

**Southwest to Eastern U.S. Winter Storm  
21-27 November 2013  
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**Meteorological Overview:** A deep upper level trough over northern California drifted southward off the southern California coast by 0000 UTC on 22 November, 2013 (Fig 1). By this time, the trough had deepened to a closed low and had become cut off from the main upper level jet. The low remained in a stable condition with very little movement for the next 36 hours. During this time, strong south to southwesterly flow across the desert Southwest lead to heavy precipitation in favored upslope locations from central Arizona to southwest Colorado and southern Utah. The upper low finally began to weaken and progress eastward by 1200 UTC on 24 November. As the low drifted over Arizona northerly upslope flow lead to heavy snowfall over portions of southern Nevada and southern California.

Meanwhile in the southern Plains, a cold front was pushing through the region between 0000 UTC and 1200 UTC on 22 November. A strong surface high settled in across the central Plains leading to a strong east to northeasterly flow in southern High Plains. The region was located in a favorable area with respect to the upper level jet and vertical ascent was aided by upslope flow leading to the development of an area of snow by 1200 UTC on 22 November. Further south across central Texas, a shallow layer of cold air was over run by a warmer southeasterly low level jet. With increasing low level moisture due to the southeasterly jet off the Gulf of Mexico, a broad area of light to moderate precipitation developed over much central Texas and Oklahoma between 1200 UTC 24 November and 0000 UTC 25 November. Much of that precipitation fell in the form of freezing rain and sleet.

With the upper level low ejecting into the southern Plains on 25 November the precipitation began to organize into a more linear structure across eastern Texas and into the lower Mississippi Valley. A surface low that developed in the western Gulf of Mexico began to interact with the upper low by 0000 UTC on 26 November. At the same time, the upper low in the southern Plains began to phase with a northern stream system. The phasing of the northern and southern stream systems led to a very broad area of ascent over the eastern U.S. A strengthening southerly low level jet across the Southeast drew much more moisture up the east coast. The combination lead to a broadening of the precipitation shield northeastward ahead of the now phased upper trough. The surface low in the Gulf tracked up the east coast over the next 24 hours, but well inland. Cold air damming lead to pockets of freezing rain up the eastern slopes of the Appalachians. West of the Appalachians across portions of the lower Great Lakes, the atmosphere remained cold enough to support snow through the event. A secondary cold front tracking through the Great Lakes reinforced to cold air and

provided westerly upslope flow. This led to enhanced snowfall totals across the Allegheny Plateau and into western New York.

**Impacts:** Heavy rainfall of over 5 inches fell across portions of Arizona. Heavy rainfall of 1 to 4 inches fell across a broad area of the Southeast U.S. and up the east coast. Heavy snow in the higher terrain of the Southwest on the order of 1 to 3 feet (Fig 2). Up to 1 foot of snow across the lower Great Lakes (Fig 3). Significant icing occurred from central Texas into portions of the mid Mississippi Valley as well as portions of the Appalachians. Gusty winds up to 60 mph were observed all along the storm track across the southern U.S. and up the east coast. The combination of wind, heavy rain, and wintry precipitation led to flight delays across the country for the Thanksgiving holiday. The storm was blamed for at least 13 deaths.

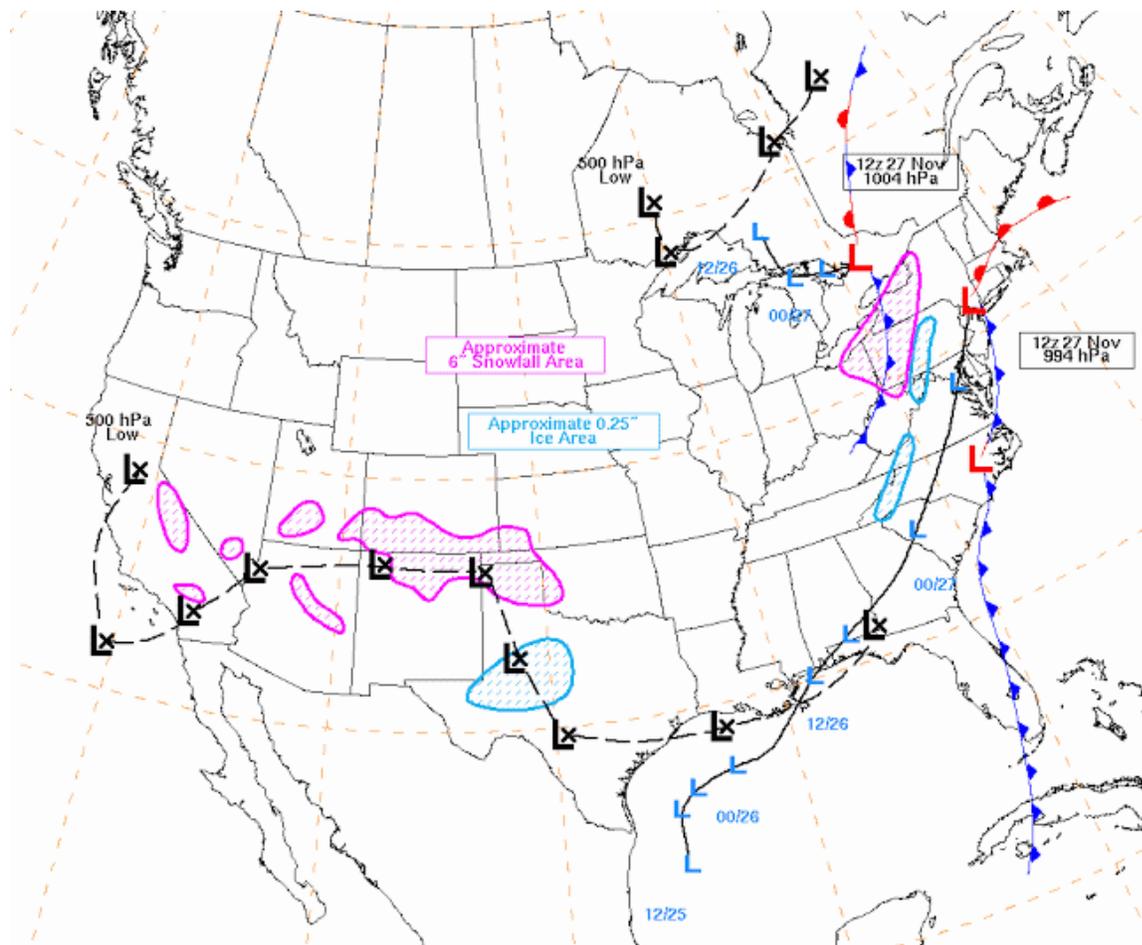


Figure 1. Surface low track (light blue), 500 hPa low track (black), surface frontal analysis from 1200 UTC 27 November, 2013, approximate area of 6" snowfall (pink), and approximate area of 0.25" ice accumulation.

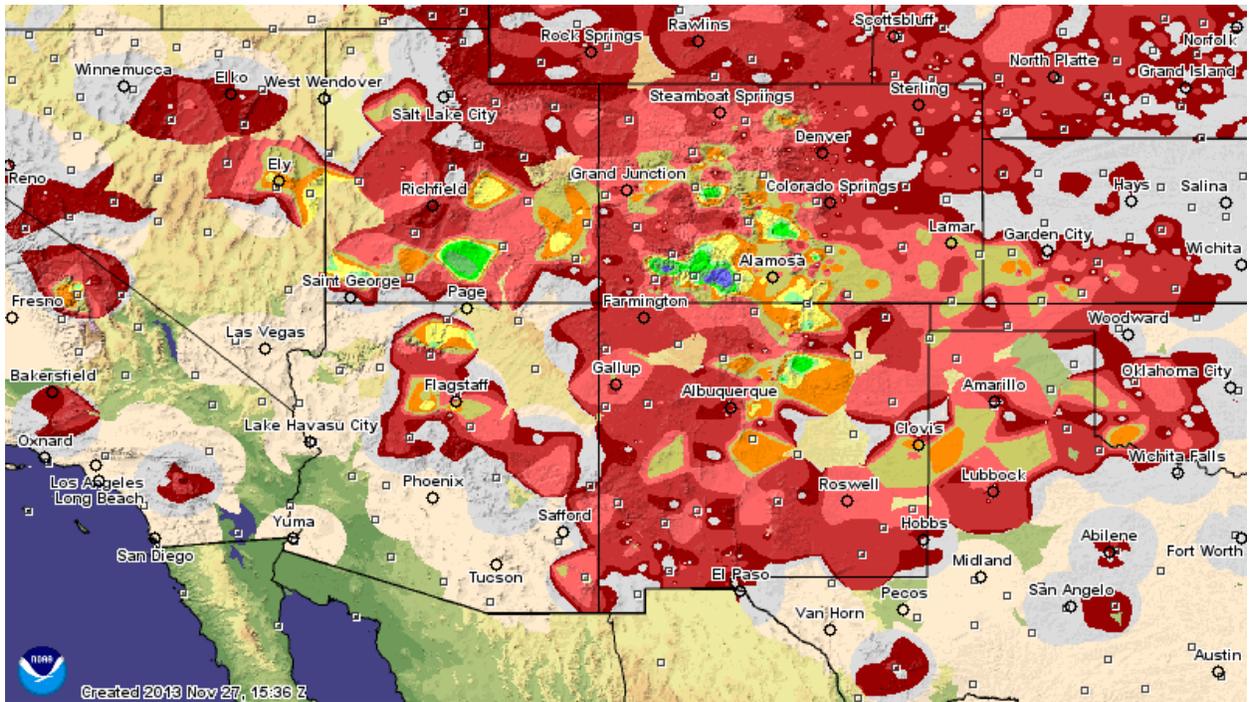


Figure 2. 72 hour snowfall ending 1200 UTC 24 November, 2013 (National Operational Hydrologic Remote Sensing Center)

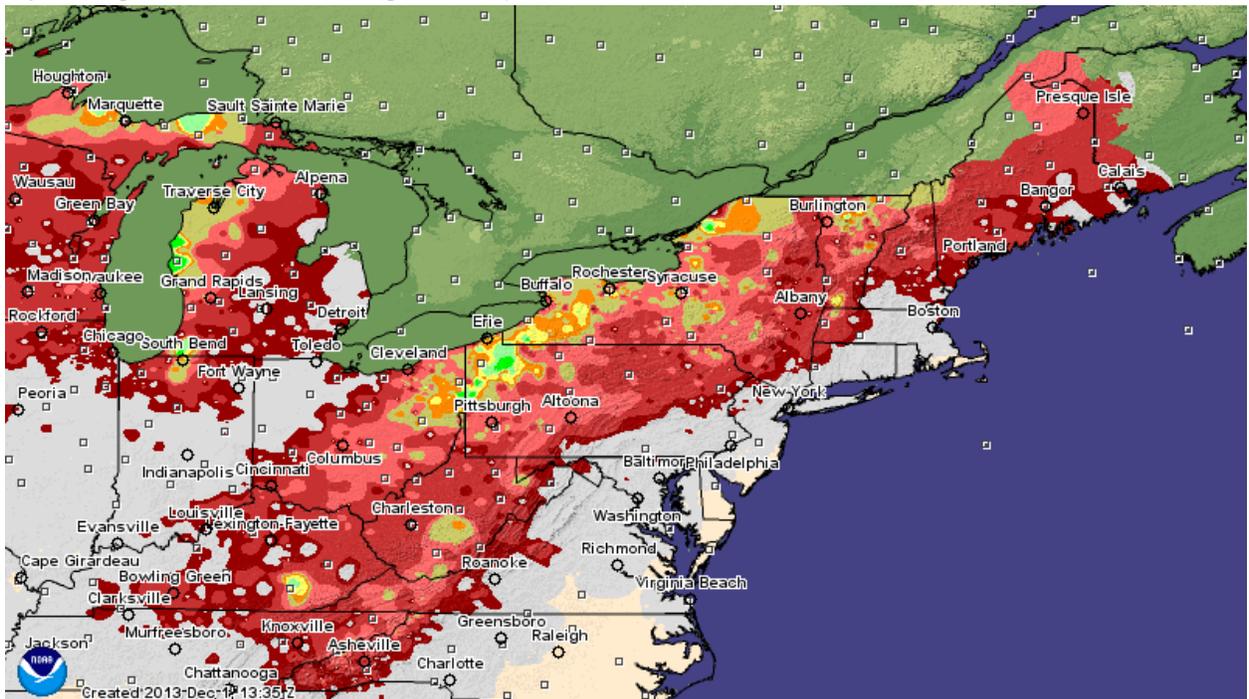


Figure 3. 72 hour snowfall ending 1200 UTC 28 November, 2013 (National Operational Hydrologic Remote Sensing Center)