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A COMPARISON BETWEEN MANUAL OBSERVATIONS AND ASOS OBSERVATIONS FOR WSO GRAND ISLAND, NEBRASKA

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1. Introduction

Before commissioning the Automated Surface Observing System (ASOS) in Grand Island, Nebraska, there was a need for an extensive comparison between the manual observations and the ASOS observations. In order to establish consistency in the comparison, only hourly observations were checked.

The comparison was done for the following dates:

December 27 - 31, 1991
January 01 - 16, 1992
May 1, 3, 4, 5(1/2 day only),6 - 19, and 24, 1992

Total number of observations checked: 948

The following elements of the observations were compared: ceiling heights, visibility, temperature, dew point, wind direction and wind speed. The altimeter setting was initially included in the comparison. However, after examining the first 100 observations, I found that the ASOS altimeter was always within 0.01 inches of mercury of the aneroid barometer used in the manual observation. As a result, further altimeter setting comparisons were discontinued.

2. Ceilings

Overall, ceiling heights from both the manual and ASOS observations were very similar. With ceilings below 1000 feet, the differences were frequently on the order of one or two hundred feet. Greater differences occurred with ceilings above 1000 feet. There are two basic reasons for this. The higher the cloud decks measured by the laser ceilometers the greater will be the variability in the height measurements. Also, differences between human observers and ASOS in determining the amount of cloud coverage will lead to differences as to which cloud decks constitute ceilings. The second reason is by far the most significant for cloud decks in the 3,000 to 12,000 foot range. The Grand Island ASOS had a tendency to overestimate the

coverage. Thus, many times it reported a ceiling when in reality a ceiling did not exist, or it reported a ceiling at a lower level than what actually existed.

3. Visibilities

Visibility is vital to aviation safety. During this study, it was the element that showed the most variability between the manual and ASOS observations.

When visibilities of less than three miles were reported in the manual observation, the ASOS reported a visibility that was higher than the corresponding manual visibility 80% of the time (Figure 1). The greatest differences arose when the manual observation reported a visibility in the 3/4 to 2 1/2 mile range. In this range, the corresponding ASOS visibility was occasionally a mile or more higher. When manual observations reported visibilities consistently 1/4 mile or less over several hours, the ASOS visibilities were very similar.

When visibilities of from three to nine miles were reported in the manual observation, ASOS reported visibilities higher than the corresponding manual visibility only 62% of the time (Figure 2). Visibilities in the three to nine mile range are not nearly as significant to the aviation community as visibilities less than three miles.

4. Temperatures and Dew points

The ASOS-observed temperature was cooler than the corresponding manual observation 68.3% of the time (Figure 3). It was warmer 1.9% of the time. In two-thirds of the observations checked, the ASOS temperature was either one or two degrees cooler. When temperatures are close to 32°F, a one or two degree difference in the surface temperature can be very important to the forecasters in the WSFO. In addition, a cumulative climatic effect of this magnitude would be significant.

The ASOS observed dew points also tended to be lower than those of the corresponding manual observation, but not to as large an extent as the temperatures (Figures 4). ASOS observations had a dew point lower than the corresponding manual observation 48.7% of the time. ASOS and manually observed dew points were exactly the same 45.8% of the time. In only 5.5% of all the observations checked, ASOS had a higher dew point than the corresponding manual observation.

5. Wind Directions and Speeds

Judging the accuracy of the wind directions and/or speeds from ASOS via comparisons with manual observations is difficult. Whereas ASOS uses the previous two minutes worth of data for averaging its output, most human observers will only stare at the direction and speed dials for 10 or 15 seconds before making a determination. This is done despite the FMH-1 requirement that a 1-minute average be determined. Because of this large disparity in the sampling time, it would be difficult to pinpoint whether the ASOS wind sensors or the human observers were in error. Keeping this fact in mind, 75% of the ASOS observed wind directions (Figures 5) and 54% of the wind speeds (Figure 6) were within ten degrees and one knot respectively of the corresponding manual observations.

When comparing the wind direction and speed, I did not take into account whether the differences were positive or negative. Because of this method, the data for both the direction and speed indicated a larger percentage of ASOS observations that were ten degrees and one knot different, respectively, than the percentage of observations that showed no difference. Though true, this fact can be misleading. For example, the data suggest that 38.8% of all the ASOS observed winds were ten degrees different than the manually observed winds. Keep in mind that roughly half of these (19.4%) were -10 degrees different and the other half (19.4%) were +10 degrees different. Making this same assumption for all the percentages given for the wind direction and speed from 10 to 100 degrees and from 1 to 10 knots, respectively and dividing them by two as shown above, then the graphs of these data would indicate more or less a standard "bell curve". The highest points on the "bell curve" would represent a difference of zero degrees and zero knots respectively.

6. Summary

One of the main purposes of this comparison was to provide information to the station MIC for examination before the commissioning date of our ASOS (October 1, 1992). Commissioning was done with the knowledge that the WSO Grand Island staff would be available to augment/backup ASOS. Data indicated some problems with ASOS that need to be addressed. These problems include: (1) inaccurate sky conditions due to problems in determining the amount of cloud coverage, (2) visibilities that are often too high, particularly when the prevailing visibility is less than three miles, and (3) temperatures that are one or two degrees low nearly two-thirds of the time.

Although these problems are significant both to the aviation community and to the forecasters at the WSFO, they are not insurmountable. As these systems improve over the next couple of years, the potential of ASOS data will be enormous. In the near future, surface observations will be available from very small airports and remote sites that currently do not report weather. This will greatly decrease the "gaps" in coverage of observation data. This new data source will enhance the quality of forecasts, especially in rural areas. The ability to archive ASOS data, available in 5-minute increments, will be very useful for meteorological case studies. The 5-minute data has already proven useful in studying a downburst that occurred at Concordia, Kansas, in the summer of 1992. The prospects and uses of ASOS data in conjunction with Doppler radar and GOES-Next will be limitless in the future.

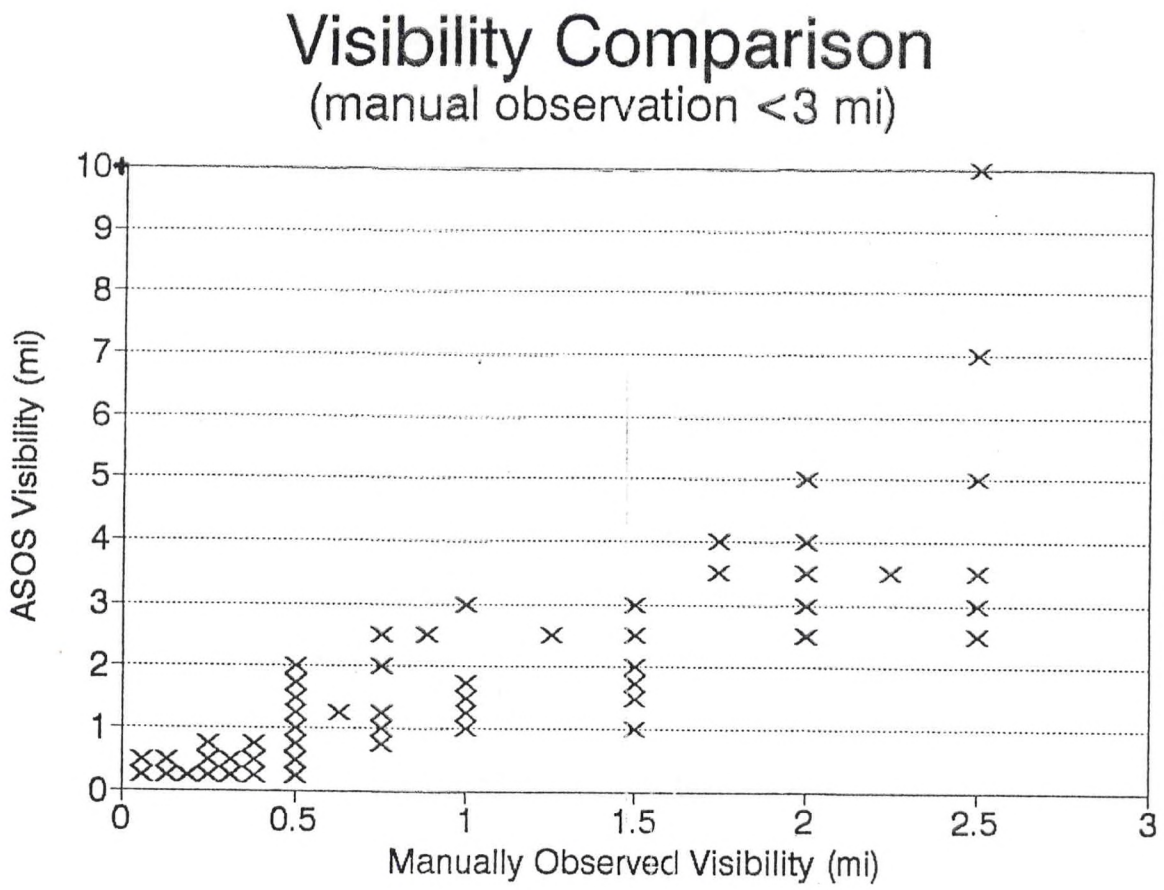

Figure 1. Scatter plot of ASOS vs. manually observed visibilities when the manual visibility was less than three miles.

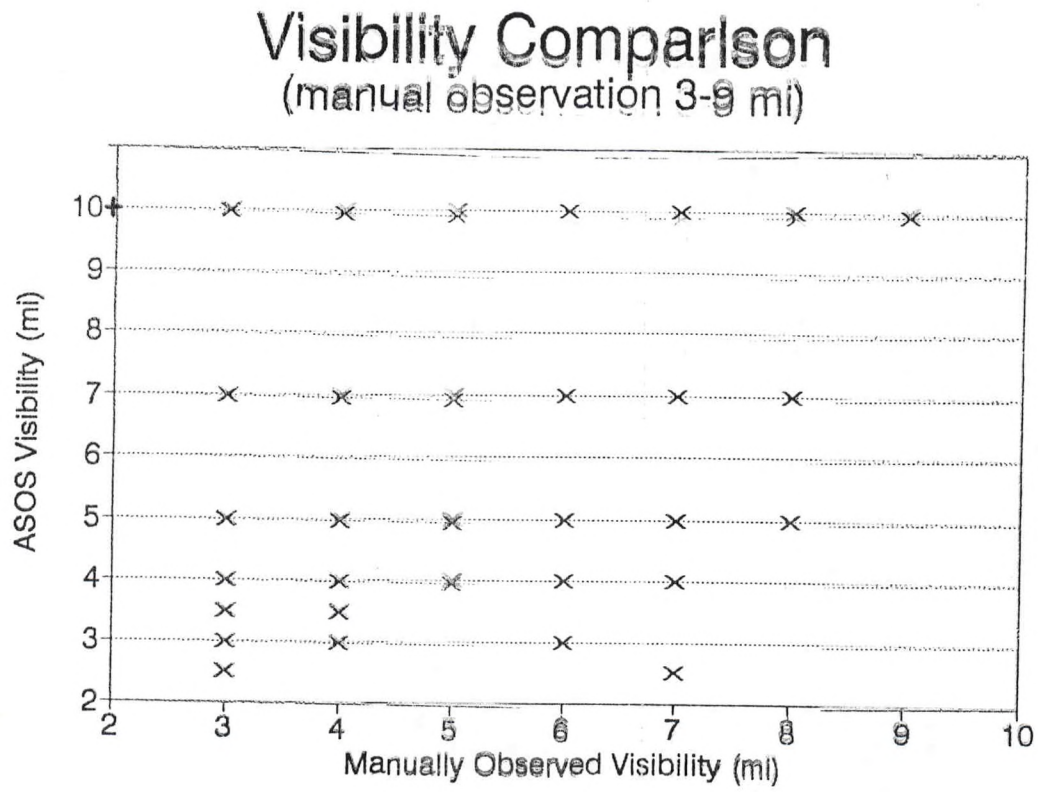

Figure 2. Scatter plot of ASOS vs. manually observed visibilities when the manual visibility was three to nine miles.

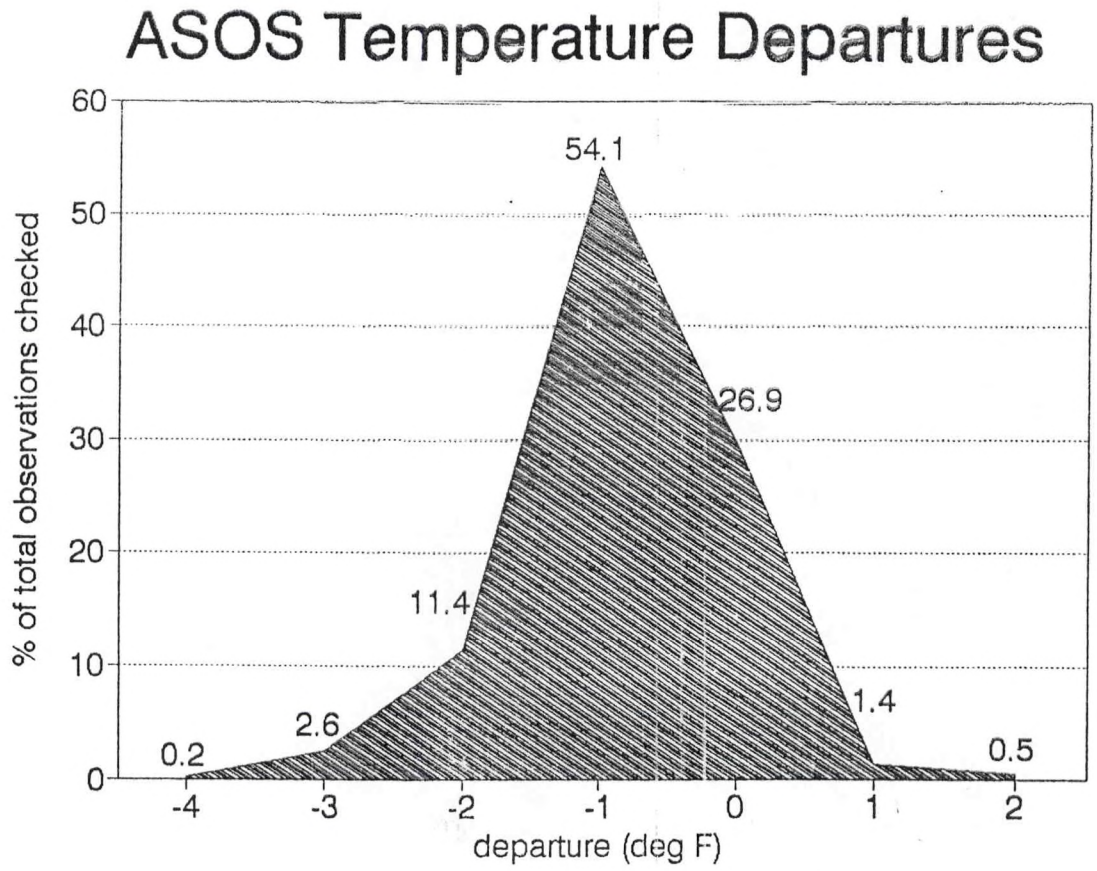

Figure 3. Graph of ASOS temperature departures vs. the percentage of the total number of observations checked.

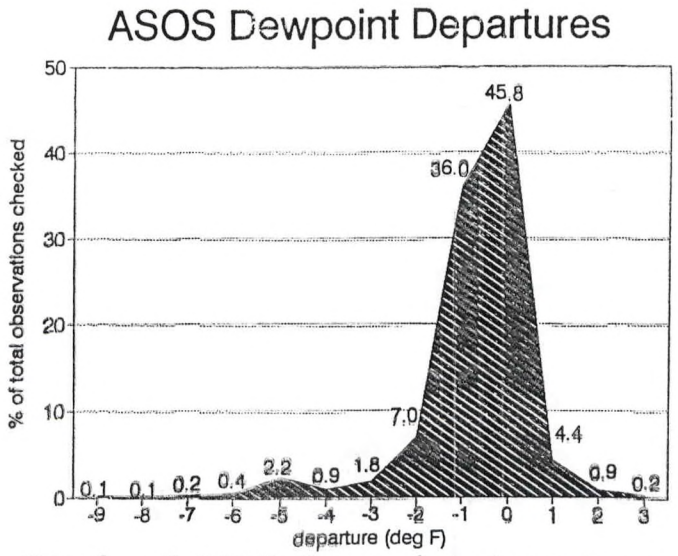

Figure 4. Graph of ASOS dew point departures vs. the percentage of the total number of observations checked.

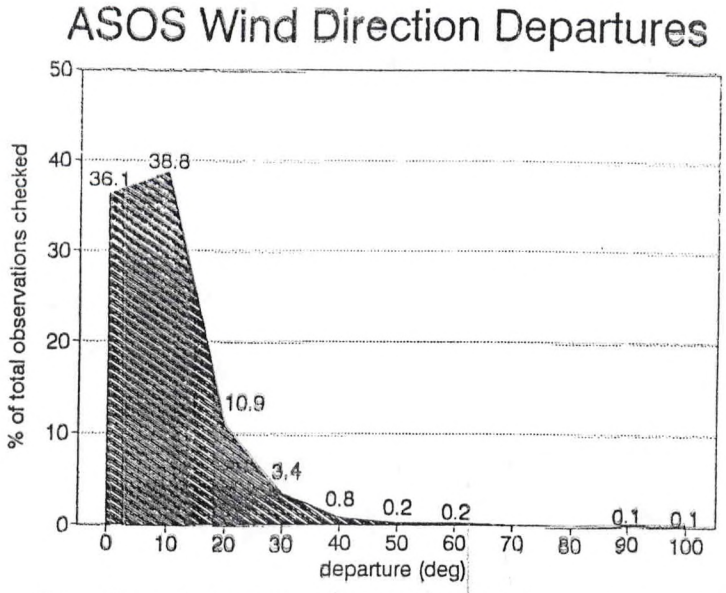

Figure 5. Graph of ASOS wind direction departures vs. the percentage of the total number of observations checked.

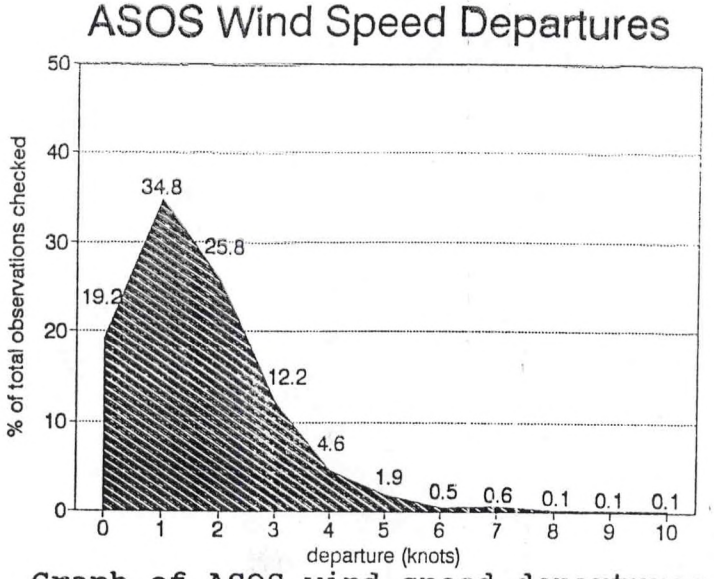

Figure 6. Graph of ASOS wind speed departures vs. the percentage of the total number of observations checked.