

Intense Cold Wave of February 2011

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Synopsis

On Tuesday, February 1st, 2011, an intense arctic air mass moved into southern New Mexico and Far West Texas, while an upper-level trough moved in from the north. The system brought locally heavy snowfall to portions of the area on the night of Feb 1st and into the afternoon of the 2nd, and was followed by several days of sub-freezing temperatures. Temperatures in El Paso rose no higher than the upper 10s (°F) on February 2nd and 3rd. The prolonged cold weather caused widespread failures of infrastructure. Water and Gas utilities suffered from broken pipes and mains, with water leaks flooding several homes. At El Paso Electric, all eight primary power generators failed due to freezing conditions. While energy was brought into the area from elsewhere on the grid, rolling blackouts were implemented during peak electric use hours. Even as temperatures warmed up, water shortages continued to affect the El Paso and Sunland Park areas, as failed pumps caused reservoirs to quickly dry up.

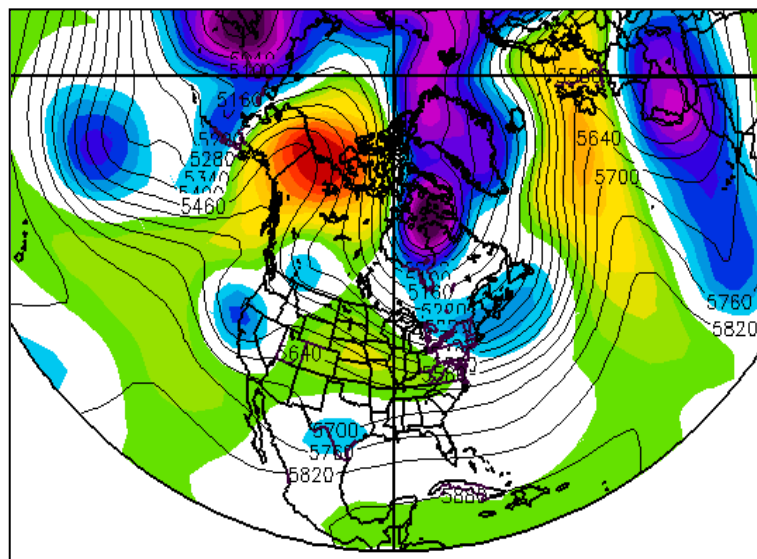


Figure 1 – Mean 500mb Heights for 01/30/2011 with shaded Anomalies, from NCEP Reanalysis (NOAA/ESRL).

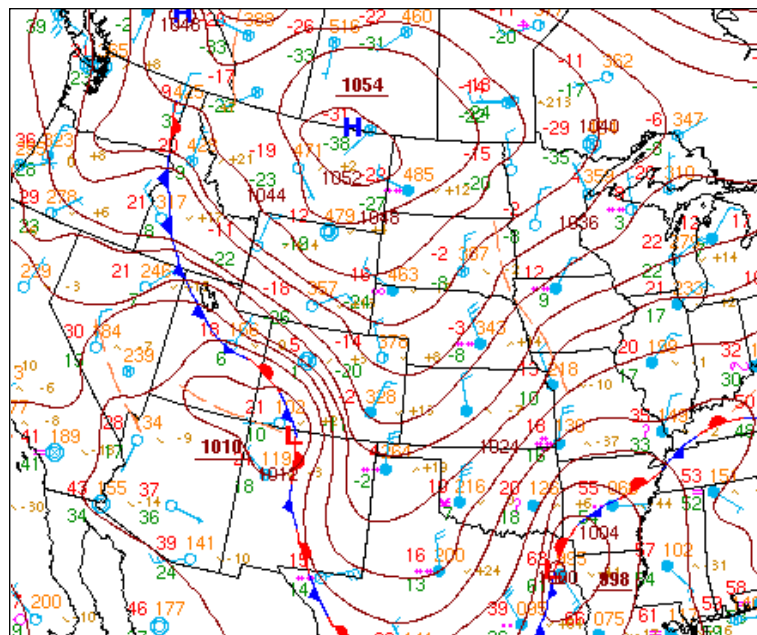


Figure 2 – Surface Plot and HPC Analysis from 12z (5am MST) 02/01/2011.

Meteorological Summary

On Sunday, January 30th, a strong and sharply-defined upper level high pressure ridge was building across western Canada into the Arctic Ocean **[Figure 1]**. Northerly flow to the east of the Ridge allowed cold air from the polar regions to begin flowing south into the Yukon and Northwest Territories. By the next morning, temperatures in the -30 and -40s (°F) were common across northern Alberta and Saskatchewan, under a strengthening 1048 millibar (mb) surface high.

The cold air quickly flowed southward down the Great Plains, remaining east of the Rocky Mountains. By Monday Evening (1/31), sub-zero temperatures had made it into Nebraska, with lower 20s sneaking into the Eastern Plains of New Mexico.

By Tuesday morning (2/1), the colder air had pushed deep into Central Texas, with single-digit temperatures reported across the Texas Panhandle **[Figure 2]**. The surface high had strengthened to 1054mb (it would peak a few hours later at 1055mb over eastern Montana). However, morning upper air soundings indicated that at the southern portion of the Arctic air mass was rather shallow, extending only up to about 6,000ft MSL **[Figure 3]**.

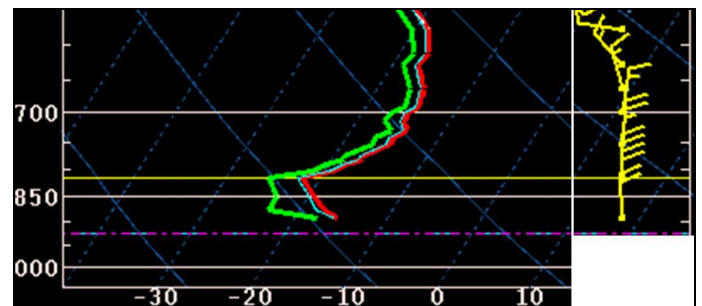


Figure 3 – Portion of Skew-T plot from Amarillo, TX at 12z (5am MST) 02/01/2011 showing shallow leading edge to the approaching arctic air mass.

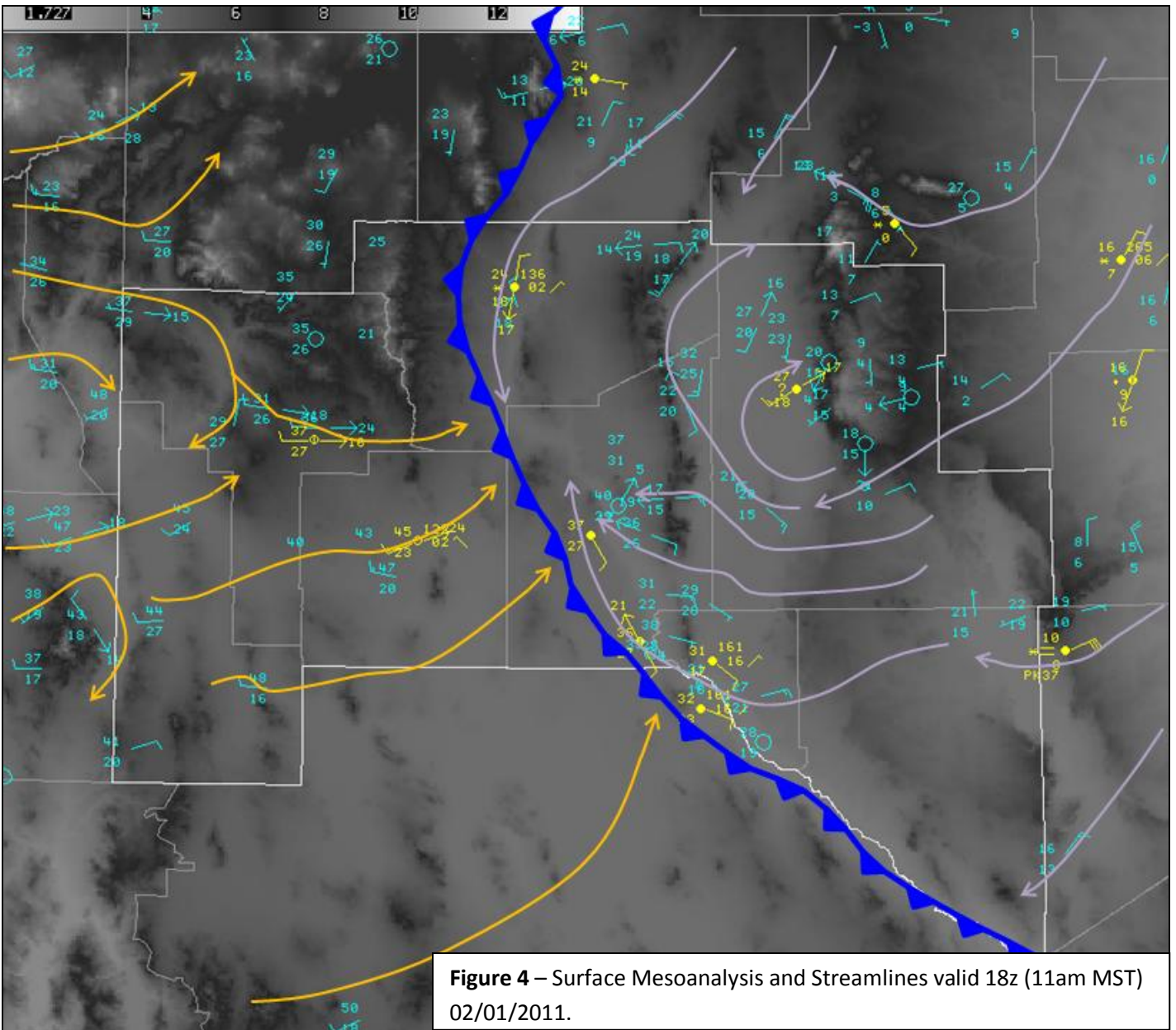


Figure 4 – Surface Mesoanalysis and Streamlines valid 18z (11am MST) 02/01/2011.

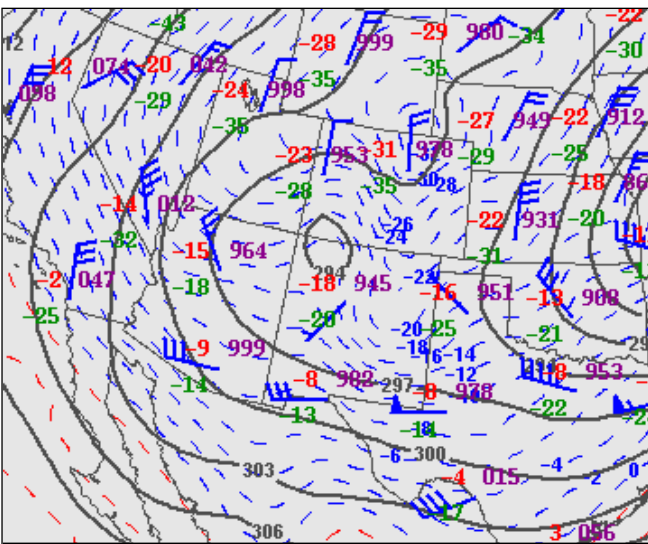


Figure 5 – 700mb Analysis valid 00z 02/02/2011 (5pm MST 02/01/2011), showing upper low over the Four Corners Region.

By 11am, the leading edge of the colder air had filtered into the Rio Grande Valley, with the shallow, but dense mass of colder air flowing around the higher terrain [Figure 4]. By late afternoon, large temperature contrasts had developed between the Rio Grande Valley and the Tularosa Basin. By 4pm, temperatures in West El Paso were in the upper 30s, while middle 20s were in place east of the Franklin Mountains. In Las Cruces, temperatures reached the lower 40s, while it was in the lower 20s just on the other side of the Organ Mountains at White Sands Missile Range Headquarters.

Meanwhile...a deepening upper level low approached the area from the Four Corners region [Figure 5]. Increasing westerly winds aloft resulted in isentropic ascent up and over the denser cold air mass, while positive vorticity advection aloft increased, and a 140-knot jet streak over the area provided divergence aloft [Figure 6]. Combined, these factors led to increasing lift over the region, allowing precipitation to spread across the area.

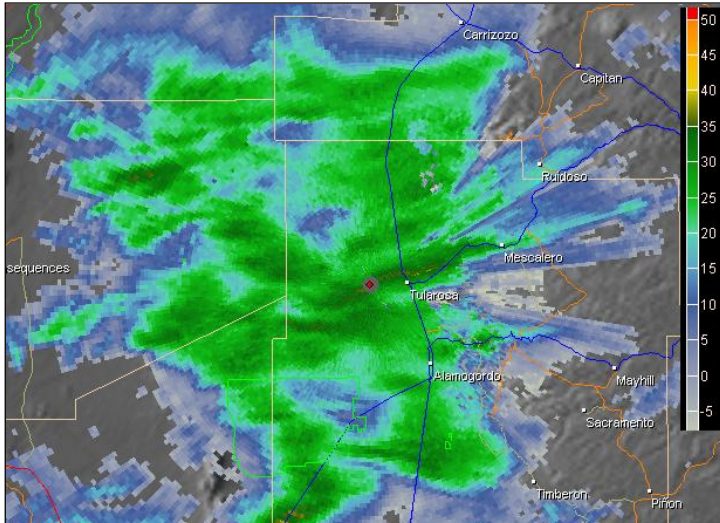
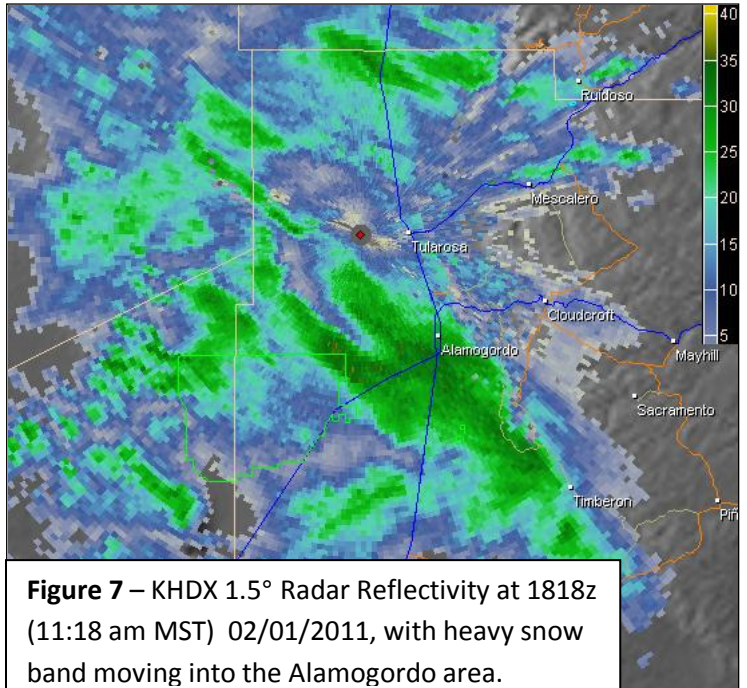
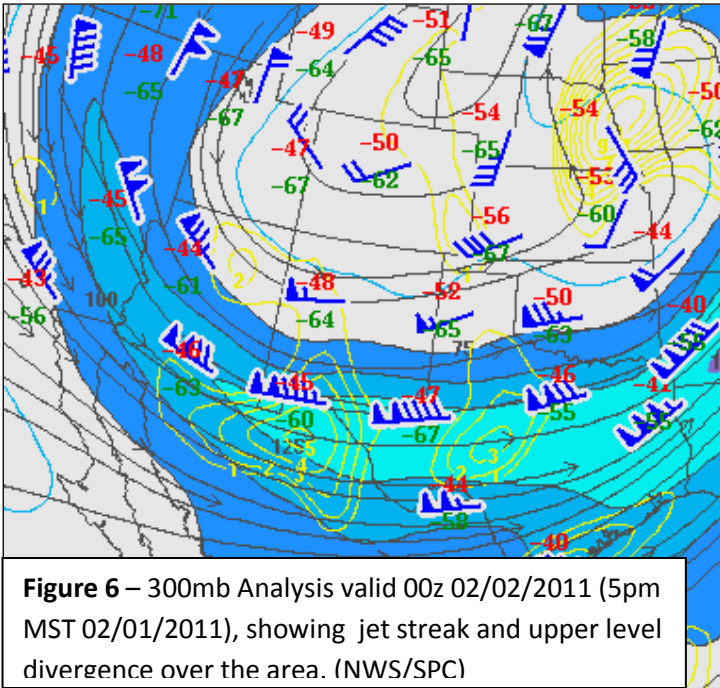


Figure 8 – KHDx 1.5° Radar Reflectivity at 0224z 02/02/2011 (7:24 pm 2/1 MST), showing banded snow increasing in coverage.

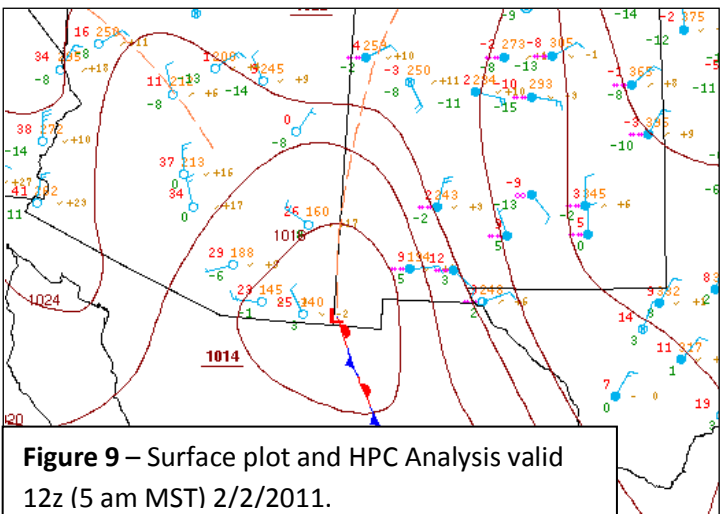


Figure 9 – Surface plot and HPC Analysis valid 12z (5 am MST) 2/2/2011.

Heavy snow bands affected parts of northern Otero County during the late morning [Figure 7] and evening hours of 2/1, dropping visibility to less than a quarter of a mile at times. Radar echoes indicated mesoscale banding, which increased as the evening hours approached [Figure 8].

During the overnight hours of 2/1, the cold front made a second push to the west, reaching the Arizona border by dawn on Wednesday 2/2 [Figure 9].

Snow continued overnight and into the morning hours of Wednesday 2/2, tapering off over most of Otero County by midday, while light snow continued over the Borderland through the mid-afternoon. Cloud cover remained in place over El Paso [Figure 10], helping to hold temperatures in the mid-teens, setting records for cold maximum temperatures.

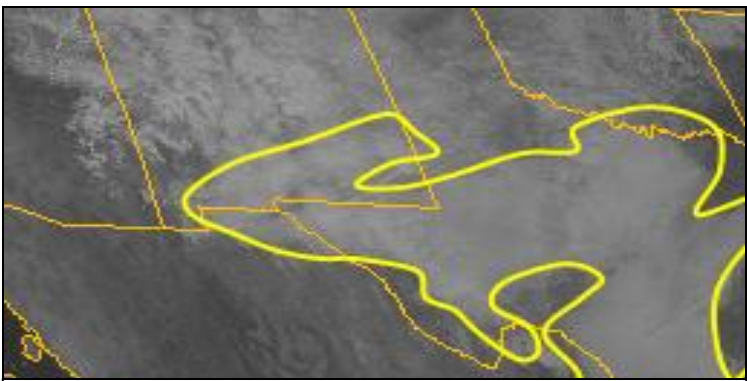


Figure 10 – Visible Satellite Image from 21z (2pm MST) 2/2/2011. Cloudy areas outlined in yellow to distinguish from snow covered ground.

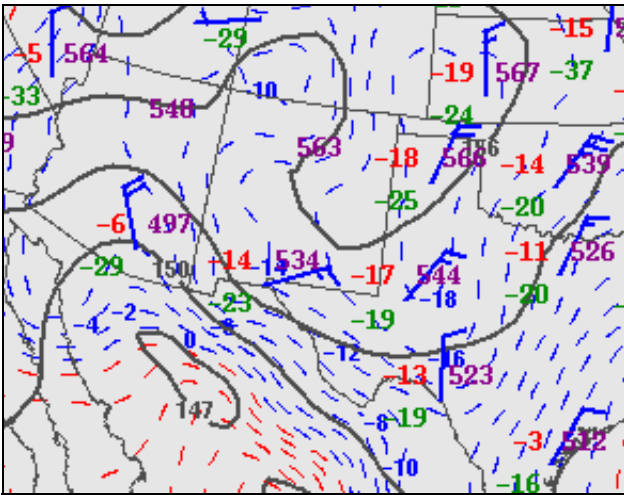


Figure 11 – 850mb Plot valid 00z 2/3/2011 (5pm 2/2 MST). Coldest air remained over the Texas Panhandle, poised to move into El Paso.

Upstream upper air observations on 2/2 indicated that the coldest air had yet to arrive, and trajectories indicated that the coldest part of the air mass would move into El Paso within 24 hours [Figure 11].

Clearing skies overnight coincided with the arrival of the coldest air aloft... allowing temperatures to plummet across the entire area. Low temperatures fell into the single digits in the El Paso area, and well below zero across the Sacramento Mountains.

The morning sounding from Santa Teresa, NM on Thursday 2/3 tied the unofficial station record for coldest 850mb Temperature, registering -17.9°C [Figure 12]. Temperature records higher aloft at 700mb still stood, indicating that historical cold air outbreaks, including one in January 1962, were associated with an even deeper arctic air mass.

Despite having nearly full sunshine on the 3rd, continued strong cold advection kept temperatures in the teens, with El Paso only reaching a Max Temperature of 18°F.

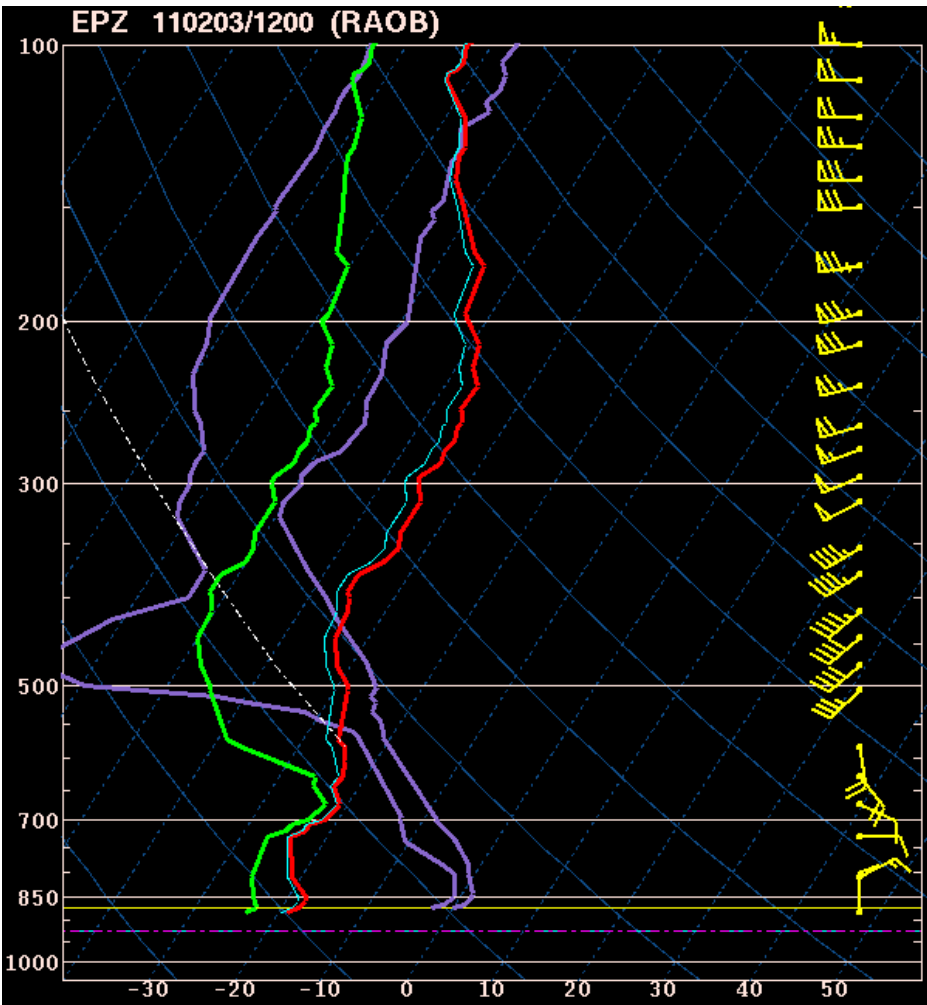


Figure 12 – Skew-T plot from Santa Teresa, NM RAOB at 12z (5am MST) 2/3 (Red/Green) during the peak of the cold wave (and record-tying 850mb Temperature). RAOB from same station, just ahead of the arctic front at 12z 2/1 is overlaid (Purple). Note significant cooling below about 550mb.

Temperatures once again plunged on the night of the 3rd across the area, but remained several degrees warmer than the previous night, the coldest air having moved out of the area.

Temperatures made a quick recovery on Friday the 4th, reaching a Maximum of 37°F at El Paso, ending the streak of Freezing Temperatures at 78 hours.

Temperatures dropped significantly on the night of the 4th, but remained in the teens across most lowland sites.

On Saturday the 5th, temperatures area-wide made an impressive recovery, reaching the upper 50s at El Paso, Las Cruces, and Deming. Snowpack held temperatures in the lower 40s over the northern Tularosa Basin.

By the Numbers

Snowfall amounts by Wednesday morning (2/2) were heaviest in the higher terrain of the Gila Region and especially the Sacramento Mountains, where up to 10 inches fell around the Cloudcroft area (Above 8000 ft MSL). Significant accumulations also fell in lowland areas, especially in the northern Tularosa Basin from Alamogordo and points north. 2 to 4 inch reports were common in Las Cruces. Reports in El Paso varied greatly, with a half inch in the Upper and Lower Valleys, 1 to 2 inches across the Westside, and 2 to 4 inches in the Northeast, where upslope flow along the east face of the Franklin Mountains enhanced snowfall rates. **Figure 13** contains a sample of snowfall reports received (both official and unofficial). Contours are based on reports and estimates, and accuracy is limited in areas with few or no reports.

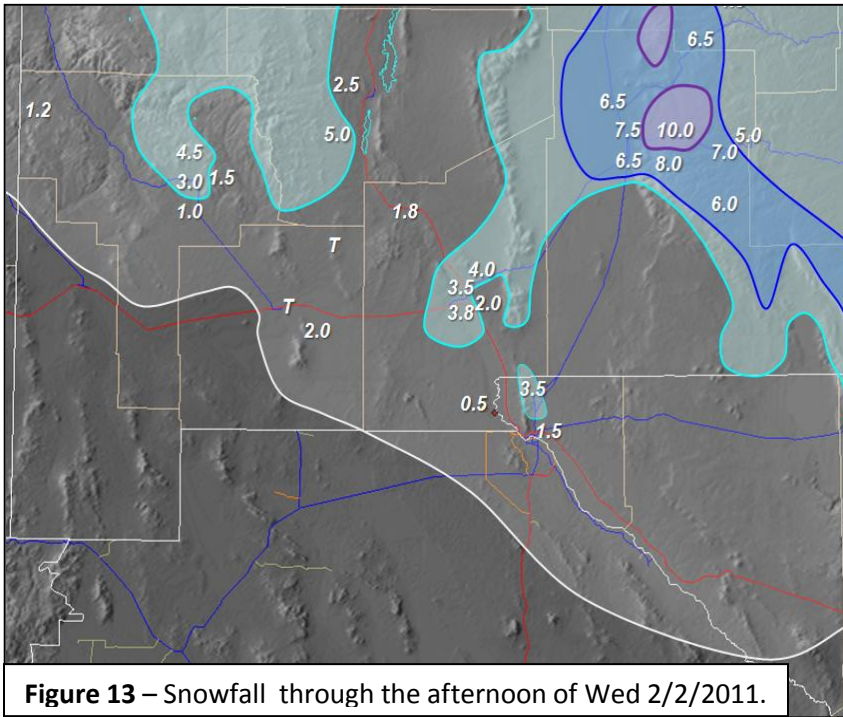


Figure 13 – Snowfall through the afternoon of Wed 2/2/2011.

Strong cold air advection and extensive cloud cover held back Maximum Temperatures well below freezing on Wednesday afternoon (2/2) [**Figure 14**]. Much of the Sacramento Mountains remained below zero through the day, while lowland areas east of the Continental Divide were stuck in the teens. At El Paso, an All-Time Record for Coldest Maximum Temperature was set at 15°F. This broke the previous record of 17°F, set in a similar Arctic Outbreak on January 10th, 1962.

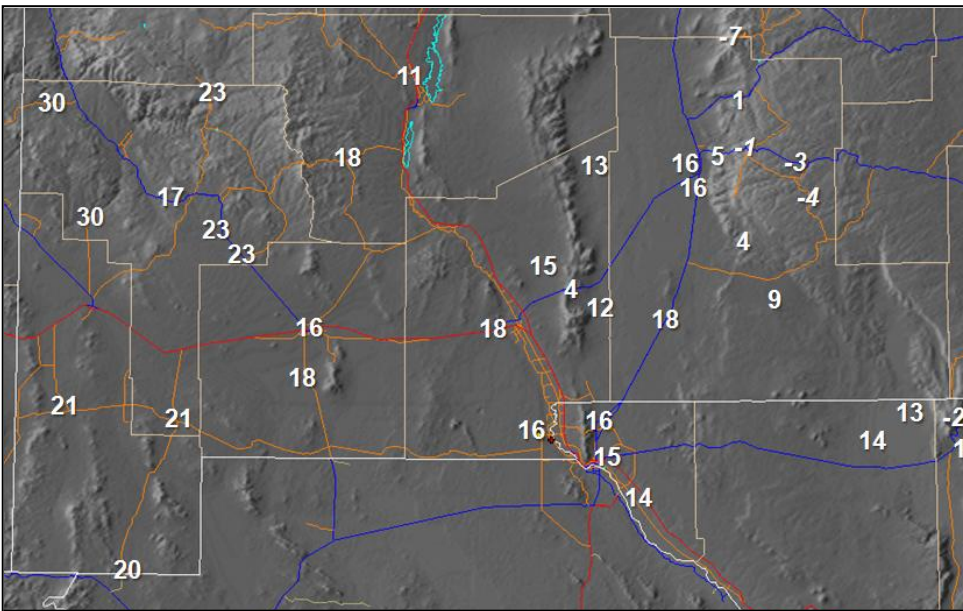


Figure 14 – Maximum Temperatures for Wednesday, Feb 2nd 2011
(Observations from a mix of official and unofficial sources)

The morning of February 3rd brought the coldest Minimum Temperatures to the region overall [**Figure 15**].

Temperatures were coldest over the Tularosa Basin and Sacramento Mountains. Temperatures bottomed out at -30°F at the Inn of the Mountain Gods near Mescalero, while most of the Cloudcroft area was in the lower -20s. Temperatures across the Tularosa basin ranged from -10 to -15°F.

In El Paso, temperatures ranged from a few degrees above, to a few degrees below zero. A steady breeze likely helped keep temperatures on the “warmer” side in this area.

Across Las Cruces, single digits below zero were commonplace, while sites in Jornada Range and Holman Well registered -20 and -12°F, respectively. Both locations are notorious cold spots for cold air drainage off the San Andres Mountains.

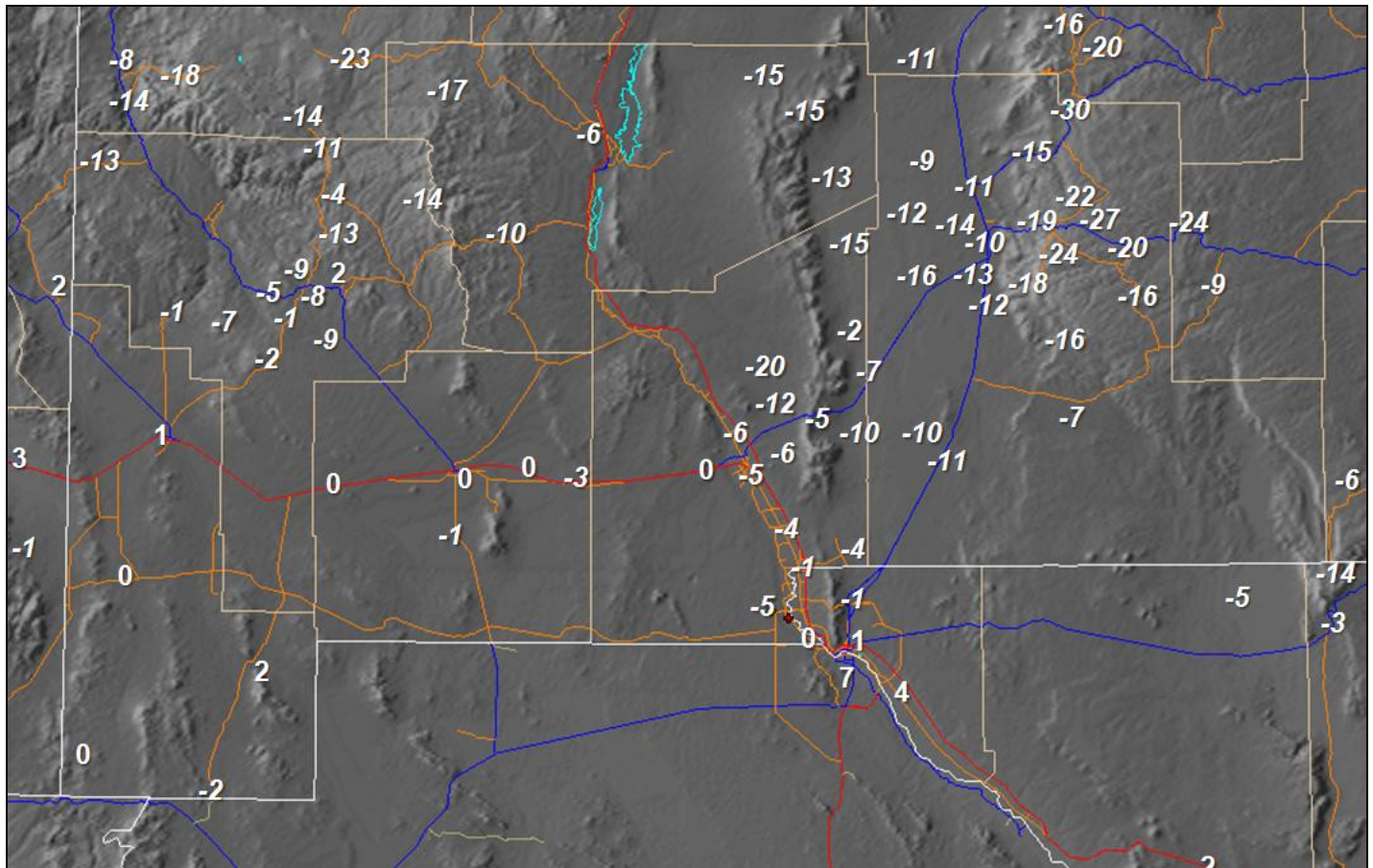


Figure 15 – Minimum Temperatures for Thursday, Feb 3rd 2011 (Official and Unofficial sources).

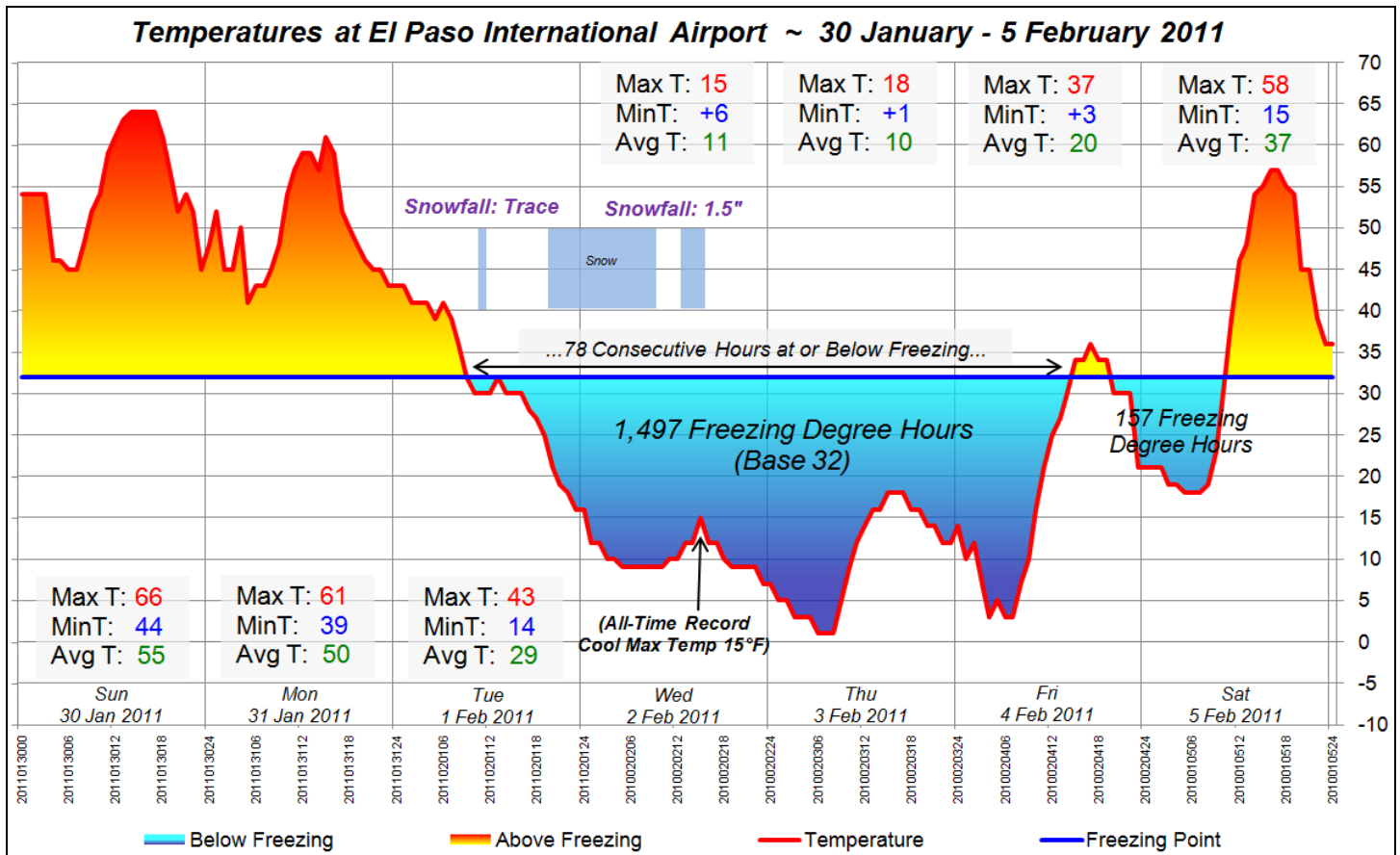


Figure 16 – Hourly thermograph for El Paso, TX, 30 January to 5 February 2011.

Temperatures were generally “milder” west of the Rio Grande, except in the Gila Region, where temperatures were several degrees below zero, varying with elevation.

By the end of the event, El Paso experienced freezing temperatures for 78 consecutive hours, and accumulated 1,497 Freezing Degree Hours [Figure 16]. (A freezing degree hour is defined here as the number of degrees at or below 32°F for each hourly observation, summed through the entire event. For example, if it is 32°F at 2pm, and 29°F at 3pm, 5 Freezing Degree Hours have been accumulated.)

The table below lists the total consecutive hours at or below freezing, and total Freezing Degree Hours at several observing stations across the region.

Location (Station)	Consecutive Hours ≤ 32°F	Freezing Degree Hours
Alamogordo (KALM AWOS)	103:20	2,305
Deming (KDMN ASOS)	67:39	1,468
El Paso (KELP ASOS)	78:00	1,497
Las Cruces (KLRU AWOS)	65:16	1,421
T-or-C (KTCS ASOS)	84:00	1,867

Climatological Perspective

Through the event and its aftermath, many have asked just how rare it is to have such a prolonged period of cold weather in the El Paso area. While there are many ways to look at the statistics and rank previous Cold Waves, by just about all metrics, at least for El Paso, this was not the worst Cold Wave on record. That dubious honor appears to belong to the Cold Wave of January 1962, although this 2011 was a close rival.

El Paso, TX - Consecutive Days with Max Temp ≤ 32°F (ending date)		El Paso, TX - Consecutive Days with Max Temp < 25°F (ending date)							
4 days+	7 Jan 1971, 3 Jan 1947 12 Jan 1962, 5 Jan 1949	2 days	3 Feb 2011, 11 Jan 1962 8 Jan 1913, 22 Dec 1887						
3 days+	29 Jan 1948, 23 Jan 1940 9 Jan 1913, 20 Jan 1909 23 Dec 1887	1 day	1 Feb 1985, 2 Feb 1956, 29 Jan 1949, 28 Jan 1948, 14 Feb 1895						
2 days+	3 Feb 2011, 16 Dec 1987 3 Feb 1956, 30 Jan 1949 12 Dec 1923, 9 Jan 1920 10 Jan 1906, 10 Dec 1898 15 Feb 1895, 10 Jan 1891	<table border="1"> <thead> <tr> <th colspan="2">El Paso, TX - Consecutive Days with Max Temp < 20°F (ending date)</th> </tr> </thead> <tbody> <tr> <td>2 days</td> <td>3 Feb 2011, 11 Jan 1962</td> </tr> <tr> <td>1 day</td> <td>28 Jan 1948</td> </tr> </tbody> </table>		El Paso, TX - Consecutive Days with Max Temp < 20°F (ending date)		2 days	3 Feb 2011, 11 Jan 1962	1 day	28 Jan 1948
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The tables above show that while there have been longer stretches with sub-freezing temperatures, most of them featured overall milder temperatures than the 2011 and 1962 events, as the list of dates quickly becomes shorter as you lower the temperature threshold.

Using Maximum Temperature can be deceiving, as the daily max temperature may have occurred for a very brief part of the day. The tables below instead use daily average temperature. One again, January 1962 emerges as an extreme event.

El Paso, TX - Consecutive Days with Average Temp < 20°F (ending date)	
4 days	7 Jan 1971
3 days	4 Feb 2011 , 12 Jan 1962, 9 Jan 1913, 23 Dec 1887
2 days	16 Dec 1987, 29 Nov 1976, 30 Jan 1949, 29 Jan 1948

El Paso, TX - Consecutive Days with Average Temp < 15°F (ending date)	
3 days	12 Jan 1962
2 days	3 Feb 2011 , 29 Jan 1948, 8 Jan 1913, 23 Dec 1887

The following table ranks Cold Waves in El Paso, TX by total number of Freezing Degree Hours. Using this metric, the January 1962 event comes out on top.

Simply looking at consecutive hours at or below freezing, the longest cold wave on record for El Paso stretched from late December 1946 through early January 1947. However, temperatures through this event were mainly in the 20s, and minimums did not drop below 10°F. As a result, very few Freezing Degree Hours were accumulated each day.

El Paso, TX Cold Waves Ranked by Freezing Degree Hours			
Ending Date	Consecutive Hours ≤ 32°F	Freezing Degree Hours	Frz Deg Hrs Hours ≤ 32°F
13 Jan 1962	93	1,943	20.9
10 Jan 1913	105	1,770	16.9
4 Feb 2011	78	1,497	19.2
30 Jan 1948	87	1,463	16.8
4 Jan 1947	114	1,097	9.6
17 Dec 1987	69	1,037	15.0

Corrigendum

02/22/2011 – Changed “On Monday, February 1st, 2011” to “On Tuesday, February 1st, 2011.”

03/31/2011 – Figure 15 included an erroneous Minimum Temperature of -21°F in northeast Alamogordo. This was removed, and replaced with a -10°F reading from northern Alamogordo. A sentence on page 5 which originally read, “While most of the Tularosa Basin was in the -10s, a few locations on the east side of Alamogordo reached -20°F” was likewise changed to read: “Temperatures across the Tularosa basin ranged from -10 to -15°F.”