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COMPARISON OF NORTH PLATTE ASOS MAXIMUM AND MINIMUM TEMPERATURES TO LOCAL SURROUNDING AREA

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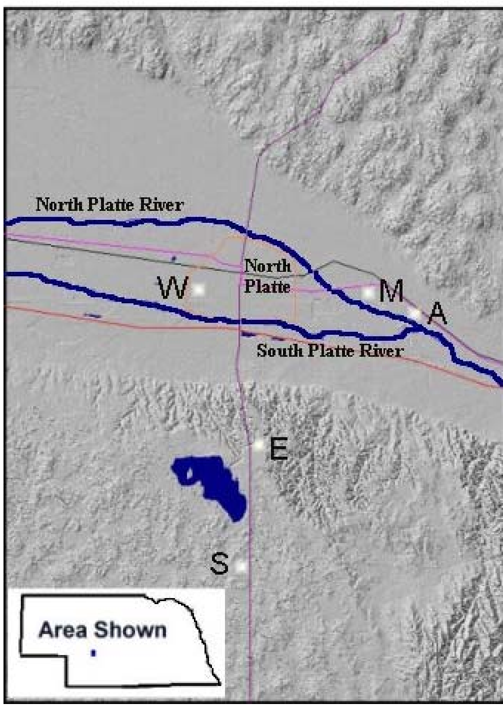
1. Introduction

At the National Weather Service (NWS) office in North Platte, maximum and minimum temperature forecasts for city of North Platte and surrounding area of Lincoln County are measured against the Automated Surface Observing System (ASOS) at Lee Bird Field for verification purposes. The ASOS is located in the airfield more than one mile east of the NWS office and several miles east of the city of North Platte. The airport and city of North Platte are located in the relatively flat Platte River Valley with higher rolling sand hills to the north and more gentle rolling farmland on a plateau that rises abruptly to the south of the city. An overview of the terrain can be seen in Figure 1.



W - Site W (West North Platte)
- 6.7 miles west of ASOS
- elevation: 2819 feet msl

S - Site S (10 South North Platte COOP Site)
- 9.5 miles south -southwest of ASOS
- elevation: 3068 feet msl

E - Site E (Experimental Farm COOP Site)
- 6.5 miles southwest of ASOS
- elevation: 3050 feet msl

M - Site M (National Weather Service MMTS)
- 1.3 miles west-northwest of ASOS
- elevation: 2785 feet msl

A - Site A (LBF ASOS at Lee Bird Field)
-elevation: 2778 feet msl

Figure 1. Terrain map showing ASOS and comparative Sites.

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The ASOS site, while optimal for the measurement of meteorological data for aviation purposes, occasionally produces maximum and minimum temperatures that are unrepresentative of nearby North Platte and surrounding countryside. An overall cool temperature tendency has been well documented through numerous comparison studies at other locations nationwide when ASOS was first implemented in the mid 1990s (Griffith 1995; Grosshans 1992; Lamberty and Noel1994; Lashley 1994; Noahan 1995; Sheets 1997; Woodworth 1994). Locally, forecasters have long had the perception that the ASOS often produces unrepresentative values, especially with respect to minimum temperatures. However, no formal study or comparison has been carried out to quantify the magnitude of the differences, or determine which weather regimes result in the greatest temperature variations in the area around North Platte. This study was carried out to measure the former and possibly stimulate future interest and research into the latter.

2. Methodology

Monthly average high and low temperatures from the North Platte airport ASOS were compared to readings from four other temperature recording sites within a ten mile radius over a one year period. Figure 1 shows the location of the North Platte ASOS, surrounding temperature recording sites utilized for comparison, and terrain of the region.

Two of the comparative sites are located in the Platte River Valley. The MMTS (Maximum Minimum Temperature Sensor), further referenced as "Site M", is located just outside the NWS office, which is the closest of the sites to the ASOS. This temperature sensor is the same as those used at NWS cooperative observer (COOP) sites. At the North Platte NWS office, it is used for backup purposes only. It is about seven feet higher in elevation than the ASOS sensor.

The other site in the valley is near the west edge of the city of North Platte, referenced as "site W". This site consists of an Oregon Scientific wireless maximum/minimum thermometer located in a cotton region shelter. It is about 49 feet higher in elevation than ASOS. Daily high and low temperatures are measured around midnight local standard time at this site as well as at site M. ASOS also follows this standard, by recording the daily extremes at midnight.

The other two other comparative sites, Experimental Farm COOP (Site E), and 10 Miles South of North Platte COOP (Site S), are located in the higher terrain above and to the south of the valley, about 300 feet higher in elevation. Their distance is roughly 6.5 and 9.5 miles south-southwest of the North Platte ASOS, respectively. Both utilize MMTS equipment to measure maximum and minimum temperatures as does the backup at the NWS office. The difference, however, is that observers at these sites record temperature daily extremes and reset the equipment at 7 am LST, which made direct daily temperature comparisons to the other sites that reset at midnight rather difficult.

Monthly average maximum and minimum temperature data from the months of May 1999 through April 2000 were used in this comparison. This data set was nearly complete for ASOS and the NWS cooperative stations. The exception was the experimental farm site (Site E), where data for the month of September 1999 was unavailable.

Data was much more limited for Sites W and M. An average of five days per month were missing or not available from one or more of these sites. To ensure consistency, only days with complete data sets from all three sources (ASOS and Sites W and M) were used in calculating monthly averages. Table 1 shows the number of days with complete data for the two valley sites, listed by highs and lows. From the bottom row, it can be seen that complete data was available about for about 88 percent of the days during the twelve month period. By contrast, the complete data set (except the month of September) was used to calculate monthly high and low temperature averages and differences for Site E, Site S and, and ASOS. Because the missing data occurred on a random basis throughout the year at sites W and M, the data set was considered to be statistically representative. This resulted in a statistical database about 12 percent smaller for Sites W and M than for E and S, which was not deemed to significantly affect the comparative findings in this paper.

Table 1. Listing of number of days with complete data from ASOS, Site W, and Site M, and percent of possible for each month.

Month	Number of complete days: Highs and percent	Number of complete days: Lows and percent
May	26/31 84%	25/31 81%
June	25/30 83%	26/30 87%
July	27/31 87%	27/31 87%
August	26/31 84%	25/31 81%
September	25/30 83%	25/30 83%
October	28/31 90%	28/31 90%
November	24/30 80%	29/30 97%
December	25/31 81%	25/31 81%
January	26/31 84%	28/31 90%
February	29/29 100%	29/29 100%
March	27/31 87%	27/31 87%
April	29/30 97%	29/30 97%
12 month total	317/366 87%	323/366 88%

3. Comparison

The most pronounced temperature differences showed up in the comparison of monthly average low temperatures. ASOS averaged around two degrees colder than the other four comparative sites over the 12 month period. Figure 2 shows how the average differences varied throughout the year. The actual average low temperatures for the five sites can be seen in Table 2. The winter months of November through January showed the greatest differences, with lows averaging from 3.5 to 4.5 degrees warmer than those reported by ASOS. The smallest differences were noted during the summer months of June through August, with differences between .5 and 1.5 degrees.

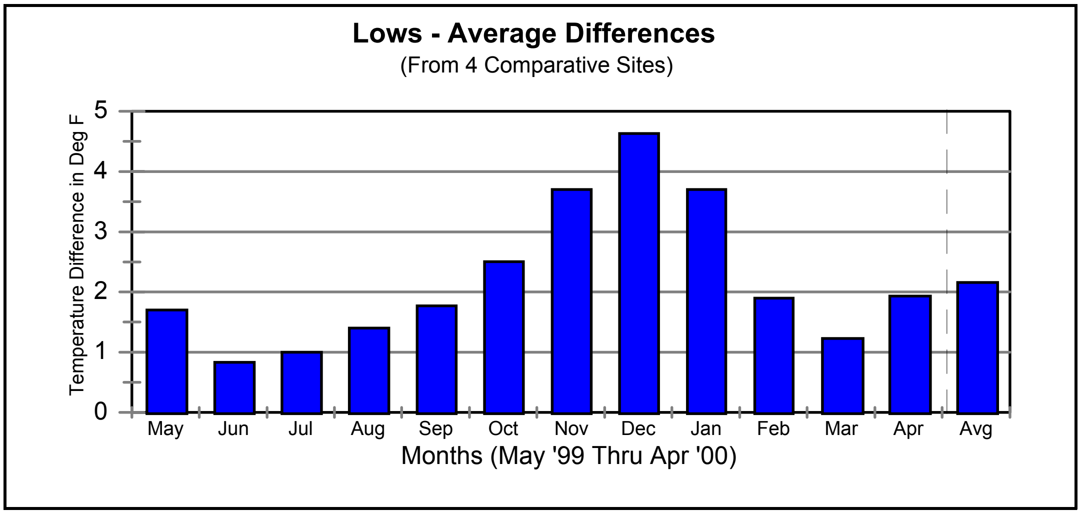

Figure 2. Average monthly differences between four comparative sites and ASOS in daily minimum temperatures for twelve month period and overall average.

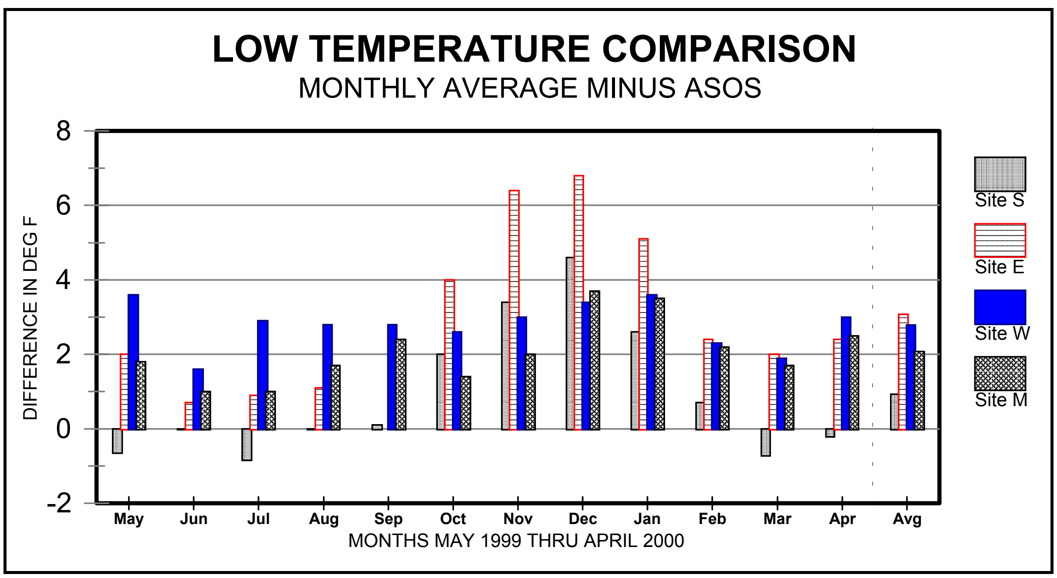

Figure 3. Monthly average minimum temperature differences of the four comparative sites and the twelve month averages.

Figure 3 shows how the differences from individual comparative sites varied through the 12 months. Site E had the largest difference, with an average low of 3.1 degrees warmer than ASOS. It also demonstrated the largest differences in the winter months, averaging from around 5 to 7 degrees warmer than the ASOS site. Site W averaged close to Site E in average difference throughout the year, but did not show as large of a departure during the winter months as Site E. Site W also showed the most consistency, averaging nearly 2 degrees warmer than the ASOS for most of the 12 months of data.

Table 2. Average monthly low temperature and 12 month averages for the 5 stations.

Month	ASOS	Site M	Site W	Site S	Site E
May	43.1	45.0	46.0	42.5	45.1
June	55.3	56.2	57.5	55.3	56.0
July	62.0	63.1	64.6	61.2	62.9
August	58.1	60.1	60.6	58.1	59.2
September	43.1	45.4	45.9	43.2	N/A
October	31.5	33.4	34.4	33.5	35.5
November	22.5	24.5	25.5	25.9	28.9
December	13.4	16.8	15.8	18.0	20.2
January	12.4	15.8	16.0	15.0	17.5
February	18.5	20.9	20.6	19.2	20.9
March	26.9	28.5	28.9	26.2	28.9
April	30.2	33.0	33.4	30.0	32.6
Averages:	34.8	36.9	37.4	35.7	37.1*

*Average based on 11 months of complete data.

Looking at high temperatures, the differences between the four comparative sites and ASOS were not as pronounced. The overall average difference between the sites and ASOS for the 12 months was .7 degrees. The largest average differences occurred in the late summer months of July, August, and September, as shown in Figure 4. Individual site differences are shown in Figure 5.

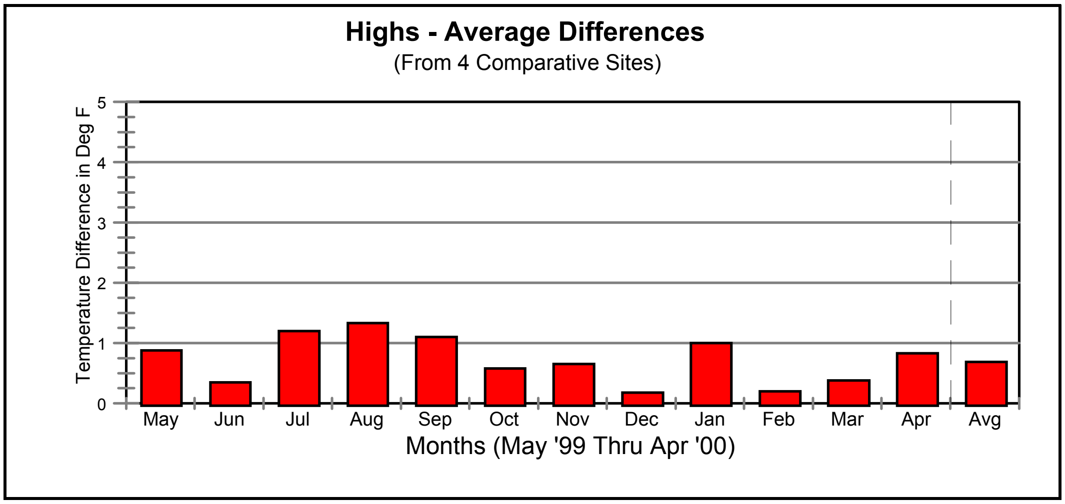

Figure 4. Average monthly differences between four comparative sites and ASOS in daily maximum temperatures for twelve month period and overall average.

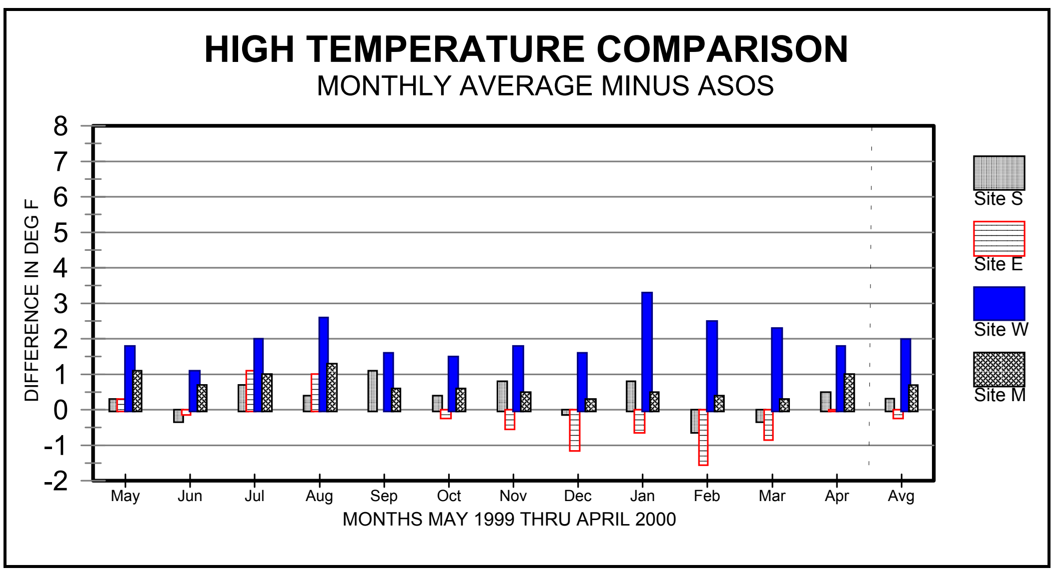

Figure 5. Monthly average maximum temperature differences of the four comparative sites and the twelve month averages.

As with lows, Site W high temperatures were most consistently warmer than ASOS, averaging 2 degrees warmer through the 12 months of data. Table 3 shows the average high and low temperatures of the five sites for the 12 month period. The largest variation between the sites was noted during the period of December through March, where measurements at Site E indicated high temperatures around 1 to 2 degrees colder than ASOS. At the same time, Site W was around 2 to 3 degrees warmer, as can be seen in Figure 5. Overall, Site E had a negative average high temperature difference (-.2), meaning that it averaged slightly cooler with high temperatures than ASOS. The other 3 comparative sites averaged warmer than the ASOS.

Table 3. Average monthly high temperatures and 12 month averages for the 5 stations.

Month	ASOS	Site M	Site W	Site S	Site E
May	71.1	73.3	72.9	71.4	71.4
June	78.5	78.6	79.9	78.2	78.4
July	89.1	89.8	90.5	89.8	90.2
August	83.3	84.8	87.8	83.7	84.3
September	73.2	75.1	74.8	74.3	N/A
October	68.5	69.7	70.1	68.9	68.3
November	61.0	61.6	65.3	61.8	60.5
December	48.0	48.3	48.1	47.9	46.9
January	42.2	43.1	45.3	43	41.6
February	49.3	49.8	51.6	48.7	47.8
March	54.9	55.2	57.9	54.6	54.1
April	65.7	66.1	67.6	66.2	65.7
Averages:	65.4	66.3	67.7	65.7	64.5*

*average based on 11 months of data.

4. Discussion

In analyzing the differences in low temperatures, it is apparent that Site E averaged the warmest compared to ASOS, with an average difference of 3.1 degrees over the twelve month period. This was largely expected due to the significant difference in elevation and terrain between the sites. Not being located in the river valley, the experimental farm site is not as prone to nighttime cold air drainage and shallow inversions that affect the ASOS and comparative valley sites. However, because the data from Site S, located in the same geographical region, did not show such large differences by comparison (averaged only .9 degrees warmer than ASOS), other factors must have contributed to the differences.

Site W was a close second behind Site E, with an annual average low temperature difference of 2.8 degrees warmer than ASOS. This site is slightly higher in elevation and located at a greater distance from nearby rivers than ASOS. Also, it is located in an urban setting, with a sheltering effect and heat flux contribution from nearby houses, trees and paved areas. This effect is commonly referred to as the “urban heat island”. Another possible contribution to the difference in low temperatures may be that Site W is in a wider part of the valley. Because of this, it may be less impacted by funneling and drainage of cold air from the valley and surrounding hills that may influence the ASOS site, which is in a narrower part of the valley as shown in Figure 1.

The low temperature difference at Site M was not far behind Site W, with an average difference of 2.1 degrees. This is significant, considering that it is only about 1.3 miles from the ASOS site and only a few feet higher in elevation. The slightly more “urban” setting of Site M due to the nearby brick NWS office, concrete and asphalt walkways, as well as parking lots and aprons, may have made the biggest contribution to these differences.

In analyzing the differences in high temperatures, Site W was most consistently warmer than ASOS. As with the low temperature differences, the “heat island” effect was likely a factor, and was most significant during the climatologically cold winter months of January through April. Site M also averaged consistently warmer than ASOS, which like the low temperatures, was likely influenced by the nearby brick NWS building and nearby pavement. This difference may also be attributed to an overall cool bias of 1 to 2° F that has been documented in numerous NWS ASOS temperature comparison studies (Grosshans 1992; Griffith 1995; Lamberty and Noel1994; Lashley 1994; Noahan 1995; Sheets 1997; Woodworth 1994).

The difference between both high and low temperatures between the ASOS and MMTs sites Sites S and E both averaged close to ASOS for high temperatures in the 12 month period. High temperature differences, which were around plus or minus 1 degree, showed no consistent trends throughout the year, other than somewhat colder highs at both locations during the cool season months. One possible explanation for this could be differences in snow cover or soil moisture between the valley and highland sites.

5. Conclusions

As expected, monthly average temperatures at the four comparative sites demonstrated how the ASOS temperatures were unrepresentative of the region, especially in regard to minimum temperatures. The differences in low temperatures were most pronounced during the winter months, and Site W showed the most consistency in being warmer than the ASOS. Differences in high temperatures were not nearly as large and showed no significant seasonal trends.

From this comparative study, it can be concluded that certain precautions should be taken when forecasting low temperatures for Lincoln county, and more specifically, the North Platte area. Since the ASOS is apparently the coldest low temperature recording site, on average, forecasters should use anticipated temperatures for ASOS as the bottom end of a forecast range in the public forecast for Lincoln county. Forecasters should be most aware of this factor during the winter months, when low temperatures across the area average 3 to 4 degrees warmer than ASOS.

With respect to average high temperatures, the ASOS is fairly representative of the surrounding region, with a few exceptions noted in this study. Some large differences showed up in the date for Site W for the winter months, where highs were from 2 to 3 degrees warmer than the ASOS and this tendency should also be considered and accounted for in the high temperature forecasts for the region. Through the year, there was a tendency for ASOS to underestimate daily high temperatures by nearly 1 degree. This was found to be especially true for the late summer months.

This study was limited to measuring maximum and minimum temperature differences across the area around North

Platte as they compare to the official standard, ASOS. Some of the findings may be a factor of the limited data set used for analysis and long term climatic trends that prevailed during the data-gathering period. September 1999 through April 2000 were unusually warm and dry and this may have contributed to some of the findings. Longer term comparisons will be needed to confirm trends observed in this study. More in-depth studies into specific meteorological conditions that lead to the largest discontinuities would be required to enable forecasters to create more accurate temperature forecasts for users across the area.

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