

CENTRAL REGION TECHNICAL ATTACHMENT 93-07

COMPARISON OF ASOS AND HO-83 TEMPERATURES AT LINCOLN, NEBRASKA
FROM NOVEMBER 1991 THROUGH OCTOBER 1992

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1. Introduction

Since the installation of the Automated Surface Observing System (ASOS), at the Lincoln Airport in the fall of 1991, temperature differences were continually noticed between the ASOS temperature and the HO-83 observed temperature. The ASOS temperature was almost always cooler, by a few degrees, when compared with the HO-83 temperature. This short study compares the maximum and minimum temperatures of ASOS and the HO-83 for a one year period. The sites of the sensors are briefly discussed, as well as the collection of data and results. An explanation is suggested for the notable temperature differences between the two sites.

2. Sensor Sites and Types

The HO-83 temperature sensor is co-located with the wind equipment at the centerfield of the Lincoln Municipal Airport (Figure 1). The sensor is 1183 feet above mean sea level (WS FORM A-1) and is approximately 4700 feet west-southwest of the General Aviation Building, where the Lincoln Weather Service Office is located. The ground cover near the sensor is grass and fairly level, with a concrete ramp approximately 1300 feet by 6725 feet located about 325 feet west of the site.

Both the ASOS temperature sensor and the HO-83 temperature sensor are very similar in design. The ASOS sensor is a slightly modified HO-83 sensor (ASOS User's Guide, 1992). The ASOS pad, where the temperature sensor is located, is on the southern end of Runway 17R-35L, close to the Runway Visual Range equipment (Figure 1). The temperature sensor is 1159 feet (Daly, 1990) above mean sea level and is approximately 8500 feet southwest of the General Aviation Building. Ground conditions around the sensor consist of crushed rock. The ground is fairly level, and the immediate area is covered by grass.

The ASOS site is located at one of the lowest elevations on the airport (Figure 1). The ASOS site is located 6100 feet south of the HO-83 site and the ASOS temperature sensor is 24 feet

lower than the HO-83 sensor. A creek is located to the west of the runway complex, and then curves around the south end of the airport. At its closest, the creek is approximately 950 feet west of the ASOS pad. A small area of rolling hills, with a peak elevation around 1257 feet, are located around 3000 feet west of the ASOS site, to the west of the creek. To the south of the airport, the terrain rises slightly. Finally, Capitol Beach Lake lies within 3000 feet to the southeast of the ASOS pad.

3. Data Collection

Data sets were collected and analyzed during a one year period from November 1991 through October 1992. Daily maximum, minimum, and mean temperatures, as well as departures from normal were determined from the official Lincoln records and also ASOS. From November 1991 through April 1992 the ASOS SAOs were reviewed to collect the maximum and minimum temperature for each date from the six-hourly synoptic observations. During the period from May through October of 1992, the ASOS data were retrieved from the ASOS daily summary screen.

Of 367 possible days of data, 358 days were available. Generally, the nine days of missing data were a result of the ASOS temperature sensor being inoperative.

4. Results

To assess the difference in maximum temperatures between the ASOS site and the HO-83 site, the HO-83 maximum temperature was subtracted from the ASOS maximum temperature. This calculation resulted in a value usually having a negative number. That is, the ASOS temperatures were generally cooler than the HO-83 temperatures. The same procedure was then performed for minimum temperatures. Next, the arithmetic mean, μ , and standard deviation, σ , were calculated from these differences for each month and for the entire data set. Also, the coefficient of determination, r^2 , was calculated for each month, and the year, by using the maximum and minimum temperatures from the ASOS hygothermometer and the HO-83 hygothermometer.

From November 1991 through October 1992, ASOS daily maximum and minimum temperatures ranged from -7 degrees F cooler than the HO-83 maximum and minimum temperatures, to +2 degrees F warmer. However, of the 358 days of data, only on eight occasions were the ASOS temperature, maximum or minimum, warmer than the HO-83 recorded temperature.

The range of the monthly average maximum temperature differences, for the ASOS temperature compared to the HO-83 temperature was anywhere from -1.385 to -2.581 degrees F cooler (Table I and Figure 2). The variability of the standard deviation during the one year period when examining the average monthly maximum temperature differences was from 0.506 to 1.193. The monthly average minimum temperature differences, of the ASOS and HO-83 temperatures, ranged from -0.742 to -2.548 degrees F cooler. While the standard deviation during that time varied from 0.965 to 1.565.

TABLE I

AVERAGE TEMPERATURE DIFFERENCES
AND STANDARD DEVIATIONS
(ASOS TEMPERATURE - HO-83 TEMPERATURE)

MONTH AND YEAR	AVERAGE MAXIMUM TEMPERATURE DIFFERENCE (ASOS - HO-83)	STANDARD DEVIATION	AVERAGE MINIMUM TEMPERATURE DIFFERENCE (ASOS - HO-83)	STANDARD DEVIATION
11/91	-1.385	0.697	-1.769	1.177
12/91	-1.633	0.669	-2.200	1.375
01/91	-1.452	1.091	-2.129	1.432
02/92	-1.414	0.780	-1.793	1.292
03/92	-1.483	0.634	-1.448	1.352
04/92	-1.967	0.669	-1.733	1.363
05/92	-2.452	0.506	-2.129	1.565
06/92	-2.000	0.886	-2.413	1.119
07/92	-2.129	0.846	-0.742	0.965
08/92	-1.903	1.193	-0.968	1.110
09/92	-2.100	0.995	-1.500	1.306
10/92	-2.581	0.992	-2.548	1.261

For the entire year, November through October, the yearly average maximum temperature difference between the ASOS temperature and the HO-83 temperature was -1.885 degrees F with a standard deviation of 0.929. While the yearly minimum temperature difference was -1.779 degrees F with a standard deviation of 1.376.

The distribution of the data, is a very condensed bell shaped curve with a left skewed tail distribution pattern (Table II and Figure 3). The maximum temperature difference between ASOS and the HO-83, from November through October, contained 93 percent of the data from -3.0 to -1.0 degrees F, or from $\mu - 1.26$ to $\mu + 0.956$. When looking at the -4 to zero degree F range, 99 percent of the data were contained within this range, or from $\mu - 2.286$ to $\mu + 2.036$. The distribution of the minimum temperature difference, from November through October, contained 87 percent in the -3 to zero degree F range, or from $\mu - 0.896$ to $\mu + 1.296$. At the -5 to +1 degree F range, 98 percent of the data occurred within $\mu - 2.346$ to $\mu + 2.026$.

TABLE II

DISTRIBUTION OF MAXIMUM AND MINIMUM
TEMPERATURE DIFFERENCES
(ASOS TEMPERATURE - HO-83 TEMPERATURE)

<u>DIFFERENCE</u>	<u>MAXIMUM TEMPERATURE</u>	<u>MINIMUM TEMPERATURE</u>
-7	1	1
-6	0	4
-5	1	6
-4	10	28
-3	67	62
-2	158	80
-1	08	127
0	12	43
1	0	5
2	1	2

In spite of the differences, there is a very strong positive linear relationship of the maximum and minimum temperatures between the HO-83 site and the ASOS site. The annual coefficient of determination, r^2 , for the HO-83 and ASOS maximum temperature was 0.998, and 0.993 for the minimum temperature. The minimum temperature r^2 values are less than the maximum temperature r^2 values for each month, except one, for the year. (Table III and Figures 4 and 5).

TABLE III

COEFFICIENT OF DETERMINATION
FOR ASOS & HO-83
MAXIMUM AND MINIMUM TEMPERATURES

<u>MONTH</u>	<u>MAXIMUM</u>	<u>MINIMUM</u>
11/91	.977	.989
12/91	.993	.956
01/92	.989	.969
02/92	.996	.962
03/92	.997	.975
04/92	.998	.976
05/92	.996	.980
06/92	.984	.962
07/92	.972	.964
08/92	.970	.971
09/92	.985	.990
10/92	.996	.972
FOR THE YEAR:	.998	.993

4. Discussion

Though the temperature difference between the ASOS site and the HO-83 site is small, it is not likely that there is a problem with the ASOS temperature sensor, as it is essentially the same as the HO-83 temperature sensor. However, the main cause for the temperature difference is probably a result of cooler air draining into the small basin where the ASOS site is located. A few contributing factors would be: 1) the relatively low elevation of the ASOS pad when compared to the rest of the airport elevation; 2) a 24-foot difference between the centerfield site and the ASOS pad location; 3) a creek that runs along the west side of the airport; 4) small hills to the west of the ASOS site; and 5) the slight rise in elevation to the south of the airport. Thus, the difference in temperatures can be attributed to the siting of the ASOS temperature sensor compared to the HO-83 sensor.

Comparing the standard deviation values between the maximum and minimum temperature differences for the year and by the month, the minimum standard deviations have a larger range. The

range in the minimum temperature standard deviations and minimum temperature r^2 values is likely a consequence of low level winds mixing the air in the low lying site. When winds become calm to light at the site cooler air will drain into the area resulting in larger temperature differences, but when the wind is present and mixing the air, temperature differences would tend to be negligible. Also, this difference is likely aided when an inversion in the temperature profile exists and clear skies are present allowing good radiational cooling.

5. Conclusion

Even though the maximum and minimum temperatures at the ASOS site are slightly cooler than those at the HO-83 site, it should have only a minor impact for the operational forecaster. From a climatological viewpoint, the slight difference in temperatures may have a slight cooling effect for the local climatology. If this effect continues, thus lowering the climatological normal temperatures, it could easily be accommodated. A short subroutine could be included within the ASOS program to correct the observed temperature. However, before final conclusions on the possible climatological impact can be made, more analysis needs to be performed. This will be carried out by the Climate Data Continuity Project.

The temperature differences between the ASOS site and HO-83 site from November 1991 through October 1992 are small, and the ASOS site was approximately two degrees cooler than the HO-83 site.

6. Acknowledgements

The author wishes to thank Steve Byrd and Phil Clark of WSFO Omaha for their review and comments on the article. Also, thanks to Steve Evans at NCDC for providing the ASOS observations from November 1991 through April 1992.

7. References

Daly, L.A., 1990: ASOS Site Survey Report for Lincoln Municipal Airport, Lincoln, Nebraska. NOAA, Rev. 2.

NOAA 1992: ASOS User's Guide, June.

Weather Service FORM A-1, 1977: Station Description and Instrumentation for WSO Lincoln Municipal Airport. Latest version in station records, Lincoln, Nebraska.

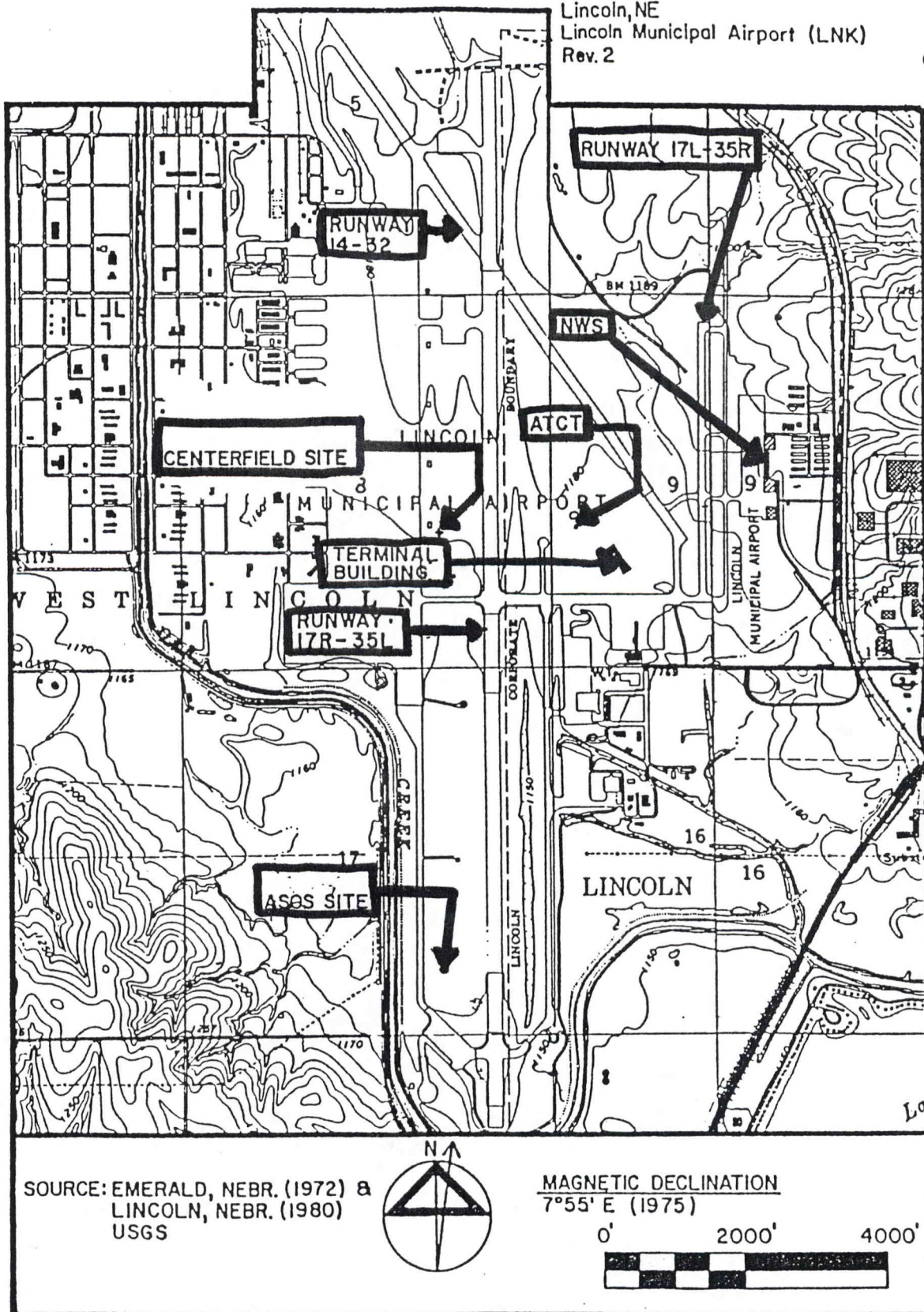


Figure 1. Lincoln Municipal Airport Site Location Plan. NWS office, sensor locations, topography and airport layout are depicted. Original figure was modified to remove 'PLANNED' from the depiction of the ASOS SITE.

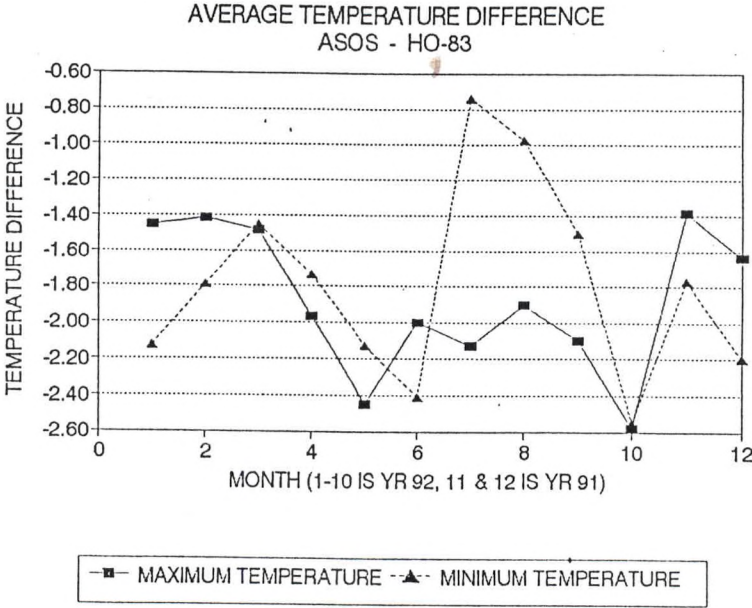


Figure 2. Average monthly temperature difference between the ASOS temperature and HO-83 temperature. Please note that months 11 and 12 are year 1991.

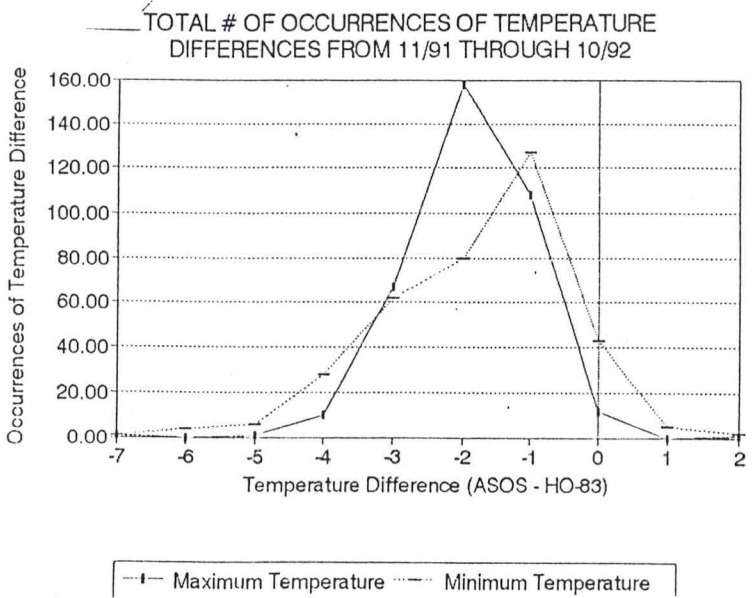


Figure 3. Distribution of temperature differences from November 1991 through October 1992 for both maximum and minimum temperature.

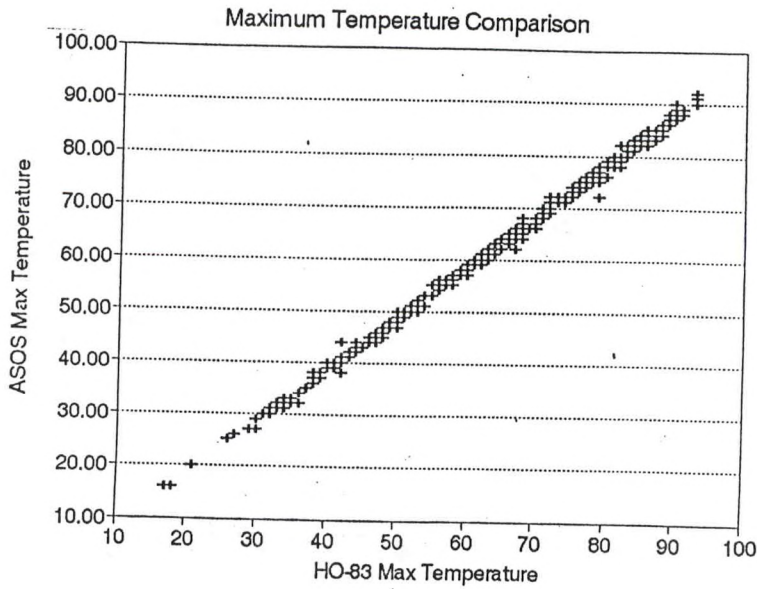


Figure 4. Scattered plot of maximum ASOS and HO-83 temperatures during the period from November 1991 through October 1992.

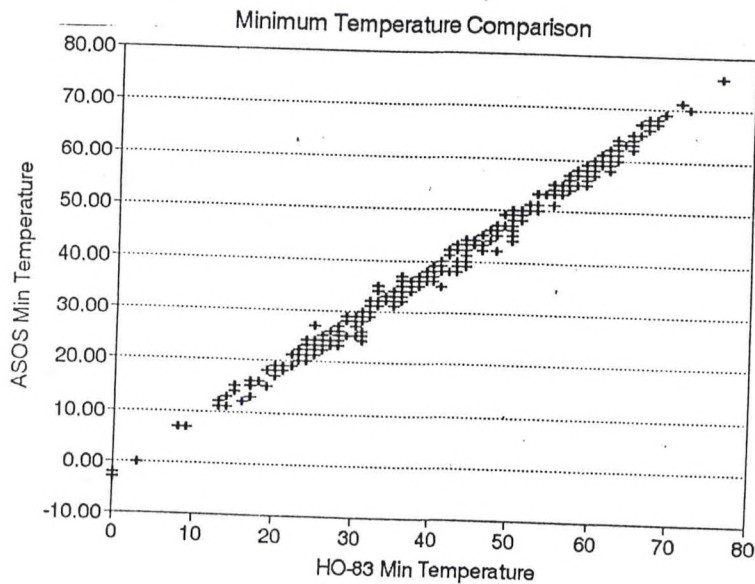


Figure 5. Scattered plot of minimum ASOS and HO-83 temperatures during the period from November 1991 through October 1992.