Heavy Rainfall and Associated Flooding Event on 23 May 2013

Introduction:

Heavy rain impacted much of the North Country between May 22nd and May 26th, which caused localized flash flooding and some minor river flooding. The flash flooding temporary closed over two dozen roads across Chittenden and Lamoille Counties, due to culverts being washed out or significant erosion. In several locations across Chittenden and Lamoille Counties, 6 day rainfall totals were over a half of foot. In this event write up, we will mainly focus on the flash flooding that occurred during the afternoon and evening hours on 23 May 2013, across portions of the central Champlain Valley to mountains of central and northern Vermont. This region was affected by two discrete rounds of heavy rainfall, the second of which produced considerable flash flooding in the Essex to Jericho to Underhill to Jeffersonville areas.

Synoptic Features:

The surface analysis showed a stationary boundary was oriented across central Vermont, as a slow moving cold front was approaching the region from the Great Lakes on 23 May 2013 at 12 UTC. These boundaries, along an anomalously moist airmass and some instability produced showers and thunderstorms with localized very heavy rainfall rates. Figure 1 below shows a complex surface analysis across the eastern Great Lakes into the northeast United States, with several weak areas of low pressure along with a surface cold front approaching the Saint Lawrence Valley.

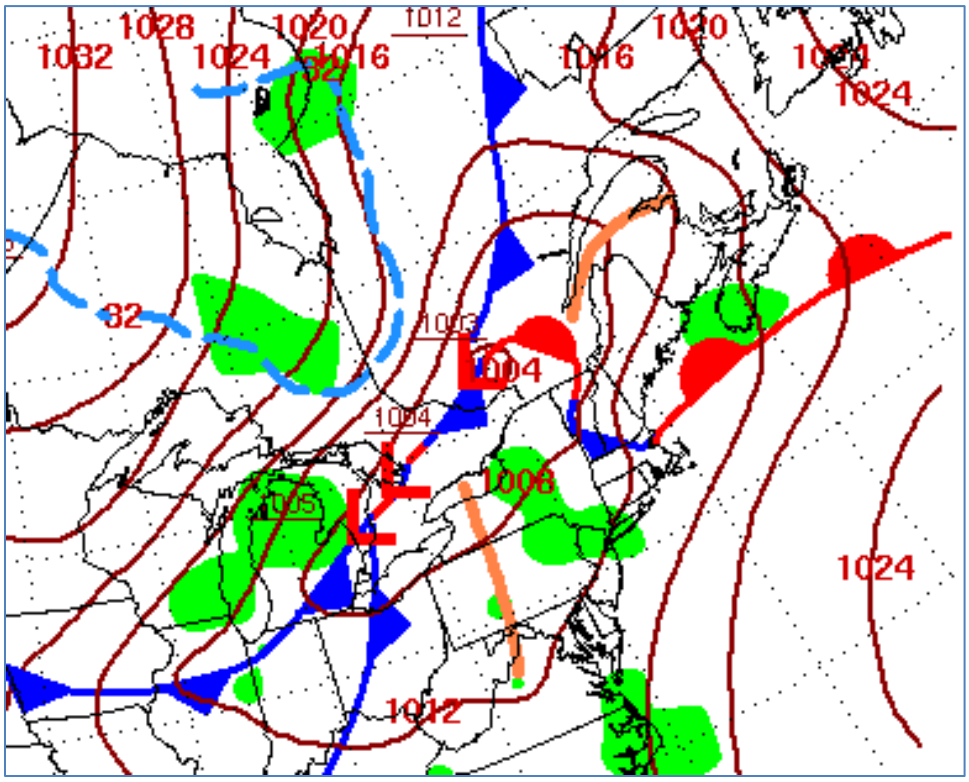

Figure 1: Surface weather map 23 May 2013 at 12 UTC.

This surface pattern resembles the synoptic flash flood archetype (Figure 2) defined by Maddox et al (1979, Bull. Amer. Meteor. Soc., 60, 115-123), with areas identified with the potential for flash flooding aligned along and ahead of a slow moving surface front at the intersection of an old warm front.

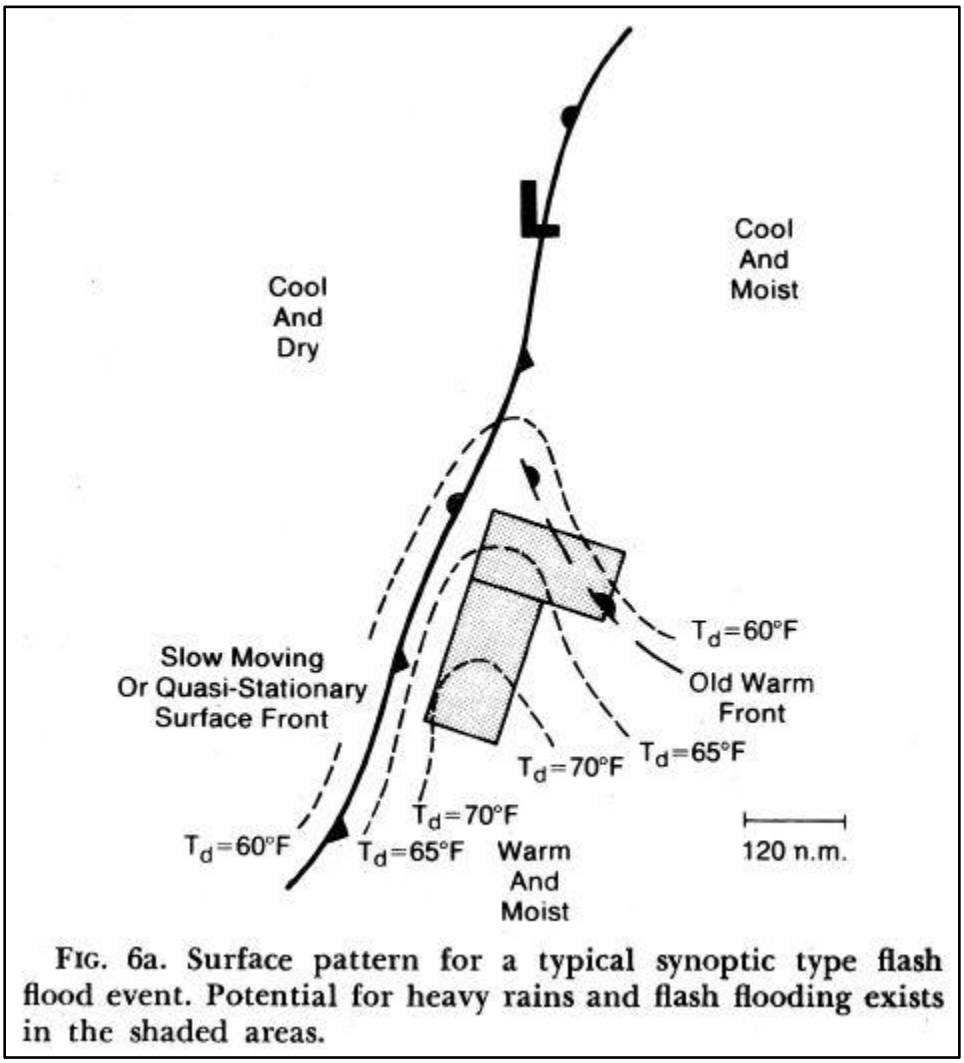

FIG. 6a. Surface pattern for a typical synoptic type flash flood event. Potential for heavy rains and flash flooding exists in the shaded areas.

Figure 2, Synoptic Flash Flood Event archetype from Maddox et al.

In addition, a strong 100 knot anticyclonic curved jet at 250hPa was lifting across the eastern Great Lakes into central Canada and placing our region in a very favorable region of upper level divergence, which promoted deep thunderstorm convection. This strong jet energy was associated with a digging mid/upper level trough and cold pool aloft located over the central Great Lakes. Figure 3 shows the 250hPa (35,000 feet above the ground level) upper air analysis on 23 May 2013 at 12 UTC. Isotachs are lines of equal wind speeds (blue contours). Also shown are streamlines (black lines), trough axis (red line) and temperatures (red numbers in station plots).

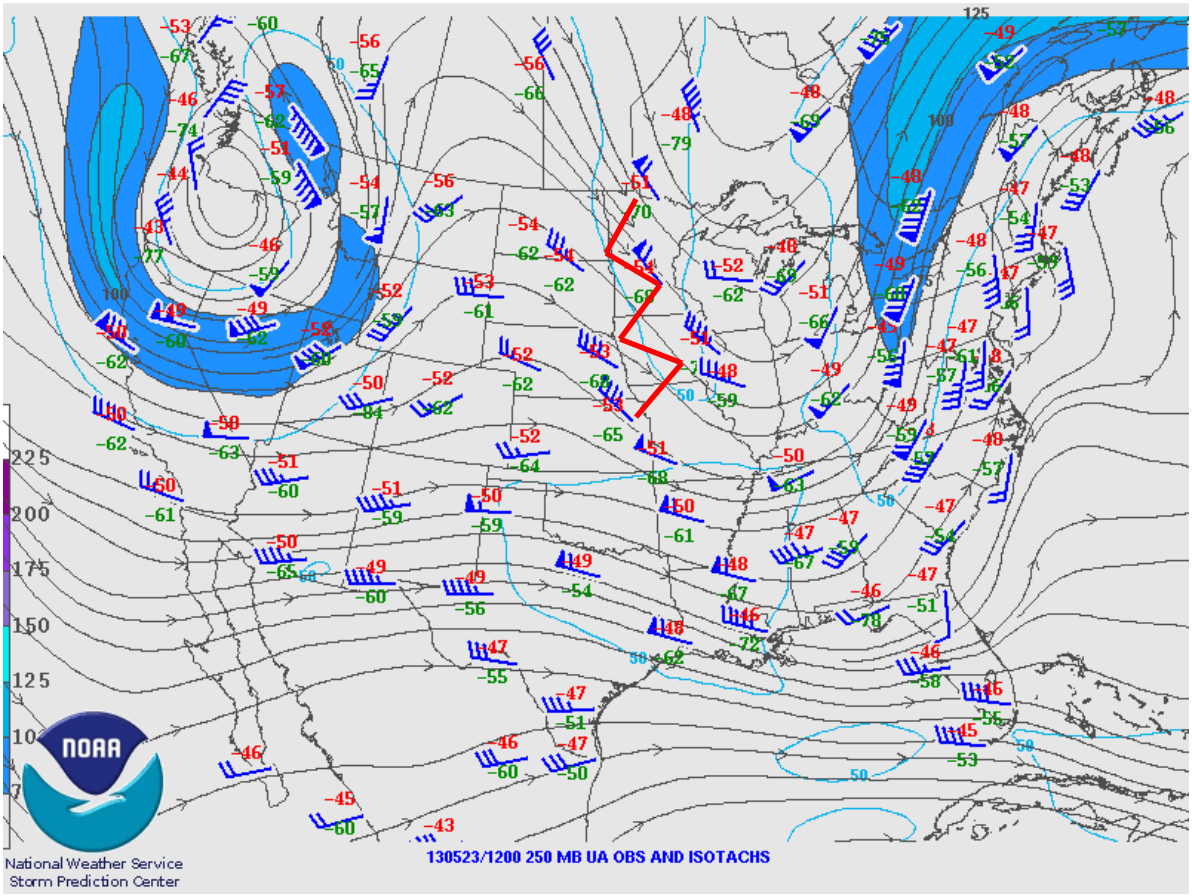

Figure 3: The 250 hPa (35,000 feet above the ground level) upper air analysis on 23 May 2013 at 12 UTC. Isotach, (dark blue >75 knots, and lighter blue >100 knot), streamlines (black lines), and temperatures (red).

The orientation of upper flow aligned with the surface front provides an environment favorable for the training of thunderstorms. The surface front provides a forcing mechanism for convection, while the parallel upper level steering flow keeps storms anchored on the front, while feeding warm moist air from the south to fuel the storms.

Model forecast soundings also point to the heavy rain potential. Bufkit NAM sounding from 12 UTC 23 May 2013 valid at 21 UTC (Figure 4) show a warm rain process sounding with a saturated sounding, a tall skinny CAPE with NCAPE value of 0.05, warm cloud depth of nearly 9,000 feet, and a low Lifted Condensation Level near 1,000 feet. Showers and thunderstorms that develop in this environment are very efficient rain producers. The MBE velocity of 5 knots underscores the potential for training and back building storms, with the storm motion and inflow vectors opposite each other.

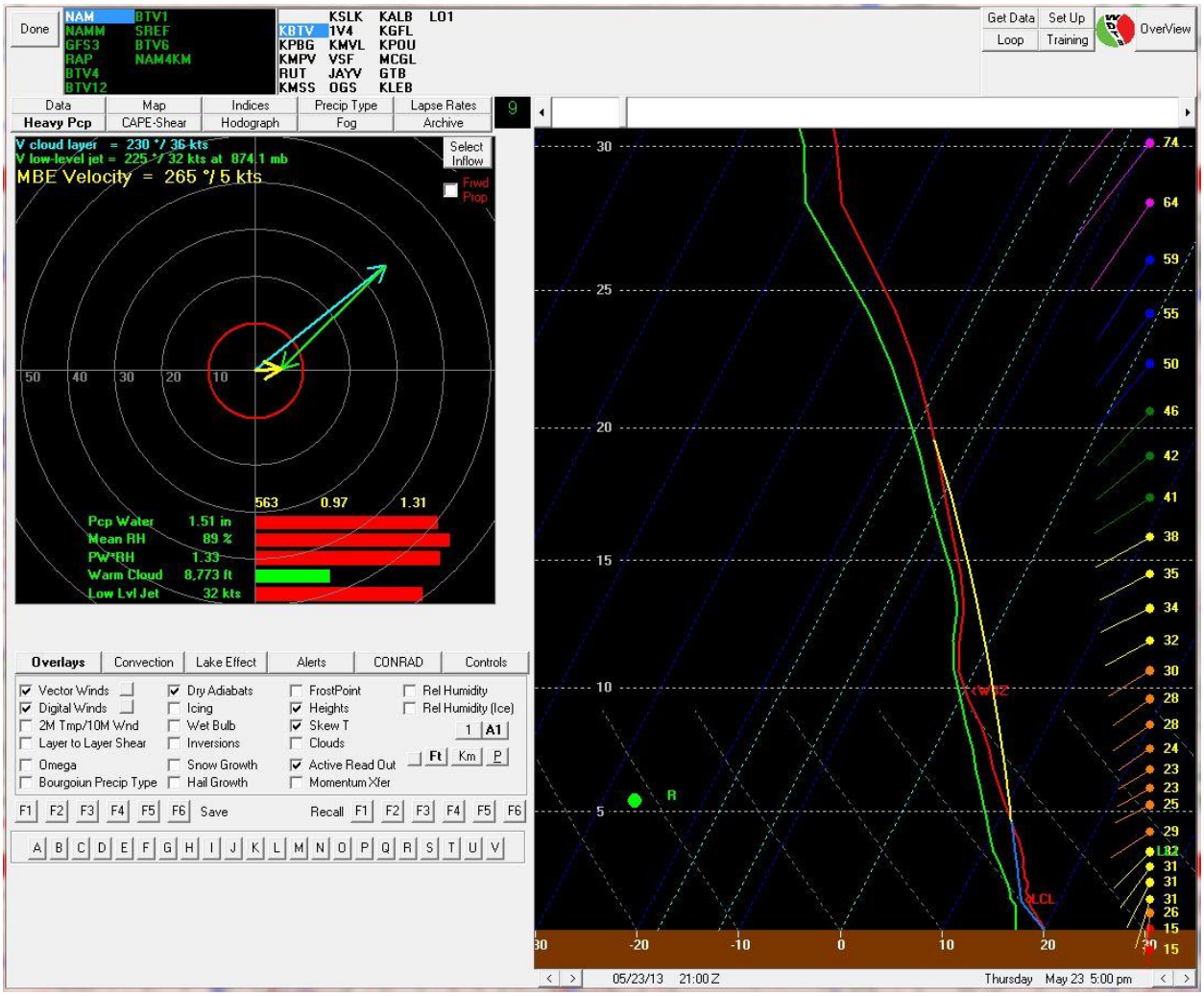

Figure 4, Forecast sounding valid 21 UTC 23 May 2013.

Antecedent Rainfall:

Several rounds of showers and thunderstorms prior to the May 23rd, helped to produce very saturated soils across the region, with some minor urban street flooding in Burlington, Vermont on 22 May 2013. These showers and thunderstorms produced 1 to 2 inches of rainfall with localized amounts approaching 3 inches. Figure 5 below shows the 24 hour rainfall across the North Country from 7 AM on 22 May to 7 AM on 23 May 2013.

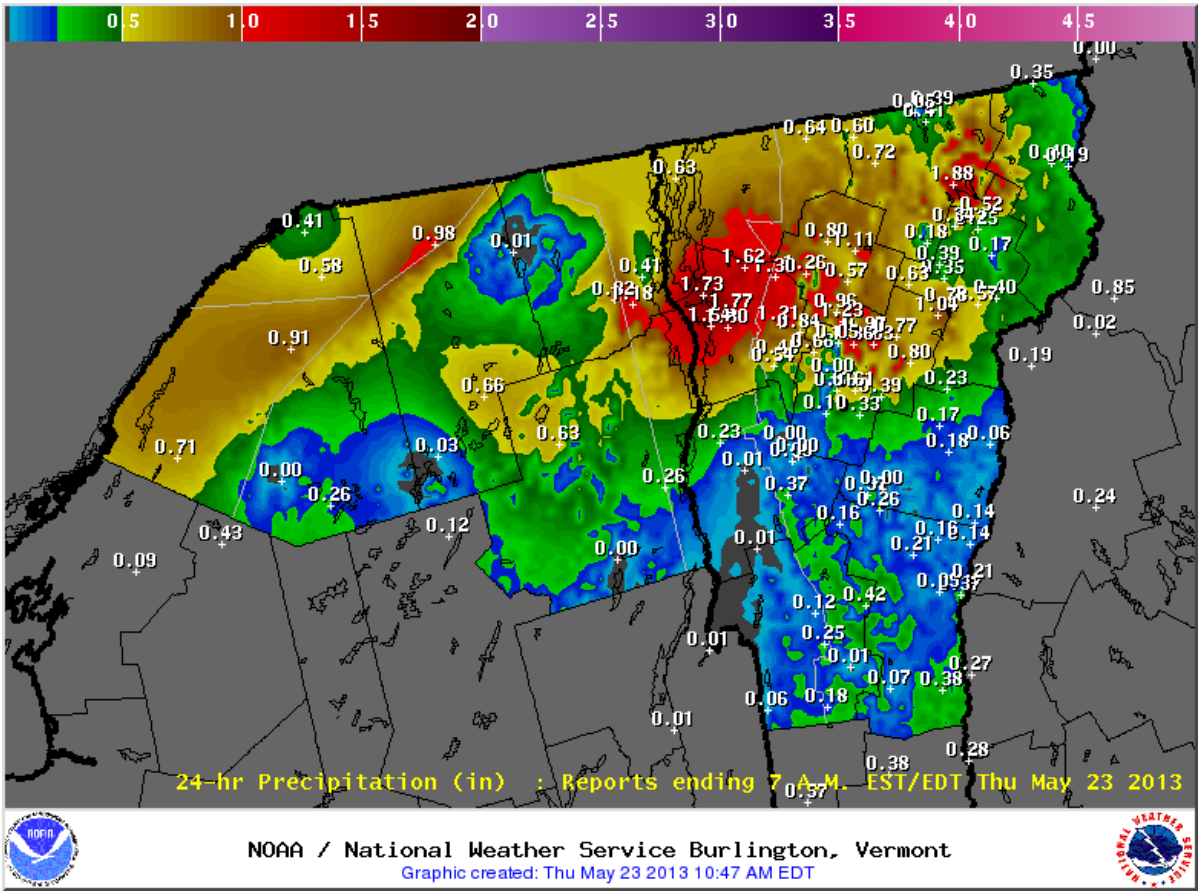

Figure 5: 24 Hour precipitation ending at 7 AM EDT on 23 May 2013

The combination of deep layer moisture and modest instability helped to produce additional rounds of very heavy thunderstorm activity during the afternoon and evening hours on May 23rd. Rainfall amounts from Essex County, New York to Lamoille County, Vermont ranged 1 to 3 inches with localized amounts over 5 inches across the western slopes of the Green Mountains. Figure 6 shows the 24 hour precipitation from 7 AM on May 23rd to 7 AM on May 24th. The purple shading in the image below shows observed 24 hour rainfall amounts in the 2 to 3.5 inch range from near Shelburne, to Johnson, Vermont. Some observed rainfall values during this 24 hour period included: 2.73 inches at Jeffersonville, 3.72 at 4.4 miles north-northeast of Underhill, and 3.83 at 5.1 north-northeast of Underhill, Vermont.

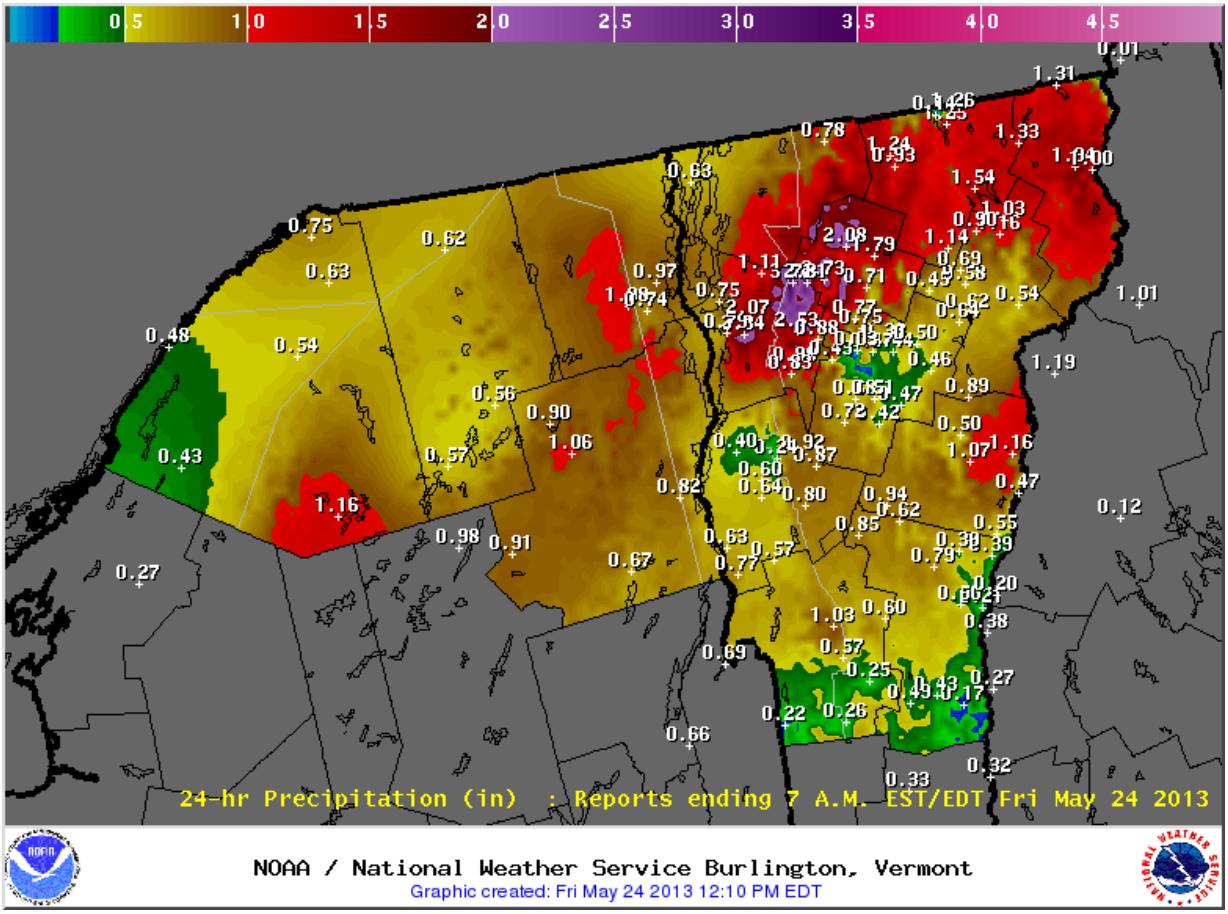

Figure 6: 24 Hour precipitation ending at 7 AM EDT on 24 May 2013

Radar:

Figure 7 below is a KCXX composite reflectivity loop from 1736 UTC on May 23rd to 0222 UTC on 24 May 2013. The brighter orange and red colors in the image below indicates very heavy rainfall, with rates of 1 to 2 inches per hour. Also, note the very slow movement eastward in the precipitation during the 8 hour loop and the redevelopment of heavy rain between 22 UTC and 00 UTC. This redevelopment of very heavy rain from Shelburne to Jericho to Underhill created the localized flash flooding and washed out many of the back country dirt roads in the steeper terrain. Furthermore, note how the stronger reflectivity returns were located along the Western Slopes of the Green Mountains during the radar loop, this was caused by localized upslope flow on southwest to west winds near the surface.

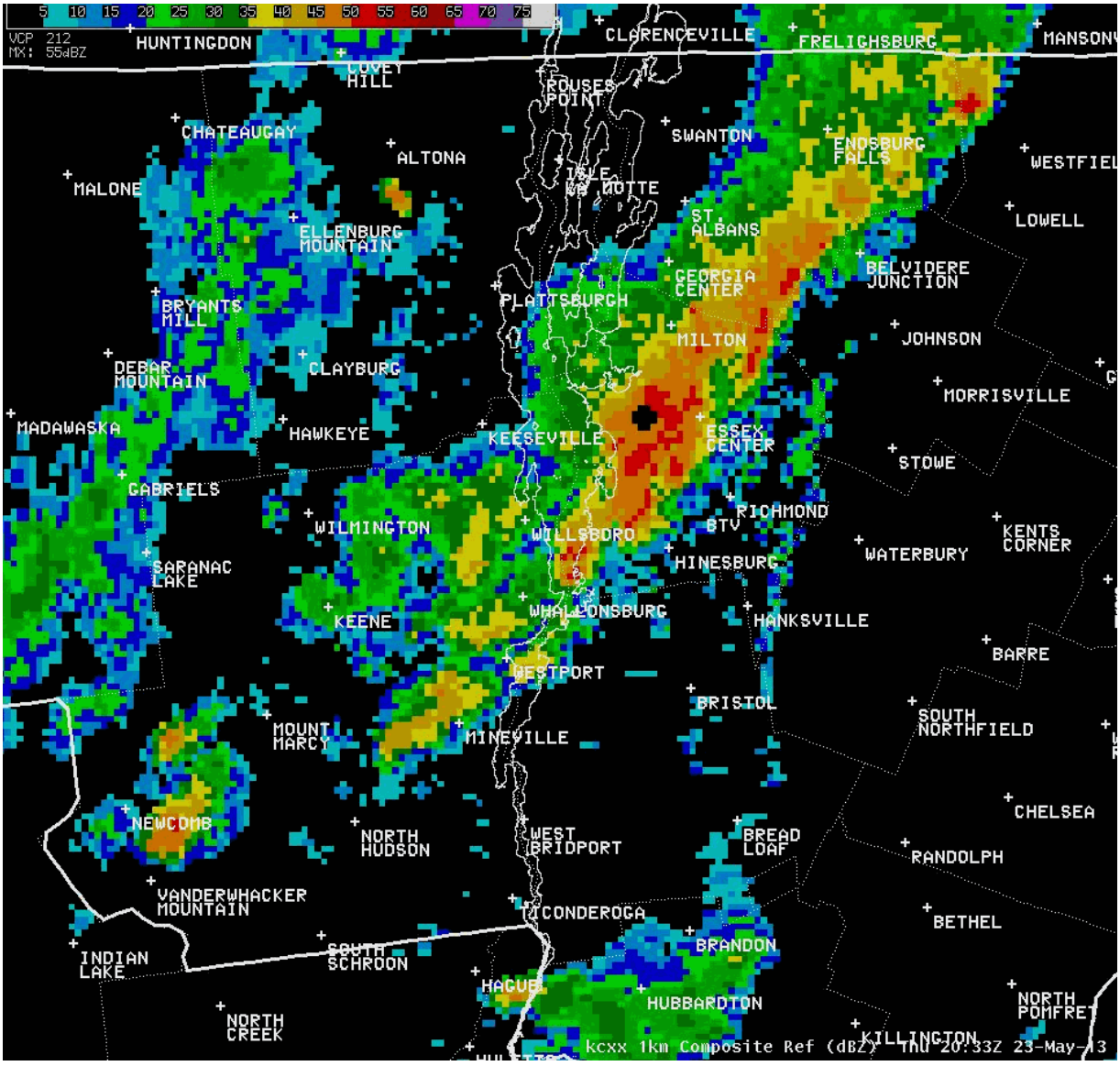

Figure 7: KCXX composite reflectivity from 1736 UTC on 23 May to 0222 UTC on 24 May 2013. (Click image to animate)

Summary:

This heavy rainfall event caused devastating flash flooding across portions of the central Champlain Valley and Western Slopes of Vermont during the evening hours on 23 May 2013. The combination of recent heavy rains, and several additional rounds of showers and thunderstorms with rainfall rates of 1 to 2 inches per hour, caused significant damage to roads and property in the area. Observed rainfall for the 24 hour period ranged from 1 to 3 inches with localized amounts approaching 4 inches in Underhill and Jericho, Vermont. Figure 8 below shows a 6 day total rainfall map across the North Country. The light blue/greyish color indicates 6 day rain totals over 5 inches, with the darkest blue contouring showing rainfall amounts greater than 7 inches. Click here for a complete listing of 6 day rainfall totals. Finally, figures 9 through 11 show some of the damage that occurred from the flash flooding.

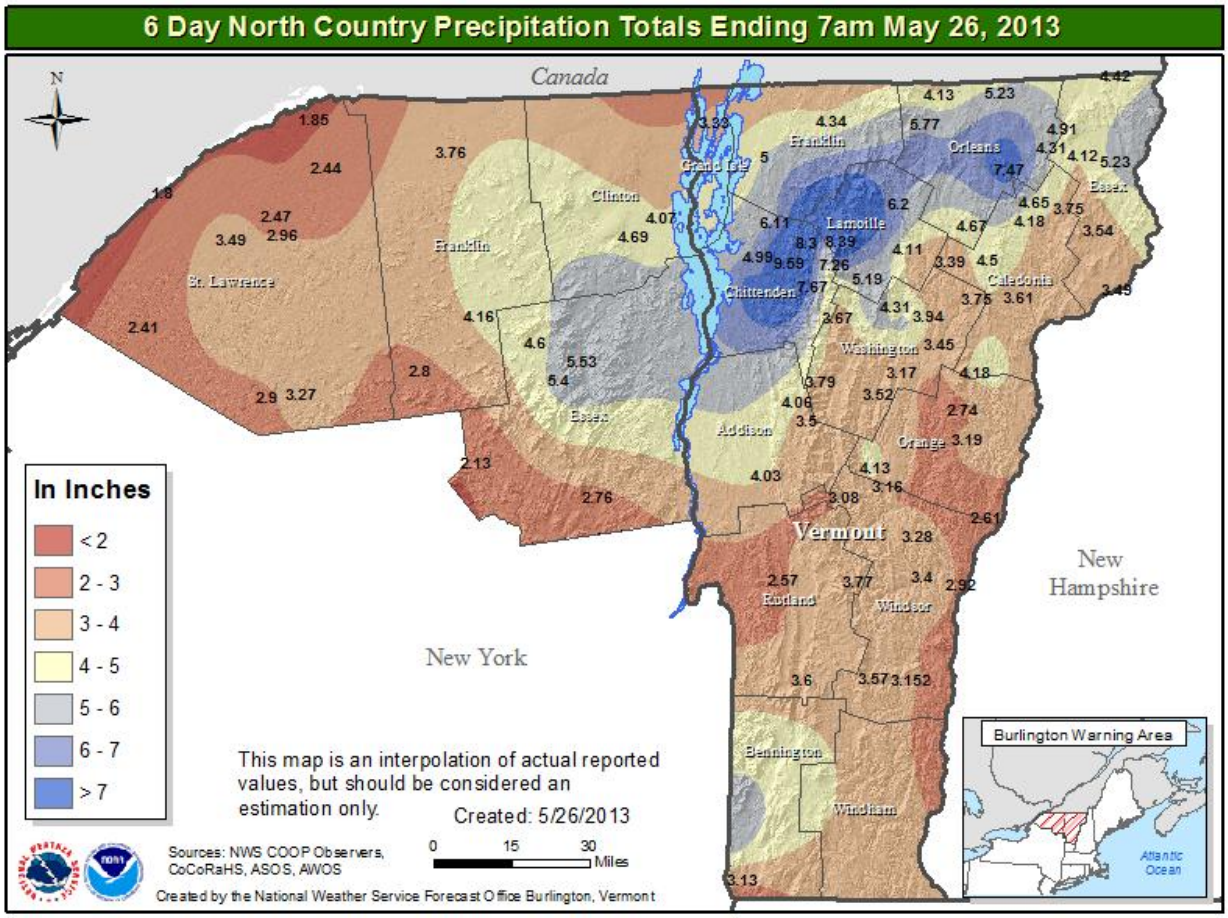

Figure 8: A 6 Day North Country precipitation total map ending at 7 AM on 26 May 2013.

Figure 9: Flash flood damage on 23 May 2013.

Figure 10: Flash flood damage on 23 May 2013.

Figure 11: The intersection of Route 15 and Cilley Hill Road and associated damage from flash flooding.