Climate Data Continuity with ASOS – 1994 Annual Report

for the period September 1993 - August 1994

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Table of Contents

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1. Introduction

The past year for the CDCP has been marked by three significant issues. The first is that the modified hygrothermometer has been implemented in the field starting in November 1993. By Spring 1994 all of the MARD sites that are commissioned received the modified hygrothermometer. The second issue is that the final 15-month test period began on June 1, 1994 for all commissioned sites with the modified instrument. Other sites both in the central U.S. area and in the expansion list will be included as sites are commissioned and have the modified instrument installed. The third issue is that the ASOS heated tipping bucket was found to need several modifications which included the Reed switch, funnel extension, and modified stops. These modifications did not reach the field in the current year.

Three presentations were made or will be made at scientific meetings. Extended abstracts are included as Appendices A and B for American Meteorological Society meetings in January 1994 and January 1995. Another presentation was made at the National Weather Association Annual Meeting in October 1994.

Since the final 15-month testing period has begun, this annual report will include an analysis of temperature for the three-month period June to August 1994. Precipitation data for the entire year are compiled and discussed. This is the first report containing CDCP wind comparisons.

2. Data

The ASOS sites for the central U.S. sites and the national expansion sites are given in Tables 1 and 2 and shown in Figure 1. All central U.S. sites have the modified hygrothermometer and were commissioned by June 1, 1994 except Springfield, MO. ALS does not have midnight to midnight maximum and minimum temperatures from the conventional (CONV) observations due to its parttime status. A station move at PUB has resulted in discontinuing it as a CDCP site effective in August 1994. Consequently, there are only 11 complete central U.S. sites used in some of the analyses. A total of 5 expansion sites met the conditions to begin the final 15-month test on June 1. One other site, PWM, will be included starting in the fall season in September 1994. Data flow from NCDC has gone rather smoothly in the past three months. Special attention has been devoted to the examination of data outliers in maximum and minimum temperatures for the summer season so the final comparison is not influenced by bad data. A list of outliers is given in Table 3. Twenty-five data values have been replaced with a corrected value or identified as missing. Fifteen of the values were from ASOS while ten were from CONV. Values were specified as "missing" if confidence in a replacement value was low. If the real value of the observation was available, it was used as the replacement. The CONV errors were usually obvious since we have a copy of the MF1-10B forms. One type is simply an error in keypunching. A second type is the daily values were not entered and someone picked the wrong value from the 6-hourly maximum and minimum values. Also, the observer could record a daily maximum or minimum which was clearly in conflict with the 6-hourly values. On one occasion one of the 6-hourly maximum and minimum values was missing. The ELY site has some times when the 6-hourly periods don't seem to fit the data selected for midnight to midnight. The source of ASOS errors is not clear. In all cases an ASOS maximum or minimum had a conflict with either the SAO or the 6-hourly maximum or minimum. Four potential error sources exist which include the ASOS instrument, an observer which edits an ASOS value, processing at NCDC, or processing at CSU. We have no way to determine which is the real source. Table 3 is offered so that we might find out if NCDC or the NWS can help determine the cause of these outliers.

Several items related to data quality also emerged with the precipitation records. These are discussed in the beginning of the section on precipitation. Wind data are also discussed separately.

3. Temperature and Humidity

Tables 4 and 5 contain monthly and seasonal statistics for all sites included for the comparison of maximum and minimum temperatures with a midnight to midnight 24-hour period during the June through August 1994 period. Tables 6 and 7 contain monthly summaries for the 6-hourly observations and the humidity variables. The past year of maximum and minimum temperature differences are presented in Figures 2-5. A vertical bar between May and June 1994 denotes the start of the final 15-month comparisons of ASOS and CONV.

Mean monthly systematic differences continue to show ASOS consistently cooler than CONV in both the daily maximum and minimum temperatures. Considerable station to station variability persists along with sizeable month to month variations at individual stations. The National Expansion CDCP sites show similar overall characteristics. ELY is a notable exception with ASOS minimum temperature much warmer than CONV.

Observations for June, July and August provide a good opportunity to assess how well we can determine the systematic difference (often called "bias") between the ASOS and the CONV. If we consider the summer period, we have a sample (ranging from 90 to 92 observations) with a known sample mean and sample standard deviation. The relationship between the sample mean and the true population mean is given from the student's t distribution for a large number of degrees of freedom as

$$t_{-.025}\sqrt{\frac{s^2}{n}} < \bar{y}-\mu < t_{.025}\sqrt{\frac{s^2}{n}}$$

where $t_{-.025}$ is the t value which has 2.5% of the distribution below it, s is the sample standard deviation, n is the size of the sample, $\bar{y}$ is the sample mean, and μ is the population mean. The parameter $t\sqrt{\frac{s^2}{n}}$ establishes a confidence interval. If a large number of samples were taken, the sample mean would be within $t\sqrt{\frac{s^2}{n}}$ of the population mean for some known percentage of the samples. The $t_{.025}$ would establish the confidence interval for 95% of the samples. For the application to the ASOS - CONV observation, we have a 90-92 day sample for which we establish a sample interval of $\pm t\sqrt{\frac{s^2}{n}}$. This parameter is included in Tables 8 and 9 along with the seasonal mean and the standard deviation for both 95% and 99% of the t distribution.

The range of the mean values is related to the fact that the ASOS is a new instrument and the location has changed so local effects could be important. Note that COS and ICT are essentially colocated. These minimums of -0.47°F and -0.63°F with confidence intervals of approximately 0.2°F indicate a real bias exists between the instruments. Our field calibration tests at COS, OKC and TUL have indicated that ASOS does not have an absolute bias so a tentative conclusion is that the HO-83 has a warm bias of something near 0.5°F. In a similar way the COS and ICT maximums of -1.59°F and -1.50°F would tend to confirm that the HO-83 has a solar heating problem leading to something near a 1°F magnitude. Mean values of other locations would indicate the local effects are important since the variation is quite wide compared with COS and ICT. The range of the standard deviations is also quite large and this leads to a rather large variation in the confidence intervals given in Table 6. We are concerned that the rounding of observations to whole numbers may have a significant effect on the range of the standard deviation but not on the means. A further analysis of this problem will be pursued in a later reporting period.

It is apparent now with close to two years of CDCP comparison data, that much of the observed station to station variability that produces the wide (±2°F) in Figures 2-5 is attributable to station location differences. Proximity to buildings, local vegetation differences, minor topographic features and large areas of pavement are factors that are affecting observed differences. An inventory of local exposure differences is currently being compiled to accompany CDCP results. But this still does not explain the month to month variations at individual stations that sometimes are as much as ±1°F. Instrument changes (ASOS or CONV) continue to introduce variability, and discontinuities in ASOS-CONV records continue to appear periodically. For example, LNK had one such change in mid July resulting in larger negative mean values in July and August.

Similar variability continues to be a common feature in ASOS-CONV humidity differences. Table 10 provides a summary of ASOS-CONV differences in dewpoint temperature, dewpoint depression and relative humidity. In general, ASOS dew points have been very similar to CONV with very little systematic bias when averaged across all stations. Since ASOS temperatures are cooler, dewpoint depressions are less and ASOS relative humidities are higher at nearly all sites. For the summer of 1994 all Central U.S. CDCP sites except one showed higher ASOS relative humidities than CONV. Summer season differences ranged from -1.1% at Topeka to +4.8% at Tulsa. The average difference was +1.9%. National expansion sites showed similar differences. Many sites continue to see larger daily variability in dewpoint differences than with temperature.

Meteorological conditions have been found to contribute to ASOS-CONV difference although these effects appear smaller than overall instrument difference and station location differences. The April-June 1994 progress report dedicated several pages to discussing temperature differences as a function of time of day, sky cover, wind speed and wind direction. No further analyses are presented here but this will be revisited later in the 15-month final test.

4. Precipitation

Beginning 1 September 1993, ASOS one-minute data became the primary source of ASOS precipitation data for CDCP sites. This greatly helped overcome data problems that had plagued CDCP analyses during the first year of commissioned ASOS comparisons. Unlike precipitation observations contained in ASOS SAO data, the one-minute ASOS data cannot be editted or augmented. Hence, it represents what ASOS actually observed. This information is what was used for subsequent comparisons with CONV precipitation observations. The hourly and six-hourly precipitation contained in the PCPN and additive data fields in the ASOS SAO transmissions were also compiled for comparative purposes.

ASOS one-minute and ASOS PCPN reports were combined to form six-hourly and daily totals for comparison with CONV. Periods when the two ASOS sources differed could usually be traced to periods when observers were editting ASOS PCPN data fields due to unrepresentative or deconfigured ASOS measurements. Under those circumstances, the sum of the hourly PCPN totals equalled CONV. There were some instances, however, when the PCPN data differed from the raw one-minute data and also differed from CONV. This occurred frequently at some stations and not at all at other sites. There was also a considerable amount of missing one-minute data at some CDCP sites. It was difficult to determine if ASOS was really not functioning during these periods or whether data had been available on site but were simply missing from the final data files transmitted to the Colorado Climate Center. If the data are truly missing, such as is the case when the precipitation gage is deconfigured, then CONV data are normally used in the ASOS PCPN reports. When totals don't match up, local observers may only be using CONV data to edit SAO reports for a subset of the hours. There were many examples where one-minute data were missing from the files received but there was nothing to suggest that PCPN data were being modified. On a case by case basis, decisions were made whether to use the PCPN data as ASOS precipitation or to treat it as missing. Thus, despite the noticeable improvements over the past year in data available for precipitation comparisons, careful manual evaluations were still required. As many as 25% of all precipitation events required manual checking at a few sites while at other sites no special checking was required. Overall, less than 10% of the daily precipitation totals required close inspection. Our goal to automate much of the precipitation intercomparison process during 1994 proved unrealistic because of these data challenges. However, our confidence is much greater than last year that the results presented here are representative of how ASOS precipitation compares to CONV.

Tables 11 and 12 provide an inventory of available precipitation data for the period 1 September 1993 - 31 August 1994 for the Central U.S. and the National Expansion CDCP sites, respectively. With the availability of ASOS one-minute data, the number of days with missing or suspect data have decreased. Only those days with missing or deconfigured ASOS one-minute precipitation on days when precipitation was known to fall were counted as missing. Spurious ASOS precipitation days are listed separately but also were removed from the list of valid comparison days. These include all days on which ASOS reported significant precipitation (equal to or greater than 0.08") but where there was neither any CONV precipitation reported or any nearby shower activity indicated by ASOS and CONV weather conditions. Thirteen of 19 CDCP sites with commissioned operations experienced at least one day with falsely reported precipitation. Most of these reports were successfully removed from ASOS data transmissions either automatically or manually. Colorado Springs had the greatest number of false reports with four. Sixteen of the 19 CDCP sites experienced some missing data. Five of these sites reported missing or spurious ASOS precipitation on 6 or more days during the year on which precipitation is known to have fallen. CONV precipitation that fell on days with missing ASOS reports was not included in the comparative statistics.

The total number of valid comparison days across the 13 Central U.S. CDCP sites was 4,659, which was 528 more than last year. However, the number of days with reported CONV and ASOS precipitation were significantly less than last year due to a consistently drier regional weather pattern. Similar comparisons cannot be made for National Expansion CDCP sites as only two sites had been commissioned prior to the period covered by this report. Four additional national sites were commissioned throughout the current year. Among all sites, the station with by far the highest daily frequency of precipitation was AST (Astoria, Oregon).

Accumulated precipitation totals for each comparison site were computed and will be retained as a part of the CDCP data archive. Figures 6 and 7 show selected examples for two Central U.S. sites and two National Expansion sites. AST, as well as being the site that experienced the most frequent precipitation, is also the only site where ASOS consistently measured more precipitation than CONV in all seasons of the year.

Tables 13 and 14 show monthly CONV and ASOS precipitation totals, respectively, for the Central U.S. CDCP sites. Comparable information for the National Expansion sites are contained in Tables 15 and 16. Please note that some precipitation amounts in these tables may differ from what appears in progress reports published during the year. Some differences are a result of including data that had not been received on time. Other changes came about when the final quality control analyses were completed .

Total CONV and ASOS precipitation by month for all Central U.S. CDCP sites combined are presented in Figure 8. This part of the country is characterized by a distinct seasonal precipitation cycle with relatively low amounts of precipitation in the cold season and much higher amounts in summer. In comparison to the previous year, less precipitation fell this year across the region in every month except April. Total CONV precipitation for valid comparison days from the 13 sites combined totalled 277.26 inches compared to 381.08" the previous year. ASOS precipitation totalled 250.32" compared to 338.59". ASOS precipitation for the whole year was 90.3% of CONV compared to 88.9% last year.

Monthly values of Central U.S. ASOS precipitation as a percent of CONV are shown in Figure 9. Combined three-month percentages are shown in Figure 10. ASOS and CONV were most similar in Autumn and Spring. ASOS precipitation was slightly lower with respect to CONV in each season this year compared to last except during the summer. The low winter value is likely due to the fact that a higher percentage of regional precipitation fell in the form of snow this year. The lower spring value can also be traced to a large March snowstorm that affected much of the Southern Plains. Improved summer percentages in 1994 appear to relate to fewer very intense rainstorms than occurred during the extremely wet summer of 1993.

Total 12-month precipitation for the Central U.S. CDCP sites is shown in Figure 11 and 12. COS and DDC both registered very similar ASOS and CONV totals for the year. GLD, LNK and OKC had less ASOS precipitation than CONV but were within 5%. The lowest percentages were GRI and PUB with 78% and 72%, respectively. It is interesting to note that annual percentages were very similar between this analysis period and the previous year at ALS, CNK, COS, DDC, GLD, GRI, ICT, OKC, and TOP. AMA, PUB and TUL each experienced significantly lower ASOS percentages this year while LNK saw a noticeable improvement. The variations in differences and year-to-year consistency may suggest that some of the CONV to ASOS differences that have been observed so far are directly associated with individual gage performance characteristics (both ASOS and CONV).

Central U.S. CDCP precipitation for just the 1994 summer months and for all four seasons separately (Figure 13) show some interesting results. Several sites experienced summer ASOS totals equal to or greater than CONV. TUL and AMA have each experienced recent declines in ASOS precipitation with respect to CONV that may be associated with deteriorating ASOS gage performance. At the same time, LNK, ICT and PUB have noted significant improvements. The improvement at ICT appears to relate to a gage replacement that occurred there 12 May 1994. Keep in mind that large ASOS-CONV differences may not always imply gage problems. Large spatial variability in convective precipitation is a natural part of our climate system. CDCP sites are not stictly colocated and the effects on CDCP results may be significant at times. Such differences, however, should be random and should average out over time. More discussion of this topic appears at the end of this section.

By far the most consistent characteristic of ASOS precipitation measurements affecting climate data continuity has been the systematic undermeasurement of precipitation that falls as snow. Figure 14 shows the effects of air temperature on ASOS precipitation as a percent of CONV observed this past winter. For precipitation events that were primarily snow, ASOS reported only 43% of CONV. These findings essentially duplicated what had been observed during the first winter following commissioning.

The 1993 results also pointed toward significant undermeasurement of precipitation by ASOS during heavy rain results. To further test this theory, all CONV and ASOS precipitation were compared for any 6-hour period during the September 1993 through August 1994 period when precipitation totals exceeded 0.75" in either the CONV or ASOS gage (Figure 15). The 1994 results were not as dramatic as what was first documented in 1993. ASOS precipitation as a percent of CONV for these heavier rain events averaged 90.7% with ASOS reporting less precipitation than CONV about 80% of the time. At heavier rain rates where at least 1.50" of rain was reported in 6 hours, ASOS measured only 85% of CONV.

Data from National Expansion sites is still limited but is increasing steadily. Precipitation totals and percentages for the six commissioned expansion sites are presented in Figure 16 (top and bottom). Results are generally comparable in magnitude and variation with what has been observed in the Central U.S. Syracuse, New York, (SYR) which experienced a large amount of winter snow has shown the lowest ASOS percentages. Baton Rouge, Lousiana, (BTR) which has received only rain but several very intense rains has shown very similar CONV and ASOS totals. Astoria, Oregon, (AST) continues to be unique in that it consistently reports more ASOS precipitation than CONV at all times of year.

The frequency of precipitation is just as important as the quantity of accumulated precipitation for many applications. Based on the approximately 1000 precipitation days sampled by the 13 Central U.S. CDCP sites this past year, the overall frequency of measurable precipitation was very comparable for both ASOS and CONV. Of the 4,659 valid comparison days, measurable precipitation was reported 20.7% of the days by CONV and 21.2% by ASOS. Last year, ASOS also reported a 0.5% higher frequency than CONV across the region. The frequency of events in various size ranges is shown in Figure 17. The dominant feature which also appeared last year was the large number of ASOS daily reports of 0.01". It has now been confirmed that many of these events are the result of dew collection, fog deposition or delayed tips from rain that partially filled the bucket the previous day. This higher frequency is offset by a lower frequency of events in other size ranges.

Before applying a stict interpretation to the results that have been presented here, it is useful to contemplate what effect the separation of ASOS and CONV gages are having. Very few gage pairs are within 1,000 feet of each other and some are more than 5,000 feet apart. ASOS gage locations are more uniformly exposed in that nearly all installations are in open areas near runways and taxiways. CONV exposures are more varied ranging from open to protected. In some cases, CONV instrumentation is within a few tens of feet of existing buildings or other obstacles. These distances in combination with exposure effects are sufficient to introduce variability in the CONV-ASOS relationships that are not strictly related to the instruments themselves. The greatest variability would be expected in the summer during convective precipitation and during wind driven rain or snow. The least variability would be expected when precipitation is most stratiform.

Several months of side-by-side comparisons with additional raingages have been performed by NWS Staff during the past years. Results from these studies at selected sites will be reviewed and incorporated in future CDCP results.

5. Wind

The work began on July 25 with overall project planning. The method for photographically recording metadata of wind site exposure was begun and tested on a day trip (1) to Olympia, WA, (OLY) on August 2.

A paper, entitled "Wind Climate Data Continuity Study" was written and submitted to the American Meteorological Society as paper 16.2 for the Eleventh International Conference on Interactive Information and Processing Systems (IIPS) to be held in Dallas, TX, January 15-20, 1995. It was also to be presented at the National Weather Association annual meeting in Salt Lake City in October.

A trip (2) was made by T.J. Lockhart and J.T. Lockhart to Silver Spring, MD, on August 16, returning to Fox Island on August 24, 1994. Among the activities during the trip were the following: attended ASOS meeting, gave talk at NCDC, discussed support activities from NCDC in Asheville, discussed project plans at Silver Spring, visited the ASOS Project Office, visited Belfort Instruments, visited NIST regarding wind climate requirements, and visited NWS/T&ED at Sterling to discuss project goals. The trip resulted in a considerable amount of data from NCDC and a more comprehensive understanding of the ASOS program from NWS.

A brief trip (3) was taken to Billings, MT, (BIL) to inspect one of the two data continuity sites which still operates a totalizing anemometer and triple register recorder used for the daily fastest mile observation. Metadata photographs were taken, sensors were inspected and data were gathered to look at some F420 vs. ASOS comparisons. This data evaluation was more a familiarizing exercise than final data analysis since the BIL ASOS has not been commissioned nor has the official list of stations been chosen.

The time between trips 2 and 3 was devoted to the study of the data and materials gathered during trip 2. A one-day trip (4) to Binghamton, NY, (BGM) was taken on September 25 to examine the special wind instrument comparison being operated there and at Cheyenne, WY, (CYS).

The process made during this period was entirely preparatory to the data collection, compilation and analysis necessary to judge whether or not the new ASOS wind instruments and data handling procedures will have an effect on the continuity of the apparent wind climate.

6. Conclusions

The past year has been marked by the fielding of modified hygrothermometers, the beginning of the final 15-month temperature test phase on June 1 for all sites commissioned and equipped with modifications, and the continuation of comparison of precipitation as modifications to the heated-tipping bucket gage are in progress. Also, wind was added to the CDCP in July 1994.

Significant conclusions for temperature include ASOS does not have a systematic bias relative to field calibration thermometers, colocated sites of COS and ICT indicate the HO-83 has a warm bias (approximately 0.5°F) and a solar heating at temperature maximums (approximately 1°F), local effects of station location are important, and seasonal bias in the summer has a confidence interval of 95% of 0.1°F to 0.4°F.

Precipitation comparisons continue as the modifications to the HTB are implemented. Observations in the 1993-94 winter confirm that ASOS is not a good frozen precipitation gage. ASOS continues to record more 0.01" events than the universal gage. ASOS continue to record less rain in heavy rain events but the summer of 1994 had far fewer events than did 1993.

Table 1.

Climate Data Continuity Study (CDCP)
Comparison Sites in the Central U.S.

Site ID	Station Name	Modified Hygrothermometer Installed	Commissioned Dates
ALS	Alamosa, CO	December 8, 1993	September 1, 1992
AMA	Amarillo, TX	January 10, 1994	November 1, 1992
CNK	Concordia, KS	January 7, 1994	September 1, 1992
COS	Colorado Springs, CO	November 30, 1993	November 1, 1992
DDC	Dodge City, KS	January 11, 1994	September 1, 1992
GLD	Goodland, KS	February 11, 1994	September 1, 1992
GRI	Grand Island, NE	December 21, 1993	October 1, 1992
ICT	Wichita, KS	December 6, 1993	November 1, 1992
LNK	Lincoln, NE	May 20, 1994	November 1, 1992
OKC	Oklahoma City, OK	November 1, 1993	October 1, 1992
PUB	Pueblo, CO	March 31, 1994	October 1, 1992
SGF	Springfield, MO	February 17, 1994	Expected date: 1995
TOP	Topeka, KS	December 10, 1993	December 1, 1992
TUL	Tulsa, OK	November 22, 1993	October 1, 1992

Table 2.

Climate Data Continuity Study (CDCP)
National Expansion Sites

Site ID	Station Name	Modified Hygrothermometer Installed	Commissioned Dates
ACY	Atlantic City, NJ	May, 1993	Expected date: 1995
AST	Astoria, OR	April 28, 1994	March 1, 1993
BIL	Billings, MT	September 17, 1993	Expected date: 1995
BIS	Bismarck, ND	August, 1994	Expected date: 1995
BRO	Brownsville, TX	November 15, 1993	May 1, 1994
BRW	Barrow, AK	August 10, 1994	Expected date: 1995
BTR	Baton Rouge, LA	March 2, 1994	November 1, 1993
CYS	Cheyenne, WY	March, 1993	Expected date: 1995
DAB	Daytona Beach, FL	December 14, 1993	Expected date: 1995
ELY	Ely, NV	December 16, 1993	June 1, 1994
GRR	Grand Rapids, MI	November 15, 1993	Expected date: 1995
ITO	Hilo, HI	March 18, 1994	Expected date: 1995
ADQ	Kodiak, AK	July 1, 1993	Expected date: 1995
PAH	Paducah, KY	June 30, 1994	Expected date: 1995
PWM	Portland, ME	March 25, 1994	August 1, 1994
SJU	San Juan, PR	Oct 27 - Nov 10, 1994*	Expected date: 1995
SMX	Santa Maria, CA	March 20, 1994	Expected date: 1995
SYR	Syracuse, NY	January 15, 1994	November 1, 1993
TUS	Tucson, AZ	May 16, 1994	Expected date: 1995

Table 3.

A summary of data outliers in temperature identified for the period June through August 1994.

Station Code	Date Yr-Mo-Day	ASOS or CONV	Parameter	Old Value	New Value	Reason
AMA	94-08-07	ASOS	Tmn	46	-99	SAO or 6-hrly
AST	94-08-25	ASOS	Tmn	67	-99	SAO or 6-hrly
AST	94-08-26	ASOS	Tmn	66	-99	SAO or 6-hrly
AST	94-08-27	ASOS	Tmx	69	-99	SAO or 6-hrly
CNK	94-06-11	CONV	Tmn	79	61	Keypunch error
COS	94-08-26	ASOS	Tmn	66	59	SAO or 6-hrly
COS	94-08-27	ASOS	Tmn	63	57	SAO or 6-hrly
DDC	94-06-28	CONV	Tmn	69	-99	Missing 6-hrly
DDC	94-08-26	ASOS	Tmn	68	61	SAO or 6-hrly
DDC	94-08-27	ASOS	Tmx	90	103	SAO or 6-hrly
ELY	94-06-21	CONV	Tmn	63	-99	Ely observation confusing
GLD	94-06-09	CONV	Tmn	69	57	Keypunch error
GRI	94-07-07	ASOS	Tmx	87	-99	ASOS not operating
ICT	94-07-04	CONV	Tmn	78	70	Missing 6-hrly
ICT	94-07-11	CONV	Tmn	76	67	Missing 6-hrly
ICT	94-07-17	CNV	Tmn	80	67	Observer error
ICT	94-07-25	ASOS	Tmx	81	87	SAO or 6-hrly
ICT	94-08-27	ASOS	Tmn	64	-99	SAO or 6-hrly
LNK	94-08-25	ASOS	Tmn	57	68	SAO or 6-hrly
OKC	94-08-27	CONV	Tmn	80	74	Observer error
SYR	94-08-26	ASOS	Tmn	52	-99	SAO or 6-hrly
TOP	94-08-22	CONV	Tmn	65	55	Observer error
TOP	94-08-23	CONV	Tmn	76	59	Observer error
TOP	94-08-26	ASOS	Tmn	62	68	SAO or 6-hrly
TUL	94-08-26	ASOS	Tmn	62	69	SAO or 6-hrly

-99 = missing value code.

Table 4.

Monthly statistical summaries of ASOS-CONV maximum and minimum temperature differences, June-August 1994, for Commissioned CDCP sites in the central U.S. Comparisons are based on ASOS Summary of the Day data and CONV midnight-midnight data except at noted.

als - Daily Max Temperatures

Year	Mn	N	d	s	M	k	C
94	6			Parttime station:			
94	7			Midnight to midnight			
94	8			CONV data not available.			
Season							

als - Daily Min Temperatures

Year	Mn	N	d	s	M·	k	C
94	6			Parttime station:			
94	7			Midnight to midnight			
94	8			CONV data not available.			
Season							

ama - Daily Max Temperatures

Year	Mn	N	d	s	M	k	C
94	6	29	-0.41	0.91	0.3073	3.1840	0.9826
94	7	31	-0.90	1.01	-0.3720	2.8905	1.3440
94	8	30	-1.03	0.67	0.0332	2.1597	1.2247
Season		90	-0.79	0.91	0.0288	3.4970	1.1972

ama - Daily Min Temperatures

Year	Mn	N	d	s	M	k	C
94	6	29	-0.72	0.96	-0.7783	3.0101	1.1890
94	7	31	-0.81	0.91	-0.1133	2.7492	1.2048
94	8	30	-0.83	0.65	-0.1499	6.7729	1.0488
Season		90	-0.79	0.84	-0.4057	3.6454	1.1556

cnk - Daily Max Temperatures

Year	Mn	N	d	s	M	k	C
94	6	30	0.07	1.31	-0.4728	2.2682	1.2910
94	7	31	-0.52	1.03	-0.1360	1.7748	1.1359
94	8	31	-1.26	0.86	0.4909	2.9517	1.5134
Season		92	-0.58	1.20	0.1777	2.1139	1.3229

cnk - Daily Min Temperatures

Year	Mn	N	d	s	M	k	C
94	6	30	0.07	0.69	-0.0789	2.0175	0.6831
94	7	31	-0.16	0.58	-0.9670	4.9055	0.5957
94	8	31	-0.39	0.76	-0.5900	2.8185	0.8424
Season		92	-0.16	0.70	-0.5333	3.4854	0.7247

cos - Daily Max Temperatures

Year	Mn	N	d	s	M	k	C
94	6	30	-1.50	0.94	0.1213	2.0209	1.7607
94	7	31	-1.39	1.02	-0.2956	3.3061	1.7133
94	8	31	-1.87	1.77	-2.4058	9.7150	2.5527
Season		92	-1.59	1.30	-2.3220	13.5969	2.0483

cos - Daily Min Temperatures

Year	Mn	N	d	s	M	k	C
94	6	30	-0.67	0.66	-0.4362	2.1355	0.9309
94	7	31	-0.42	0.50	-0.3112	1.0366	0.6476
94	8	31	-0.32	0.98	2.5030	12.6145	1.0160
Season		92	-0.47	0.75	1.9166	14.7922	0.8911

ddc - Daily Max Temperatures

Year	Mn	N	d	s	M	k	C
94	6	30	0.10	0.96	-0.4166	2.5879	0.9487
94	7	31	0.74	1.09	-0.2374	3.2722	1.3075
94	8	31	0.26	1.24	-0.8870	3.1272	1.2443
Season		92	0.37	1.13	-0.5221	3.4122	1.1795

ddc - Daily Min Temperatures

Year	Mn	N	d	s	M	k	C
94	6	29	-1.38	1.15	-0.4917	2.1522	1.7811
94	7	31	-0.87	0.88	-0.5197	3.3378	1.2313
94	8	31	-0.52	1.34	0.6387	4.1004	1.4142
Season		91	-0.91	1.18	0.1933	4.5019	1.4906

gld - Daily Max Temperatures

Year	Mn	N	d	s	M	k	C
94	6	30	-1.77	0.77	0.0332	2.3057	1.9235
94	7	31	-1.68	0.98	-0.0304	2.6244	1.9344
94	8	31	-1.45	0.89	-0.1410	2.1853	1.6944
Season		92	-1.63	0.89	-0.0288	2.5836	1.8533

gld - Daily Min Temperatures

Year	Mn	N	d	s	M	k	C
94	6	30	-1.83	1.15	-0.8439	3.4274	2.1525
94	7	31	-1.58	0.96	-1.3176	6.0927	1.8404
94	8	31	-1.32	1.30	-1.1695	3.6821	1.8404
Season		92	-1.58	1.15	-1.0363	4.0834	1.9528

gri - Daily Max Temperatures

Year	Mn	N	d	s	M	k	C
94	6	30	-1.40	0.81	-0.3119	2.4894	1.6125
94	7	30	-1.17	0.70	-0.3688	3.0866	1.3540
94	8	31	-1.61	0.76	-1.1695	4.0871	1.7780
Season		91	-1.40	0.77	-0.6324	3.6115	1.5933

gri - Daily Min Temperatures

Year	Mn	N	d	s	M	k	C
94	6	29	-0.72	0.70	-0.4013	1.9857	1.0000
94	7	31	-0.65	0.71	-1.1255	4.6855	0.9504
94	8	31	-0.74	0.82	-0.1171	3.7933	1.0925
Season		91	-0.70	0.74	-0.5194	3.7441	1.0249

ict - Daily Max Temperatures

Year	Mn	N	d	s	M	k	C
94	6	30	-1.37	0.72	-0.4547	2.8742	1.5384
94	7	31	-1.68	0.91	-0.3875	2.8301	1.9008
94	8	31	-1.45	0.62	-0.1758	2.5611	1.5760
Season		92	-1.50	0.76	-0.5135	3.3566	1.6811

ict - Daily Min Temperatures

Year	Mn	N	d	s	M	k	C
94	6	30	-0.47	0.51	-0.1270	0.9511	0.6831
94	7	31	-0.52	0.51	0.0615	0.9404	0.7184
94	8	30	-0.90	0.40	0.7970	5.1917	0.9832
Season		91	-0.63	0.51	0.2621	1.6433	0.8166

Mn = Month; N = number of occurrences; d = systematic difference; s = estimated standard deviation of the difference; M = skewness; k = kurtosis; C = operational comparability.

lnk - Daily Max Temperatures

Year	Mn	N	d	s	M	k	C
94	6	30	-2.17	1.26	-0.6933	2.6757	2.4967
94	7	31	-2.61	1.33	0.5201	2.7956	2.9238
94	8	31	-2.55	0.89	0.1410	2.1853	2.6941
Season		92	-2.45	1.18	0.0302	2.6819	2.7127

lnk - Daily Min Temperatures

Year	Mn	N	d	s	M	k	C
94	6	30	-1.40	1.38	-1.3434	5.0131	1.9494
94	7	31	-1.52	1.18	-0.3755	2.2267	1.9092
94	8	31	-2.10	1.51	-0.5121	2.0407	2.5716
Season		92	-1.67	1.38	-0.8355	3.2070	2.1737

okc - Daily Max Temperatures

Year	Mn	N	d	s	M	k	C
94	6	30	-0.10	0.96	-0.4890	2.2104	0.9487
94	7	27	0.63	1.45	-0.1019	2.2464	1.5516
94	8	31	0.35	1.14	1.9080	9.2701	1.1778
Season		88	0.28	1.21	0.6374	4.7685	1.2386

okc - Daily Min Temperatures

Year	Mn	N	d	s	M	k	C
94	6	29	-2.52	1.72	-0.5773	2.0356	3.0343
94	7	27	-2.11	1.31	-1.2842	4.1536	2.4721
94	8	31	-2.48	1.61	-0.1905	2.4710	2.9457
Season		87	-2.38	1.56	-0.6426	2.6894	2.8411

top - Daily Max Temperatures

Year	Mn	N	d	s	M	k	C
94	6	30	-0.17	1.26	1.4973	5.7271	1.2517
94	7	31	0.10	1.30	0.3560	2.0634	1.2826
94	8	30	0.07	2.92	-2.7448	13.7480	2.8752
Season		91	0.00	1.96	-2.7728	22.4290	1.9499

top - Daily Min Temperatures

Year	Mn	N	d	s	M	k	C
94	6	30	-0.10	0.96	-0.2626	4.6642	0.9487
94	7	31	0.39	1.26	-1.2165	5.4962	1.2952
94	8	29	0.28	1.25	-0.9317	5.9226	1.2594
Season		90	0.19	1.17	-0.8234	5.4616	1.1877

tul - Daily Max Temperatures

Year	Mn	N	d	s	M	k	C
94	6	30	-2.17	0.99	-0.0967	2.4887	2.3735
94	7	31	-2.35	1.02	-0.0156	1.7500	2.5590
94	8	31	-2.16	1.16	-2.1929	10.1839	2.4429
Season		92	-2.23	1.05	-1.0092	6.0190	2.4606

tul - Daily Min Temperatures

Year	Mn	N	d	s	M	k	C
94	6	30	-1.63	0.96	-0.5257	2.5229	1.8886
94	7	31	-1.35	0.88	-0.1446	2.2184	1.6064
94	8	31	-1.45	0.72	-0.1626	2.6088	1.6164
Season		92	-1.48	0.86	-0.3766	2.8402	1.7146

Mn = Month; N = number of occurrences; d = systematic difference; s = estimated standard deviation of the difference; M = skewness; k = kurtosis; C = operational comparability.

Table 5.

Monthly statistical summaries of ASOS-CONV maximum and minimum temperature differences, June-August 1994, for commissioned Expansion sites in the central U.S. Comparisons are based on ASOS Summary of the Day data and CONV midnight-midnight data except at noted.

ast - Daily Max Temperatures

Year	Mn	N	d	s	M	k	C
94	6	30	-1.00	1.05	1.3804	8.1034	1.4376
94	7	31	-0.55	0.57	0.7101	2.3504	0.7829
94	8	29	0.52	2.69	4.2876	21.6525	2.6974
Season		90	-0.36	1.78	5.8730	47.8146	1.8012

ast - Daily Min Temperatures

Year	Mn	N	d	s	M	k	C
94	6	30	0.43	0.86	-0.2750	2.1438	0.9487
94	7	31	-0.10	0.54	-0.0914	3.1904	0.5388
94	8	29	0.66	0.55	0.0073	2.0472	0.8510
Season		90	0.32	0.73	-0.0589	2.5198	0.8083

bro - Daily Max Temperatures

Year	Mn	N	d	s	M	k	C
94	6	29	-1.21	1.18	-1.0097	3.0689	1.6713
94	7	31	-0.55	0.81	-0.2135	2.3229	0.9672
94	8	31	-0.74	0.63	-0.2279	2.2262	0.9672
Season		91	-0.82	0.93	-1.0959	4.8601	1.2359

bro - Daily Min Temperatures

Year	Mn	N	d	s	M	k	C
94	6	29	0.03	0.94	0.6724	4.6219	0.9285
94	7	31	0.03	0.60	-0.0091	8.4326	0.5957
94	8	31	-0.10	0.54	-0.0914	3.1904	0.5388
Season		91	-0.01	0.71	0.5747	6.7629	0.7128

btr - Daily Max Temperatures

Year	Mn	N	d	s	M	k	C
94	6	30	-2.60	0.67	0.0261	2.6025	2.6833
94	7	31	-2.26	0.68	0.3384	2.0515	2.3555
94	8	31	-2.32	0.75	0.0983	2.3561	2.4363
Season		92	-2.39	0.71	0.1641	2.5675	2.4935

btr - Daily Min Temperatures

Year	Mn	N	d	s	M	k	C
94	6	30	-1.33	0.71	-1.6888	7.2400	1.5055
94	7	31	-1.10	0.94	-2.1203	9.9346	1.4368
94	8	31	-1.13	0.92	2.7165	13.2984	1.4480
Season		92	-1.18	0.86	-0.0473	11.8636	1.4726

ely - Daily Max Temperatures

Year	Mn	N	d	s	M	k	C
94	6	30	-1.40	1.07	-0.9862	5.0707	1.7512
94	7	31	-1.26	0.68	0.3384	2.0515	1.4256
94	8	31	-1.42	0.96	0.4378	2.7164	1.7039
Season		92	-1.36	0.91	-0.3746	4.6257	1.6319

ely - Daily Min Temperatures

Year	Mn	N	d	s	M	k	C
94	6	29	2.17	1.31	-1.1327	4.5669	2.5257
94	7	31	2.32	1.42	-1.7660	7.0854	2.7120
94	8	31	2.90	1.19	-0.6186	2.5463	3.1315
Season		91	2.47	1.34	-1.2824	5.7346	2.8102

pwm - Daily Max Temperatures

Year	Mn	N	d	s	M	k	C
94	6	not available					
94	7	not available					
94	8	31	-0.71	0.86	-0.8636	4.0259	1.1072
Season		31	-0.71	0.86	-0.8636	4.0259	1.1072

pwm - Daily Min Temperatures

Year	Mn	N	d	s	M	k	C
94	6	not available					
97	7	not available					
94	8	31	-0.71	1.07	-1.9901	8.8218	1.2700
Season		31	-0.71	1.07	-1.9901	8.8218	1.2840

syr - Daily Max Temperatures

Year	Mn	N	d	s	M	k	C
94	6	30	-1.10	0.71	0.1330	1.9059	1.3038
94	7	31	-1.19	0.70	-0.2930	2.9239	1.3796
94	8	31	-1.35	2.30	-4.1423	21.1417	2.6396
Season		92	-1.22	1.44	-5.8865	48.4269	1.8824

syr - Daily Min Temperatures

Year	Mn	N	d	s	M	k	C
94	6	30	-0.47	0.68	-0.4317	2.6791	0.8165
94	7	31	-0.68	0.60	-0.2199	2.2085	0.8980
94	8	30	-0.60	0.62	0.3667	2.7390	0.8563
Season		91	-0.58	0.63	-0.0817	2.6309	0.8700

Mn = Month; N = number of occurrences; d = systematic difference; s = estimated standard deviation of the difference; M = skewness; k = kurtosis; C = operational comparability.

Table 6.

Monthly statistical summaries of ASOS-CONV hourly temperature, dewpoint temperature, dewpoint depression and relative humidity differences, June-August 1994, for commissioned CDCP sites in the Central U.S.

ALS - All Hourly Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	52	-1.71	1.36	-1.1571	5.6865	2.1794
1994	7	52	-2.17	1.42	-0.1399	2.2990	2.5907
1994	8	54	-2.17	1.45	0.6858	2.9695	2.5999
Season		158	-2.02	1.42	-0.1521	3.2040	2.4662

ALS - 06 UTC Max Temperatures

Year	Mn	N	d	s	M	k	C
1994	6		Part-time station.				
1994	7		Midnight to Midnight				
1994	8		CONV data not available				
Season							

ALS - 18 UTC Min Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	30	-0.60	1.45	0.8768	4.6514	1.5492
1994	7	31	-0.68	1.11	0.3654	2.2514	1.2826
1994	8	29	-0.79	0.68	-0.2439	2.0711	1.0339
Season		90	-0.69	1.12	0.8536	5.4920	1.3185

ALS - All Hourly Dewpoint Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	52	-0.17	3.87	1.5573	6.0362	3.8406
1994	7	52	0.83	1.54	0.0017	3.3147	1.7376
1994	8	54	0.87	2.52	1.2360	6.2684	2.6422
Season		158	0.51	2.83	1.2988	7.5144	2.8710

ALS - All Hourly Dewpoint Depressions

Year	Mn	N	d	s	M	k	C
1994	6	52	-1.54	4.24	-1.0242	4.2735	4.4764
1994	7	52	-3.00	2.31	0.2061	2.0823	3.7724
1994	8	54	-3.04	3.16	-0.2458	4.9083	4.3589
Season		158	-2.53	3.38	-0.4525	4.4818	4.2179

ALS - All Hourly Relative Humidities (percent)

Year	Mn	N	d	s	M	k	C
1994	6	52	1.24	3.11	1.2120	4.3563	3.3228
1994	7	52	3.38	3.05	0.1812	2.0817	4.5368
1994	8	53	3.97	3.99	-0.7767	3.4865	5.6006
Season		157	2.87	3.59	0.0603	2.6515	4.5923

AMA - All Hourly Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	116	-0.26	1.24	0.1670	4.1651	1.2594
1994	7	121	-0.58	1.33	0.5598	4.7262	1.4431
1994	8	124	-0.63	0.98	0.6896	4.9577	1.1640
Season		362	-0.49	1.20	0.4793	4.7257	1.2917

AMA - 06 UTC Max Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	28	-0.43	0.92	0.3481	3.1336	1.0000
1994	7	29	-0.79	1.35	1.1618	6.4936	1.5425
1994	8	31	-0.97	0.66	-0.0291	2.2361	1.1640
Season		89	-0.75	1.03	1.0001	7.2390	1.2733

AMA - 18 UTC Min Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	29	-0.72	1.44	0.5763	5.5586	1.5866
1994	7	31	-0.61	1.20	1.4827	7.8569	1.3320
1994	8	31	-0.29	1.70	1.8682	5.9356	1.6944
Season		91	-0.54	1.46	1.5513	7.3174	1.5487

AMA - All Hourly Dewpoint Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	116	0.27	2.04	3.7566	21.6930	2.0490
1994	7	120	-0.56	1.17	-1.8617	15.4118	1.2942
1994	8	123	-0.04	0.77	0.4919	3.3980	0.7704
Season		360	-0.12	1.45	3.3700	33.8529	1.4564

AMA - All Hourly Dewpoint Depressions

Year	Mn	N	d	s	M	k	C
1994	6	118	-0.32	2.92	-0.4860	13.4857	2.9256
1994	7	120	-0.03	1.79	1.7309	14.4392	1.7819
1994	8	123	-0.59	1.30	-0.2368	2.9724	1.4200
Season		362	-0.31	2.11	-0.0540	19.0404	2.1294

AMA - All Hourly Relative Humidities (percent)

Year	Mn	N	d	s	M	k	C
1994	6	115	0.32	2.43	-0.4192	5.8364	2.4381
1994	7	120	0.04	3.02	-0.4887	7.2818	3.0053
1994	8	123	0.75	2.43	-0.2981	3.1715	2.5385
Season		359	0.36	2.66	-0.4731	6.2970	2.6777

CNK - All Hourly Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	115	0.15	1.00	0.6900	6.9899	1.0087
1994	7	124	-0.27	1.01	0.6835	7.6780	1.0434
1994	8	123	-0.56	0.93	-0.2440	3.3134	1.0858
Season		363	-0.23	1.02	0.4160	6.1899	1.0458

CNK - 06 UTC Max Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	28	0.00	1.52	-0.8006	2.9395	1.4880
1994	7	31	-0.45	0.99	-0.2274	1.9073	1.0776
1994	8	31	-1.29	0.86	0.5633	2.9271	1.5450
Season		91	-0.60	1.25	0.0142	2.4270	1.3830

CNK - 18 UTC Min Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	27	0.37	1.24	1.8400	7.5910	1.2766
1994	7	31	0.32	1.35	1.8561	6.9315	1.3678
1994	8	31	0.29	2.13	1.6088	5.5069	2.1175
Season		89	0.33	1.62	1.8732	7.6032	1.6503

CNK - All Hourly Dewpoint Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	115	-0.03	0.69	0.1898	4.3286	0.6916
1994	7	124	0.58	1.20	0.4460	4.6190	1.3259
1994	8	123	1.49	1.64	0.8785	4.8181	2.2068
Season		363	0.70	1.39	1.2174	6.2609	1.5549

Mn = Month; N = number of occurrences; d = systematic difference; s = estimated standard deviation of the difference; M = skewness; k = kurtosis; C = operational comparability.

CNK - All Hourly Dewpoint Depressions

Year	Mn	N	d	s	M	k	C
1994	6	115	0.17	1.28	0.0502	4.6504	1.2854
1994	7	124	-0.85	1.57	-0.4756	3.0988	1.7803
1994	8	123	-2.05	2.07	-1.0598	3.8289	2.9078
Season		363	-0.93	1.90	-0.9776	4.8899	2.1181

CNK - All Hourly Relative Humidities (percent)

Year	Mn	N	d	s	M	k	C
1994	6	115	-0.15	2.88	0.0940	5.3349	2.8746
1994	7	124	1.74	3.39	-0.2097	4.6965	3.8010
1994	8	123	3.88	3.25	0.3649	2.9012	5.0590
Season		363	1.88	3.59	0.1391	3.8336	4.0461

COS - All Hourly Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	118	-0.85	1.22	-0.4313	4.3738	1.4787
1994	7	124	-0.98	0.95	-0.4217	3.3357	1.3678
1994	8	123	-0.79	1.07	-0.1859	5.2224	1.3282
Season		366	-0.87	1.08	-0.3325	4.6370	1.3899

COS - 06 UTC Max Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	29	-1.48	0.95	0.0733	1.9791	1.7518
1994	7	31	-1.42	1.03	-0.2101	3.2369	1.7413
1994	8	31	-1.52	0.81	-0.3124	2.3519	1.7133
Season		92	-1.46	0.93	-0.1252	2.8172	1.7301

COS - 18 UTC Min Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	30	-0.33	2.01	1.3375	6.2644	2.0000
1994	7	31	-0.26	0.77	1.2853	5.0278	0.8032
1994	8	31	0.23	1.59	1.6797	4.9529	1.5760
Season		92	-0.12	1.54	1.6280	8.0411	1.5419

COS - All Hourly Dewpoint Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	118	0.96	1.25	0.3656	3.3864	1.5704
1994	7	124	1.63	1.77	1.7636	7.3665	2.3996
1994	8	123	0.84	1.18	0.4340	4.5284	1.4399
Season		366	1.14	1.46	1.4771	8.2409	1.8566

COS - All Hourly Dewpoint Depressions

Year	Mn	N	d	s	M	k	C
1994	6	118	-1.81	1.99	-0.4812	5.1157	2.6792
1994	7	124	-2.61	2.21	-1.3140	5.1151	3.4172
1994	8	124	-1.56	2.00	0.1306	5.9290	2.5305
Season		367	-1.99	2.11	-0.6717	5.8333	2.9021

COS - All Hourly Relative Humidities (percent)

Year	Mn	N	d	s	M	k	C
1994	6	118	2.06	2.41	-0.4888	5.3171	3.1574
1994	7	123	3.36	2.60	0.5506	3.8539	4.2386
1994	8	122	2.34	2.53	-1.1178	8.1585	3.4371
Season		364	2.58	2.57	-0.2487	6.0177	3.6429

DDC - All Hourly Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	119	-0.72	1.12	-1.3454	6.8149	1.3284
1994	7	124	-0.23	1.06	0.3725	3.2889	1.0776
1994	8	124	-0.13	1.14	-0.2710	5.7250	1.1430
Season		368	-0.35	1.13	-0.4266	5.7718	1.1841

DDC - 06 UTC Max Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	29	0.14	0.95	-0.5017	2.7568	0.9469
1994	7	30	0.63	1.13	-0.1125	3.0261	1.2780
1994	8	30	0.47	1.11	-0.8060	3.1040	1.1832
Season		90	0.40	1.08	-0.3546	3.1190	1.1508

DDC - 18 UTC Min Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	30	-1.17	3.18	-2.2924	12.8095	3.3417
1994	7	30	-0.43	1.41	1.1264	4.1252	1.4491
1994	8	31	-0.16	2.13	1.8643	6.8123	2.1022
Season		91	-0.58	2.37	-1.5668	17.9763	2.4273

DDC - All Hourly Dewpoint Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	119	-0.61	0.86	-0.1193	5.8101	1.0572
1994	7	124	-1.06	0.80	0.0053	3.1905	1.3229
1994	8	124	-0.81	0.84	-0.5339	4.7145	1.1640
Season		368	-0.83	0.85	-0.1804	4.5320	1.1892

DDC - All Hourly Dewpoint Depressions

Year	Mn	N	d	s	M	k	C
1994	6	119	-0.11	1.54	-1.4775	8.0906	1.5367
1994	7	124	0.83	1.36	0.0743	4.3950	1.5888
1994	8	124	0.68	1.57	0.7494	6.4402	1.7039
Season		368	0.47	1.54	-0.2475	7.1152	1.6111

DDC - All Hourly Relative Humidities (percent)

Year	Mn	N	d	s	M	k	C
1994	6	118	0.35	2.66	1.3132	5.5273	2.6744
1994	7	124	-1.44	2.66	0.6410	6.5997	3.0129
1994	8	123	-1.05	2.88	0.7055	5.8510	3.0522
Season		366	-0.72	2.83	0.7756	5.8791	2.9183

GLD - All Hourly Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	119	-1.37	1.56	1.9201	18.4806	2.0682
1994	7	124	-1.51	1.02	-0.0010	3.7888	1.8206
1994	8	124	-0.88	1.02	0.3116	4.1797	1.3410
Season		368	-1.25	1.25	1.1802	15.5086	1.7624

GLD - 06 UTC Max Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	29	-1.79	0.77	0.0999	2.3615	1.9476
1994	7	31	-1.65	0.98	-0.1134	2.5820	1.9092
1994	8	31	-1.45	0.89	-0.1410	2.1853	1.6944
Season		92	-1.63	0.89	-0.0288	2.5836	1.8585

GLD - 18 UTC Min Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	30	-1.70	2.74	-2.8120	13.9050	3.1885
1994	7	31	-0.77	2.03	1.1870	5.1267	2.1402
1994	8	31	-0.52	2.36	1.8640	9.0087	2.3827
Season		92	-0.99	2.42	-0.6337	13.5146	2.6061

GLD - All Hourly Dewpoint Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	119	-0.21	1.81	-0.4762	9.7643	1.8173
1994	7	124	-0.35	1.04	0.6782	5.2007	1.0888
1994	8	124	-0.31	0.78	0.3980	5.2174	0.8376
Season		368	-0.29	1.27	-0.2025	13.8273	1.3080

Mn = Month; N = number of occurrences; d = systematic difference; s = estimated standard deviation of the difference; M = skewness; k = kurtosis; C = operational comparability.

GLD- All Hourly Dewpoint Depressions

Year	Mn	N	d	s	M	k	C
1994	6	119	-1.16	2.21	-0.3138	5.7964	2.4869
1994	7	124	-1.16	1.61	-0.1192	4.5884	1.9838
1994	8	124	-0.56	1.21	0.0815	5.5691	1.3320
Season		368	-0.96	1.74	-0.4026	6.7433	1.9818

GLD - All Hourly Relative Humidities (percent)

Year	Mn	N	d	s	M	k	C
1994	6	117	2.03	3.49	0.2129	6.3370	4.0255
1994	7	124	2.13	3.12	0.1367	3.3807	3.7673
1994	8	124	1.04	2.43	-0.4582	5.2710	2.6326
Season		366	1.72	3.07	0.1907	5.6013	3.5132

GRI - All Hourly Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	118	-1.01	0.92	-1.3555	7.7984	1.3623
1994	7	123	-0.92	0.83	0.0237	4.7591	1.2330
1994	8	124	-1.02	0.88	-0.4533	3.0190	1.3470
Season		366	-0.98	0.87	-0.6751	5.5186	1.3130

GRI - 06 UTC Max Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	28	-1.43	0.84	-0.2173	2.3566	1.6475
1994	7	30	-1.17	0.70	-0.3688	3.0866	1.3540
1994	8	31	-1.52	0.63	-0.7320	2.4344	1.6363
Season		90	-1.37	0.73	-0.3768	2.9014	1.5503

GRI - 18 UTC Min Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	28	-0.21	1.47	0.8244	3.2567	1.4639
1994	7	30	0.13	1.66	1.7353	6.1508	1.6330
1994	8	31	0.13	1.93	1.4174	4.7615	1.9008
Season		89	0.02	1.69	1.4960	5.5611	1.6879

GRI - All Hourly Dewpoint Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	117	-1.14	1.01	1.5251	14.7380	1.5163
1994	7	123	-0.61	1.20	3.9826	34.3589	1.3404
1994	8	124	-0.31	0.83	-0.0693	4.0018	0.8799
Season		365	-0.67	1.07	2.1633	22.2807	1.2689

GRI - All Hourly Dewpoint Depressions

Year	Mn	N	d	s	M	k	C
1994	6	118	0.16	1.40	-0.8277	8.2401	1.3992
1994	7	124	-0.30	1.31	-3.1870	25.0002	1.3410
1994	8	124	-0.72	1.25	-0.3149	4.1360	1.4340
Season		367	-0.29	1.36	-1.2683	11.3649	1.3912

GRI - All Hourly Relative Humidities (percent)

Year	Mn	N	d	s	M	k	C
1994	6	117	-0.40	2.64	1.3780	9.2596	2.6627
1994	7	123	0.46	2.45	-0.0858	2.6035	2.4795
1994	8	124	1.55	2.71	-0.4083	4.1074	3.1144
Season		365	0.55	2.71	0.2770	4.3914	2.7647

ICT - All Hourly Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	119	-0.76	1.35	5.2958	48.9170	1.5476
1994	7	122	-1.00	0.90	-0.2024	2.5741	1.3429
1994	8	126	-1.21	0.99	-1.4642	9.4100	1.5660
Season		368	-1.00	1.11	2.8622	40.7862	1.4882

ICT - 06 UTC Max Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	29	-1.38	0.73	-0.4067	2.7918	1.5536
1994	7	29	-1.69	0.89	-0.6123	2.8215	1.9028
1994	8	31	-1.45	0.62	-0.1758	2.5611	1.5760
Season		90	-1.50	0.75	-0.6239	3.4381	1.6816

ICT - 18 UTC Min Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	30	-0.20	1.19	2.8908	12.7977	1.1832
1994	7	29	-0.52	3.19	-0.2104	6.8138	3.1786
1994	8	31	-0.16	1.98	2.3196	7.6215	1.9593
Season		90	-0.29	2.24	0.3650	11.2827	2.2501

ICT - All Hourly Dewpoint Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	118	0.31	1.49	5.9303	47.8196	1.5183
1994	7	123	0.50	0.99	0.9276	4.1373	1.1080
1994	8	126	0.81	1.05	0.6706	7.7618	1.3214
Season		368	0.54	1.21	3.7819	35.4967	1.3242

ICT - All Hourly Dewpoint Depressions

Year	Mn	N	d	s	M	k	C
1994	6	118	-1.08	1.32	-1.9104	12.6145	1.7000
1994	7	122	-1.50	1.49	-0.7216	3.0806	2.1097
1994	8	126	-2.02	1.65	-0.8155	10.9401	2.6049
Season		367	-1.54	1.54	-1.0775	8.3220	2.1782

ICT - All Hourly Relative Humidities (percent)

Year	Mn	N	d	s	M	k	C
1994	6	118	1.96	2.32	0.6990	6.4136	3.0283
1994	7	122	2.84	2.73	0.3184	3.5677	3.9303
1994	8	125	3.71	2.41	-0.1852	8.7073	4.4161
Season		366	2.85	2.58	0.2547	5.1648	3.8472

LNK - All Hourly Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	119	-1.19	0.98	-0.5311	2.9748	1.5394
1994	7	124	-1.69	1.16	-0.5323	3.1858	2.0458
1994	8	116	-1.83	1.14	-0.7248	3.6295	2.1496
Season		360	-1.56	1.13	-0.6434	3.4739	1.9271

LNK - 06 UTC Max Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	29	-2.21	1.26	-0.6477	2.6319	2.5325
1994	7	30	-2.57	1.38	0.4370	2.5022	2.9040
1994	8	29	-2.62	0.78	0.1679	2.5234	2.7292
Season		89	-2.45	1.18	0.0454	2.7370	2.7189

LNK - 18 UTC Min Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	30	-1.00	1.55	-0.1067	7.4031	1.8257
1994	7	30	-0.97	1.63	0.4572	2.7664	1.8708
1994	8	29	-1.31	2.45	0.2915	2.1900	2.7418
Season		89	-1.09	1.90	0.1766	3.5830	2.1871

LNK - All Hourly Dewpoint Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	119	-1.47	1.93	-3.2798	16.6160	2.4202
1994	7	124	-1.07	1.88	-2.4116	11.6727	2.1571
1994	8	116	-0.51	0.84	0.2895	3.2310	0.9782
Season		360	-1.02	1.68	-3.1194	18.1817	1.9630

Mn = Month; N = number of occurrences; d = systematic difference; s = estimated standard deviation of the difference; M = skewness; k = kurtosis; C = operational comparability.

LNK - All Hourly Dewpoint Depressions

Year	Mn	N	d	s	M	k	C
1994	6	119	0.28	2.00	2.6214	13.8509	2.0147
1994	7	124	-0.61	2.44	1.2025	6.4300	2.5081
1994	8	116	-1.32	1.36	-0.5848	2.7871	1.8915
Season		360	-0.54	2.09	1.5303	9.7194	2.1602

LNK - All Hourly Relative Humidities (percent)

Year	Mn	N	d	s	M	k	C
1994	6	116	-0.30	3.45	-0.9007	5.7812	3.4441
1994	7	120	1.67	4.37	-0.4970	3.9084	4.6601
1994	8	115	2.78	2.85	0.2683	3.0056	3.9702
Season		352	1.38	3.82	-0.4971	4.6827	4.0581

OKC - All Hourly Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	117	-1.33	1.74	0.1153	3.4715	2.1878
1994	7	108	-1.16	1.54	-0.3974	3.8955	1.9173
1994	8	124	-1.39	1.60	-0.7749	3.9128	2.1099
Season		350	-1.30	1.62	-0.3277	3.8232	2.0771

OKC - 06 UTC Max Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	29	-0.07	0.96	-0.5687	2.3129	0.9469
1994	7	27	0.59	1.47	-0.0704	2.1165	1.5635
1994	8	31	0.32	1.14	2.0074	9.6451	1.1640
Season		88	0.28	1.21	0.6374	4.7685	1.2481

OKC - 18 UTC Min Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	29	-2.28	1.98	0.0243	3.1392	2.9942
1994	7	27	-1.56	1.85	0.3141	4.5124	2.3882
1994	8	31	-2.29	2.48	0.3606	3.4766	3.3457
Season		87	-2.06	2.14	0.1940	3.8911	2.9600

OKC - All Hourly Dewpoint Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	118	-0.02	0.97	0.1450	3.5963	0.9655
1994	7	108	-0.22	0.87	0.0136	3.5628	0.8924
1994	8	123	-0.24	0.86	-0.2774	4.1772	0.8926
Season		350	-0.16	0.90	0.0235	3.8932	0.9227

OKC - All Hourly Dewpoint Depressions

Year	Mn	N	d	s	M	k	C
1994	6	117	-1.32	1.59	0.0003	2.8154	2.0652
1994	7	108	-0.94	1.60	-0.6858	3.3402	1.8484
1994	8	123	-1.15	1.65	-0.4652	3.4091	2.0020
Season		349	-1.14	1.62	-0.3838	3.1357	1.9754

OKC - All Hourly Relative Humidities (percent)

Year	Mn	N	d	s	M	k	C
1994	6	117	3.30	3.80	0.3738	2.8503	5.0178
1994	7	107	2.14	3.55	0.8207	3.3885	4.1322
1994	8	123	2.90	3.98	0.9002	3.5746	4.9071
Season		348	2.79	3.81	0.7202	3.3007	4.7150

PUB - All Hourly Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	113	-1.43	1.84	-0.5892	9.2400	2.3234
1994	7	123	-1.32	1.06	-0.8308	4.4059	1.6869
1994	8	data not taken.					
Season		237	-1.37	1.48	-0.7608	11.1901	2.0137

PUB - 06 UTC Max Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	21	-0.29	1.38	0.8146	2.6624	1.3801
1994	7	31	-1.06	0.77	0.1029	3.8118	1.3075
1994	8	data not taken.					
Season		53	-0.75	1.11	1.1834	4.9131	1.3459

PUB - 18 UTC Min Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	21	-2.00	1.90	-0.5856	3.7037	2.7255
1994	7	31	-1.13	2.00	3.0695	14.3620	2.2647
1994	8	data not taken.					
Season		52	-1.48	1.99	1.6830	11.7839	2.4665

PUB - All Hourly Dewpoint Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	113	0.17	1.60	-0.5204	5.5197	1.5992
1994	7	123	0.28	0.95	1.0428	6.1189	0.9918
1994	8	data not taken.					
Season		237	0.23	1.30	-0.3099	7.0962	1.3192

PUB - All Hourly Dewpoint Depressions

Year	Mn	N	d	s	M	k	C
1994	6	115	-1.47	2.65	0.3894	9.7271	3.0231
1994	7	123	-1.60	1.21	-0.4341	3.1435	2.0061
1994	8	data not taken.					
Season		239	-1.54	2.03	0.4308	13.8601	2.5453

PUB - All Hourly Relative Humidities (percent)

Year	Mn	N	d	s	M	k	C
1994	6	113	2.01	3.84	-0.6620	7.9709	4.3209
1994	7	123	2.38	2.21	1.0876	4.1159	3.2386
1994	8	data not taken.					
Season		237	2.20	3.09	-0.4887	9.8320	3.7910

TOP - All Hourly Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	118	-0.03	1.23	0.6157	3.6944	1.2213
1994	7	123	0.28	1.29	0.2607	3.0269	1.3159
1994	8	121	0.42	1.10	0.5692	4.5029	1.1748
Season		363	0.23	1.22	0.4227	3.5936	1.2376

TOP - 06 UTC Max Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	29	-0.17	1.28	1.4837	5.5564	1.2731
1994	7	31	0.03	1.25	0.4356	2.3070	1.2313
1994	8	30	0.57	1.59	0.5535	3.8910	1.6633
Season		91	0.13	1.40	0.8969	4.2025	1.4034

TOP - 18 UTC Min Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	30	0.43	1.77	1.3935	5.4260	1.7981
1994	7	31	0.55	1.12	-0.3231	2.1093	1.2313
1994	8	27	0.81	3.45	1.2243	10.3360	3.4854
Season		88	0.59	2.25	1.7325	18.8136	2.3194

TOP - All Hourly Dewpoint Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	115	0.30	1.20	-1.5145	8.3683	1.2301
1994	7	123	-1.00	1.40	-1.0077	4.1092	1.7179
1994	8	121	-0.30	1.22	0.0598	5.7813	1.2531
Season		360	-0.34	1.38	-0.8038	5.1134	1.4243

Mn = Month; N = number of occurrences; d = systematic difference; s = estimated standard deviation of the difference; M = skewness; k = kurtosis; C = operational comparability.

TOP - All Hourly Dewpoint Depressions

Year	Mn	N	d	s	M	k	C
1994	6	116	-0.32	1.98	1.3605	7.2305	1.9978
1994	7	124	1.29	1.93	0.8907	3.7202	2.3141
1994	8	123	0.77	1.77	0.4057	4.4705	1.9233
Season		364	0.60	2.00	0.7405	4.5156	2.0863

TOP - All Hourly Relative Humidities (percent)

Year	Mn	N	d	s	M	k	C
1994	6	116	0.79	4.57	-0.9223	5.2085	4.6218
1994	7	124	-2.73	3.63	-0.3597	2.6167	4.5366
1994	8	122	-1.41	3.79	0.7609	4.8957	4.0292
Season		363	-1.14	4.25	-0.0727	3.8411	4.3978

TUL - All Hourly Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	119	-1.66	1.04	0.0746	5.9865	1.9575
1994	7	124	-1.42	1.07	-0.2285	2.6842	1.7735
1994	8	123	-1.35	0.97	-0.0011	3.8507	1.6626
Season		367	-1.47	1.03	-0.0766	4.1034	1.7984

TUL - 06 UTC Max Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	29	-2.17	1.00	-0.0786	2.4029	2.3853
1994	7	31	-2.39	0.99	-0.0037	1.8442	2.5778
1994	8	31	-1.97	0.75	-0.0488	1.7120	2.1022
Season		92	-2.18	0.92	-0.1272	2.2881	2.3747

TUL - 18 UTC Min Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	30	-1.27	1.70	1.6651	6.5528	2.0976
1994	7	31	-0.94	1.53	1.0933	3.7891	1.7689
1994	8	31	-0.55	2.28	2.1237	7.7822	2.3071
Season		92	-0.91	1.87	2.0386	8.7102	2.0757

TUL - All Hourly Dewpoint Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	119	0.52	1.01	0.9054	4.7601	1.1302
1994	7	124	0.59	1.00	1.1278	6.2188	1.1535
1994	8	123	1.24	1.51	1.3242	5.4370	1.9527
Season		367	0.78	1.24	1.4920	7.0730	1.4654

TUL - All Hourly Dewpoint Depressions

Year	Mn	N	d	s	M	k	C
1994	6	119	-2.18	1.42	-0.8021	3.9993	2.6025
1994	7	124	-2.01	1.55	-1.1216	5.6326	2.5352
1994	8	124	-2.56	1.91	-1.2728	5.0743	3.1902
Season		368	-2.25	1.65	-1.2306	5.6299	2.7914

TUL - All Hourly Relative Humidities (percent)

Year	Mn	N	d	s	M	k	C
1994	6	119	4.57	2.78	0.5406	3.8972	5.3439
1994	7	124	4.30	3.08	0.3858	2.7256	5.2813
1994	8	124	5.41	3.44	0.3786	2.9006	6.3983
Season		368	4.76	3.14	0.4756	3.2180	5.6976

Mn = Month; N = number of occurrences; d = systematic difference; s = estimated standard deviation of the difference; M = skewness; k = kurtosis; C = operational comparability.

Table 7.

Monthly statistical summaries of ASOS-CONV hourly temperature, dewpoint temperature, dewpoint depression and relative humidity differences, June-August 1994, for commissioned Expansion sites in the U.S.

AST - All Hourly Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	119	-0.44	0.99	-0.1997	3.2532	1.0769
1994	7	124	-0.26	0.76	-0.6215	3.7774	0.8032
1994	8	124	-0.08	0.77	-0.7067	4.0575	0.7725
Season		368	-0.26	0.86	-0.5244	3.7135	0.8923

AST - 06 UTC Max Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	29	-0.93	1.00	1.7448	9.2408	1.3519
1994	7	30	-1.23	1.48	-2.0874	8.5415	1.9061
1994	8	31	-0.06	0.81	0.1110	3.2338	0.8032
Season		91	-0.73	1.22	-1.3253	10.2554	1.4177

AST - 18 UTC Min Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	30	1.17	1.60	1.1066	4.0164	1.9579
1994	7	31	0.45	1.26	1.7477	6.4661	1.3198
1994	8	31	1.35	1.62	1.6081	4.3799	2.0945
Season		92	0.99	1.54	1.5087	5.0181	1.8250

AST - All Hourly Dewpoint Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	119	0.61	0.77	-1.0606	6.5143	0.9788
1994	7	124	0.21	0.62	0.4703	3.6091	0.6476
1994	8	124	0.48	0.68	0.4415	3.6758	0.8328
Season		368	0.43	0.71	-0.1036	4.4954	0.8321

AST - All Hourly Dewpoint Depressions

Year	Mn	N	d	s	M	k	C
1994	6	119	-1.04	0.99	0.0318	3.5720	1.4378
1994	7	124	-0.47	0.91	-0.5838	3.7059	1.0160
1994	8	124	-0.56	0.84	-0.2083	3.0938	1.0080
Season		368	-0.69	0.95	-0.3027	3.3348	1.1712

AST - All Hourly Relative Humidities (percent)

Year	Mn	N	d	s	M	k	C
1994	6	119	2.89	2.67	-0.4395	3.5927	3.9253
1994	7	124	1.40	2.65	0.4934	3.4780	2.9876
1994	8	124	1.64	2.44	-0.0666	2.6865	2.9303
Season		368	1.98	2.67	0.0368	2.9870	3.3176

BRO - All Hourly Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	117	-0.67	1.04	-0.7802	4.6894	1.2334
1994	7	124	-0.19	0.76	-1.3081	7.2920	0.7829
1994	8	123	-0.31	0.80	-1.5799	11.4729	0.8554
Season		365	-0.38	0.89	-1.2515	7.0842	0.9708

BRO - 06 UTC Max Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	25	-1.28	1.24	-0.8624	2.6051	1.7664
1994	7	27	-0.74	1.35	-2.0932	8.9640	1.5154
1994	8	28	-0.68	0.61	-0.2614	2.1895	0.9063
Season		81	-0.89	1.12	-1.7530	7.7889	1.4271

BRO - 18 UTC Min Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	26	-0.19	1.50	-1.1287	5.5480	1.4806
1994	7	25	0.08	0.64	-0.0570	8.0288	0.6325
1994	8	28	0.14	1.33	3.0618	13.8905	1.3093
Season		79	0.01	1.21	0.6127	12.5956	1.2140

BRO - All Hourly Dewpoint Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	117	-0.33	0.85	-0.0647	4.6508	0.9105
1994	7	121	-0.31	0.62	-0.7610	5.0093	0.6863
1994	8	111	-0.45	0.75	1.1907	6.4632	0.8699
Season		350	-0.36	0.74	0.1928	5.3932	0.8284

BRO - All Hourly Dewpoint Depressions

Year	Mn	N	d	s	M	k	C
1994	6	118	-0.25	1.48	2.1995	22.2818	1.4929
1994	7	121	0.12	0.89	-0.1534	3.0246	0.8907
1994	8	110	0.15	1.06	-0.6585	4.8314	1.0617
Season		350	0.01	1.18	1.1017	18.8461	1.1770

BRO - All Hourly Relative Humidities (percent)

Year	Mn	N	d	s	M	k	C
1994	6	117	0.67	2.70	0.6728	5.0498	2.7693
1994	7	121	-0.39	2.05	0.0659	3.6064	2.0779
1994	8	110	-0.55	2.75	0.7867	5.6220	2.7925
Season		349	-0.09	2.56	0.6435	5.3282	2.5605

BTR - All Hourly Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	114	-1.67	1.43	-3.4306	24.6806	2.1925
1994	7	124	-1.62	1.31	-3.1469	22.5073	2.0810
1994	8	124	-1.51	0.97	-0.3521	2.8828	1.7893
Season		363	-1.60	1.24	-3.0046	23.9219	2.0233

BTR - 06 UTC Max Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	28	-2.64	0.68	0.1610	2.7004	2.7255
1994	7	30	-2.30	0.65	0.3475	2.1441	2.3875
1994	8	30	-2.33	0.76	0.1360	2.3099	2.4495
Season		89	-2.43	0.71	0.2241	2.5934	2.5308

BTR - 18 UTC Min Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	29	-1.10	1.37	-0.5426	8.6162	1.7420
1994	7	31	-0.77	1.48	1.1853	9.8502	1.6461
1994	8	30	-1.00	0.95	1.4136	5.0593	1.3663
Season		90	-0.96	1.28	0.6493	10.6888	1.6005

BTR - All Hourly Dewpoint Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	114	0.26	1.50	1.1272	3.9131	1.5160
1994	7	124	0.02	1.52	0.9524	4.2196	1.5134
1994	8	124	-1.28	1.16	0.3402	3.6039	1.7251
Season		363	-0.36	1.56	0.8507	4.2839	1.5968

Mn = Month; N = number of occurrences; d = systematic difference; s = estimated standard deviation of the difference; M = skewness; k = kurtosis; C = operational comparability.

BTR - All Hourly Dewpoint Depressions

Year	Mn	N	d	s	M	k	C
1994	6	115	-1.79	2.76	0.7198	12.2770	3.2784
1994	7	124	-1.64	2.10	-1.1589	4.4534	2.6564
1994	8	124	-0.23	1.60	-0.7130	2.9245	1.6064
Season		364	-1.20	2.29	-0.2755	9.5263	2.5857

BTR - All Hourly Relative Humidities (percent)

Year	Mn	N	d	s	M	k	C
1994	6	111	3.90	4.15	0.2810	2.0767	5.6803
1994	7	121	3.34	4.04	0.2049	2.9079	5.2239
1994	8	124	-0.03	3.81	0.3160	2.5551	3.7977
Season		357	2.32	4.36	0.2387	2.5998	4.9324

ELY - All Hourly Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	83	1.24	1.50	-0.5788	5.9966	1.9419
1994	7	93	1.34	1.53	-0.0413	3.9122	2.0294
1994	8	92	1.54	1.48	-0.3061	3.4502	2.1315
Season		268	1.38	1.50	-0.2983	4.4814	2.0388

ELY - 06 UTC Max Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	27	-1.41	1.08	-1.1030	5.2189	1.7638
1994	7	31	-1.26	0.68	0.3384	2.0515	1.4256
1994	8	30	-1.33	0.92	0.4155	2.7747	1.6125
Season		89	-1.34	0.89	-0.4432	5.0159	1.6112

ELY - 18 UTC Min Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	29	2.45	0.95	-0.4638	2.9027	2.6196
1994	7	31	2.61	0.95	-0.5348	3.1178	2.7766
1994	8	31	3.74	1.65	2.0723	8.4174	4.0798
Season		91	2.95	1.35	1.8025	11.2953	3.2406

ELY - All Hourly Dewpoint Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	90	1.46	5.19	1.0347	3.6165	5.3635
1994	7	28	-7.61	8.60	1.6034	4.4650	11.3657
1994	8	98	0.45	3.94	0.9138	5.9564	3.9409
Season		216	-0.18	5.99	0.1291	3.9467	5.9827

ELY - All Hourly Dewpoint Depressions

Year	Mn	N	d	s	M	k	C
1994	6	86	0.76	4.77	-0.9812	4.0347	4.8019
1994	7	24	10.75	3.91	-0.7495	2.5747	11.4127
1994	8	100	2.25	4.01	0.7155	4.5754	4.5793
Season		210	2.61	5.26	0.0952	3.9033	5.8603

ELY - All Hourly Relative Humidities (percent)

Year	Mn	N	d	s	M	k	C
1994	6	85	-0.83	3.36	-0.4082	4.9870	3.4431
1994	8	93	-0.92	3.54	-0.3141	4.8351	3.6364
Season		181	-1.00	3.58	-0.4600	4.8138	3.7109

SYR - All Hourly Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	117	-0.89	0.87	-1.3079	6.9476	1.2403
1994	7	124	-0.89	0.67	-0.1264	3.2094	1.1072
1994	8	123	-0.62	0.89	-0.9524	7.2267	1.0820
Season		364	-0.80	0.82	-0.8646	6.6876	1.1435

SYR - 06 UTC Max Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	29	-1.41	7.30	0.3300	1.8898	7.3085
1994	7	31	-1.42	5.03	0.1405	2.1024	5.1494
1994	8	30	-1.27	4.86	0.3440	2.3772	4.9396
Season		90	-1.37	5.74	0.3127	2.4172	5.8729

SYR - 18 UTC Min Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	30	0.43	2.70	2.3679	8.8193	2.6895
1994	7	31	0.23	2.12	1.5705	4.3849	2.1022
1994	8	31	0.61	3.03	1.8278	5.0955	3.0427
Season		92	0.42	2.62	2.1295	7.1778	2.6516

SYR - All Hourly Dewpoint Temperatures

Year	Mn	N	d	s	M	k	C
1994	6	115	0.12	1.37	-4.8938	38.8697	1.3705
1994	7	124	-0.17	0.62	-1.6931	8.9255	0.6413
1994	8	123	-0.09	0.70	0.1223	2.8209	0.7042
Season		362	-0.05	0.95	-4.5132	50.8553	0.9557

SYR - All Hourly Dewpoint Depressions

Year	Mn	N	d	s	M	k	C
1994	6	116	-0.98	1.47	2.4046	19.7706	1.7617
1994	7	124	-0.72	0.88	0.3518	3.4150	1.1324
1994	8	124	-0.52	0.99	-0.4767	3.3088	1.1144
Season		364	-0.73	1.15	1.3720	16.7135	1.3607

SYR - All Hourly Relative Humidities (percent)

Year	Mn	N	d	s	M	k	C
1994	6	115	2.39	2.54	-0.1168	4.4741	3.4771
1994	7	124	1.69	2.19	-0.4890	3.4239	2.7557
1994	8	124	1.12	2.31	0.1440	2.8878	2.5603
Season		363	1.72	2.39	-0.0735	3.6590	2.9440

Mn = Month; N = number of occurrences; d = systematic difference; s = estimated standard deviation of the difference; M = skewness; k = kurtosis; C = operational comparability.

Table 8.

Summer season ASOS-CONV temperature comparison for mean bias, standard deviation, 95% confidence interval, and 99% confidence interval for Central U.S.

Location	Temp.	Mean (°F)	Standard Deviation (°F)	Confidence Interval	
				95% (°F)	99% (°F)
AMA	Max	-0.79	0.91	± 0.19	± 0.25
	Min	-0.79	0.84	± 0.17	± 0.23
CNK	Max	-0.58	1.20	± 0.25	± 0.32
	Min	-0.16	0.70	± 0.14	± 0.19
COS	Max	-1.59	1.30	± 0.27	± 0.35
	Min	-0.47	0.75	± 0.15	± 0.20
DDC	Max	0.37	1.13	± 0.23	± 0.31
	Min	-0.91	1.18	± 0.24	± 0.32
GLD	Max	-1.63	0.89	± 0.18	± 0.24
	Min	-1.58	1.15	± 0.24	± 0.31
GRI	Max	-1.40	0.77	± 0.16	± 0.21
	Min	-0.70	0.74	± 0.15	± 0.20
ICT	Max	-1.50	0.76	± 0.16	± 0.20
	Min	-0.63	0.51	± 0.10	± 0.14
AST	Max	-0.42	1.86	± 0.38	± 0.50
	Min	0.48	1.70	± 0.35	± 0.46
LNK	Max	-2.45	1.18	± 0.24	± 0.32
	Min	-1.67	1.38	± 0.28	± 0.37
OKC	Max	0.28	1.21	± 0.25	± 0.33
	Min	-2.38	1.56	± 0.32	± 0.42
TOP	Max	0.00	1.96	± 0.40	± 0.53
	Min	0.19	1.17	± 0.24	± 0.32
TUL	Max	-2.23	1.05	± 0.22	± 0.28
	Min	-1.48	0.86	± 0.18	± 0.23

Table 9.

Summer season ASOS-CONV temperature comparison for mean bias, standard deviation, 95% confidence interval, and 99% confidence interval for expansion sites in the U.S.

Location	Temp.	Mean (°F)	Standard Deviation (°F)	Confidence Interval	
				95% (°F)	99% (°F)
AST	Max	-0.42	1.86	± 0.38	± 0.50
	Min	0.48	1.70	± 0.35	± 0.46
BRO	Max	-0.82	0.93	± 0.19	± 0.25
	Min	-0.01	0.71	± 0.15	± 0.19
BTR	Max	-2.39	0.71	± 0.15	± 0.19
	Min	-1.18	0.86	± 0.18	± 0.23
ELY	Max	-1.36	0.91	± 0.19	± 0.25
	Min	2.30	2.09	± 0.43	± 0.56
SYR	Max	-1.22	1.44	± 0.30	± 0.39
	Min	-0.72	1.44	± 0.30	± 0.39

Table 10.
ASOS-CONV temperature (T), dewpoint temperature (T_D), dewpoint depression ($T-T_D$) difference (°F) and relative humidity (RH) for summer 1994 (June-August 1994 combined) based on 6-hourly observations 0000, 0600, 1200 and 1800 UTC.

Station	T	T_D	$T-T_D$	RH (%)
Central U.S. Sites				
ALS	-2.0	+0.5	-2.5	+2.9
AMA	-0.5	-0.1	-0.3	+0.4
CNK	-0.2	+0.7	-0.9	+1.9
COS	-0.9	+1.1	-2.0	+2.6
DDC	-0.4	+0.5	-0.7	+1.4
GLD	-1.3	-0.3	-1.0	+1.7
GRI	-1.0	-0.7	-0.3	+0.6
ICT	-1.0	+0.5	-1.5	+2.9
LNK	-1.6	-1.0	-0.5	+1.4
OKC	-1.3	-0.2	-1.1	+2.8
PUB	Inc	Inc	Inc	Inc
TOP	+0.2	-0.3	+0.6	-1.1
TUL	-1.5	+0.8	-2.3	+4.8
Average	-0.96	0.13	-1.04	1.86
National U.S. Sites				
AST	-0.3	+0.4	-0.7	+2.0
BRO	-0.4	-0.4	0	-0.1
BTR	-1.6	-0.4	-1.2	+2.3
ELY	bad data	bad data	bad data	bad data
PWM	Inc	Inc	Inc	Inc
SYR	-0.8	-0.1	-0.7	+1.7
Average	-0.78	-0.13	-0.65	1.48

Table 11.

Summary of precipitation days for each ASOS CDCP site based on 24-hour ASOS and CONV totals for period ending at 1200 UTC based on all comparison data September 1993 through August 1994.

Station	Period of Record	Valid Comparison Days[1]	Suspect ASOS Days[2]	CONV Precip Days[3]	ASOS Precip Days[4]	Mutual Precip Days[5]
ALS	9/1/93-8/31/94	360	1	58	53	49
AMA	9/1/93-8/31/94	360	2	64	65	60
CNK	9/1/93-8/31/94	357	3	83	82	76
COS	9/1/93-8/31/94	360	4	90	95	85
DDC	9/1/93-8/31/94	364	0	62	73	59
GLD	9/1/93-8/31/94	363	0	66	71	62
GRI	9/1/93-8/31/94	359	0	80	74	65
ICT	9/1/93-8/31/94	363	2	71	72	62
LNK	9/1/93-8/31/94	360	1	89	96	81
OKC	9/1/93-8/31/94	363	1	68	75	61
PUB	9/1/93-7/31/94	324	3	60	40	38
TOP	9/1/93-8/31/94	365	0	95	99	92
TUL	9/1/93-8/31/94	361	1	80	92	78
Total		4659	18	966	987	868

[1] All days when both CONV and ASOS total 24-hour precipitation data were available.

[2] Days with significant ASOS precipitation reported (≥ 0.08") when no CONV precipitation was reported or indicated from weather conditions. (These days were removed from further analysis.)

[3] Valid comparison days when measurable (≥ 0.01 inches) precipitation was reported by the conventional observation.

[4] Valid comparison days when measurable (≥ 0.01 inches) precipitation was reported by ASOS observations.

[5] Valid comparison days on which both ASOS and CONV reported ≥ 0.01 inches of precipitation.

Table 12.

Summary of precipitation days for each ASOS Expansion site based on 24-hour ASOS and CONV totals for period ending at 1200 UTC based on all comparison data from September 1993 or date of commissioning through August 1994.

Station	Period of Record	Valid Comparison Days[1]	Suspect ASOS Days[2]	CONV Precip Days[3]	ASOS Precip Days[4]	Mutual Precip Days[5]
AST	9/1/93-8/31/94	359	2	144	188	144
BRO	6/1/94-8/31/94	92	0	16	20	16
BTR	11/3/93-8/31/94	299	3	91	103	89
ELY	6/1/94-8/31/94	92	0	12	11	11
PWM	8/1/94-8/31/94	29	1	9	9	8
SYR	1/11/94-8/31/94	226	3	118	95	85
Total		1097	9	390	426	353

[1] All days when both CONV and ASOS total 24-hour precipitation data were available.

[2] Days with significant ASOS precipitation (≥ 0.08") when no CONV precipitation was reported or indicated from weather conditions. (These days were removed from further analysis.)

[3] Valid comparison days when measurable (≥ 0.01 inches) precipitation was reported by the conventional observation.

[4] Valid comparison days when measurable (≥ 0.01 inches) precipitation was reported by ASOS observations.

[5] Valid comparison days on which both ASOS and CONV reported ≥ 0.01 inches of precipitation.

Table 13.

Monthly total CONV precipitation (inches) for each commissioned ASOS CDCP site from September 1993 through August 1994. Precipitation was not included for periods when ASOS operations were suspended.

Station	Monthly Total Precipitation - Conventional (inches)												
	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	Total
ALS	0.47	0.39	0.35	0.10	0.26	0.05	0.44	0.34	1.75	0.14	0.03	0.75	5.07
AMA	0.91	0.47	0.53	0.74	1.00	0.07	0.99	1.05	1.10	1.18	4.54	3.10	15.68
CNK	3.13	0.94	0.72	1.30	0.71	0.53	0.08	1.83	1.60	5.41	3.88	0.40	20.53
COS	1.35	1.03	1.36	0.13	0.30	0.14	1.03	1.96	3.86	3.35	0.99	3.46	18.96
DDC	0.70	0.93	0.61	1.02	0.38	0.45	0.06	2.02	0.82	2.27	4.52	3.06	16.84
GLD	0.24	2.23	0.80	0.01	0.38	0.10	0.17	2.88	1.42	2.19	2.87	1.66	14.95
GRI	1.46	1.56	0.89	0.42	0.66	1.20	0.04	3.29	0.44	3.93	5.40	1.63	20.92
ICT	1.83	2.16	0.65	0.46	0.11	0.60	0.49	5.41	0.96	2.94	6.21	1.59	23.41
LNK	3.73	1.58	0.58	0.49	0.53	0.58	0.06	1.73	1.86	4.26	4.26	2.97	22.63
OKC	6.79	0.41	1.42	1.27	0.28	2.59	3.57	3.26	2.73	1.92	2.17	2.01	28.42
PUB	0.64	0.26	1.11	0.00	0.46	0.02	1.04	1.97	1.90	2.27	0.21		9.88
TOP	7.21	1.41	1.19	0.94	0.49	0.69	0.31	4.67	1.01	5.12	3.34	8.17	34.55
TUL	6.72	1.17	1.88	0.89	0.52	1.74	3.56	6.83	3.61	2.41	12.20	3.89	45.42
SUM	35.2	14.5	12.09	7.77	6.08	8.76	11.84	37.24	23.06	37.39	50.62	32.69	277.26
AVE	2.71	1.12	0.93	0.60	0.47	0.67	0.91	2.86	1.77	2.88	3.89	2.72	21.33

Note: Final editting and inclusion of additional data have resulted in some changes in precipitation totals from those shown in quarterly progress reports.

Table 14.

Monthly total ASOS precipitation (inches) for each commissioned ASOS CDCP site from September 1993 through August 1994. Precipitation was not included for periods when ASOS operations were suspended.

	Monthly Total Precipitation - ASOS (inches)												
Station	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	Total
ALS	0.58	0.32	0.25	0.10	0.22	0.04	0.43	0.39	1.76	0.15	0.03	0.46	4.73
AMA	1.00	0.53	0.51	0.95	0.47	0.06	0.73	1.11	1.41	0.96	3.87	2.56	14.16
CNK	3.13	0.84	0.56	1.10	0.60	0.19	0.06	1.62	1.58	4.64	3.15	0.05	17.52
COS	1.44	1.01	0.97	0.09	0.18	0.11	0.70	1.50	4.11	4.32	1.30	3.46	19.19
DDC	0.80	1.03	0.63	0.90	0.39	0.35	0.01	1.92	0.90	1.88	4.73	3.46	17.00
GLD	0.31	2.38	0.92	0.01	0.07	0.10	0.27	2.72	1.52	2.13	2.98	0.89	14.30
GRI	1.54	1.54	0.72	0.19	0.00	0.34	0.01	2.77	0.35	3.60	4.11	1.21	16.38
ICT	1.77	1.63	0.55	0.29	0.03	0.24	0.25	3.80	1.06	2.77	5.43	2.12	19.94
LNK	3.24	1.56	0.54	0.41	0.45	0.41	0.07	1.79	1.72	4.15	4.10	3.24	21.68
OKC	7.07	0.47	1.34	1.27	0.16	2.18	3.23	3.39	2.71	1.72	1.52	1.80	26.86
PUB	0.07	0.00	0.10	0.00	0.00	0.00	0.03	2.13	2.20	2.59	0.01		7.13
TOP	7.01	1.30	1.13	0.84	0.42	0.17	0.31	4.31	0.96	3.96	2.77	7.72	30.90
TUL	6.88	1.14	1.69	0.92	0.68	1.88	2.88	6.58	2.86	2.73	8.23	4.06	40.53
SUM	34.8	13.8	9.91	7.07	3.67	6.07	8.98	34.03	23.14	35.6	42.23	31.03	250.32
AVE	2.68	1.06	0.76	0.54	0.28	0.47	0.69	2.62	1.78	2.74	3.25	2.59	19.26

Note: Final editting and inclusion of additional data have resulted in some changes in precipitation totals from those shown in quarterly progress reports.

Table 15.

Monthly total CONV precipitation (inches) for each Expansion ASOS CDCP site from September 1993 or date of commissioning through August 1994. Precipitation was not included for periods when ASOS operations were suspended.

	Monthly Total Precipitation - Conventional (inches)												
Station	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	TOTAL
ACY													
AST	0.09	2.15	5.40	8.79	6.26	11.00	5.90	3.98	2.32	2.05	0.71	1.41	50.06
BIL													
BIS													
BRO									1.20	3.73	0.16	3.75	8.84
BRW													
BTR			3.71	3.52	6.71	2.99	4.06	9.17	(n/a)	6.97	9.88	3.24	50.25
DAB													
ELY										T	0.05	0.61	0.66
GRR													
ITO													
KDK													
PAH													
PWM												2.80	2.80
SJU													
SMX													
SYR					1.36	1.92	4.82	3.43	2.56	2.94	2.37	4.09	23.49
TUS													
SUM	0.09	2.15	9.11	12.31	12.97	13.99	9.96	13.15	3.52	12.75	10.8	9.01	109.81
AVE	0.09	2.15	4.56	6.16	6.49	7.00	4.98	6.58	1.76	4.25	2.70	2.25	8.45

Table 16.

Monthly total ASOS precipitation (inches) for each Expansion ASOS CDCP site from September 1993 or date of commissioning through August 1994. Precipitation was not included for periods when ASOS operations were suspended.

	Monthly Total Precipitation - ASOS (inches)												
Station	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	TOTAL
ACY													
AST	0.18	2.32	5.42	9.05	6.49	11.36	6.48	4.31	2.56	2.30	0.82	1.58	52.87
BIL													
BIS													
BRO									1.27	3.32	0.15	3.42	8.16
BRW													
BTR			3.72	3.30	6.68	2.99	3.76	8.75	(5.82)	6.52	10.22	3.11	43.23
DAB													
ELY										T	0.05	0.56	0.61
GRR													
ITO													
KDK													
PAH													
PWM												1.76	1.76
SJU													
SMX													
SYR					0.53	0.80	4.09	3.42	1.88	2.91	2.57	2.17	18.37
TUS													
SUM	0.18	2.32	9.14	12.35	13.7	15.15	14.33	16.48	-0.11	15.05	13.81	12.60	125.00
AVE	0.18	2.32	4.57	6.18	4.57	5.05	4.78	5.49	-0.03	3.76	2.76	2.10	6.94

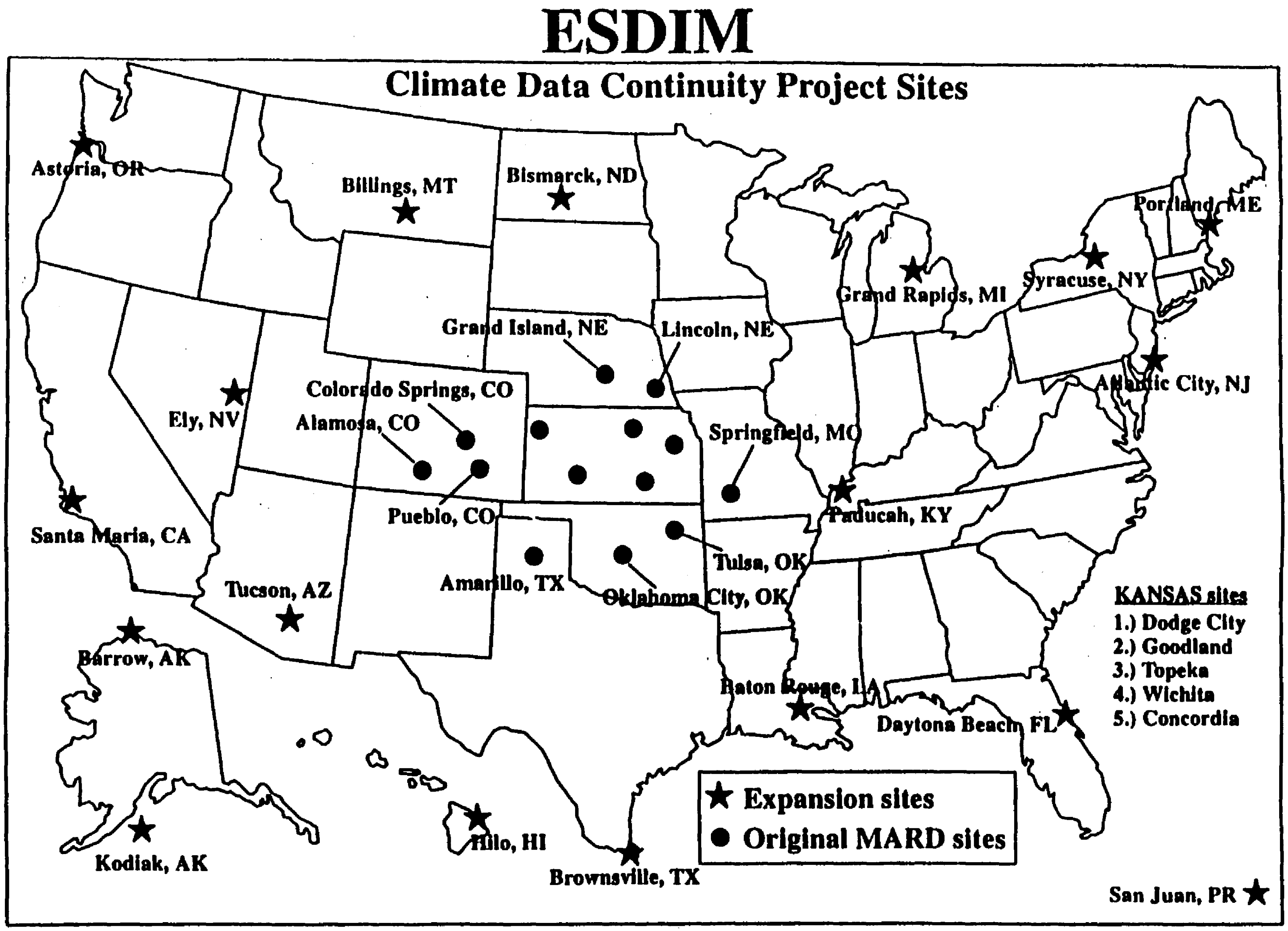


Figure 1. A national perspective on the locations of the ASOS CDCP comparison stations in the Central U.S. (solid circles) along with the names and locations of CDCP expansion sites (stars). Figure provided by Andy Horvitz, NWS, Office of Meteorology.

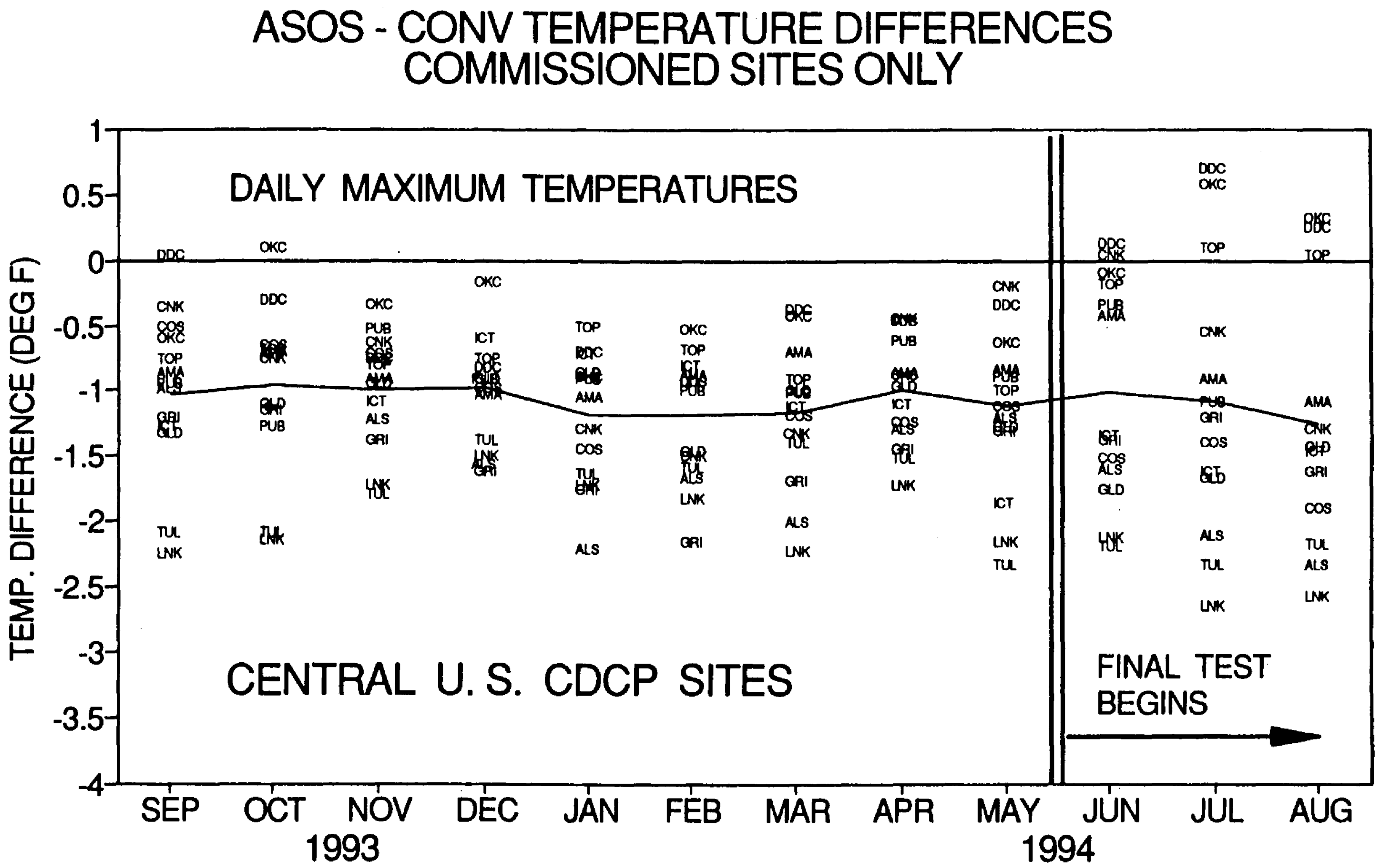


Figure 2. The composite mean ASOS-CONV systematic difference (°F), September 1993 through August 1994, for daily maximum temperature (solid line) with the actual monthly systematic differences plotted for each of the 13 ASOS CDCP sites in the Central U.S.

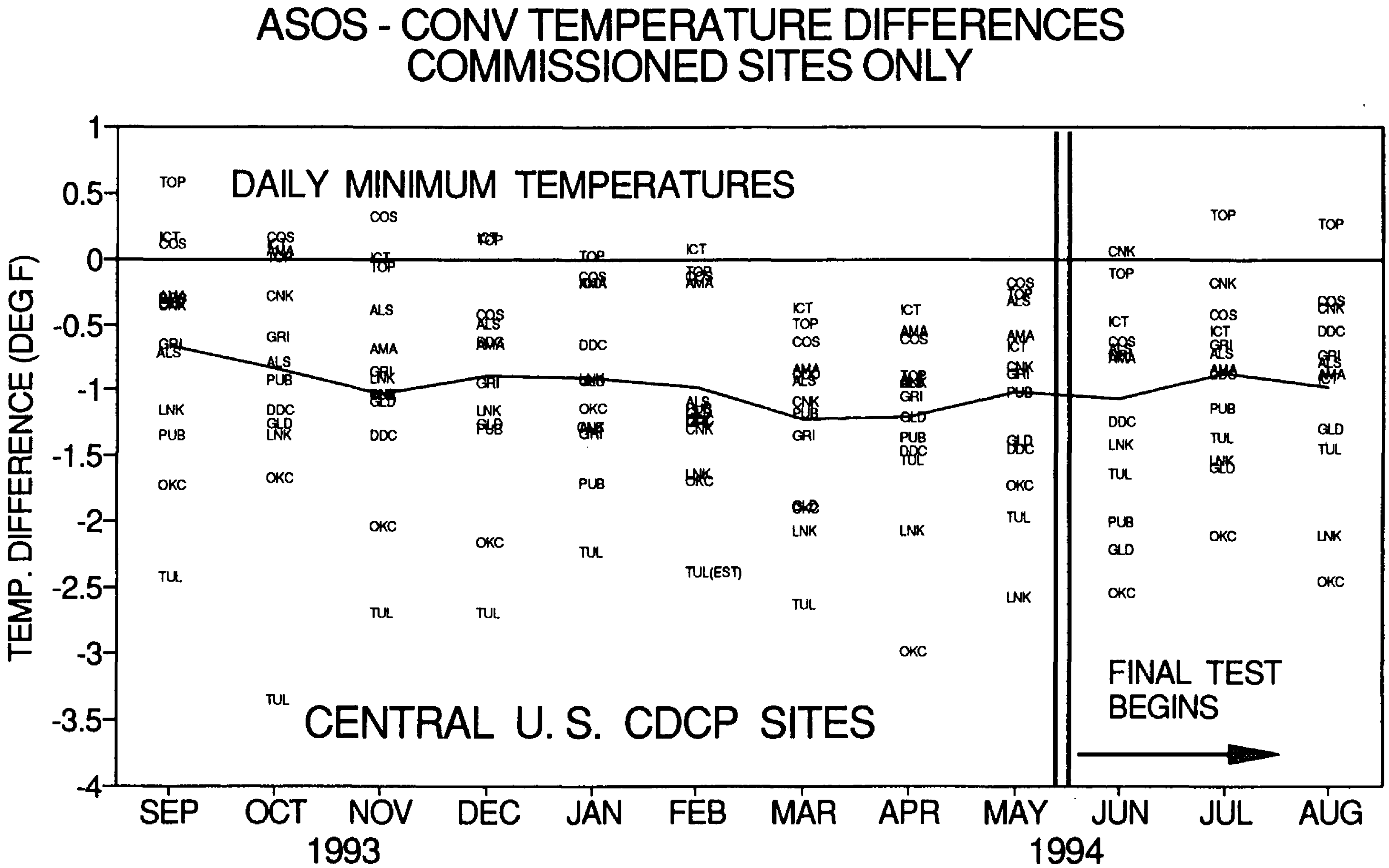


Figure 3. The composite mean ASOS-CONV systematic difference (°F), September 1993 through August 1994, for daily minimum temperatures (solid line) with the actual monthly systematic differences plotted for each of the 13 ASOS CDCP sites in the Central U.S.

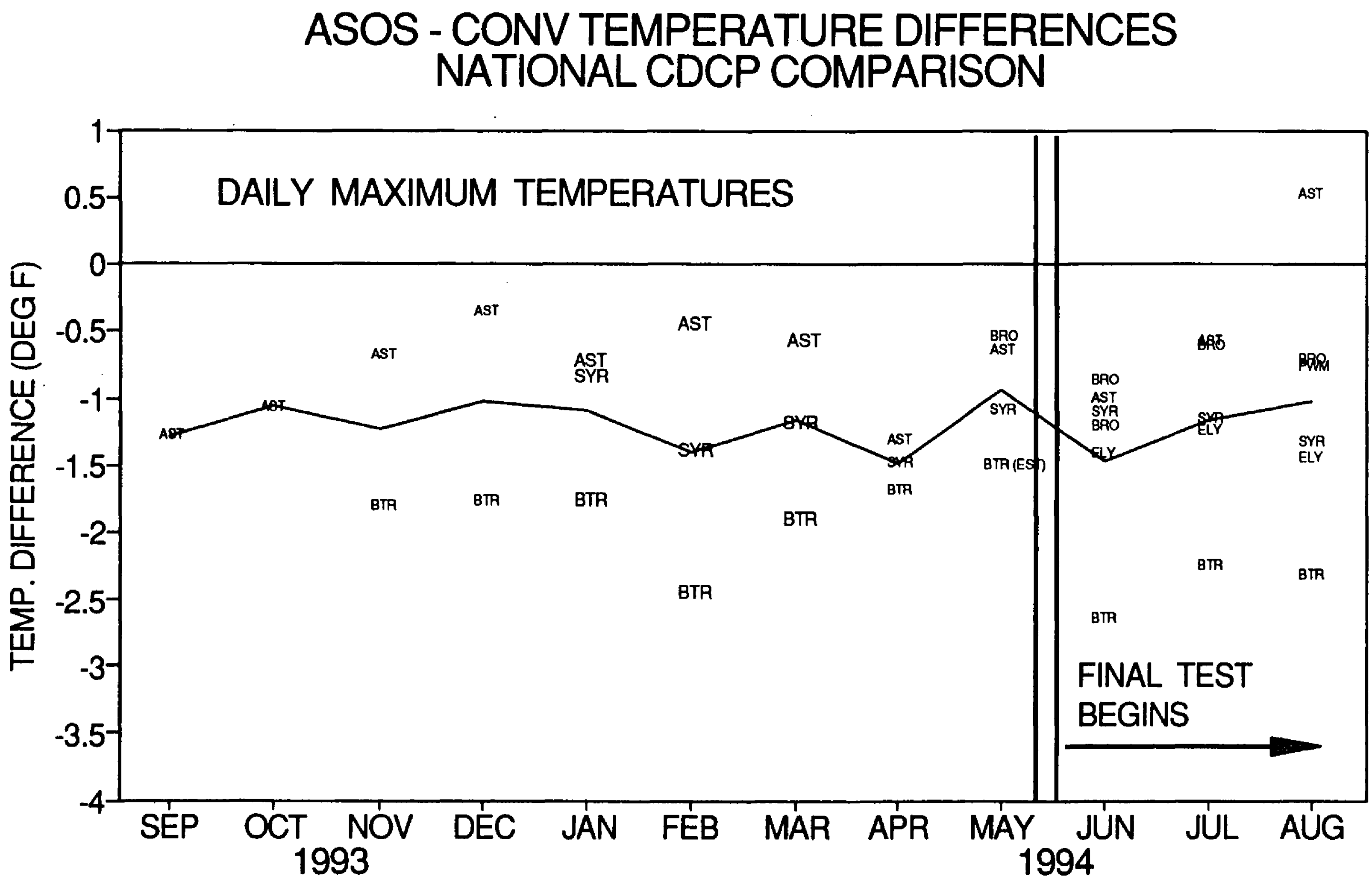


Figure 4. The composite mean ASOS-CONV systematic difference (° F), September 1993 through August 1994, for daily maximum temperatures (solid line) with the actual monthly systematic differences plotted for each of the commissioned national expansion CDCP sites.

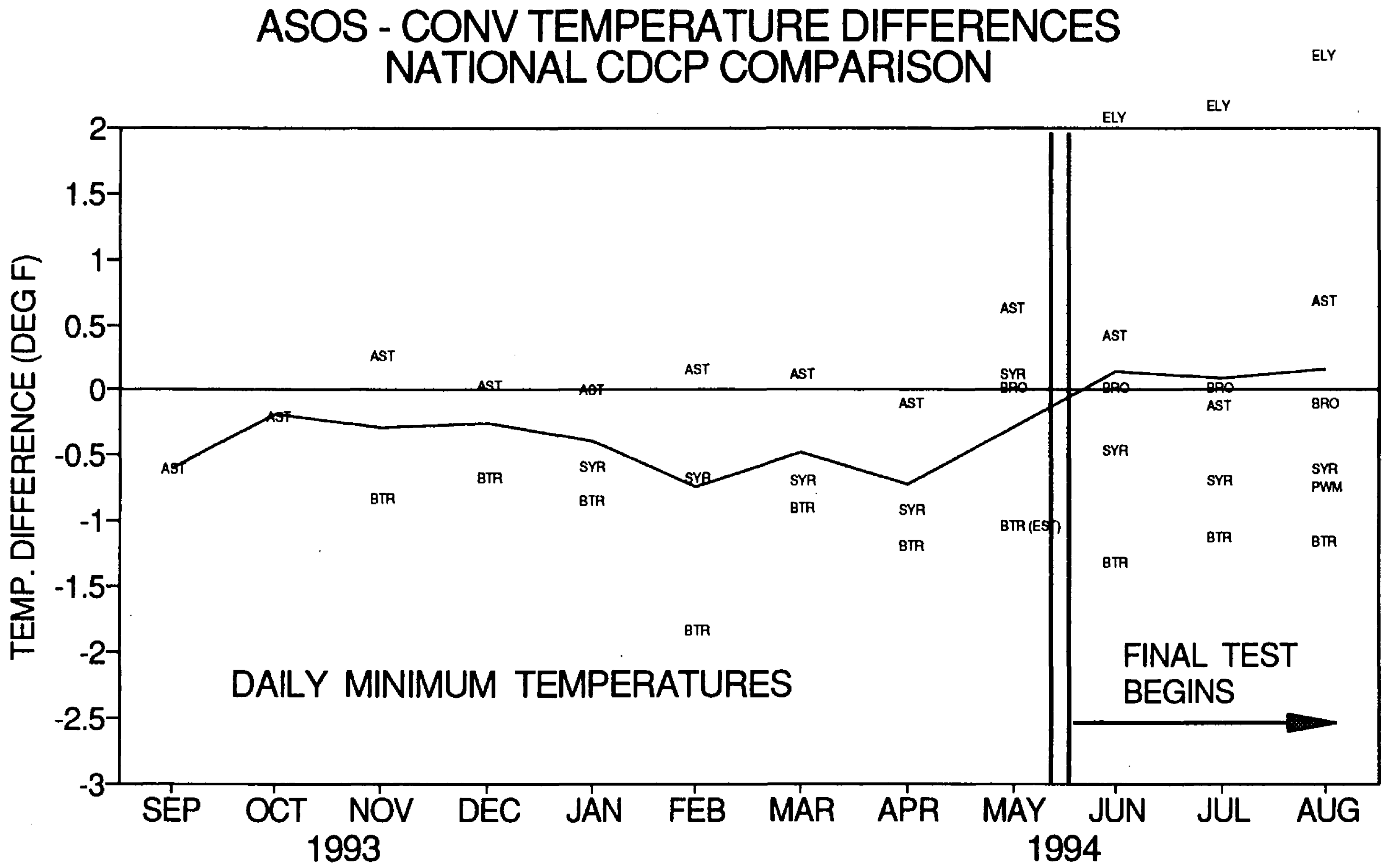
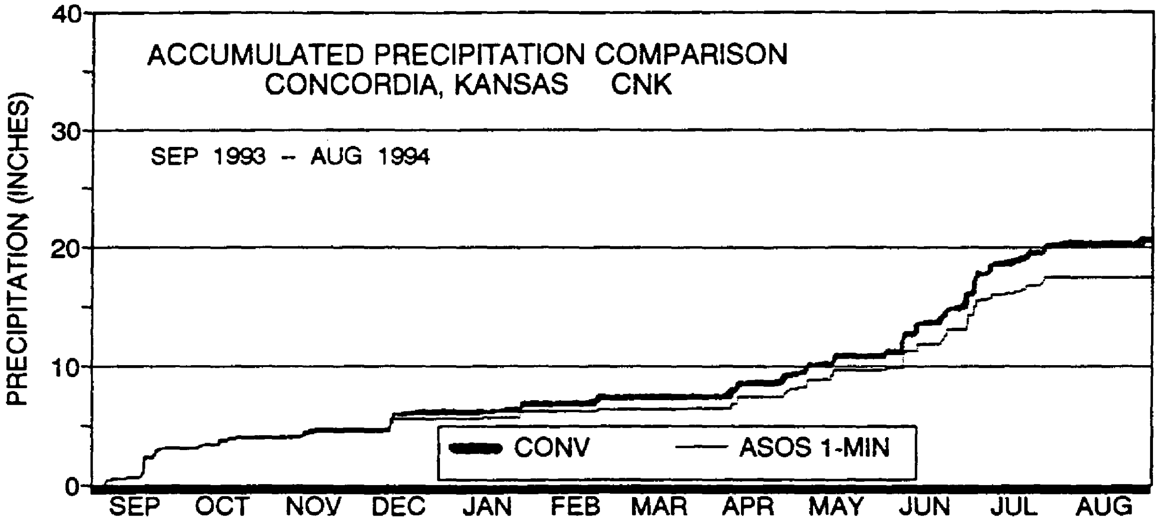


Figure 5. The composite mean ASOS-CONV systematic difference (°F), September 1993 through August 1994, for daily minimum temperatures (solid line) with the actual monthly systematic differences plotted for each of the commissioned national expansion CDCP sites.



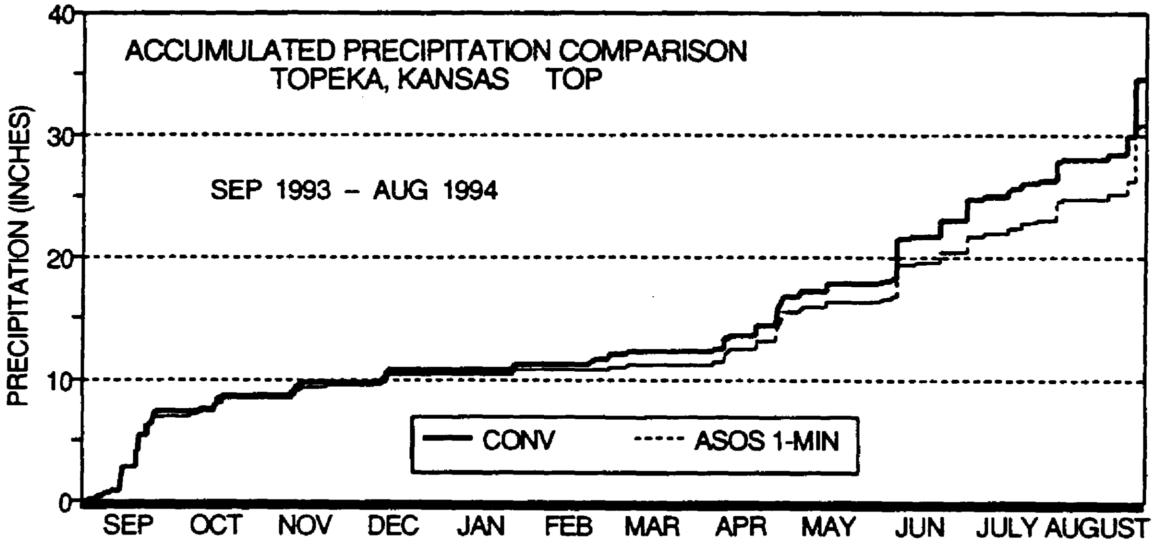


Figure 6. Accumulated precipitation (inches) for CONV (heavy solid line) and ASOS (thin line) for Concordia, Kansas (top) and Topeka, Kansas (bottom) for September 1993 through August 1994.

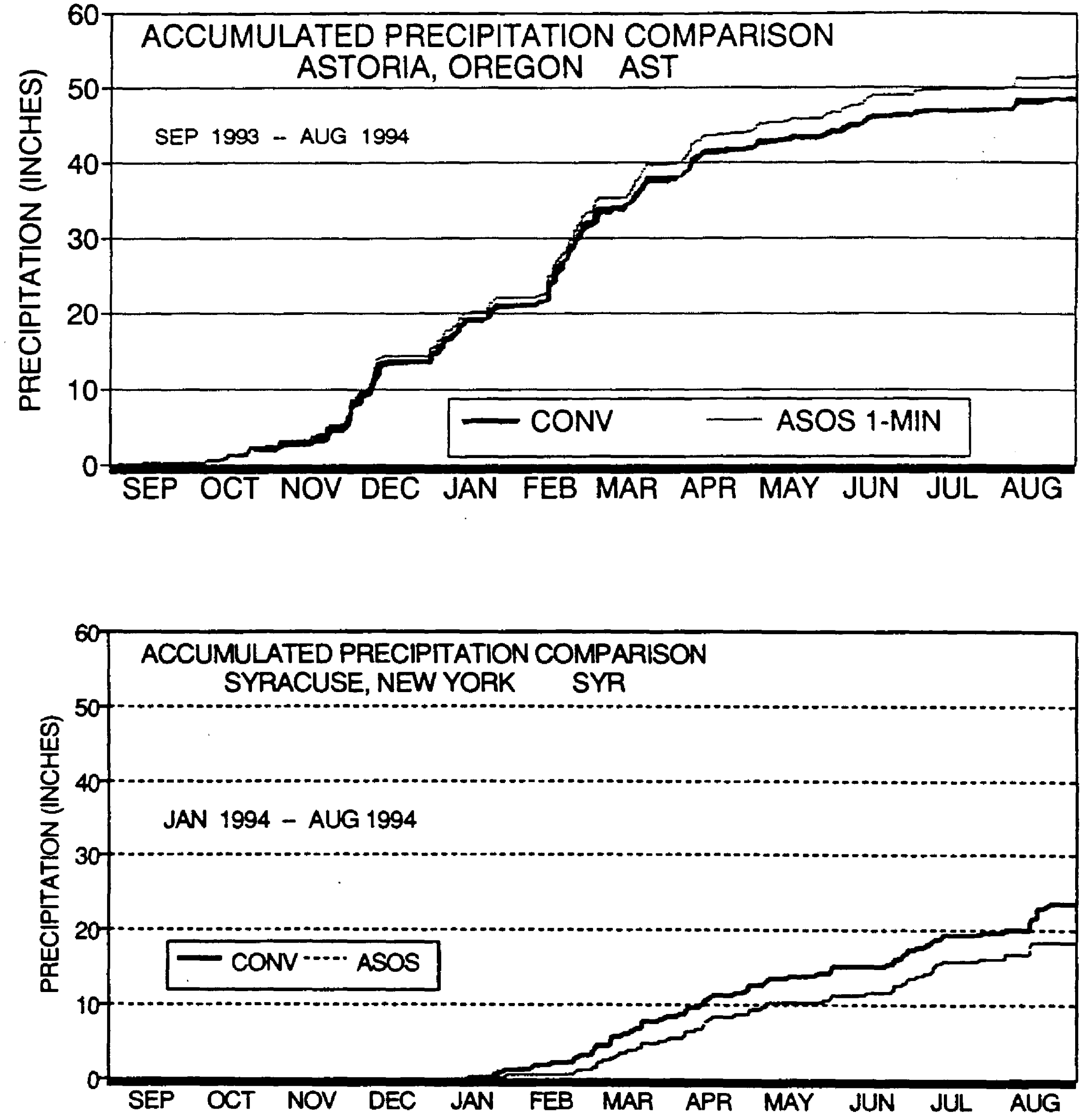


Figure 7. Accumulated precipitation (inches) for CONV (heavy solid line) and ASOS (thin line) for Astoria, Oregon (top) and Syracuse, New York (bottom) for September 1993 or date of commissioning through August 1994.

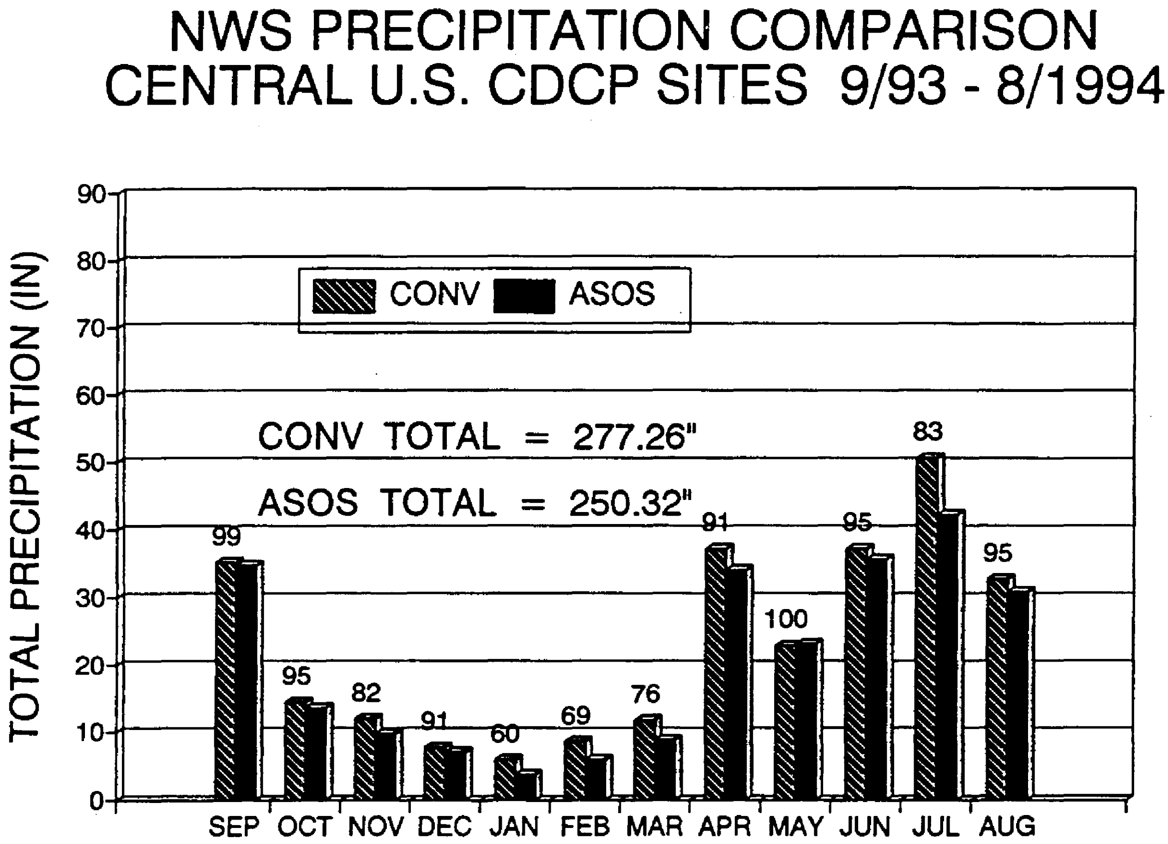


Figure 8. Total CONV and ASOS cumulative precipitation, by month, for all 13 CDCP sites in the Central U.S. combined for the period September 1993 through August 1994. Numbers above each set of monthly bars show ASOS precipitation as a percent of CONV.

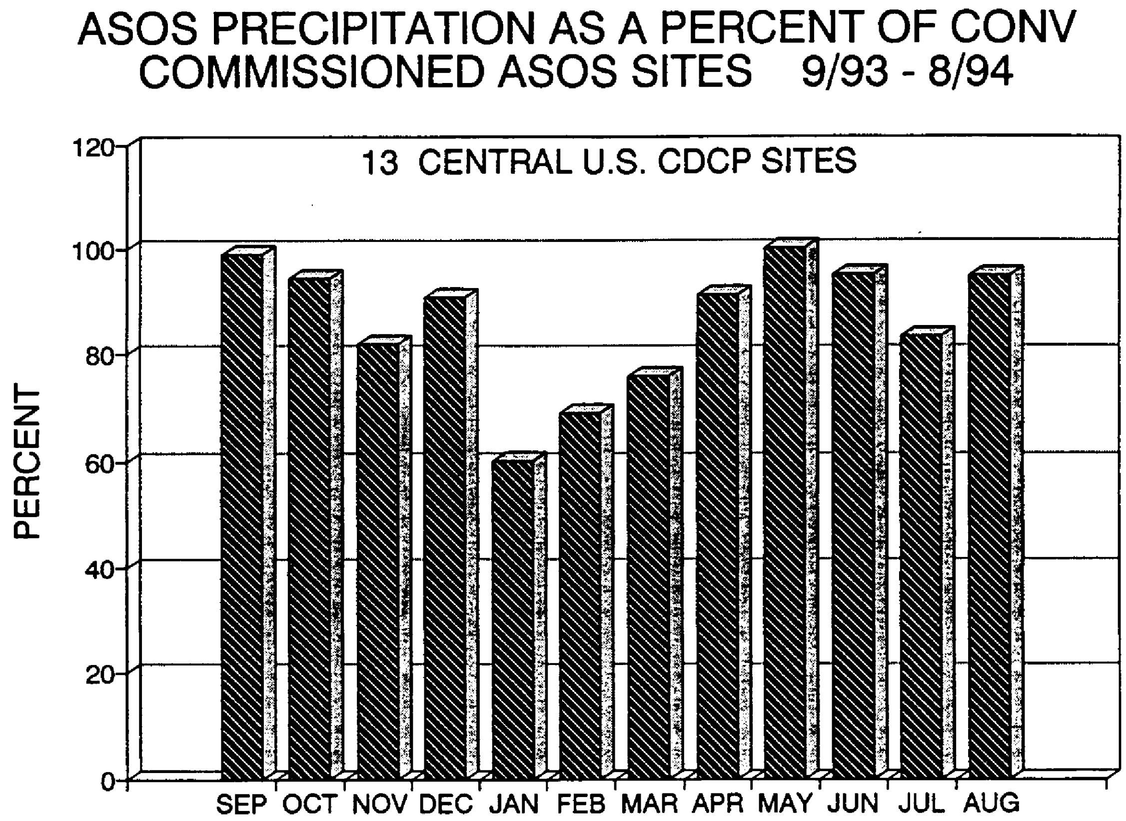


Figure 9. Total cumulative ASOS precipitation as a percent of CONV, by month, for all 13 Central U.S. CDCP sites combined for the period September 1993 through August 1994.

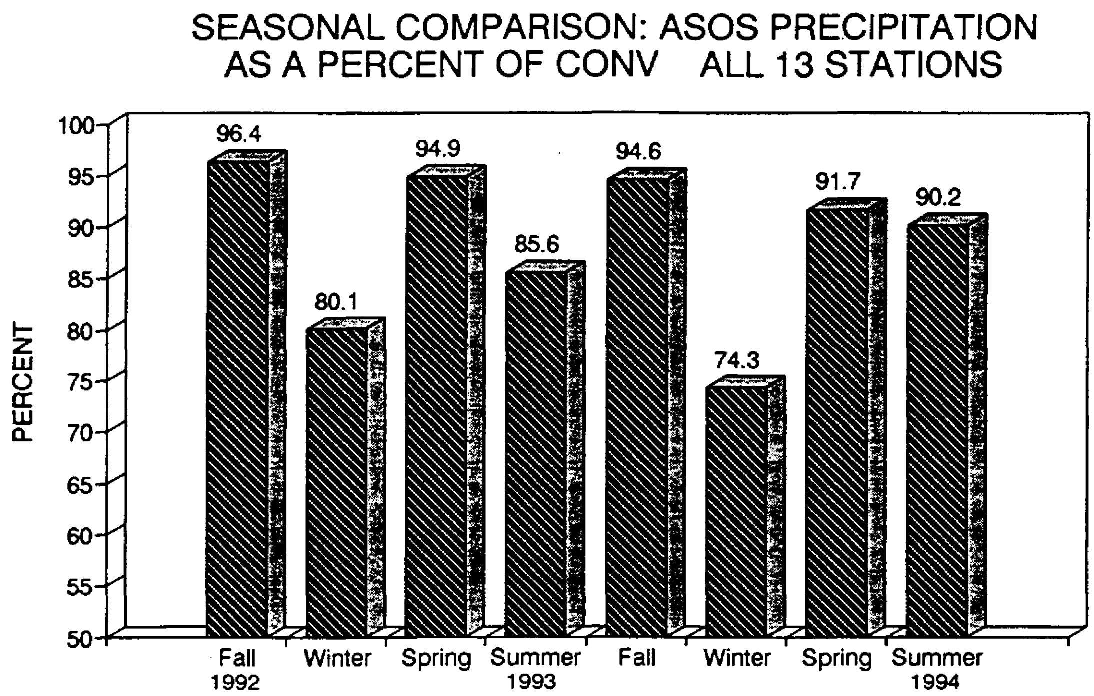
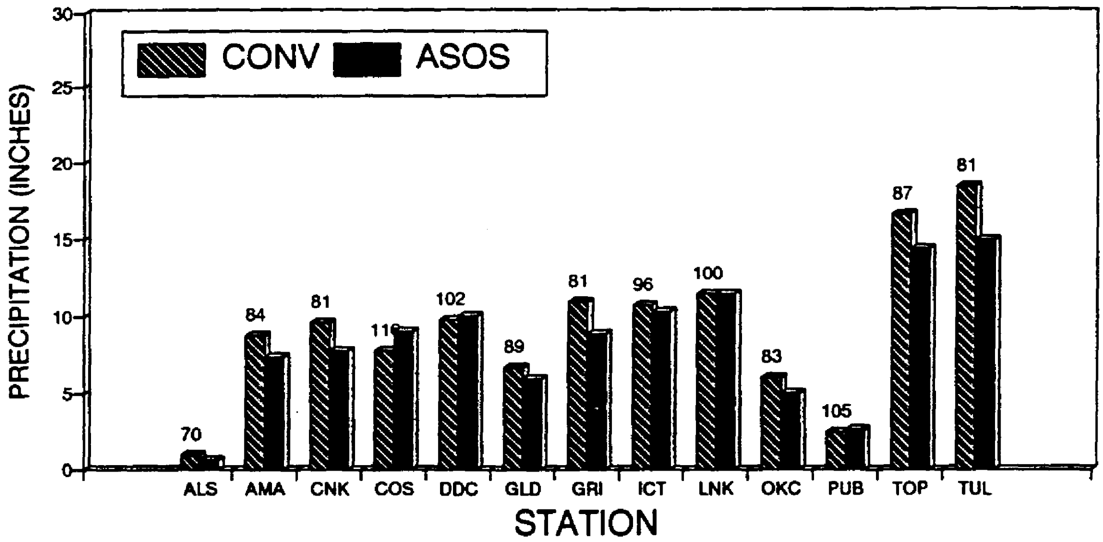


Figure 10. Total cumulative ASOS precipitation as a percent of CONV, by season, for each three-month period September 1992 through August 1994 based on all valid Central U.S. CDCP comparison data from date of commissioning through August 1994.

CUMULATIVE PRECIPITATION COMPARISONS
CENTRAL U.S. CDCP SITES 6/94 - 8/1994



CUMULATIVE PRECIPITATION COMPARISONS
CENTRAL U.S. CDCP SITES 9/93 - 8/1994

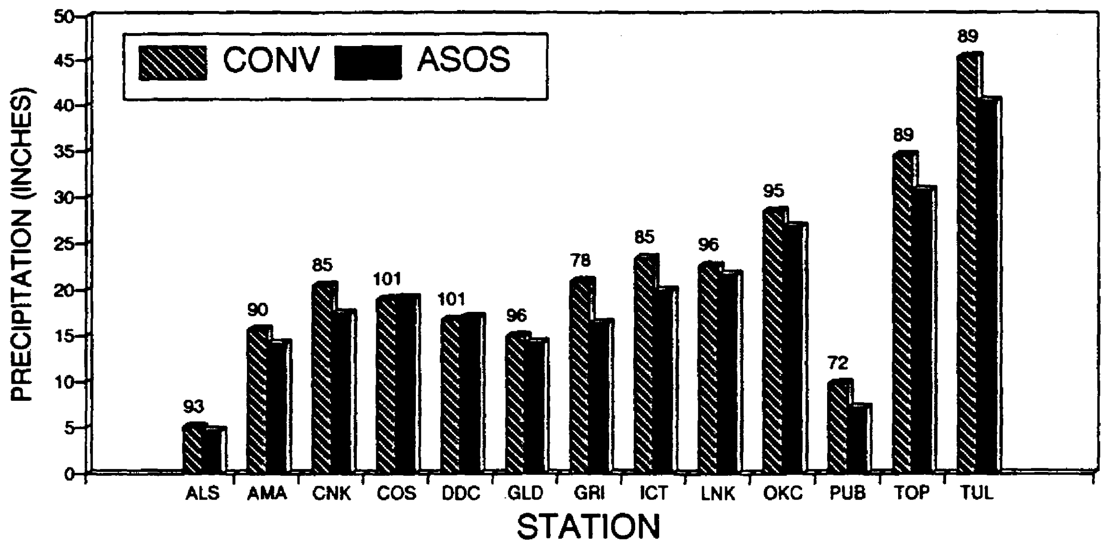


Figure 11. Comparison of total cumulative CONV and ASOS precipitation data for the summer (June through August) season (top) and for September 1993 through August 1994 (bottom) for each of the 13 ASOS CDCP sites in the Central U.S. The number above the bar represents ASOS precipitation as a percent of CONV for each site.

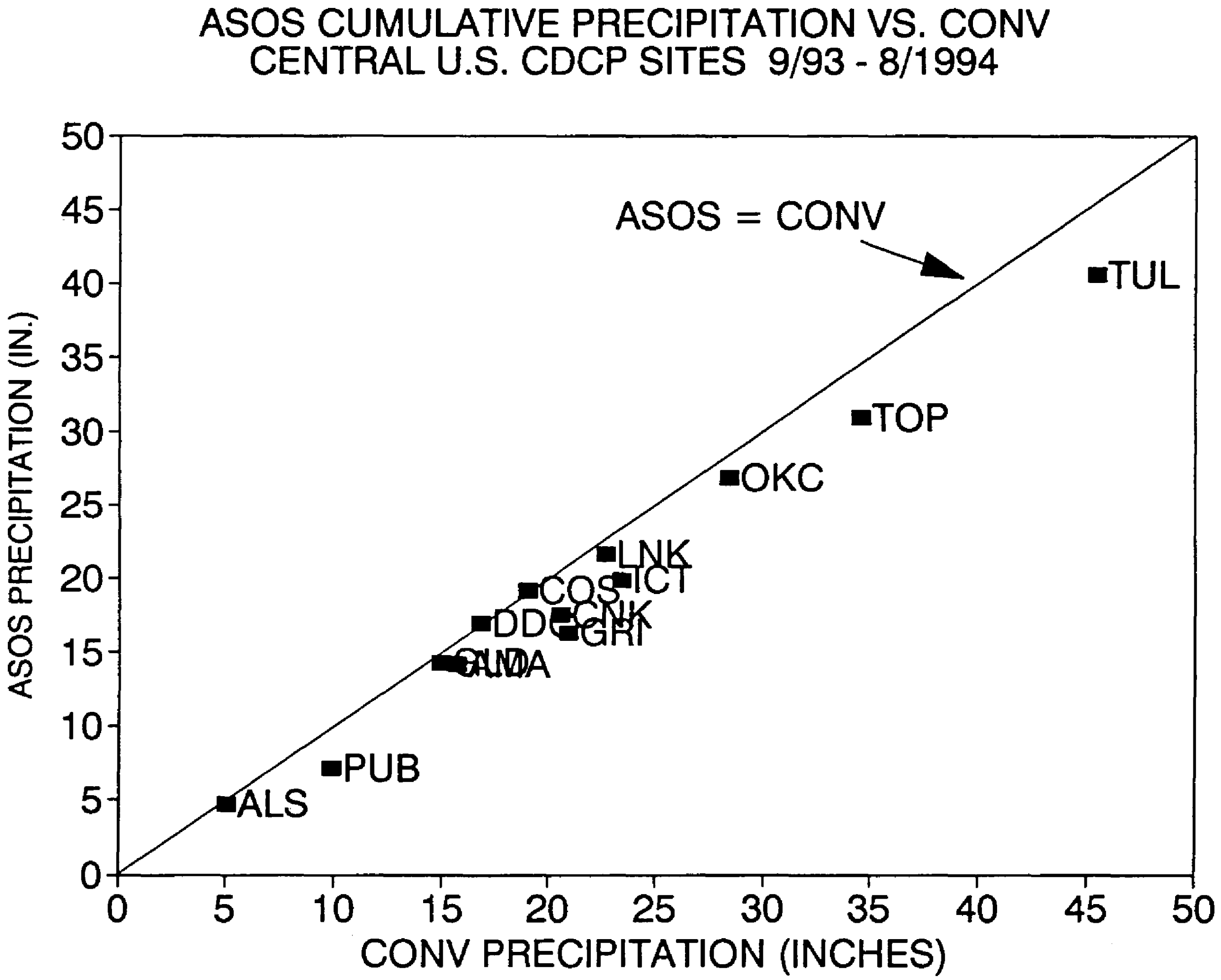


Figure 12. Total cumulative ASOS precipitation (y-axis) versus total cumulative CONV precipitation (x-axis) for the 13 commissioned ASOS CDCP stations based on all valid comparison data from September 1993 through August 1994.

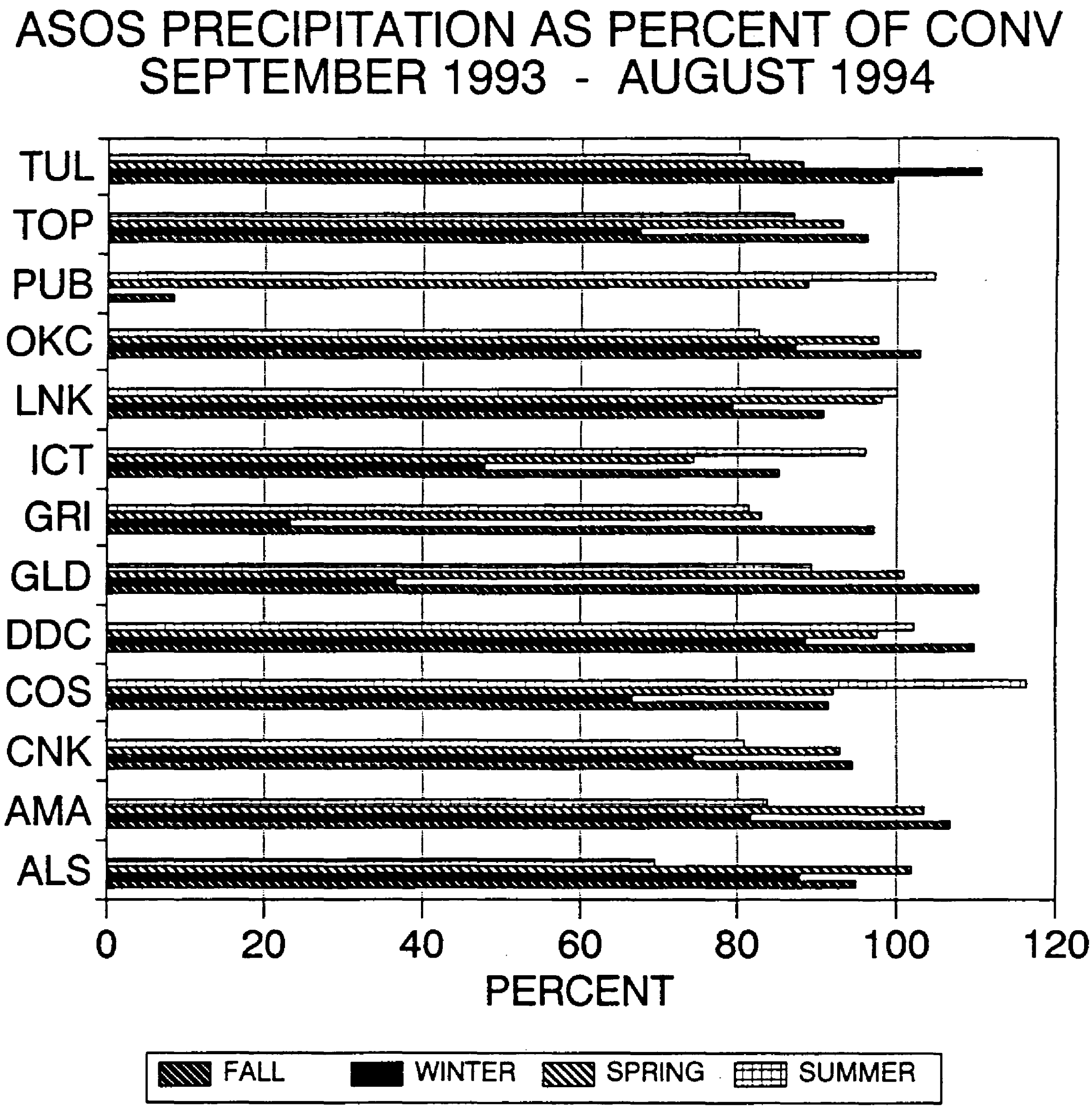


Figure 13. ASOS precipitation as a percent of CONV, by season, for each of the 13 Central U.S. CDCP sites based on all valid comparison data from September 1993 through August 1994.

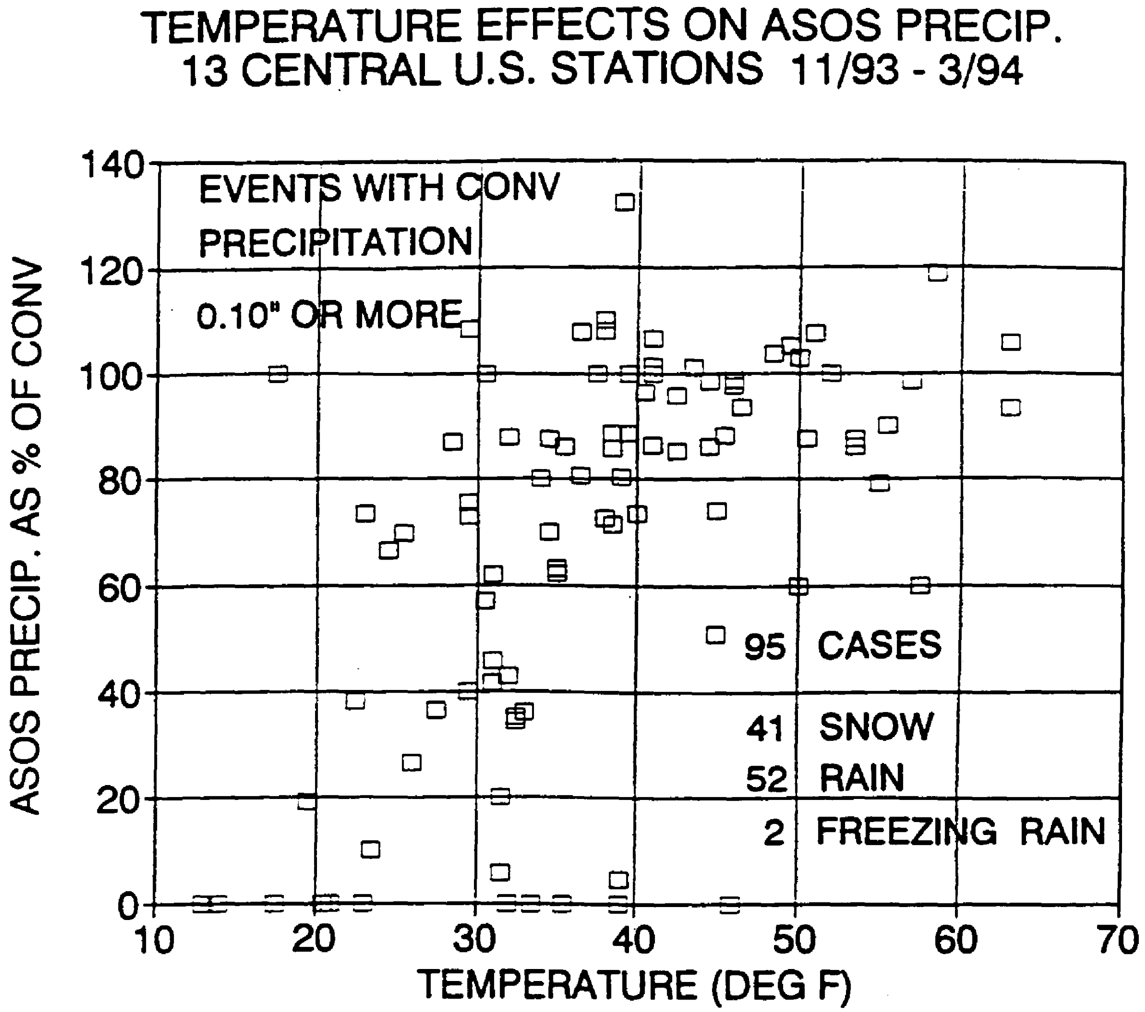


Figure 14. ASOS precipitation as a percent of CONV precipitation versus temperature for each storm event, November 1993 through March 1994, with at least 0.10 inches of CONV precipitation within 36 hours for all commissioned CDCP sites in the Central U.S.

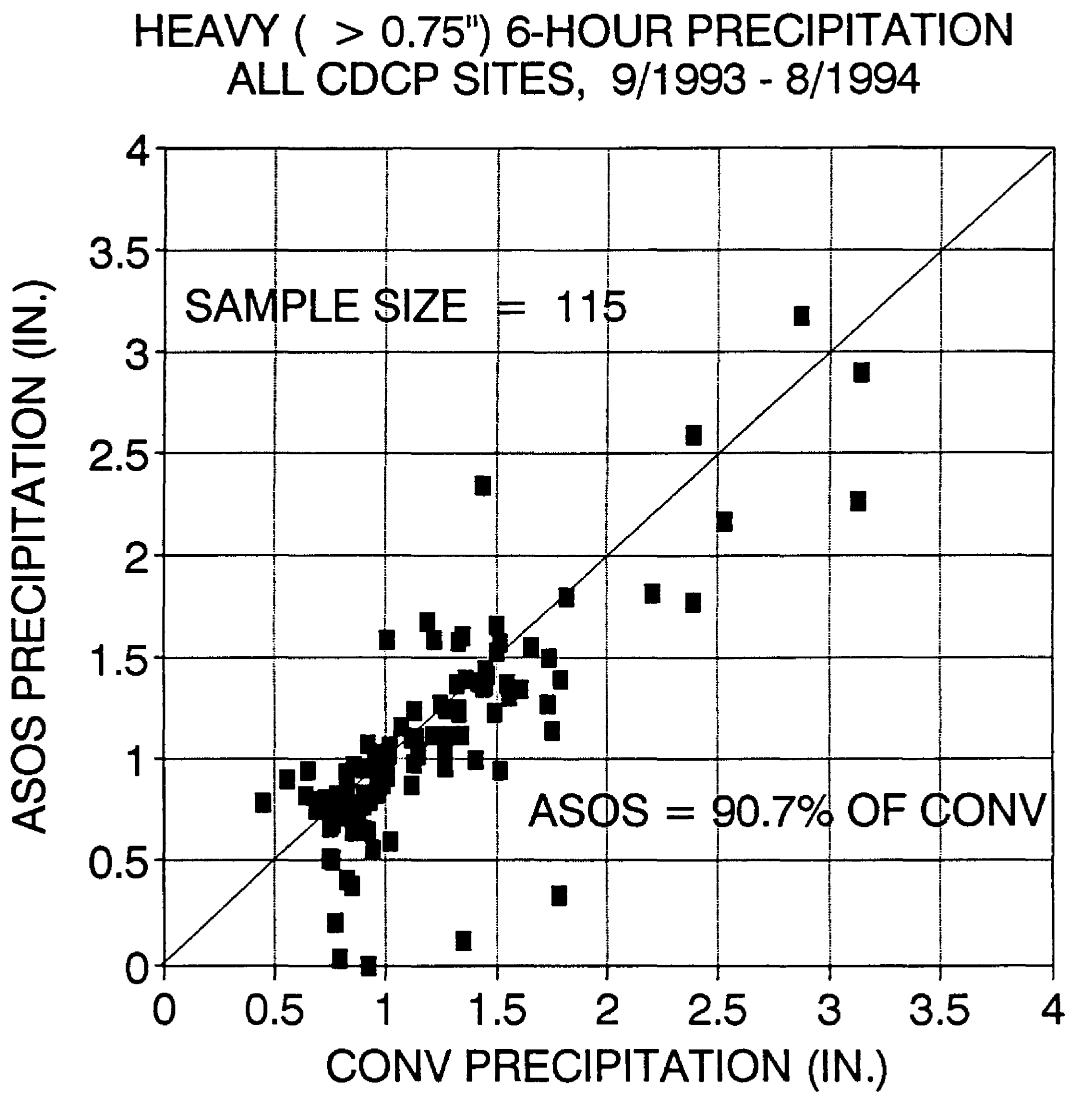
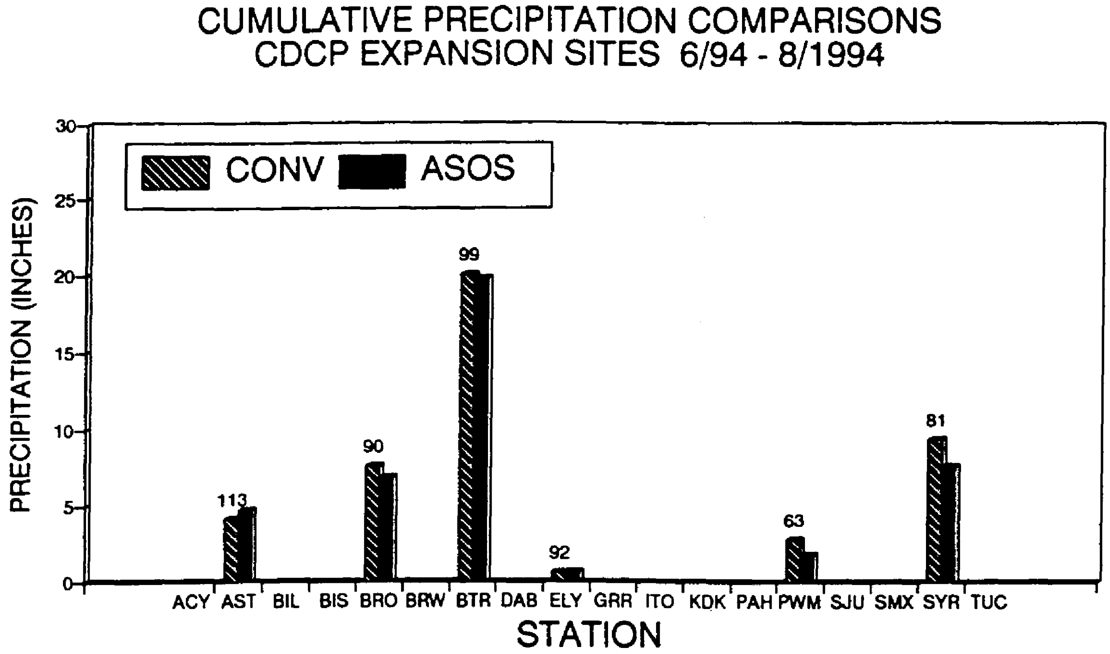


Figure 15. Six-hour ASOS precipitation totals (y-axis) versus CONV totals (x-axis) for all precipitation events of 0.75″ or greater (either CONV or ASOS) for all U.S. CDCP sites September 1993 through August 1994.



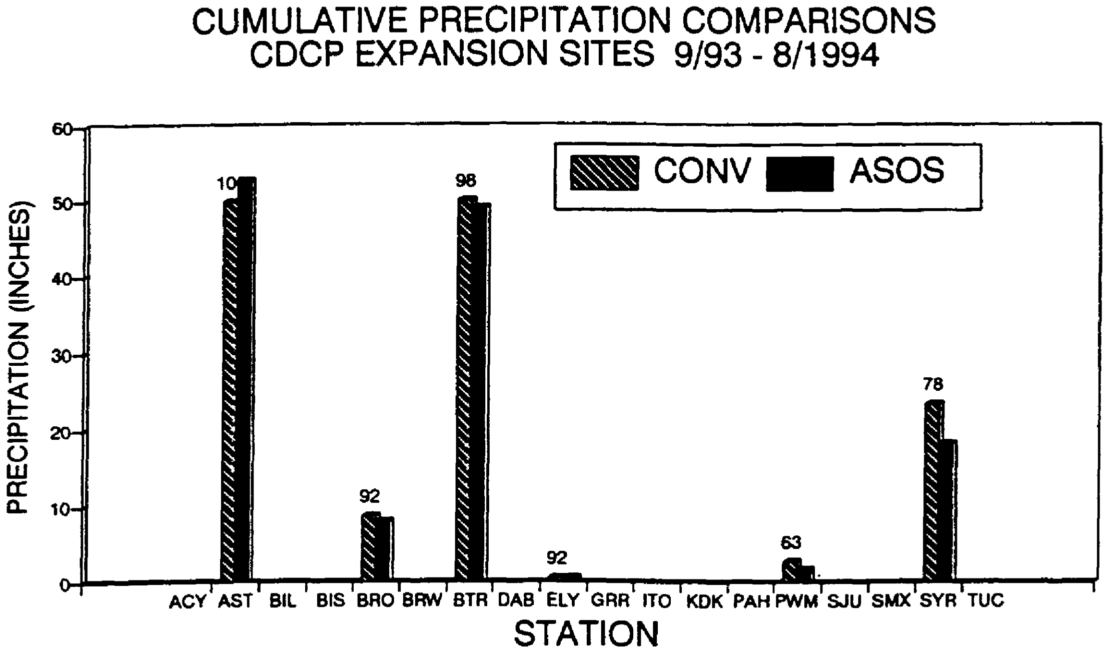


Figure 16. Comparison of total cumulative CONV and ASOS precipitation data for the summer season, June through August 1994, (top) and for September 1993 through August 1994 (bottom) for each of the commissioned National Expansion CDCP sites. The number above each bar represents ASOS precipitation as a percent of CONV for each site.

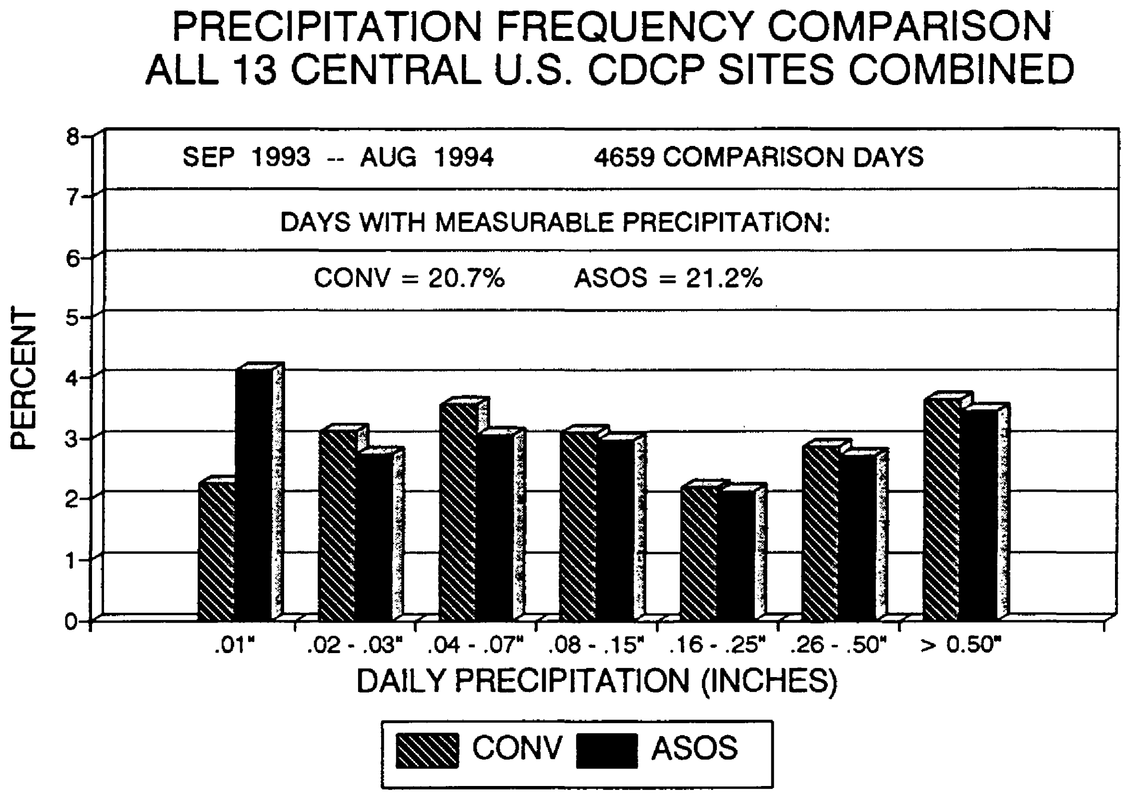


Figure 17. Frequency of occurrence of daily precipitation in selected categories for CONV and ASOS based on data from the 13 commissioned ASOS CDCP sites in the Central U.S. for all valid comparison days September 1993 through August 1994.

Appendix A.

An Assessment of Temperature, Precipitation, and Relative Humidity Data Continuity with ASOS

Preprints, 10th AMS International Conference on Interactive Information and Processing Systems (IIPS) for Meteorology, Oceanography and Hydrology 23-28 January 1994, Nashville, TN.

10th International Conference on Interactive Information and Processing Systems (IIPS) for Meteorology, Oceanography and Hydrology, 23-28 January 1994, Nashville, TN.

AN ASSESSMENT OF TEMPERATURE, PRECIPITATION, AND RELATIVE HUMIDITY DATA CONTINUITY WITH ASOS

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1.0 INTRODUCTION

One of the elements of the modernization program of the National Weather Service (NWS) is the development and deployment of the Automated Surface Observing System (ASOS). As the ASOS is deployed in the field, an effort is being made to provide the climate community with information to document the impact of this change on the continuity of climate data. The Climate Data Continuity Project (CDCP) was initiated when pre-commissioning deployment of ASOS began in the Fall of 1991. Results of pre-commissioning comparisons of ASOS observations of temperature and precipitation with conventional observations (CONV) have been presented by McKee et al. (1993). The commissioning of ASOS installations commenced on September 1, 1992 and marked the start of official ASOS observations. The purpose of this report is to provide a comparison of ASOS with CONV observations for commissioned ASOS observations for the variables of temperature, dewpoint temperature, and precipitation and to provide an update on the status of the ASOS observations.

2.0 DATA

The current phase of the CDCP is limited to the NWS stations in Table 1 and Figure 1. A later phase of the CDCP will include an expanded set of stations representing a wide variety of climates in the U.S. The present sites are in the states of Colorado, Kansas, Nebraska, Missouri, Oklahoma and Texas. The climate is of an interior continental nature with some range in latitude and elevation. The ASOS and CONV sites are not co-located and are usually separated by several hundred meters.

Data for the present study include hourly and summary of the day observations for ASOS and six-hourly and summary of the day observations for CONV.

TABLE 1. Climate Data Continuity Project NWS-ASOS Stations

ID	Station Location	Commissioning Date
ALS	Alamosa, CO	Sept 1, 1992
AMA	Amarillo Int'l, TX	Nov 1, 1992
CNK	Concordia, KS	Sept 1, 1992
COS	Colorado Springs, CO	Nov 1, 1992
DDC	Dodge City, KS	Sept 1, 1992
GLD	Goodland, KS	Sept 1, 1992
GRI	Grand Island, NE	Oct 1, 1992
ICT	Wichita/Mid-Cont., KS	Nov 1, 1992
LNK	Lincoln, NE	Nov 1, 1992
OKC	Oklahoma City/Rogers, OK	Oct 1, 1992
PUB	Pueblo, CO	Oct 1, 1992
SGF	Springfield, MO	delayed
TOP	Topeka/Billard, KS	Dec 1, 1992
TUL	Tulsa Int'l, OK	Oct 1, 1992

Usually, when a station is commissioned the ASOS observations become the official observations and the CONV observations are terminated. As a part of the Climate Data Continuity Project, special arrangements have been made to continue the limited set of CONV observations at the stations listed in Table 1. These observations include precipitation, snowfall and depth, temperature, dewpoint temperature, coincident skycover, cloud types, visibility, weather and obstructions to vision at 0000, 0600, 1200 and 1800 UTC.

The hygrothermometer used in pre-ASOS observations has been designated as the HO-83. An electronic measurement is made of air temperature and of the temperature of a chilled mirror for dewpoint temperature. Similar temperature measurements are made in the ASOS HO-83, but the instruments are not identical. Precipitation observations were made with an 8-inch Universal Weighing Gage which was usually not shielded in the

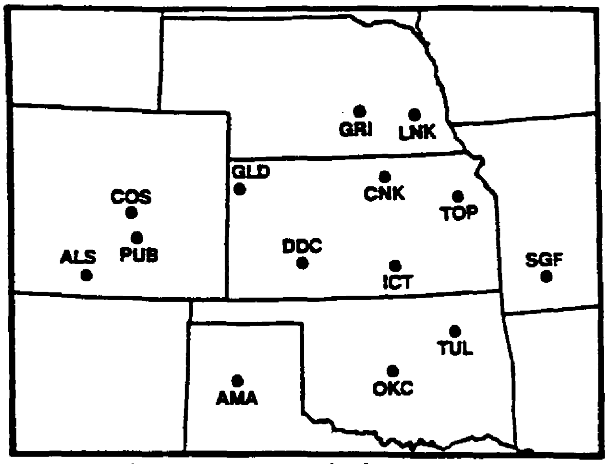

Figure 1. ASOS locations for CDCP.

southern U.S. and was shielded in most locations with a significant amount of snow. In ASOS, the precipitation observation is made with an 8-inch heated tipping bucket type gage which is shielded at most locations.

3.0 ANALYSIS

3.1 *Temperature*

The systematic ASOS-CONV temperature difference (bias) is presented for all commissioned sites for the period September 1992 through May 1993 in Figures 2 and 3. The wide variation in mean monthly differences from near 0°F to -2.5°F is obvious. A mean value near -1.3°F for the period September through February has decreased in the spring months. A significant part of the variation with time and among locations is due to variation from one ASOS instrument to another. The NWS has been aware of this characteristic of the ASOS instrument and is in the process of making modifications which will improve the ASOS performance. Modified hygrothermometers should be placed in the field beginning in the fall of 1993. Further monitoring of the modified ASOS instrument will be done in the months ahead. No evidence is found in Figure 2 indicating high maximum temperatures as reported by Gall et al. (1992), but both ASOS and CONV could carry the same trait. Kessler et al. (1993) reported on a comparison of an HO-63 to HO-83 change at Albany, NY in 1985. The ASOS hygrothermometer presently deployed is not the same instrument as the HO-83 used in Albany in 1985. The NWS expects the new modified ASOS hygrothermometer to be improved for climate applications.

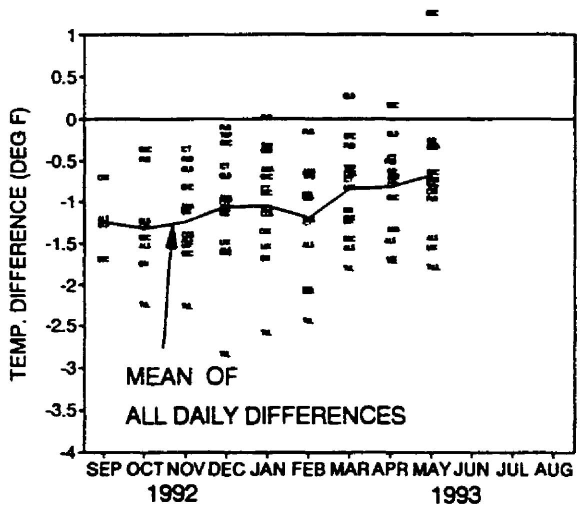

Figure 2. ASOS-CONV maximum temperature differences – commissioned sites only.

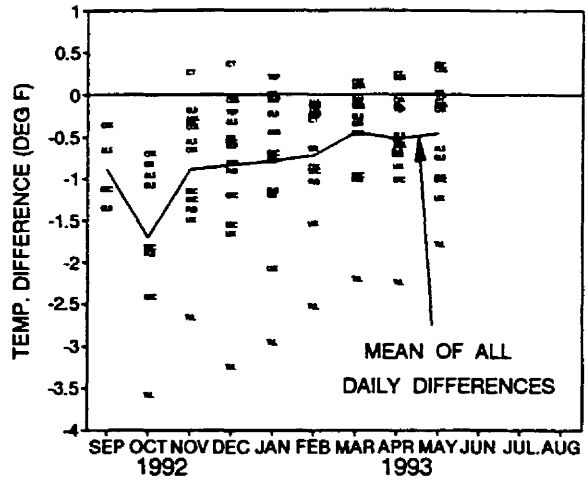

Figure 3. ASOS-CONV minimum temperature differences – commissioned stations only.

3.2 *Dewpoint temperature*

Composite results for all of the commissioned sites along with uncommissioned data for DEN, SGF and MCI are shown in Figure 4. Monthly average systematic dewpoint differences at individual stations have ranged from -1.2°F to +1.1°F. Overall, the composite 16-station systematic difference has averaged -0.2°F. In March 1993, the composite difference became slightly positive for the first time.

Although ASOS dewpoint temperatures are very similar to CONV at most stations, ASOS temperatures are consistently cooler. This means ASOS dewpoint depressions are less than CONV so relative humidities are greater. Interestingly, ASOS-CONV systematic differences in 6-hourly instantaneous temperature observations have averaged -0.9F, not as great as the differences between either daily maximum or minimum temperatures. Overall, relative humidity increases are averaging about 1.5%. Using accumulated difference analysis, discontinuities and irregular behavior have been found in ASOS-CONV systematic humidity differences at some of the stations. The irregular behavior is such that the ASOS dewpoint temperature observations can either increase or decrease

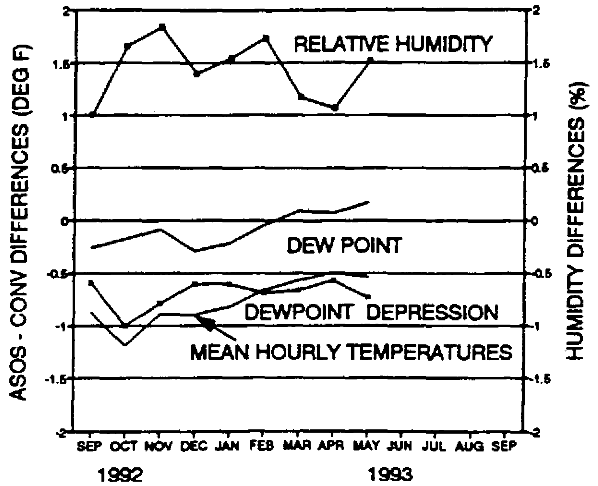

Figure 4. ASOS-CONV relative humidity, dewpoint and dewpoint depression differences. Values represent average differences of all 13 commissioned and 3 non-commissioned stations.

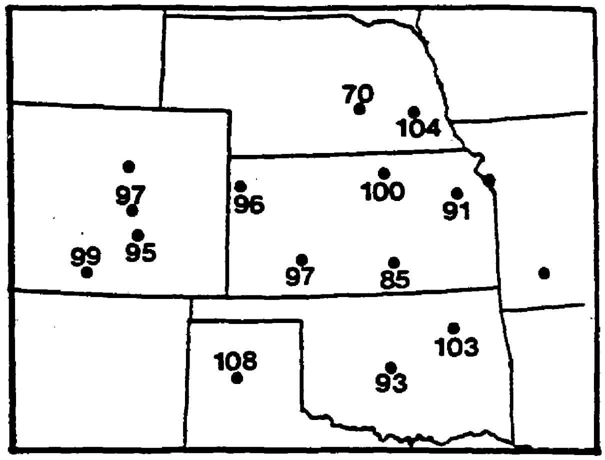

Figure 5. ASOS precipitation as a percent of CONV for commissioned ASOS stations for the fall (Sept-Nov 1992) and spring (Mar-May 1993) seasons combined. Days with missing or suspect ASOS observations were not included.

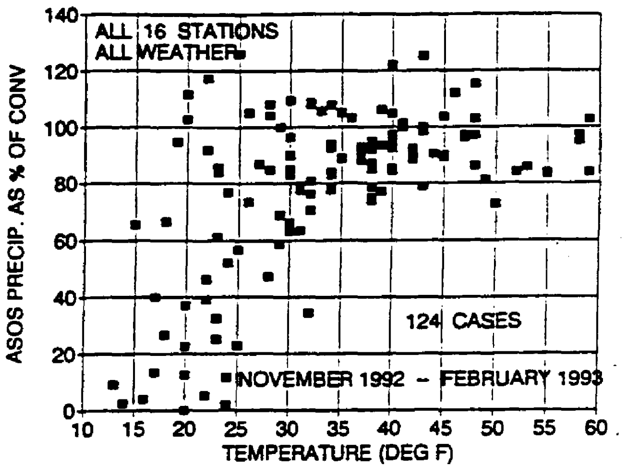

Figure 6. ASOS precipitation as a percent of CONV as a function of temperature for all storms Nov. 1992-Feb 1993 with > 0.19" CONV precipitation.

relative to the CONV observation for a limited period of time. The frequency distribution of the ASOS-CONV observations is broadened by this irregular behavior. Differences are nearly normally distributed with a low frequency of occurrence of differences of as much as ±20°F.

3.3 *Precipitation*

Precipitation analysis has been done for the period September 1992 through May 1993. This period included several widespread snow and freezing rain events along with numerous episodes of rain but very little airmass convection. A considerable effort has been required to quality control the observations to obtain a truly independent set of CONV and ASOS precipitation data. This effort has been necessitated since observers may "correct" or "augment" ASOS observations some of the time when the ASOS observations are judged not to be representative. Missing, suspect or modified observations were not included in most comparisons. The resulting data set allows an initial assessment of ASOS to CONV precipitation.

A comparison of total accumulated ASOS precipitation as a percent of CONV for the spring and fall seasons is shown in Figure 5. Most precipitation fell as rain, and totals ranged from less than 5 inches at ALS, AMA and COS to more than 20 inches as ICT, OKC and TUL. Nine of the 13 commissioned sites reported less ASOS precipitation than CONV. Over the entire area, ASOS averaged 94% of CONV for the combined September-November 1992 and March-May 1993 6-month period. This is an improvement over the 92% observed during the pre-commissioning period.

Winter precipitation was analyzed separately. For the months of December through February ASOS precipitation across the region was less than 80% of CONV. An investigation of individual storm events (Figure 6) revealed that ASOS precipitation decreased dramatically with respect to CONV as temperatures decreased below freezing. Overall ASOS performance during significant snow events was only 54% of CONV. This is a serious problem for climatology, and the NWS is responding by planning several changes in the heated tipping bucket gage and by considering other possible technologies for measuring precipitation.

Heavy rain events were also examined separately. Daily precipitation totals were compared for all days which had at least one 6-hour period with 0.40 in. CONV precipitation or greater. The results are shown in Figure 7.

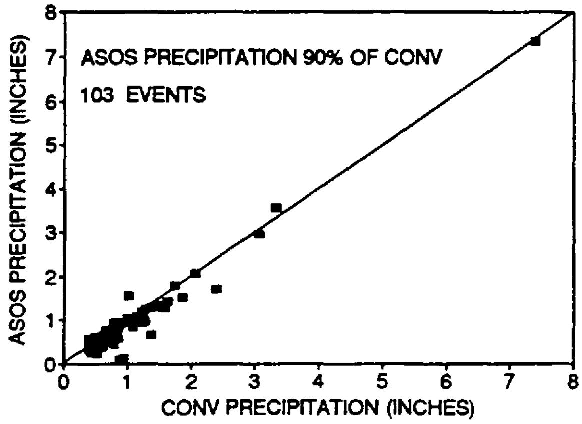

Figure 7. CONV vs. ASOS daily precipitation for heavy rain events, Sept 1992-May 1993 from all 13 commissioned stations.

ASOS precipitation was less than CONV in 69 of the 103 cases and averaged 90% of CONV for all cases combined.

Finally, the frequency of daily precipitation was compared (Figure 8). The number of days with measurable precipitation has been slightly higher with ASOS than with CONV. The frequency of daily precipitation amounts in the range of 0.02 to 0.15 in. has been about 12% of all comparison days for both ASOS and CONV. However, ASOS has recorded fewer days with heavier amounts and many more days with 0.01 in. Many of these small events have been found to occur during clear weather. It is likely that dew collection added to moisture in the tipping bucket from a previous storm may produce these reports.

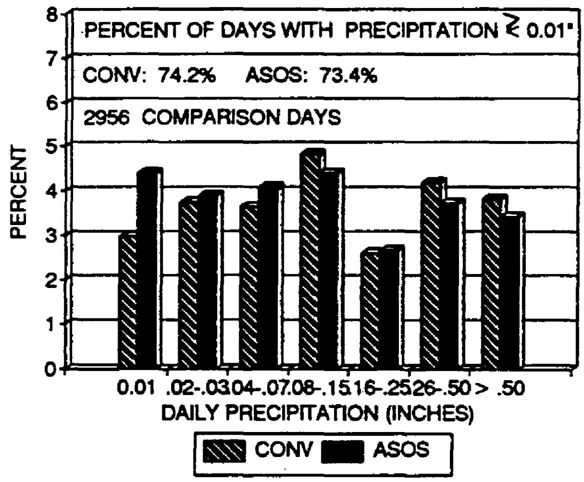

Figure 8. Precipitation frequency comparison using all daily values, Sept 1992-May 1993, for all 13 commissioned ASOS sites.

4.0 SUMMARY

A comparison of observations from commissioned ASOS sites with the observations from pre-ASOS instruments has been made for the period September 1992 through May 1993. ASOS has a consistent bias toward cooler temperatures and a noticeable variation with time and among the sites. The NWS has recognized these characteristics and has moved to have a modified instrument prepared which will be available in Fall 1993. ASOS dewpoint temperature observations have smaller biases than temperature and can be positive or negative. Relative humidity with ASOS is slightly higher. Initial analysis of ASOS precipitation shows the following traits relative to the pre-ASOS observations: a larger frequency of 0.01" precipitation events but fewer daily events greater than 0.25", accumulated fall and spring rainfall of approximately 6% less, accumulated precipitation from snow events average about 50% less with even less with cold temperatures and wind, and heavier rain events have a reduction of 10%. The ASOS precipitation catch in Spring 1993 seemed better than in Fall 1992 and better than pre-commissioning.

ACKNOWLEDGEMENTS

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Appendix B.
Early Results of Climate Data Continuity with ASOS

Preprints, 11th AMS International Conference on
Interactive Information and Processing Systems (IIPS)
Meteorology, Oceanography and Hydrology
15-20 January 1995, Dallas, TX.

11th IIPS Conference for Meteorology, Oceanography and Hydrology to be held 15-20 January 1995, Dallas Texas

FA 16.3

EARLY RESULTS OF CLIMATE DATA CONTINUITY WITH ASOS

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1.0 INTRODUCTION AND PURPOSE

The introduction of the National Weather Service's (NWS) Automated Surface Observing System (ASOS), beginning in the fall of 1991, has attracted considerable attention. Users and providers of climatic information along with operational data users have become exceedingly interested in the accuracy of ASOS measurements and their consistency with respect to the conventional surface observations that they are replacing.

The Climate Data Continuity Project (CDCP) was initiated by the National Oceanic and Atmospheric Administration (NOAA) late in 1991 to ease the transition to ASOS for the many users of NWS surface weather observations. The goal for the CDCP was to identify and quantify biases and variations introduced by ASOS into the climate record. The project has matured to include the following six components: 1) Develop an extensive data set in the public domain of coincident ASOS and conventional (CONV) observations from selected sites in the U.S., 2) Make quantitative comparisons of ASOS temperature, humidity and precipitation measurements to previous CONV data (and other elements as needed), 3) Evaluate the effects of the transition to ASOS on the continuity of climatological data, 4) Assess the accuracy of ASOS temperature observations by comparison with a calibrated field standard, 5) Present results to the scientific community and 6) Provide recommendations to the NWS.

Previous papers have focused on ASOS-CONV comparisons made prior to ASOS commissioning (McKee et al., 1993) and during the first year of commissioned ASOS operations (McKee et al., 1994). During these periods only sites in the Central U.S. were included in the CDCP. During 1994, the commissioning of ASOS sites nationwide has accelerated. Additionally, various modifications and upgrades to ASOS have been proposed and implemented. Most noteably, a modified version of the hygrothermometer used to measure temperature and dew point has been developed and recently installed at most field sites. The modifications included an increased rate of aspiration, reversed direction of aspiration and increased stability in the electronics. With these modifications in place, the final phases of the temperature portion of the CDCP are now underway.

2.0 DATA

Sixteen sites in the Central U.S. were originally selected for the CDCP. Of these, only 13 sites were commissioned (Table 1) and included in analyses to date. Nationally, 18 sites have been approved for CDCP analysis (Table 2). As of August 1994, six of these have been commissioned. Commissioning of the remaining sites will continue gradually. Upon commissioning, these sites will be added to CDCP analyses.

Table 1.
Climate Data Continuity Study (CDCP) Comparison Sites in the Central United States

Site ID	Station Name	Modified Hygrotherm Installed	Commissioned Date
ALS	Alamosa, CO	12/8/93	9/1/92
AMA	Amarillo, TX	1/10/94	11/1/92
COS	Colo. Springs, CO	11/30/93	11/1/92
CNK	Concordia, KS	1/7/94	9/1/92
DDC	Dodge City, KS	1/11/94	9/1/92
GLD	Goodland, KS	2/11/94	9/1/92
GRI	Grand Island, NE	12/21/93	10/1/92
ICT	Wichita, KS	12/6/93	11/1/92
LNK	Lincoln, NE	5/20/94	11/1/92
OKC	Oklahoma City, OK	11/1/93	10/1/92
PUB	Pueblo, CO	3/31/94	10/1/92
SGF	Springfield, MO	2/17/94	delayed
TOP	Topeka, KS	12/1093	12/1/92
TUL	Tulsa, OK	11/22/93	10/1/92

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Table 2.
Climate Data Continuity Study (CDCP)
National Expansion Sites

Site ID	Station Name	Modified Hygrotherm Installed	Commissioned Date
ACY	Atlantic City, NJ		
AST	Astoria, OR	4/28/94	3/1/93
BIL	Billings, MT	9/17/93	
BIS	Bismarck, ND		
BRO	Brownsville, TX	11/15/93	5/1/94
BRW	Barrow, AK	8/10/94	
BTR	Baton Rouge, LA	3/2/94	11/93
DAB	Daytona Beach, FL	12/14/93	
ELY	Ely, NV	12/16/93	6/1/94
GRR	Grand Rapids, MI	11/15/93	
ITO	Hilo, HI	3/18/94	
ADQ	Kodiak, AK	7/1/93	
PAH	Paducah, KY	6/30/94	
PWM	Portland, ME	3/25/94	8/1/94
SJU	San Juan, PR		
SMX	Santa Maria, CA	3/20/94	
SYR	Syracuse, NY	1/15/94	12/93
TUS	Tucson, AZ	5/16/94	

Data for the CDCP consists of ASOS high resolution 1-minute data, hourly surface observations (SAOs) and ASOS-generated summary of the day data sets from each commissioned CDCP site. Upon commissioning, CDCP sites continue reading and recording conventional (CONV) data but on a much more limited basis. Observations every 6 hours (0000, 0600, 1200 and 1800 UTC) of current temperature, dew point, visibility, cloudcover and weather conditions along with 6-hour maximum and minimum temperature, precipitation, snowfall and snowdepth are recorded manually and provided to the National Climatic Data Center and the Colorado Climate Center. Together these data sets provide what is needed to compare ASOS with conventional climate data.

The value of data comparisons and climate data continuity studies is reduced when system and instrument changes occur frequently. This was the case with temperature and humidity comparisons earlier in the CDCP. However, since modified hygro-thermometers have been deployed at most comparison sites, results now become more significant. A 15-month final comparison period for evaluating ASOS-CONV temperature and dew point biases and relationships has been established. For all commissioned CDCP sites with the modified hygrothermometer, 1 June 1994 was chosen as the

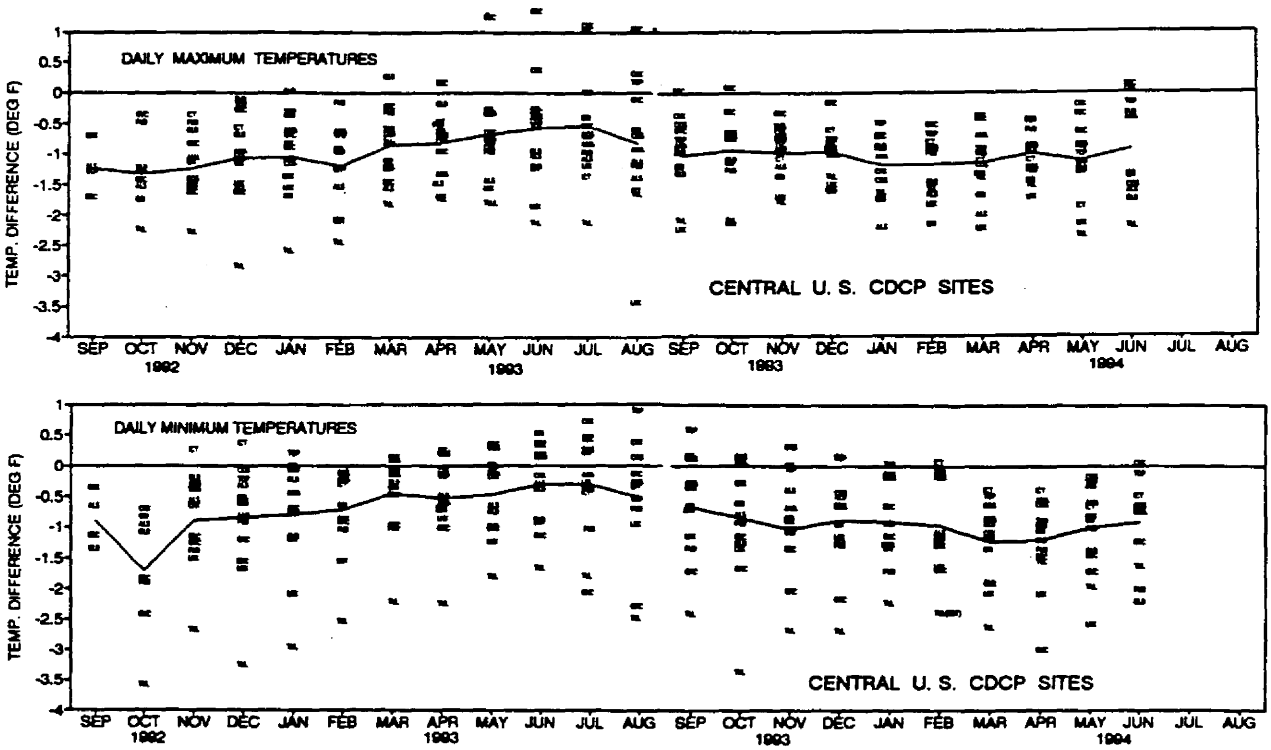

Figure 1. Mean monthly ASOS-CONV temperature differences (Deg. Fahrenheit) for daily maximum temperatures (top) and minimum temperatures (bottom) for all 13 commissioned ASOS CDCP sites in the Central U.S. from date of commissioning through June 1994. Individual monthly station differences are shown along with a composite average (solid line).

beginning of the 15-month test. Other stations will begin their final 15-month comparisons as they meet these two conditions.

3.0 RESULTS

3.1 Temperature

The general tendency for ASOS to read cooler than CONV has persisted from the very beginning. Figure 1 shows mean monthly differences for the 13 Central U.S. comparison sites since commissioning. Relationships vary from station to station and have changed over time at individual stations. Overall, daily maximum temperatures have averaged about 1.0°F cooler with ASOS than CONV while minimum temperatures have averaged 0.8°F cooler. So far, only limited data are available nationally (Figure 2). The same general results have been observed except that there may be more sites in the national comparison where ASOS minimum temperatures are equal to or warmer than CONV.

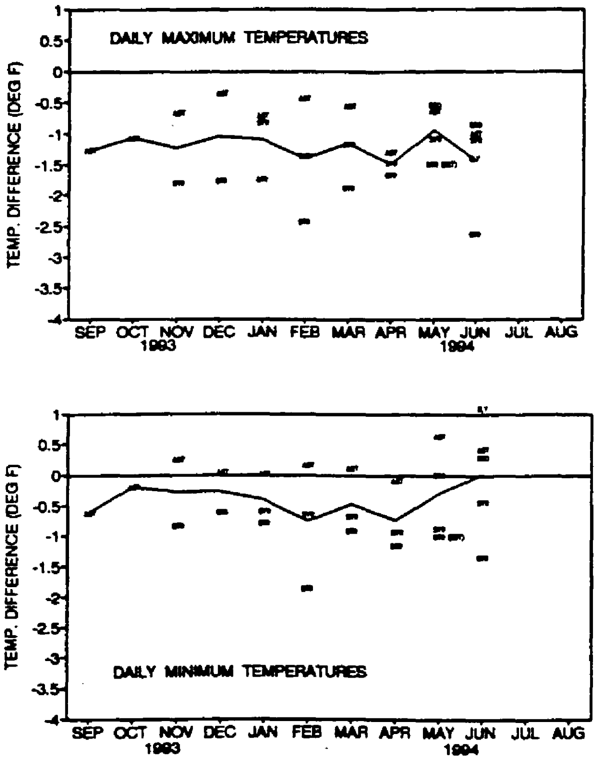

Figure 2. Mean monthly ASOS-CONV temperature differences (Deg. Fahrenheit) for daily maximum temperatures (top) and minimum temperatures (bottom) for commissioned ASOS national CDCP expansion sites from date of commissioning through June 1994. Individual monthly station differences are shown along with a composite average (solid line).

During the first year of commissioned ASOS intercomparisons, numerous discontinuities in the ASOS-CONV temperature relationship were observed. These discontinuities, many of which could be traced to modifications or servicing of either the ASOS or the CONV hygrothermometer, contributed considerably to variability in the ASOS-CONV relationship. Since the installation of modified hygrothermometers, fewer discontinuities have been observed. Large station-to-station differences continue, however.

ASOS-CONV data continuity results are complicated by the fact that instruments are not co-located. Instrument separation ranges from just a few hundred feet to more than one mile. Since all CDCP sites are at airports, little elevation differences are noted. However, local exposure and vegetation differences can be significant. Therefore, the observed ASOS-CONV differences are composed of actual instrument biases in combination with station location differences. To better quantify the roles of these two factors, side-by-side measurements are needed. For this purpose, an R. M. Young calibrated aspirated precision thermometer has been acquired. Direct intercomparisons at three sites, OKC, TUL and COS were performed prior to the beginning of the 15-month comparison. Early results suggest that ASOS temperatures have been cooler than the calibrated field instrument. More intercomparisons are planned during the 15-month test following further calibration of field sensors at the NWS Test Facility in Sterling, Virginia during September 1994.

3.2 Dew Point and Relative Humidity

Table 3 shows ASOS-CONV differences for 6-hourly temperatures, dew points and relative humidities based on data collected since the modified hygrothermometers have been installed. Early comparisons of dewpoint temperatures have shown very small differences at most stations. Only GRI has shown an average dew point difference of more than one degree. Among the Central U.S. sites, the average ASOS-CONV dewpoint difference has been -0.1°F. So far, among three national sites from more humid climates, the average difference has been +0.4°F. A characteristic of the dew point differences that has been observed so far is that while most differences are very small, occasional large differences (> ± 8°F) occur at most stations. These large differences may be inherent to the chilled mirror technology used in both the CONV and the ASOS hygrothermometers. Relative humidities computed from ASOS temperature and dewpoint measurements have systematically been higher by 1 to 3.5% at nearly all stations.

Table 3.
ASOS-CONV differences based on 6-hourly data for months since modified hygrothermometer installed through June 1994

Station	Months	Difference Temp. (°F)	Dew Point (°F)	Relative Humidity (%)
CENTRAL U.S.				
ALS	1-6/94	-1.6	-0.8	+1.2
AMA	2-6/94	-0.5	-0.1	+0.4
COS	12/93-6/94	-0.7	+0.1	+1.5
CNK	2-6/94	-0.4	-0.0	+1.0
DDC	2-6/94	-0.8	-0.2	+1.7
GLD	3-6/94	-1.2	-0.7	+1.0
GRI	1-6/94	-1.2	-1.4	-0.3
ICT	1-6/94	-0.7	+0.7	+2.7
LNK	4-5/94	-1.4	-0.2	+2.0
OKC	11/93-5/94	-1.3	+0.3	+3.3
PUB	4-6/94	-1.0	+0.5	+1.5
TOP	1-6/94	-0.2	+0.4	+1.0
TUL	12/94-6/94	-1.7	-0.3	+3.4
NATIONAL EXPANSION SITES				
AST	5-6/94	-0.4	+0.3	+1.6
BRO	5-6/94	NA	NA	NA
BTR	3-6/94	-1.3	+0.2	+3.2
ELY	6/94	NA	NA	NA
SYR	2-6/94	-0.8	+0.7	+3.5

3.3 Precipitation

Significant differences have been observed in precipitation totals from ASOS when compared to CONV. ASOS uses a heated tipping bucket precipitation gage (HTB) while CONV observations are taken from universal weighing gages. Since commissioning, ASOS precipitation as a percent of CONV combined for the Central U.S. sites has shown a distinct seasonal pattern (Figure 3). With nearly two annual cycles completed, ASOS has measured significantly less precipitation during winter and summer. Autumn and spring totals have been much more similar. Individual station comparisons are shown in Figure 4. Since September 1993, most CDCP sites in the Central U.S. have received less ASOS precipitation than CONV. Of the national expansion sites, differences are not large for those sites that have received primarily rain. Astoria, OR (AST) systematically measures slightly more ASOS precipitation than CONV. At Syracuse, New York (SYR) large differences persist. SYR is the only CDCP national expansion site commissioned so far where significant quantities of precipitation fall as snow.

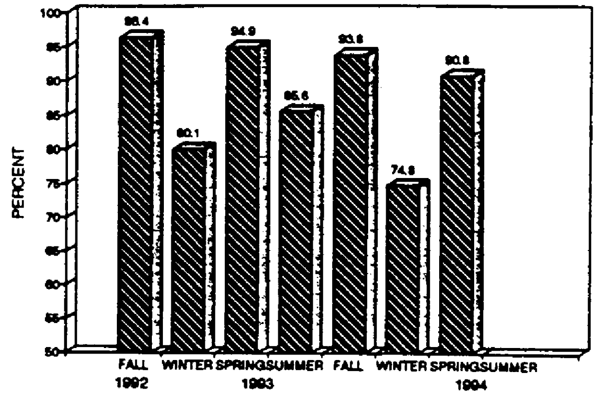

Figure 3. ASOS precipitation as a percent of CONV, by season, for each three-month period September 1992 through May 1994 based on all Central U.S. CDCP comparison data since commissioning.

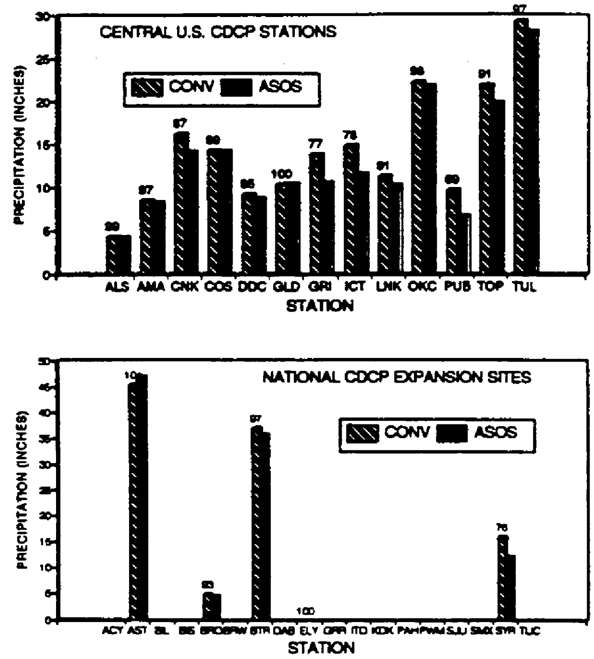

Figure 4. Comparison of total cumulative CONV and ASOS precipitation from September 1993 or date of commissioning (if after Sep. 1993) through June 1994 for each CDCP site in the Central U.S. (top) and national expansion sites (bottom). The number above the bars shows ASOS precipitation as a percent of CONV for each site.

The primary reasons for the lower precipitation measurements by ASOS have been traced to snow and heavy rain. Deficiencies in the HTB resulting in undermeasurement of intense precipitation may be overcome by a set of gage modifications which include a new switch that signals the occurrence of each tip (0.01" precipitation increment), an extension of the funnel to bring the top closer to the tipping bucket, and a redesign of mechanical stops to prevent the tipping bucket from sticking. The snow problem is more difficult. For the second winter in a row, precipitation that fell as snow, especially at temperatures below the freezing point, were significantly undermeasured by ASOS (Figure 5).

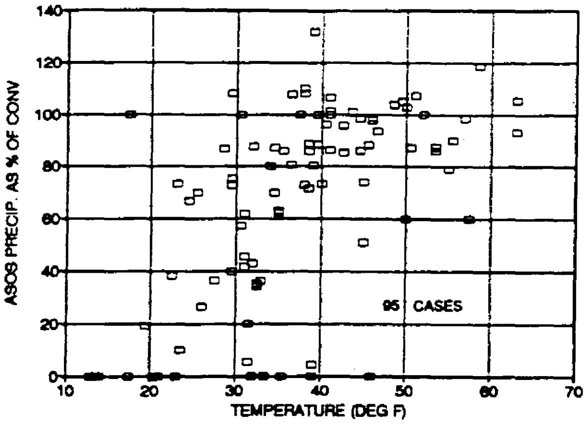

Figure 5. ASOS precipitation as a percent of CONV precipitation plotted as a function of temperature for each storm event, November 1993 through March 1994, with at least 0.10" of CONV precipitation within 36 hours for all 13 commissioned CDCP sites in the Central U.S.

4.0 PERSPECTIVE

A great deal has been learned about temperature, humidity and precipitation information from ASOS data and how it compares to CONV. This has helped justify several modifications and proposed future changes to ASOS. In the year ahead, the CDCP will focus on the 15-month comparison establishing seasonal ASOS-CONV temperature and humidity relationships. This will assist climatologists comparing current data (gathered by ASOS) with data from the past. As more data from CDCP national expansion sites becomes available, we will begin to understand if CDCP relationships can be applied nationwide or if differences vary significantly as a function of climatic conditions.

ACKNOWLEDGEMENTS

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