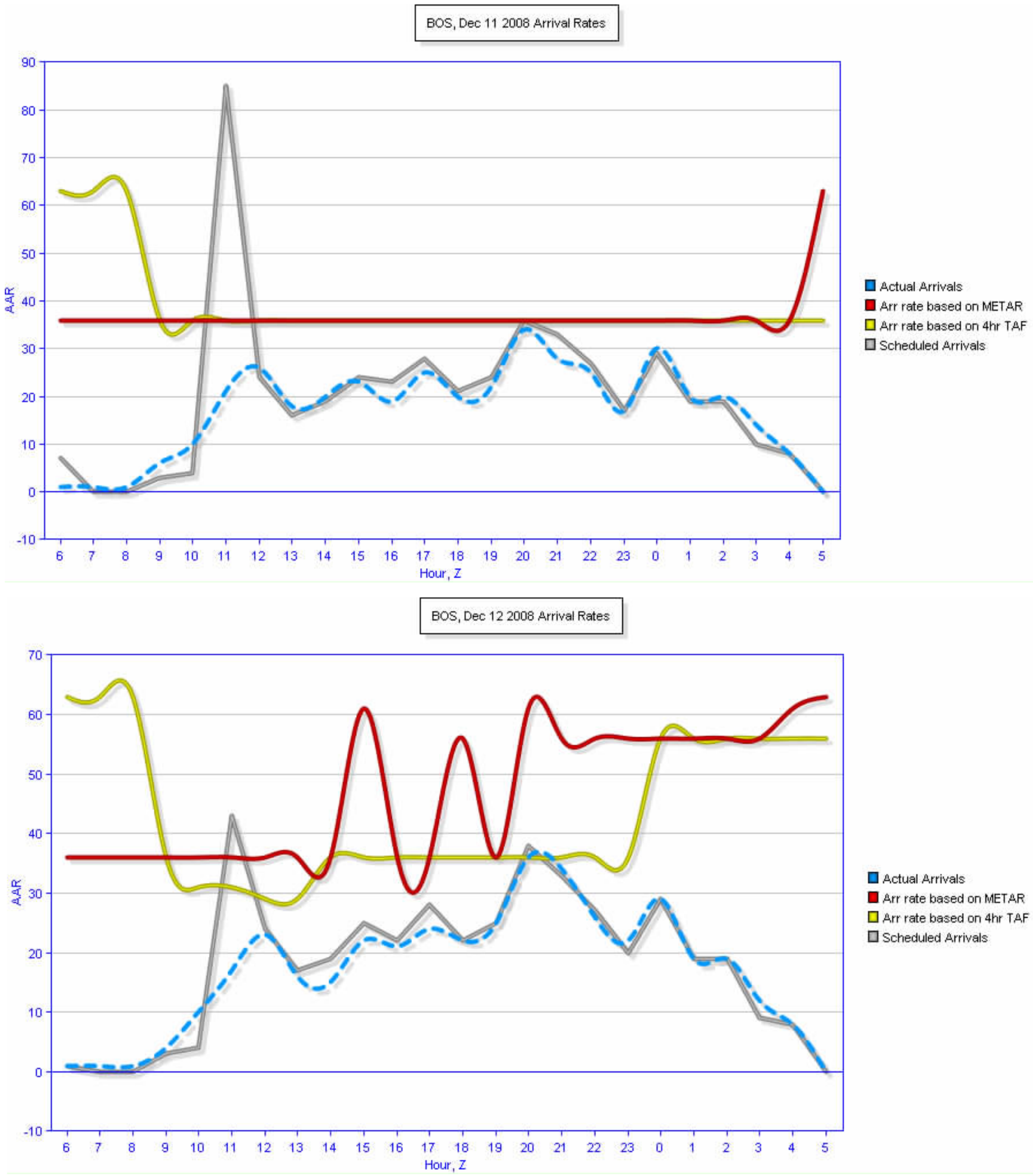

Figure 14. KBOS AAR for December 11th (top) and December 12th, 2008 (bottom)

Forecasts for KBOS were accurate on December 11th and did not negatively impact Airport Arrival Rates (AARs). Delta values frequently exceeded 50 on December 12th, indicating a significant difference between observed and forecast weather (especially between 14z and 20z). However, since scheduled AARs did not exceed TAF AARs, impact on the NAS was much lower than if it occurred during the daily AAR peak between 10z and 12z.

Feedback from customers and partners was impressive. In addition to appreciating the accuracy of the forecasts, the use of frequent conference calls to discuss storm impacts was a key to users' decision making prior to, and during the ice storm. WFO BOX also provided post-event support several days after the storm, in conference calls led by FEMA Region I to assist with cleanup efforts.

4. Conclusion and Recommendations

A destructive ice storm affected interior southern New England from 11 to 12 December 2008. The hardest hit areas were interior north central Massachusetts and southern New Hampshire. The ice storm knocked down numerous trees and power lines, leaving many residents without power for weeks. The main issue with this storm was the significant amount of ice accretion (0.50 to 1.00 inch) with marginal temperatures between 29F and 32F. Rainfall rates were rather high during the peak of the storm, which would normally not result in extreme ice accretion at these temperatures.

In this case, persistent northeast winds between 5 and 15 knots transported dry air south from northern New England. This non-saturated air lowered wet bulb temperatures and was likely responsible for offsetting latent heat release from precipitation, which normally allows temperatures to climb a few degrees in freezing rain events. Finally, since temperatures were marginal, it was a significant factor that the bulk of the event occurred during the night. Forecasters should be aware of these unusual factors in assessing future icing events.

5. Acknowledgements

This Storm Series Report was written by Hayden Frank and Joe DelliCarpini. It was reviewed by the WFO Taunton Post-Event Analysis Team including Kevin Cadima, Walter Drag, Michael Ekster, and Frank Nocera.

6. References

WITI (Weather Impact Traffic Index), “Combined WITI-FA Proof of Concept Display” http://www.avmet.com/CWITI/intro.htm

Grumm, R.H. and LaCorte, J., 2009: East Coast Storm of 1-2 March 2009, Mega Storm II. National Weather Service State College, PA