Storm Summary: 14 February 2007

A new 24-hour snowfall record for Burlington, Vermont

A major snowstorm affected Vermont and northern New York on Wednesday, 14 February 2007. Widespread 20 to 30 inch snow amounts were received from the Adirondacks eastward across much of central and northern Vermont, with isolated amounts near 3 feet. The storm set a new 24-hour snowfall record in Burlington, Vermont at 25.3 inches, exceeding the previous mark of 23.1 inches set on 14 January 1934. The Burlington storm total snowfall of 25.7 inches, was the second largest snowstorm on record behind the 29.8 inches received 25 to 28 December 1969. A storm total snow accumulation map is shown in Figure 1, for the NOAA/NWS Burlington County Warning Area. The Public Information Statement containing these snowfall amounts can be found here.

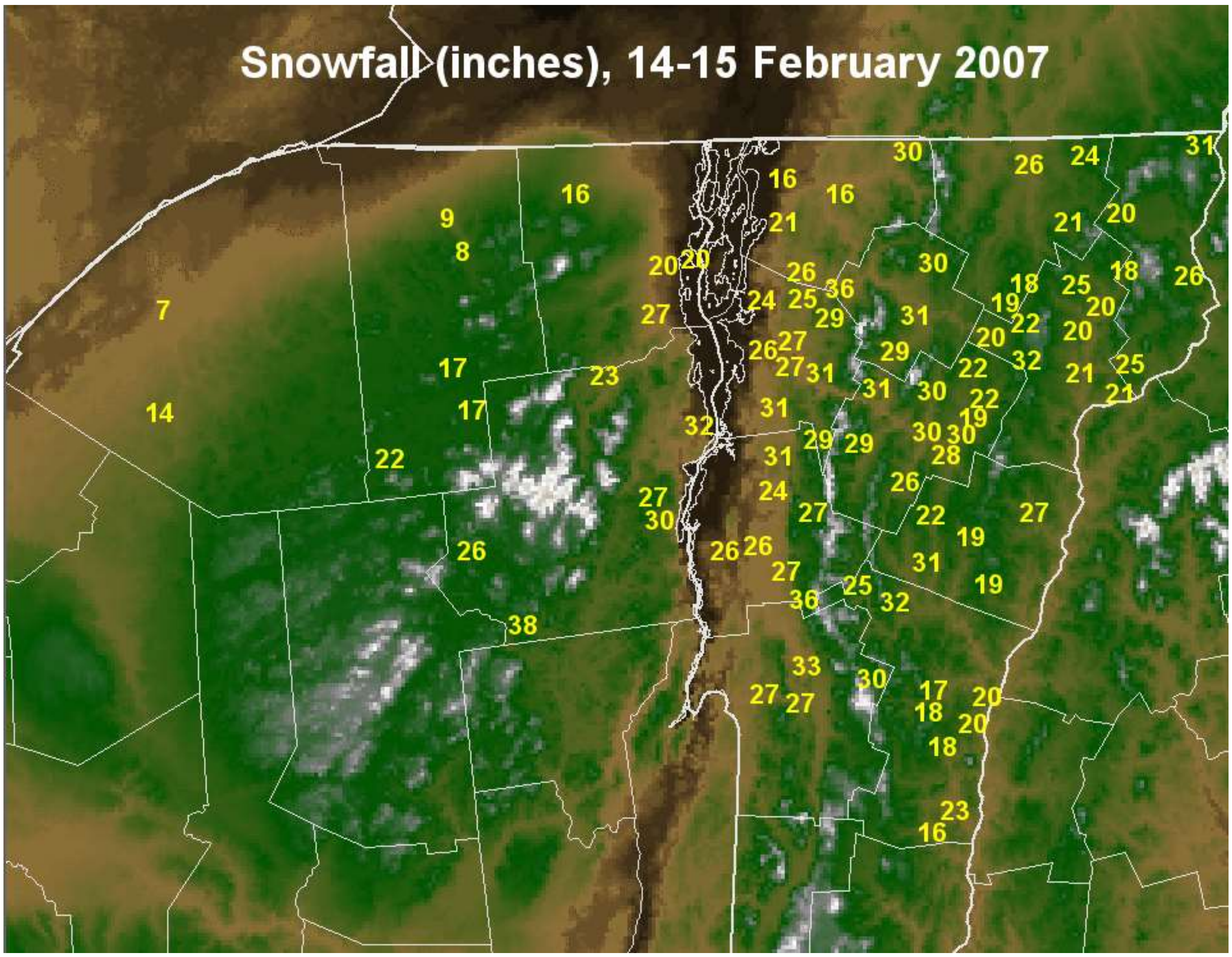


Figure 1. Storm total snow accumulations for 14-15 February 2007, in inches.

The Valentine's day storm featured many elements of a classic Nor'easter, but with several variations that turned it into a blockbuster event. For a month preceding the storm, a dry northwest flow pattern had prevailed across southeast Canada and the Northeastern United States, with temperatures significantly below seasonal averages. A fresh incursion of arctic air occurred during February 12th, as a cold front tracked from northwest to southeast across upstate New York and New England (Fig. 2). Meanwhile, a lee cyclone was developing across the southern Great Plains, and was associated with a progressive mid-tropospheric trough (Fig. 3).

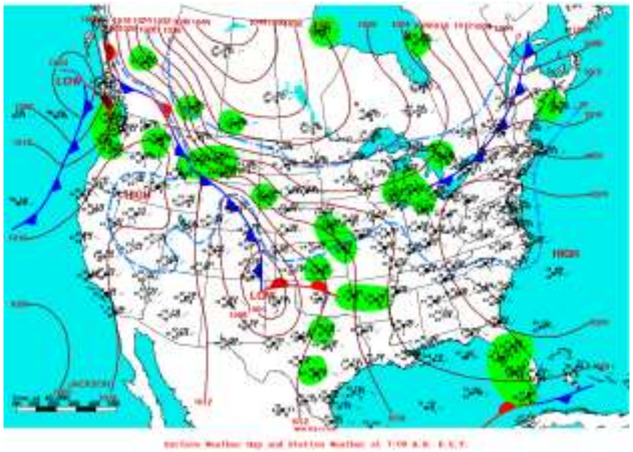


Figure 2. Surface analysis, 7 a.m. Eastern Standard Time on 12 February 2007. Frontal positions from Hydrometeorological Prediction Center (HPC) analysis. Standard surface weather plotting convention is used. Map from DOC Daily Weather Maps series.

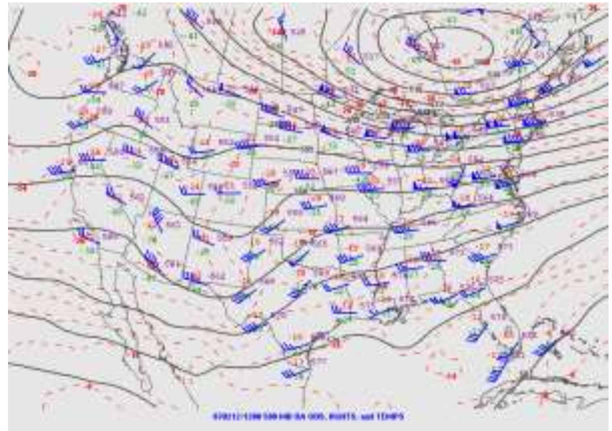
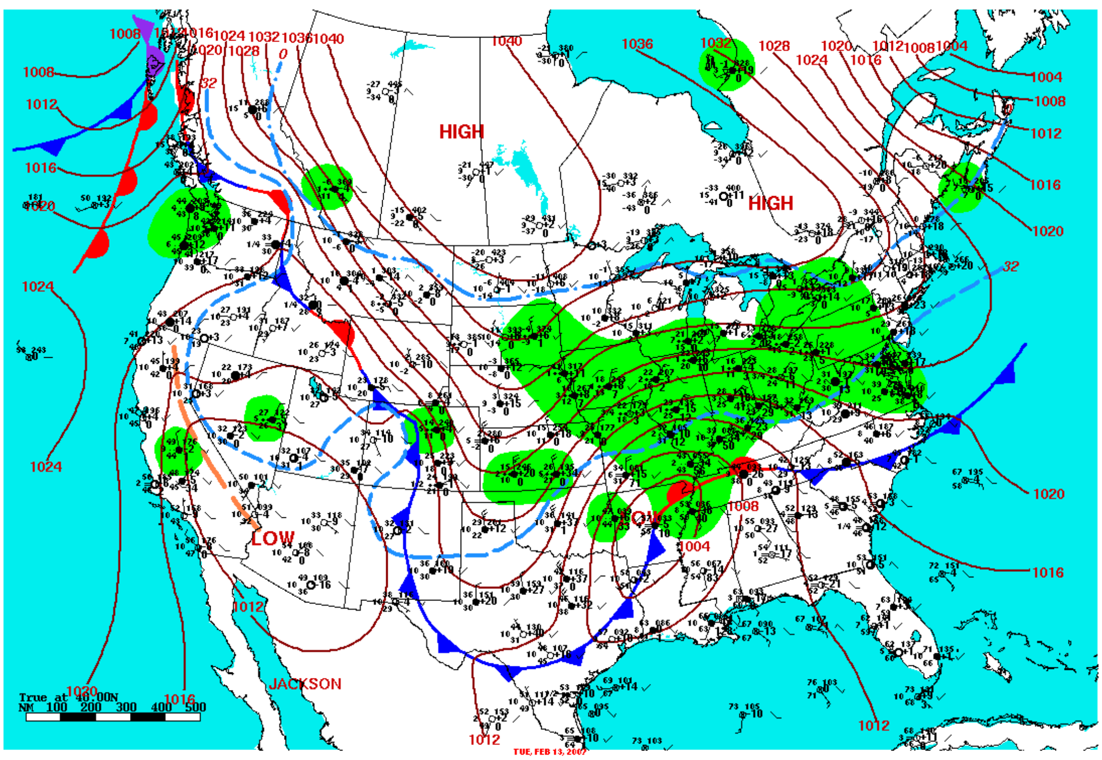


Figure 3. 500mb Analysis at 7 a.m. EST on 12 February 2007. Standard rawinsonde station plots are shown. Temperature is shown by dashed lines (in degrees Celsius). Geopotential height is shown by solid lines (decameters). Analysis courtesy NOAA/NCEP/Storm Prediction Center

With clearing skies and an eastward extending surface ridge across northern New York and Vermont, early morning lows on Tuesday, February 13th, were among the coldest of the month-long cold snap, ranging from -7 degrees Fahrenheit at Burlington, to -10 degrees at Montpelier, and -32 degrees at Saranac Lake, New York (Fig. 4). At the same time Tuesday morning, low pressure had tracked eastward from the Great Plains into central Arkansas, with a broad area of precipitation extending northward into the Ohio Valley.



Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.

Figure 4. As in Fig. 2, but for 7 a.m. EST on 13 February 2007. Map from DOC Daily Weather Maps series.

The evolution of precipitation into northern New York and Vermont would first occur from low-level warm advection, as the primary 700mb trough moved into the Ohio Valley, with a northward extending band of warm advection into New York and New England (Fig. 5). This allowed snow to begin around midnight in southern Vermont and spread northward during the pre-dawn hours across the remainder of Vermont and northern New York. As the primary shortwave trough and surface low were dissipating west of the central Appalachians, a secondary low pressure area was forming across east-central South Carolina (Fig. 6), and would deepen rapidly during the morning hours of Wednesday, February 14th, reaching the Delmarva Peninsula by 7 a.m. Eastern Standard Time (EST) (Fig. 7).

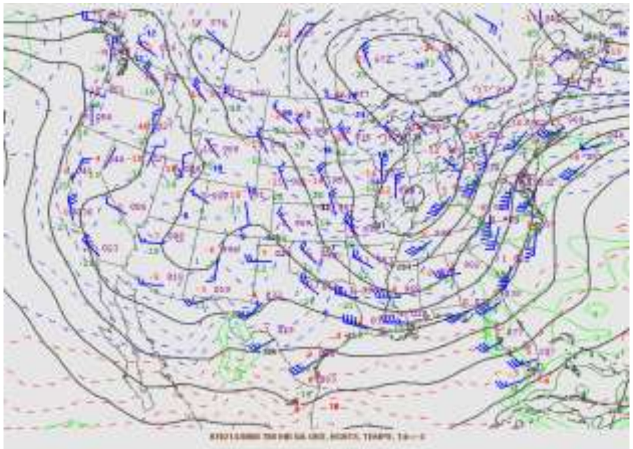


Figure 5. As in Fig. 3, but for 700mb, at 7 p.m. EST on 13 February 2007. Analysis courtesy NOAA/NCEP/Storm Prediction Center.

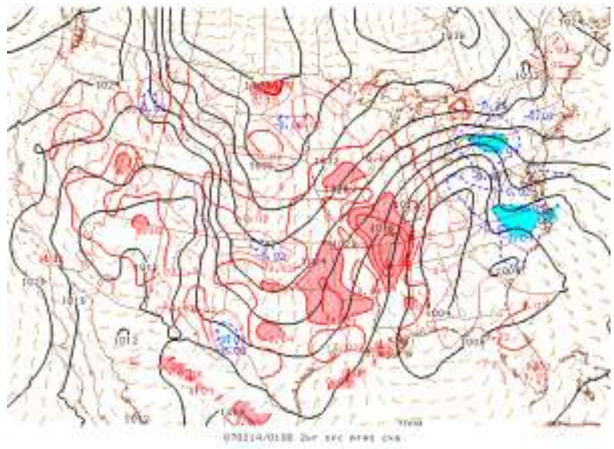
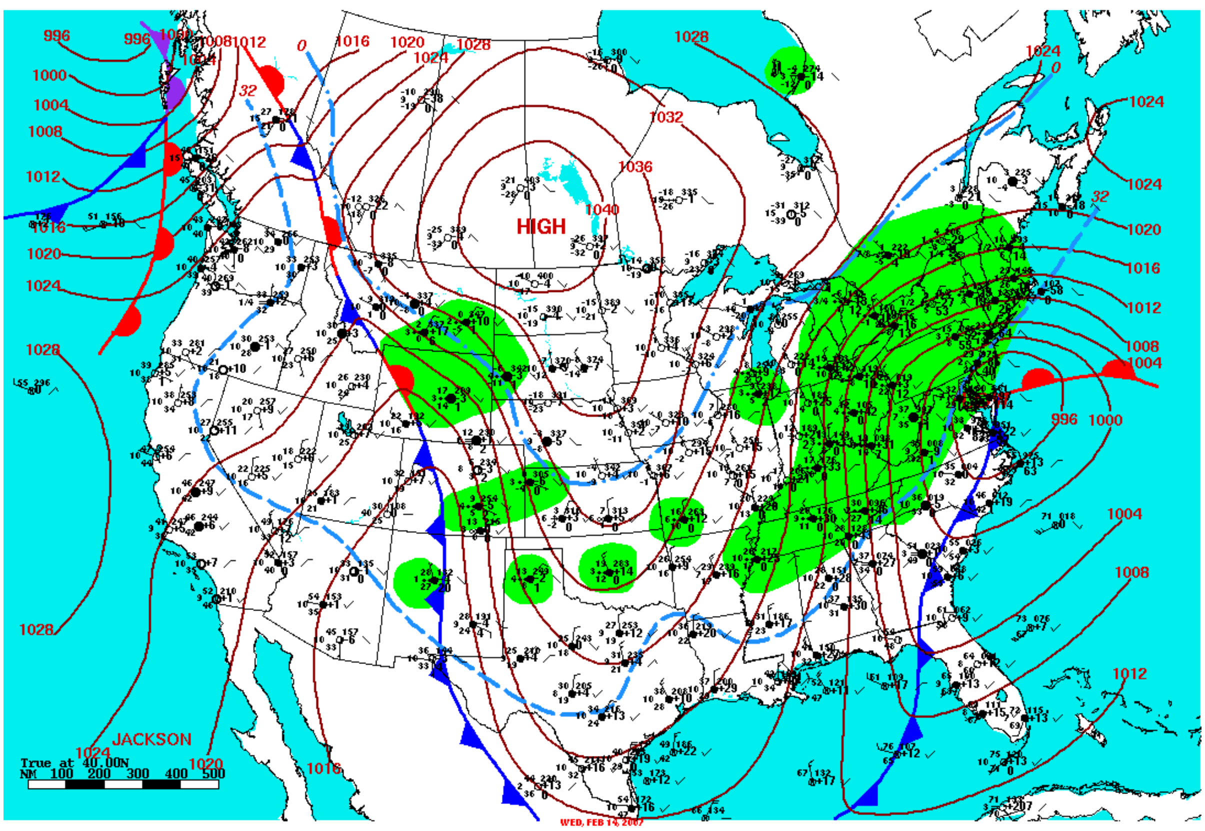


Figure 6. Sea-level pressure, wind, and 2-hr pressure change analysis valid at 8 p.m. EST on 13 February 2007, based on background 1-hour Rapid Update Cycle forecast. From NCEP/Storm Prediction Center surface objective analysis archive.



Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.

Figure 7. As in Fig. 2, but for 7 a.m. EST on 14 February 2007. Map from DOC Daily Weather Maps series.

The low pressure development was aided by a coupled upper tropospheric jet structure, which can be seen in the 250mb analysis at 7 a.m. EST on 14 February 2007 (Fig. 8). The surface low was collocated with the entrance region of an anticyclonically curved jet streak to the north across New England, and a strong zonal jet extending across the U.S. border with Mexico, eastward to the southeastern Atlantic coast. This southern jet would contain observed wind speeds of 195 knots by Wednesday evening.

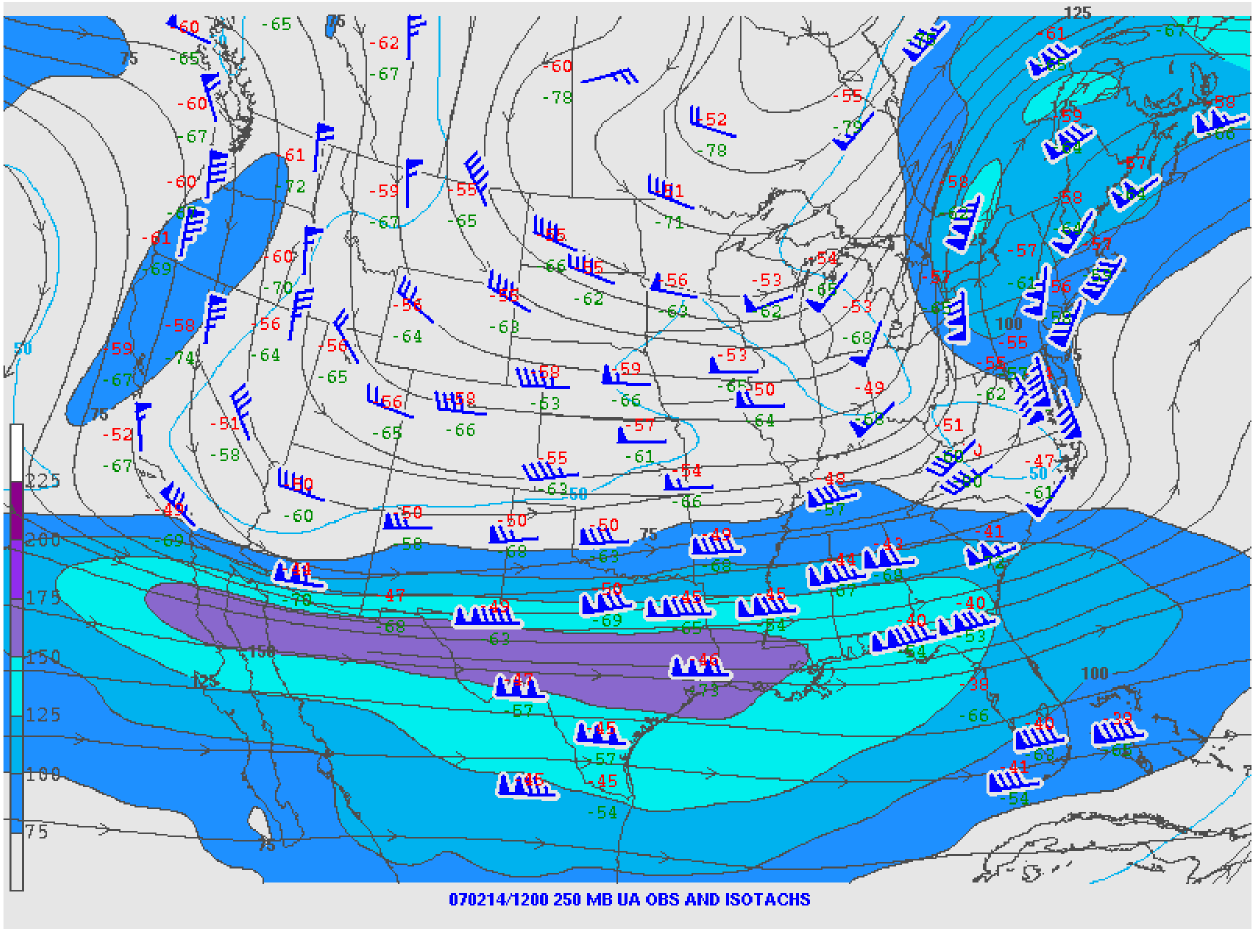


Figure 8. 250mb analysis, valid 7 a.m. EST on 14 February 2007. Shaded regions represent isotachs in 25kt increments, for wind speeds at or above 75kt. Analysis courtesy NOAA/NCEP/Storm Prediction Center.

Steady snow had accumulated 2-6" across the Burlington forecast area by 7 a.m. EST on 14 February, but the more significant heavy snow would occur in the afternoon and evening. The coastal low continued to deepen as it tracked toward eastern Long Island. The deepening surface low met the requirements for a meteorological "bomb", with minimum pressures associated with the cyclone dropping at an average rate of 1 millibar per hour for 24 hours as the secondary low tracked northeastward along the coast. This resulted in a very strong "jet" of low-level air moving from southeast to northwest across New England by the afternoon hours on Valentine's Day, north of the surface low. This jet transported ample moisture from the Atlantic Ocean into Northwestern New England and could be described as being more intense than a typical Nor'easter. The overrunning of this air over the pre-existing arctic air near the surface, caused strong dynamic lift, and enhanced snowfall rates to around 3"/hour for several hours during the late afternoon hours. Satellite imagery depicts well the conveyor belt of warm air and moisture aloft, to the north of the surface low during the afternoon hours as snowfall intensified to their maximum rates over the region (Fig. 9, Fig. 10, Fig. 11).

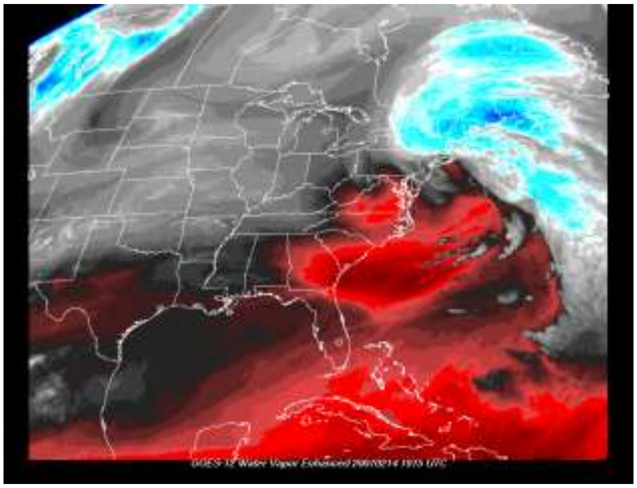


Figure 9. GOES-12 color enhanced water vapor satellite image, 2:15 p.m. EST on 14 February 2007.

Figure 10. GOES-12 visible satellite image, 2:15 p.m. EST on 14 February 2007.

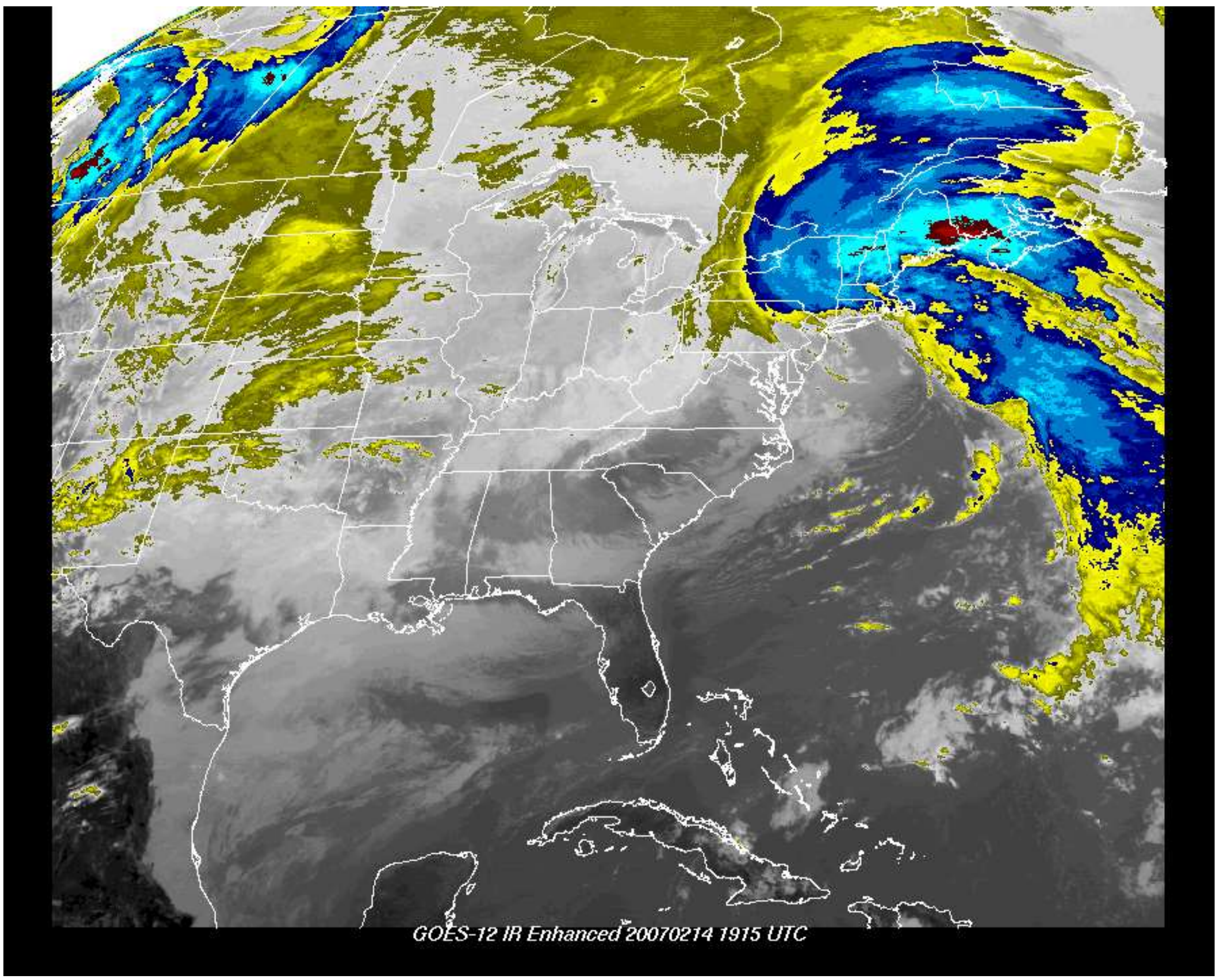


Figure 11. GOES-12 infrared satellite image, 2:15 p.m. EST on 14 February 2007.

The strong warming aloft is also evident in rawinsonde data from Albany, taken at 2 p.m. EST (Fig. 12). The Albany sounding indicates a temperature inversion from the surface up to 800mb (near 6000 feet AGL). Also evident is the strong southeast winds aloft, ranging from 40-50 knots through the mid-troposphere, which contributed to the strong moisture advection into the region. At 4 p.m. EST, surface analysis shows the intense surface low near Block Island, with an inverted surface trough extending northward into northern New England, indicative of the warming aloft associated with the fetch of moisture and precipitation from the east-southeast (Fig. 13).

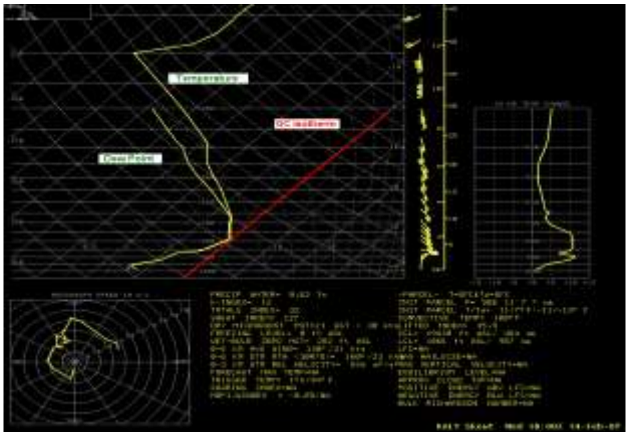


Figure 12. Albany, New York sounding taken at 2 p.m. EST on 14 February 2007.

Figure 13. HPC surface analysis valid 4 p.m. EST on 14 February 2007.

An interesting aspect to this portion of the event was the occurrence of very heavy snowfall rates with surface temperatures generally in the single digits above zero during the duration of the storm. We describe the density or weight of the snow in terms of a "snow ratio", comparing the depth of snow compared to its liquid equivalent when the snow is melted. Whereas the typical Vermont snowfall will have snow ratios in excess of 15" of snow for 1" of water, this storm had snow ratios closer to 12":1", and the storm produced the equivalent of 2" or more of rain water across most of Vermont. In terms of snow water equivalent, this was a record for February (officially 1.94″ at Burlington). We are not immediately aware of any close analogs in terms of these relatively low snow ratios with temperatures so far below freezing, and with such substantial total snow water equivalent. It indicates how optimal the dynamic forcing was across the region with this particular system.

The low pressure center would track into the Gulf of Maine during the late evening hours, with snowfall gradually tapering off across northern New York and Vermont during the overnight period (Fig. 14).

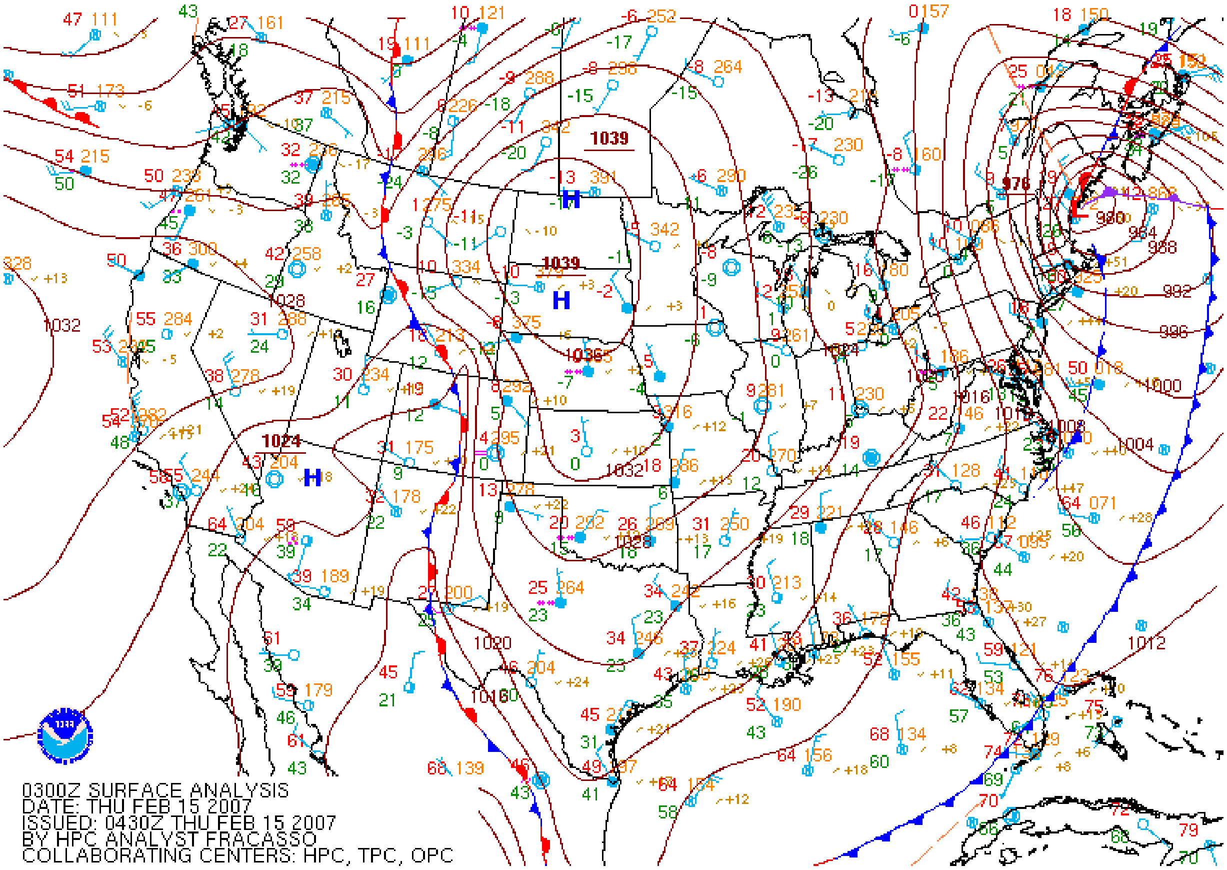


Figure 14. HPC Surface analysis valid 10 p.m. EST on 14 February 2007.

The following visible satellite picture (Fig. 15) shows the snow cover across the Northeast United States, with the brown along the coastline from southeastern Massachusetts into the Mid-Atlantic states representing a lack of snow cover. The streaky clouds off the New England coast are caused by cold northwest winds crossing relatively warm Atlantic water. Also, a closer look at the dark spot in the center is the unfrozen section of Lake Champlain near Burlington, Vermont. Lastly, the snow appears whiter in the Saint Lawrence River and Champlain Valleys compared to the rest of Vermont and the Adirondacks, due to the fewer trees in the valley.

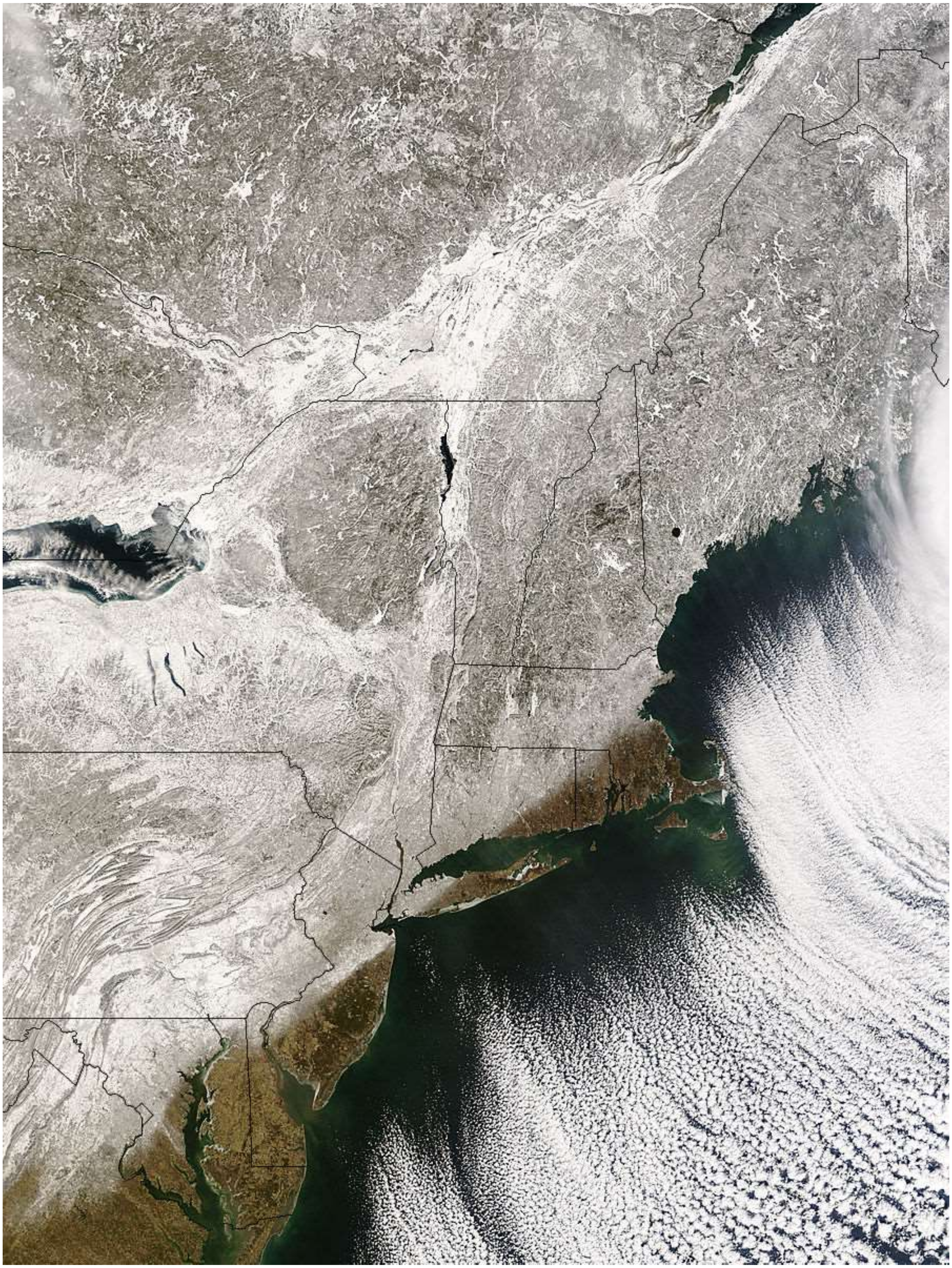


Figure 15. Image taken by NASA's Terra satellite on 19 February 2007, showing snow cover across all but southeastern New England, central and eastern Long Island, and the Mid-Atlantic region. The ice free portion of Lake Champlain south of the Champlain Islands is clearly visible

Storm Impacts

The heavy snowfall (intensity and storm totals) and brisk winds brought near white-out conditions for much of the afternoon and early evening hours on the 14th (Fig. 16, below). In addition, the combination of heavy snowfall and brisk winds caused considerable drifting of the snow with localized snow drifts in excess of 6 feet.

Coded surface METAR observations taken at 4 p.m. EST

```
KBTV 142054Z 35015G22KT 1/16SM +SN FZFG VV001 M16/M18 A2959
KMPV 142147Z AUTO 1/4SM FZFG VV001 M13/M16 A2945
KMVL 142105Z AUTO M1/4SM +SN FZFG VV001 M14/M16 A2952
KRUT 142135Z AUTO 33009G18KT 310V020 M1/4SM OVC004 M16/M18
KVSF 142054Z AUTO 02011G16KT 330V050 1/4SM +SN FZFG VV003
M11/M13 A2936 RMK AO2 SLP953 P0005 60022 T11061128 56037
KSLK 142135Z AUTO 35004KT 1/2SM SN VV003 M16/M19 A2950 RMK
AO2 P0002
KPLB 142053Z AUTO 33015G22KT 1/4SM SN FZFG OVC002 M16/M18
A2963 RMK AO2 SLP043 P0004 60005 T11561178 58037
```

Fig. 16. Surface observations at 4 p.m. EST on 14 February 2007 showing visibilities 1/2 mile or less.

This created nearly impassable roads with numerous accidents, stranded vehicles and all flights at Burlington International Airport were cancelled. All schools were closed in Vermont and New York on the 14th with many still remaining closed on the 15th, with even a few school districts not re-opening until February 19th. In addition, the weight of the heavy snowfall caused about a dozen barn roofs to collapse, killing around two dozen cattle. This forced many farmers and some homeowners to seek assistance in removing the snow pack from their roofs to possibly prevent similar damage.

Fortunately, there were no reported fatalities directly related to the storm. However, there were at least six reported post storm fatalities due to heart related problems associated with overexertion during snow removal. Further, the heavy snowfall and subsequent drifting blocked many exhaust vents to heating systems and this caused the build-up of carbon monoxide in many dwellings. There were dozens of reported carbon monoxide related health problems, including hospitalization but no fatalities as a result.

The greatest impact was the post-storm snow removal operations in many communities with several roads narrowed, dangerously high snow piles that obstructed visibility to traffic and pedestrians as well as unplowed sidewalks.

The one positive impact from this major snowstorm was the significant boost to winter sports enthusiasts and the businesses that benefit from such winter activities. The storm occurred prior to the start of the President′s Day Holiday weekend and the start of school vacations across New England and New York.