Western and Central U.S. Winter Storm – 13-16 December, 2015
By: Brendon Rubin-Oster, WPC Meteorologist

Meteorological Overview:

A pair of winter storms affected a region spanning the central Great Basin eastward through the Rockies and into the central/northern Plains during the middle of December. The initial quasi-zonal flow regime quickly gave way to a much higher amplitude pattern as strong jet energy over the Pacific surged into the western United States. The two powerful systems which evolved occurred within only a couple of days of one another with the lead shortwave generally taking a more southern track through the Four Corners region, while the other tracked into the central High Plains (Figure 1). Ultimately, the combination of these winter storms led to significant snowfall accumulations centered across the Ruby and Wasatch Ranges eastward through the central/northern Rockies and into Nebraska and South Dakota (Figure 2). Based on available observations, the highest snowfall total was over Smith Creek, NV (7,600 foot elevation) where 33 in. was reported. Meanwhile, Salt Lake City International Airport (SLC) saw 9.5 in. fall which was their highest amount in 3 years.

This multi-day event commenced across the Desert Southwest as right-entrance region jet forcing in advance of a progressive shortwave produced widespread precipitation across the southwestern states. Isolated pockets of heavier showers were noted within a region of steepening mid-level lapse rates in excess of 8°C/km. The upper trough would continue to advance eastward toward the southern High Plains on the morning of 13 December where a closed mid-level low center would develop leading to a sharp increase in low-level moisture flux advection. While the closed low itself produced widespread instability-driven showers, the more abundant shield of precipitation was located across the southern/central Plains. Low-level temperature profiles were somewhat border-line for wintry precipitation which limited snowfall amounts across the region. However, 3-6 in. reports were commonplace from the Texas Panhandle northeastward to central Kansas in spite of these limitations.

The subsequent system produced much larger snowfall accumulations as it tracked from northern California to the Central Rockies from the evening of 13 December to early on 15 December. Before the shortwave migrated inland, intense low-to-mid level westerly onshore flow (in excess of 50 knots at 700 hPa) spread heavy precipitation across Oregon into Idaho, mostly in the form of snow over the higher elevations. Eventually strong mid-level height falls accompanying the parent shortwave would bring abundant snowfall to the Sierra Nevada range eastward to the Wasatch where widespread 1-2 feet accumulations fell. As an associated 500 hPa speed maxima (100 knots) swung through the Texas/Oklahoma panhandles, a strong area of 850-700-hPa frontogenesis took shape from the Nebraska panhandle back toward eastern Colorado where moderate upslope flow ensued (Figure 3a). The combination of strong low-level orographic ascent coupled with enhanced diffluence aloft via left exit region jet dynamics aided in sufficient heavy snowfall across areas of the central Rockies into the Colorado Front Range (Figure 3b). Model objective analyses indicated this was a region of modest conditional symmetric instability (equivalent potential vorticity values (EPV) < 0). Eventually this activity would translate northeastward as the surface cyclone lifted toward the middle Mississippi Valley and Upper Midwest before the system moved across the international border into Ontario.

Impacts:

The effects from this multi-day winter storm were far reaching ranging from flooding due to the heavy rainfall across northern California and southwestern Oregon to interstate closures over sections of I-80 and I-25 across Wyoming from the impacts of the wintry precipitation. To the north across Minnesota, one indirect fatality was reported due to the icy road conditions. The impacts on travel extended to the air where over 350 flights were canceled at Denver

International Airport on 15 December. Total monetary damage of $59 thousand was reported for this event, primarily the result of heavy snow and strong winds.

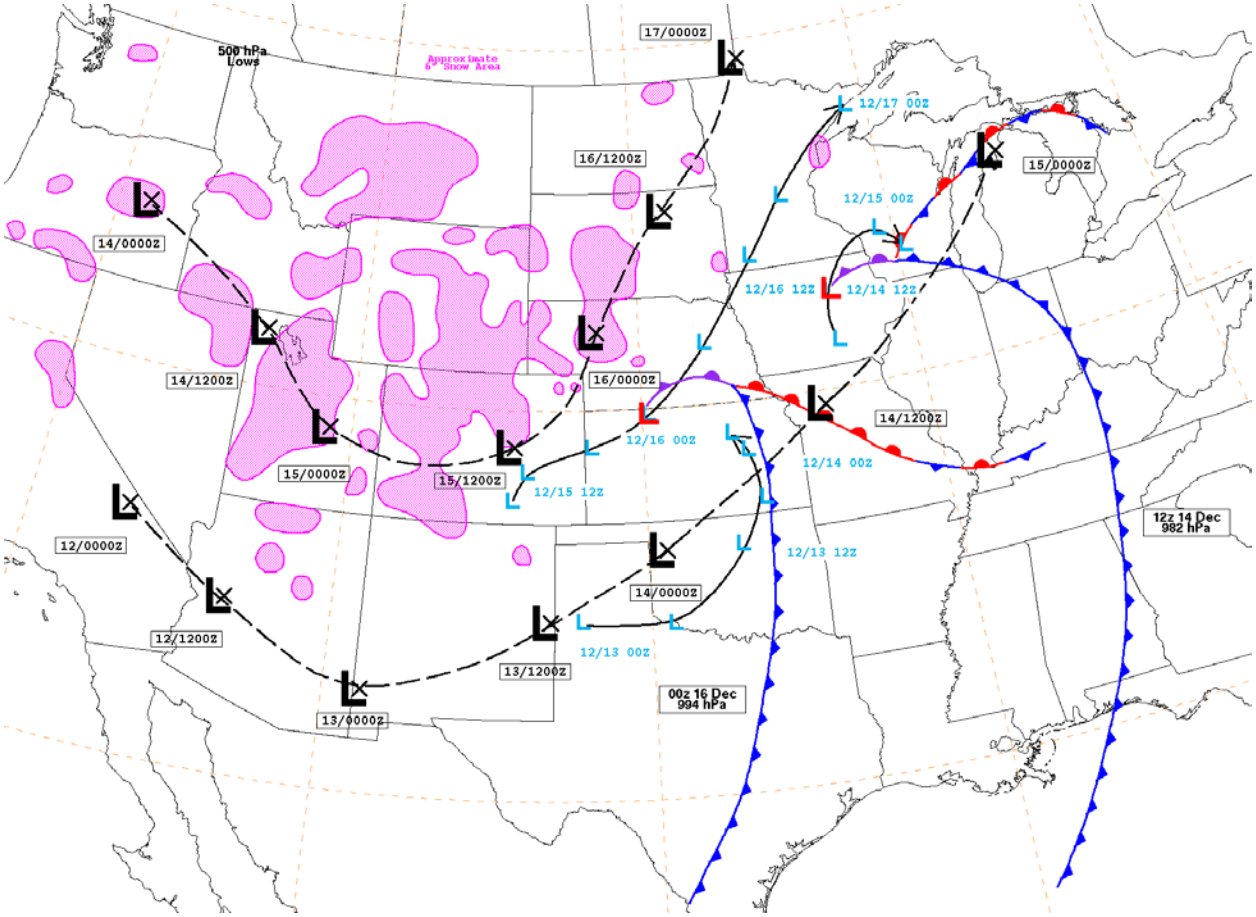

Figure 1: 500 hPa low tracks (black), surface low track (light blue), frontal analyses at 12 UTC on 14 December/00 UTC on 16 December, and snowfall axis 6 in. or more (pink)

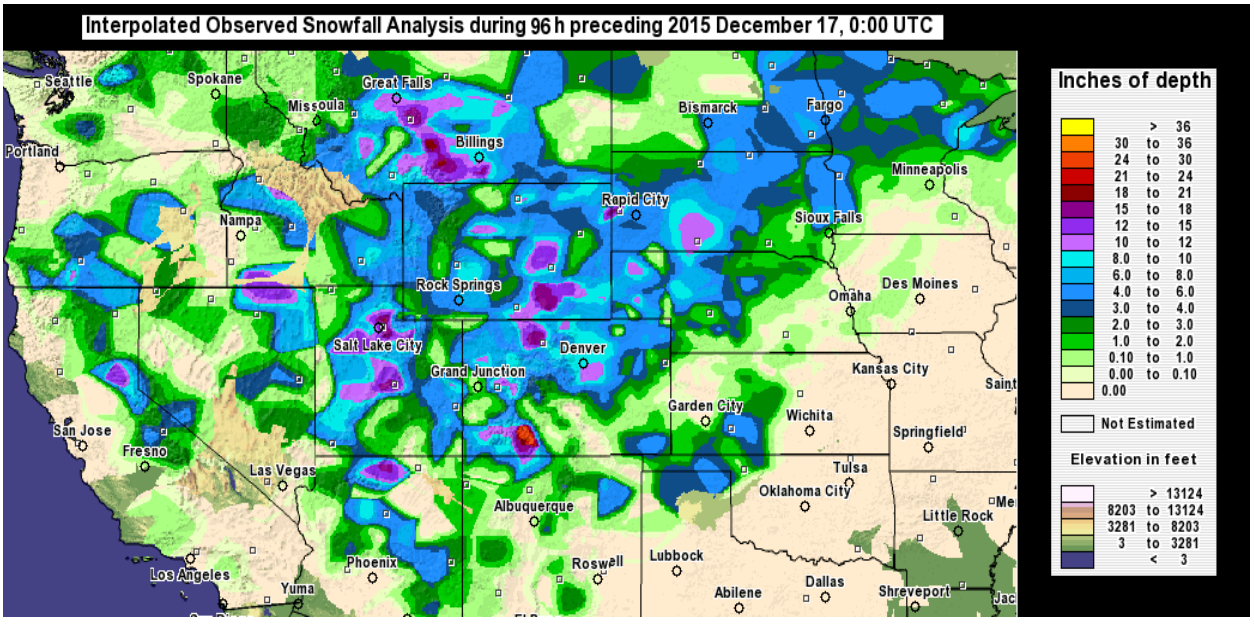

Figure 2: Total snowfall (inches) during the 13-16 December winter storm (image from National Operational Hydrologic Remote Sensing Center)

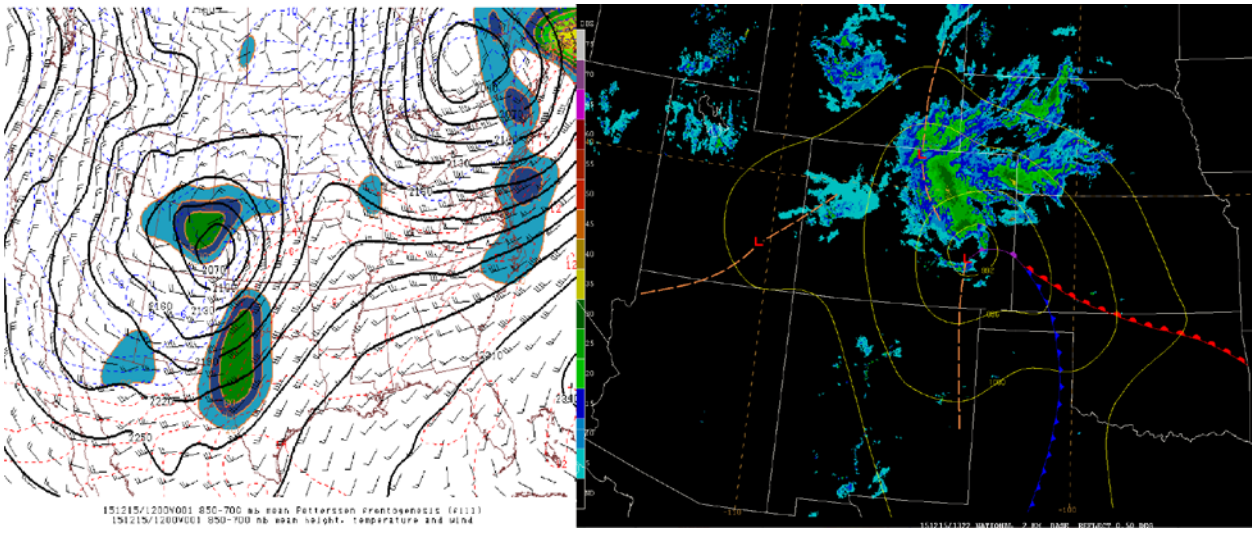

Figure 3: (a) 850-700 hPa mean Petterssen frontogenesis (fill), heights, temperatures, and wind (image created from the Storm Prediction Center mesoanalysis archives) (b) Radar imagery and 12 UTC surface analysis on 15 December