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ANALYSIS OF THE AFFECT OF ASOS-DERIVED METEOROLOGICAL DATA ON REFINED MODELING

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Meteorological Data on Refined Modeling

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PREFACE

The National Weather Service (NWS) is in the process of installing an automated surface observing network throughout the United States, the Caribbean, and overseas military bases. When the installations are completed, hourly observations of surface weather conditions will no longer be performed by a human observer. The instrumentation used in these automated systems have some limitations. It is the purpose of this study to determine the affect of these automated observations, if any, on concentration estimates from the Industrial Source Complex Short Term (ISCST3) model.

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1.0 INTRODUCTION

The Automated Surface Observing System (ASOS) is a real-time, automated weather information system that replaces conventional human observations for recording near-surface weather conditions. The first ASOS was installed in August 1991 at Topeka, Kansas. When all the installations are complete, the automated systems will be operational at over 900 stations throughout the United States, the Caribbean, and overseas military installations.

Comparisons between pre-ASOS and ASOS instrumentation and their differences are discussed in length in the paper by Heim Jr. and Guttman (1997). In addition, NWS instrumentation changed by varying degrees when stations switched from observed observations to ASOS. For example, temperature was previously measured by the HO-83 hygrothermometer. Studies show that the ASOS hygrothermometer measures cooler temperatures than the HO-83. Also, the ASOS instruments also have a smaller diurnal temperature range. In a direct comparison, there appears to be a non-linear relationship between the ASOS and non-ASOS data. With respect to precipitation amount, the ASOS gage consistently undermeasured precipitation during heavy rain and snow events. And, wind speed comparisons indicate that 5-second averages of ASOS peak winds are lower than the pre-ASOS data.

While improving the efficiency in acquiring weather data, the ASOS system lacks the observational ability of the human observer to spatially integrate some of the weather elements over a large area. Two such elements are ceiling height and opaque cloud cover, which are important in estimating atmospheric stability and mixing heights required for applications of several regulatory and nonregulatory dispersion models.

This analysis examines the effect of changing from a conventional observer-based system to an automated system on the concentration estimates from the Industrial Source Complex Short Term (ISCST3) model. Section 2 discusses the methods used to report several of the weather variables for both ASOS and conventional observations. Section 3 describes the station and time periods used in the analysis. Section 4 discusses the preparation of the meteorological data for ISCST3 using the meteorological preprocessor PCRAMMET, including special processing required for this analysis, and the differences in the meteorological data sets for both the ‘raw’ data and the processed data. Section 5 presents the ISCST3 model input (options, sources, receptors) and Section 6 presents the effects on the concentration estimates from ISCST3. Section 7 summarizes the findings and proposes additional studies to further quantify the differences that are seen in this study.

2.0 COMPARISON OF ASOS AND CONVENTIONAL OBSERVATION METHODS

In this section, characteristics of the ASOS data observations that have an affect on the concentration estimates are presented and are compared to conventional observation methods.

2.1 Cloud Cover and Height

To determine cloud cover and height, ASOS utilizes a vertical-pointing ceilometer. The ceilometer is pulsed about 770 times per second to create a profile every 12 seconds and is sampled every 30 seconds. A cloud “hit” or “no hit” is stored along with one or two cloud base heights. Since the ceilometer has a vertical range of only 12,000 feet, any clouds above this height are not detected. The cloud cover is determined from the ratio of “hits” to “possible hits” in the previous 30 minutes (with the last 10 minutes given twice as much weight). The system then converts the ratio to descriptive terms and, in the process, loses the information on the “hits” to “possible hits” ratio. Since the ceilometer currently cannot distinguish between transparent and opaque clouds, the fraction derived is recorded as opaque cloud cover. Reported cloud base heights are the most frequent and meteorologically significant during the period, with up to three layers reported for each hour.

To obtain the ceiling height under the conventional method, the human observer evaluates the trace on a chart that records the amount of light reflected by the cloud layer. The observer then views the sky to obtain cloud layer and cloud amount which is an instantaneous, areally integrated average over the celestial dome at the time of the observation. This view also allows the observer to modify the ceiling height if there are high clouds, and to make a determination on the transparency of the clouds.

2.2 Temperature

One-minute average temperature is computed from 30-second samples. The ASOS ambient and dew point temperatures are five-minute averages computed from the one-minute processed data. The conventional method is an instantaneous reading at the observation time, (taken 5 to 10 minutes before the hour).

2.3 Wind

For ASOS, wind speed and direction are collected once per second and an average is computed every five seconds. The five second data are rounded to the nearest degree and knot. A running two-minute average is computed from the five-second data. The two-minute average is stored each minute. This running two-minute average is reported at the observation time. The conventional method for reporting the winds is to take a one-minute average at the time of the observation.

3.0 STATION AND DATE SELECTION

3.1 Station Selection

Six stations across the United States were selected for this analysis. The selection was based on the availability of co-located ASOS and conventional observations and climatological regime. Since there is only a two month period available for each station, a cross-section of climates was chosen to determine if there is any seasonal trend in changing from one observational system to another. The surface stations, latitude and longitude, and the corresponding upper air stations used in this analysis are:

Surface Station (airport ID)	Latitude, Longitude	Upper Air Station
Albany, New York (ALB)	42.75N, 73.80W	Albany, New York
Montgomery, Alabama (MGM)	32.30N, 86.40W	Birmingham, Alabama
Kansas City, Missouri (MCI)	39.32N, 94.72W	Topeka, Kansas
Tucson, Arizona (TUS)	32.12N, 110.93W	Tucson, Arizona
Milwaukee, Wisconsin (MKE)	42.95N, 87.90W	Green Bay, Wisconsin
Pendleton, Oregon (PDT)	45.68N, 118.85W	Spokane, Washington

3.2 Date Selection

Since the data provided for this analysis were in 8-day segments and due to the complexity of the data structure, the analysis was limited to the following periods:

September 18, 1994 through October 18, 1994 (31 days)
March 6, 1995 through April 5, 1995 (31 days)

The 1995 data sets for Kansas City and Milwaukee contained extended periods of missing data. The 1995 data sets for these two cities were not used in this analysis.

4.0 METEOROLOGICAL DATA PREPARATION AND ANALYSIS

Prior to running the ISCST3 model, both the surface data and mixing height data were manipulated and reformatted prior to use in PCRAMMET. The steps required to reformat the data and the assumptions made in preparation for input to PCRAMMET are discussed. Handling of missing data and the running of PCRAMMET are also discussed in this section.

4.1 Hourly Surface Observations

One of the surface observation formats that PCRAMMET can process is the TD-1440 format from the National Climatic Data Center (NCDC). In this format, the weather variables for each hour are coded in an 80-character record. The ASOS hourly surface observations that were provided for this analysis required considerable manipulation prior to getting the data into the TD-1440 format for use in PCRAMMET. The effort to reformat the data is described next.

4.1.1 ASOS data

Each file consisted of one record without any carriage return or line feed characters and contained both conventional and ASOS observations for many of the first-order stations in the United States. Briefly, the steps that were followed to reformat the data to the TD-1440 format were:

1) retrieving the data from NCDC via anonymous ftp (8 files);
2) using a 'hex' editor, search for and replace the ^z (control/z) character in the body of the file with a blank; this character indicates an end-of-file, however, several of the files contained one or more occurrences of this character prior to the actual end of the file;
3) a special character indicated the end of a character string (some multiple of 80); this special character was replaced with a CR/LF to form individual records;
4) extract only ASOS data from this newly created file;
5) extract the ASOS data for those stations that are to be included in the analysis;
6) reformat the ASOS data to the TD-1440 format.

The ASOS reports as received from NCDC consist of descriptive sky conditions for up to three cloud levels rather than explicitly reporting ceiling height and cloud cover (in tenths or octals) as is done in conventional observations. These sky conditions include the height of the cloud layer in hundreds of feet and a description of the cloud layer. The descriptions are SCT, BKN, and OVC for scattered, broken, and overcast, respectively. A fourth description is CLR BLO 120 for clear skies below 12,000 feet. Since ASOS observations are limited to 12,000 feet, any clouds above this level are not detected and clear skies are reported for the hour. There can be one, two, or three descriptive conditions per hourly report. For example, the sky conditions might be reported as

43 SCT M90 BKN

which is interpreted as “the first layer is a deck of scattered clouds at 4,300 feet and the second layer is a broken cloud layer measured (the ‘M’ before the 90) at 9,000 feet.” The following sections describe the conversion of the ASOS report to numeric values.

4.1.1.1 Sky conditions and cloud cover. Four possible descriptive sky conditions are defined by the National Weather Service as follows:

clear	less than 10% sky cover
scattered	10% to 50% sky cover
broken	60% to 90% sky cover
overcast	more than 90% sky cover

A cloud layer is defined as ‘thin’ if the ratio of transparent to total cloud coverage is ½ or more. This designation is not utilized for ASOS data since the ceilometer currently cannot distinguish between transparent and opaque clouds. Hence, any distinction between total cloud cover and opaque cloud cover is lost when a station converts to ASOS.

For this analysis, these descriptive elements were converted to fractional cloud cover as follows:

clear	0.0
scattered	0.3
broken	0.7
overcast	1.0

If there is only one descriptive sky condition in an ASOS report, then the fractional cloud cover shown above will be used to construct the meteorological input to PCRAMMET. See Section 4.1.1.3 for a discussion on cloud cover when multiple sky conditions are reported.

In estimating the stability category at night, the stability changes when cloud cover changes from 4/10 to 5/10. This point can cause a difference in the stability estimate depending on whether ASOS or conventional data are used. Appendix A contains the complete discussion for estimating stability (EPA, 1987).

To see how ASOS cloud cover and conventional opaque cloud cover observations compare, conventional cloud cover expressed in tenths was converted to ASOS’ descriptive four-category scale so the two can be compared on a category basis. A cloud cover of 0/10 was assigned to clear skies, cloud coverage of 1/10 to 5/10 was assigned to scattered clouds, cloud coverage of 6/10 to 9/10 was assigned to broken clouds, and 10/10 was assigned to overcast skies. The results of this grouping and comparison are shown in Table 4.1.

TABLE 4.1

CLOUD COVER COMPARISON

Conventional Cloud Cover	ASOS Cloud Cover				
	Clear	Scattered	Broken	Overcast	Total Conventional
Clear (0/10)	2459	36	2	2	2499
Scattered (1/10-5/10)	1424	340	83	22	1869
Broken (6/10-9/10)	451	224	255	278	1208
Overcast (10/10)	181	116	191	1376	1864
Total ASOS	4515	716	531	1678	7440

From Table 4.1, it can be seen that there is a tendency for ASOS to underestimate the cloud cover when compared to conventional observer data. For example, when ASOS reports clear skies, there are 1424 occurrences of scattered clouds (1/10 - 5/10) reported by the conventional observer. There are four cases of ASOS reporting broken or overcast skies when the observer reported clear skies. There was no pattern to these events and these differences appear to be valid. Three of the cases occurred at Montgomery in March 1995, two of which were shortly before sunrise, and the fourth case was at Pendleton in October 1994. In the ASOS cases, clear skies are followed immediately by extensive cloud cover. The observer at Pendleton did not report any significant clouds for several hours. For the two periods just before sunrise at Montgomery, the observer reported extensive clouds two hours after ASOS began reporting clouds. Similar events occurred on other days, but the ASOS and observer reports were in better agreement. For the third hour at Montgomery, both ASOS and the observer reported periods of clearing mixed with periods of clouds.

4.1.1.2 Ceiling height. Currently, the ASOS ceilometer used to measure cloud base height can detect clouds at or below 12,000 feet. It is anticipated that satellites may provide data above 12,000 feet, but this information is not routinely available. Therefore, any high level clouds are not included in an ASOS observation.

The ceiling height is defined as the height of the lowest layer of clouds that covers more than 50% of the sky. From the sky conditions in Section 4.1.1.1, this definition means only ‘broken’ or ‘overcast’ are used to determine ceiling height for single descriptive sky conditions. A sky condition of ‘scattered’ and ‘clear’ indicates that the ceiling height is unlimited.

For example, if only one layer is reported and is 9,000 feet and scattered, then the cloud cover was coded as 0.3 with an unlimited ceiling. If the report is 7,000 feet and broken, then the cloud cover was coded as 0.7 and the ceiling height as 7,000 feet.

In estimating the stability category during the day, the stability changes for a ceiling height between 7,000 feet and 16,000 feet. Due to the limitation of 12,000 feet, this range can cause a difference in the stability estimate depending on whether ASOS or conventional data are used. Appendix A contains the complete discussion for estimating stability (EPA, 1987).

4.1.1.3 Multiple cloud layers. Many hourly observations contain multiple descriptive sky conditions. Since the automated system converts the heights and ratio of "hits" to "possible hits" to the descriptive elements, converting multiple descriptions back to ceiling height and cloud cover for use in dispersion modeling is not without complications. For example, if two broken layers completely cover the celestial dome, an observer may report cloud cover of 1.0, but this information cannot be determined with certainty from an automated report. Without extensive effort, any method to convert back to fractional cloud cover and ceiling height in the presence of multiple layers, or even single layers, is subject to error. For this analysis, when multiple cloud layers are present, the single element that yields the largest cloud cover and the single element that yields the lowest ceiling height were used. By not attempting to integrate multiple pieces of information, this procedure may compensate for the lack of total versus opaque clouds that a conventional observer-based system can provide, but again only for clouds below 12,000 feet.

For example, if the ASOS report indicates a broken layer at 6,000 feet and overcast at 8,000 feet, then 1.0 (10/10) is used for the cloud cover and the ceiling height is 6,000 feet associated with the broken layer. For a report of 5,500 feet and scattered and 6,500 feet and broken and 8,000 feet and broken, then the ceiling height is 6,500 feet with a cloud cover of 0.7.

As an aside, NCDC currently is using a similar method for single-level cloud coverage as is used here. The cloud cover associated with the descriptive conditions are defined by NCDC as follows (the coverage used in this analysis follows in parentheses):

clear	0.0	(0.0)
scattered	0.2	(0.3)
broken	0.7	(0.7)
overcast	1.0	(1.0)

NCDC has not made any attempt thus far to integrate multiple cloud layers into a fractional coverage.

4.1.2 Conventional observer data

The Meteorological Database Management System (MDMS) is a data base of hourly meteorological data for the first-order stations in the United States. It resides on the EPA's IBM mainframe computer. An interface allows the user to easily retrieve data from the data base. Before using the data in PCRAMMET, there are several steps to reformat the meteorological data:

1) Run MDMS for each station and for each year (once for 1994 and a second time for 1995) on the IBM mainframe computer;
2) Download the data from the IBM mainframe;
3) Reformat the data for use in PCRAMMET - the data from the IBM are in a format unique to the MDMS system which includes periods (".") to indicate missing data.

The data obtained from MDMS for this project are the conventionally observed (i.e., human) data. Minimal data manipulation was required to convert the data into the TD-1440 format.

4.2 Twice-daily Mixing Heights

Upper air data for the six upper air stations listed in Section 2 for the 2 month period in 1994 and 1995 were retrieved from the *Radiosonde Data of North America, 1990-1995* compact discs (CDS). This data served as a basis for computing the twice-daily mixing heights. The morning and afternoon mixing heights were estimated following the technique developed by Holzworth (1967) using the soundings and the surface temperature and pressure obtained from the MDMS hourly observations.

4.3 Periods of Missing Data

The ASOS data had several hours of missing data for each station. There were no missing periods of MDMS data. There were a few twice-daily mixing heights that could not be calculated and required interpolation. The number of missing data periods and how the data were filled in are discussed below.

4.3.1 Surface data

As noted earlier, the data for both Kansas City and Milwaukee for 1995 period were omitted from this analysis due to extended periods of missing data. The ASOS data for the other stations for both years suffered from several missing periods of data, as shown in Table 4.2. Most missing data were for one- or two-hour periods and were filled by linearly interpolating the meteorological data between the nonmissing periods before and after the missing period.

The exception to the linear interpolation is cloud cover. Since there are only four values corresponding to the four sky conditions, interpolation could yield a nonexistent cloud cover in the system defined in Section 4.1.1.1 and create a problem with the ceiling height. In most cases, the cloud cover before and after the period of missing data was identical, thus there was no decision to be made. However, there were a few cases where the cloud cover was different for the hour preceding the missing period from the hour after. If there was a one-category change (e.g., cloud cover changed from 3 to 7), the larger cloud cover was used and the ceiling height associated with that larger cloud cover was used. If there was a two-category change (i.e., 0 to 7 or 3 to 10), then category between the two (i.e., 3 or 7) was used. For the former (cloud cover=3), the ceiling height was defined as unlimited; for the latter, the ceiling for the overcast condition (cloud cover=10) was used.

There was one 8-hour period of missing data for the monthly period at Albany in 1995. The data for the same 8-hour period from the previous day was used to fill in for the missing data. The temperatures, however, were adjusted to to be more in line with the temperatures immediately before and after the 8 hours of missing data.

TABLE 4.2

SUMMARY OF MISSING PERIODS FOR ASOS DATA.

Station	Length of missing period	Number of missing periods	
		1994 (1 month)	1995 (1 month)
Albany	1-hr	1	3
	2-hr	1	0
	other	0	1 (8 hr)
Kansas City	1-hr	14	--
	2-hr	0	--
Montgomery	1-hr	4	4
	2-hr	0	0
Milwaukee	1-hr	2	--
	2-hr	1	--
Pendleton	1-hr	5	7
	2-hr	1	0
Tucson	1-hr	6	2
	2-hr	0	0

4.3.2 Mixing heights

Any missing morning mixing heights were filled by linearly interpolating between periods of nonmissing morning mixing heights. A similar procedure was used to fill in for any missing afternoon mixing heights. Table 4.3 shows the number of twice-daily mixing heights that could not be computed and were filled by linear interpolation.

TABLE 4.3

SUMMARY OF MISSING PERIODS OF TWICE-DAILY MIXING HEIGHTS.

Station	Missing period	Number of missing mixing heights	
		1994 (1 month)	1995 (1 month)
Albany	morning afternoon	0 0	0 1
Kansas City	morning afternoon	0 0	-- --
Montgomery	morning afternoon	2 1	1 0
Milwaukee	morning afternoon	0 0	-- --
Pendleton	morning afternoon	0 0	0 0
Tucson	morning afternoon	0 0	0 0

4.4 Running PCRAMMET

With the meteorological data formatted to the requirements for PCRAMMET, PCRAMMET was run in its simplest mode since this analysis was to run the ISCST3 model without deposition or depletion (both wet and dry). Thus, the only information required by PCRAMMET was the type of estimate to be performed by ISCST3, the output type, input file names (hourly surface observations and twice-daily mixing heights), the format of the hourly surface data, and the location of the station. An example of the input runstream for Albany is shown below:

N	No/Dry/Wet Deposition calculations
A	Unform/ASCII output type
mix94m.alb	Mixing height data file
asos-94.alb	Hourly surface data file
CD144	Surface data format
42.750	Station latitude (decimal degrees)
73.800	Station longitude (decimal degrees)
5	Station time zone

The 31-day period from each year was run separately and the results were concatenated to form a single meteorological input file for ISCST3.

4.5 Analysis of Meteorological Data

The meteorological data that are input to and output from PCRAMMET were compared. Input data included wind speed, wind direction, cloud cover, ceiling height, and ambient temperature. Output data included Pasquill-Gifford (PG) stability category and rural and urban mixing heights. Two sets of input to PCRAMMET were examined: 1) cloud cover and ceiling from ASOS and winds, temperature, and pressure from conventional observations (referred hereafter as “mixed ASOS”); and 2) all meteorological variables from ASOS (referred to as “full ASOS”). In the former, the effects of cloud cover and ceiling are isolated without the effects of winds and temperature.

4.5.1 Input to PCRAMMET

The histograms in Figures 4.1 - 4.3 show the difference between conventionally observed data and automated data for wind speed, wind direction, and temperature for all stations and hours (N=7440). Each bin represents a range of values and the values on the x-axis correspond to the endpoints of each bin, with the left endpoint included in the bin and the right endpoint excluded. The frequency in percent is shown on the y-axis with the number of observations shown above each bar. The number of exact matches (i.e., a difference of zero) is shown in parentheses next to the bar containing 0. The mean difference for wind speed, wind direction, and temperature is -0.24 m s^{-1}, -3.5 degrees, and -0.63 K, respectively. In other words, the ASOS observations tend to be less than the conventionally observed counterpart.

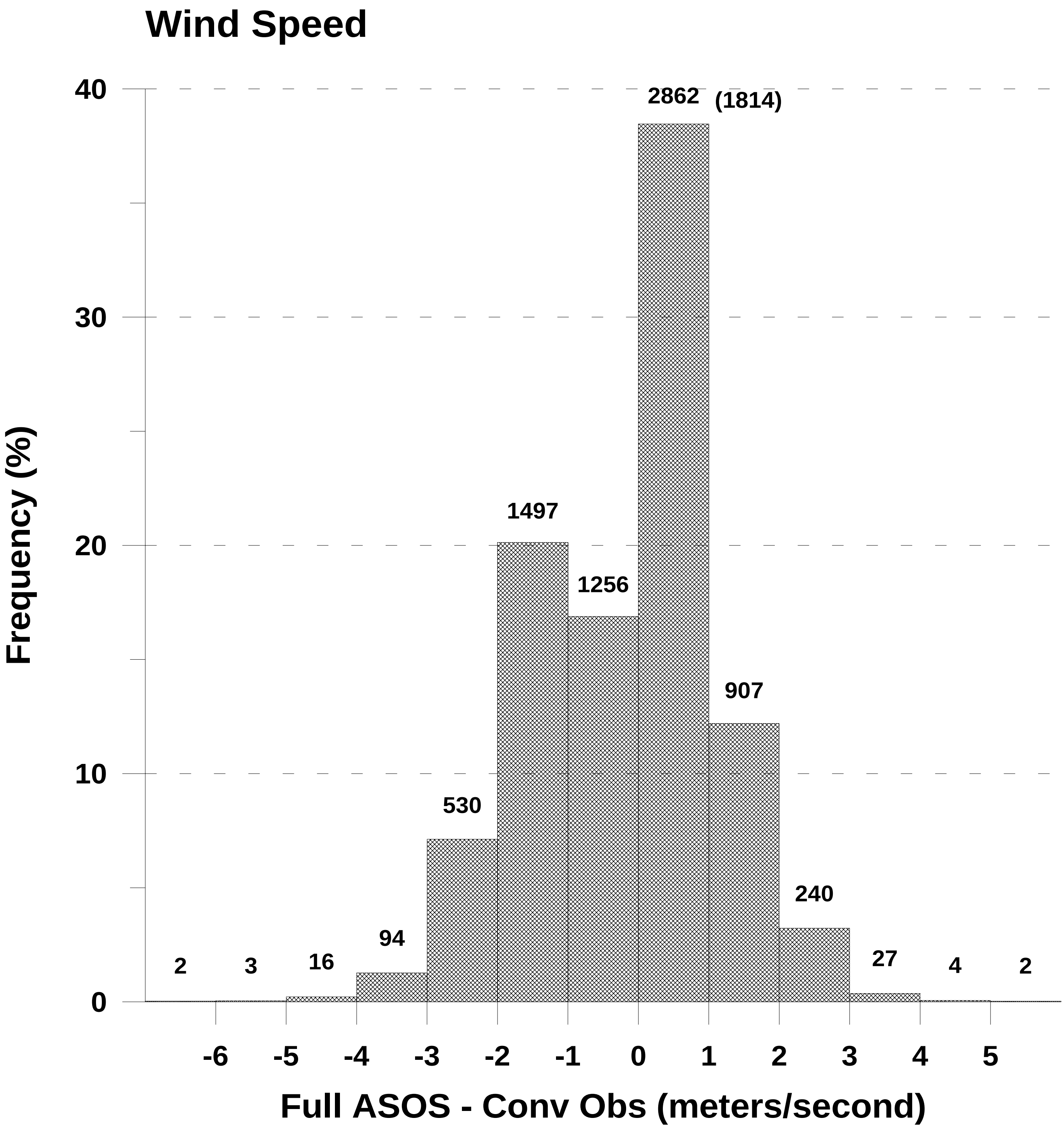

Figure 4.1 Difference in wind speed between ASOS observations and conventional (human) observations for all six stations (Number of observations = 7,440).

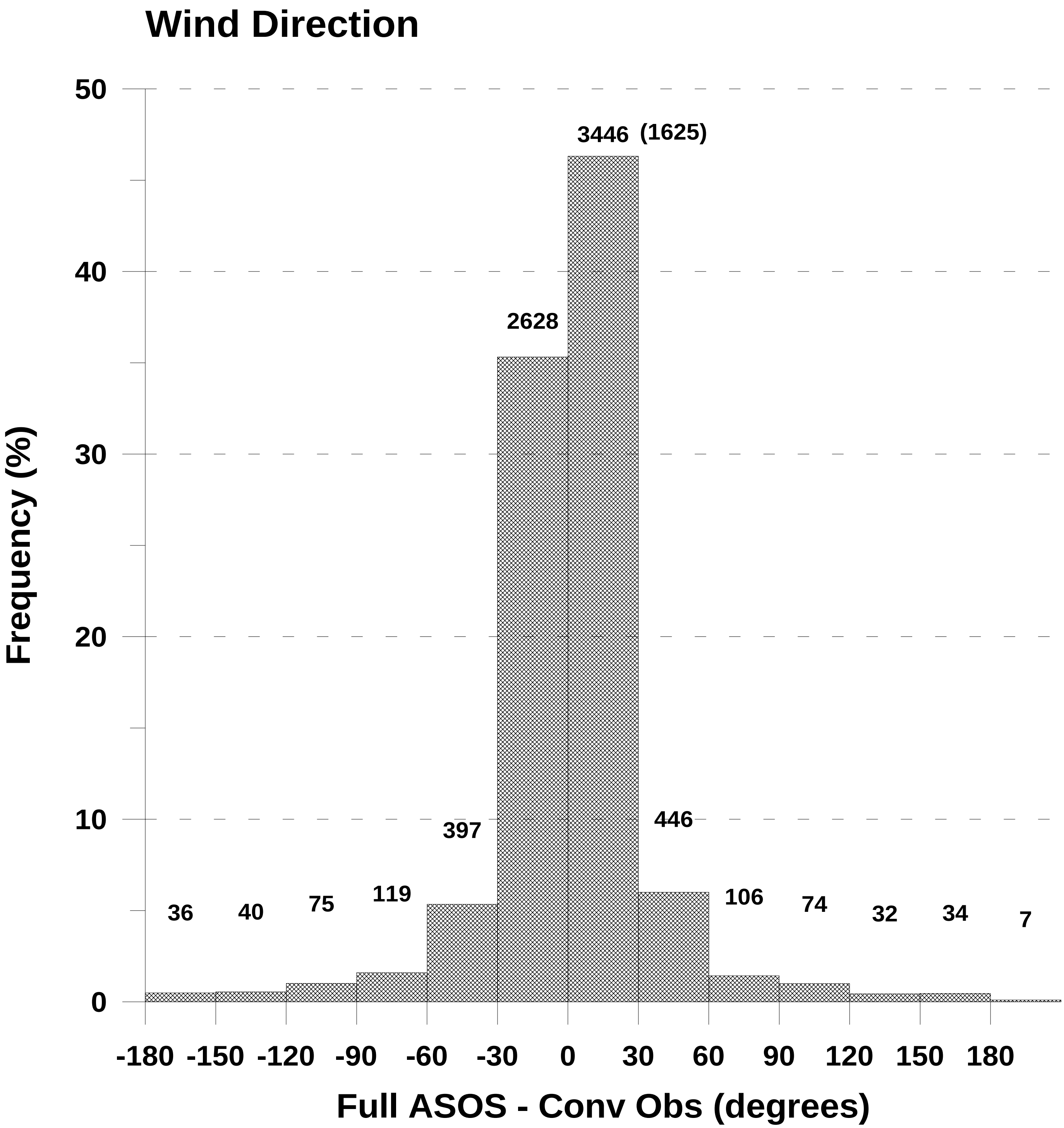

Figure 4.2 Difference in wind direction between ASOS observations and conventional (human) observations for all six stations (Number of observations = 7,440).

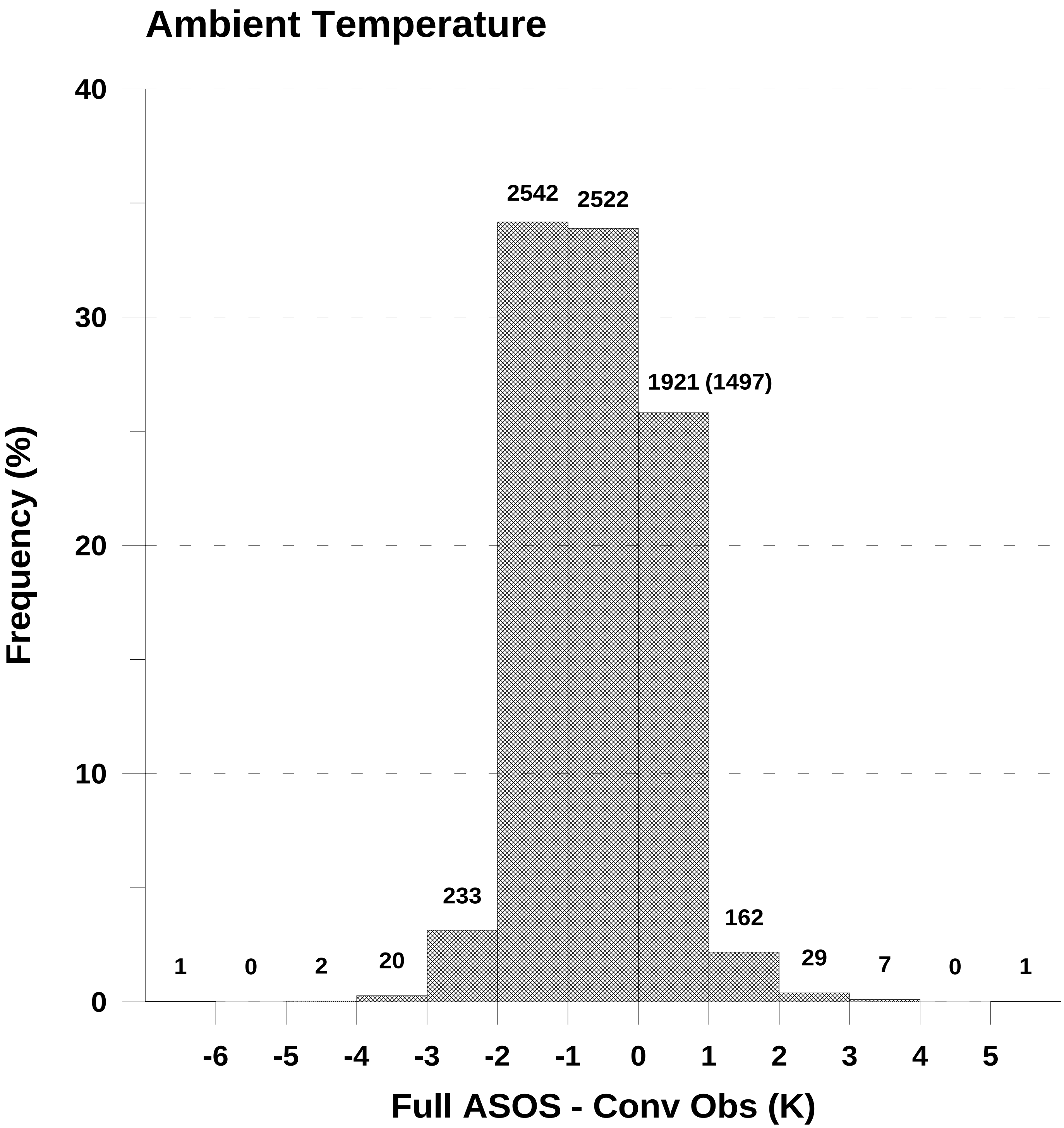

Figure 4.3 Difference in ambient temperature between ASOS observations and conventional (human) observations for all six stations (Number of observations = 7,440).

Tables 4.4 and 4.5 show the distribution of the difference in wind speed and wind direction by station. the station abbreviations can be found in Section 3.1. The columns labeled ALL6 are the distributions, in percent, that appear in Figures 4.1 and 4.2 for all stations combined. Overall, the distributions between stations are very similar, although there are some small differences in the tails of the distributions.

TABLE 4.4

DISTRIBUTION, IN PERCENT, OF THE ABSOLUTE DIFFERENCE IN WIND SPEED BETWEEN ASOS AND CONVENTIONAL OBSERVATIONS FOR ALL STATIONS AND FOR EACH STATION.

Range	ALL6***	ALB*	MCI**	MKE**	MGM*	PDT*	TUS*
$-7 \leq \Delta WS < -6$	0.03	0.07	0	0	0	0	0.07
$-6 \leq \Delta WS < -5$	0.04	0	0.13	0	0	0	0.13
$-5 \leq \Delta WS < -4$	0.22	0.07	0.27	0.13	0.13	0	0.67
$-4 \leq \Delta WS < -3$	1.26	1.75	1.48	1.08	0.34	0.34	2.62
$-3 \leq \Delta WS < -2$	7.12	13.04	6.85	4.57	4.57	2.15	10.15
$-2 \leq \Delta WS < -1$	20.12	30.71	19.89	19.62	14.85	9.68	25.60
$-1 \leq \Delta WS < -0$	16.88	15.73	20.97	19.76	16.87	12.03	19.42
$0 \leq \Delta WS < 1$	38.47	31.12	36.69	41.67	42.67	47.92	31.45
$1 \leq \Delta WS < 2$	12.19	5.04	10.89	11.69	14.52	22.24	7.86
$2 \leq \Delta WS < 3$	3.23	2.02	2.55	1.48	5.51	4.84	1.75
$3 \leq \Delta WS < 4$	0.36	0.34	0.27	0	0.40	0.67	0.27
$4 \leq \Delta WS < 5$	0.05	0.07	0	0	0.13	0.07	0
$5 \leq \Delta WS < 6$	0.03	0.07	0	0	0	0.07	0

* N=1,488 observations ** N=744 observations ***N=7,440 observations

TABLE 4.5

DISTRIBUTION, IN PERCENT, OF THE ABSOLUTE DIFFERENCE IN WIND DIRECTION BETWEEN ASOS AND CONVENTIONAL OBSERVATIONS FOR ALL STATIONS AND FOR EACH STATION.

Range	ALL6***	ALB*	MCI**	MKE**	MGM*	PDT*	TUS*
$-180 \leq \Delta WD < -150$	0.48	0.87	0.13	0.13	0.54	0.20	0.67
$-150 \leq \Delta WD < -120$	0.54	0.54	0.13	0	0.34	0.60	1.14
$-120 \leq \Delta WD < -90$	1.01	1.75	0.40	0	0.27	1.14	1.68
$-90 \leq \Delta WD < -60$	1.60	1.61	0.40	1.48	1.41	1.81	2.22
$-60 \leq \Delta WD < -30$	5.34	2.96	3.49	1.34	4.64	11.22	5.44
$-30 \leq \Delta WD < 0$	35.32	20.90	41.94	11.29	27.62	65.05	36.42
$0 \leq \Delta WD < 30$	46.32	58.13	47.85	74.46	55.65	15.46	41.20
$30 \leq \Delta WD < 60$	5.99	8.60	4.97	9.95	5.91	2.28	5.71
$60 \leq \Delta WD < 90$	1.42	1.95	0.54	0	1.68	0.94	2.28
$90 \leq \Delta WD < 120$	0.99	1.55	0.13	0.27	1.08	0.60	1.55
$120 \leq \Delta WD < 150$	0.43	0.40	0	1.08	0.13	0.20	0.87
$150 \leq \Delta WD < 180$	0.46	0.74	0	0	0.40	0.34	0.81
$\Delta WD = 180$	0.09	0	0	0	0.34	0.13	0

* N=1,488 observations ** N=744 observations ***N=7,440 observations

Under calm wind conditions, ISCST3 does not estimate pollutant concentration. Table 4.6 shows the occurrence of calm winds by station for the conventionally observed data and the ASOS data. The ASOS data contain a higher frequency of calms than observer data for all stations examined and is consistent with the tendency for ASOS wind speeds to be lower than observer wind speeds.

TABLE 4.6

NUMBER OF CALM WINDS BY STATION AND DATA TYPE.

	ALB*	MCI**	MGM*	MKE**	PDT*	TUS*	All***
Conventional	245 (16.5%)	35 (4.7%)	130 (8.7%)	29 (3.9%)	87 (5.8%)	37 (2.5%)	563 (7.6%)
ASOS	319 (21.4%)	39 (5.2%)	173 (11.6%)	57 (7.7%)	114 (7.7%)	95 (6.4%)	797 (10.7%)

* N=1,488 observations ** N=744 observations ***N=7,440 observations

Another variable that is required by PCRAMMET is the opaque sky cover. With the 12,000-foot limitation of the ceilometer, it is possible that ASOS reports clear skies when a nonzero cloud cover is reported by a human observer. Table 4.7 shows the distribution of the cloud cover reported by the human observer for those periods when ASOS reported clear skies. The human observer reported clear skies for 2,459 cases of the 4,495 cases (or 55%) when ASOS reported clear skies below 12,000 feet, but the human observer reported nonzero cloud cover for 2,036 cases (45%). In 181 cases, ASOS reported clear skies while the human observer reported overcast (10/10) skies. Although the number of cases is not exceedingly large, the highest concentration differences may be driven by these cases, as will be seen in Section 6.

TABLE 4.7

DISTRIBUTION OF CONVENTIONALLY-OBSERVED CLOUD COVER WHEN ASOS REPORTED CLEAR SKIES.

Cloud Cover (tenths)	0	1	2	3	4	5	6	7	8	9	10	Total Non-zero
ALB*	365	99	65	56	31	9	19	19	7	8	19	332
MCI**	291	24	29	16	10	16	7	4	16	5	10	137
MGM*	374	96	64	86	20	33	39	15	29	27	59	468
MKE**	147	21	21	22	22	17	13	12	13	6	29	176
PDT*	568	107	40	50	40	36	24	28	10	22	20	377
TUS*	714	130	88	62	56	38	31	28	39	30	44	546
Total***	2459	477	307	292	179	149	133	106	114	98	181	2036

*N=1,488 observations **N=744 observations ***N=7,440 observations

4.5.2 Output from PCRAMMET

The two basic output parameters generated by PCRAMMET are the Pasquill-Gifford stability category and the rural and urban mixing heights. Figure 4.4 shows the difference between PG categories obtained from mixed ASOS and conventional observations. There is no change for nearly 90% of the hours. For the non-zero differences, ASOS cloud cover overall tends to increase the stability. Table 4.8 shows the distribution of the difference in PG category by station. The column labeled ALL6 is the distribution, in percent, that appears in Figure 4.4 for all stations combined. Overall, the distributions between stations are very similar.

TABLE 4.8

DISTRIBUTION, IN PERCENT, BY STATION OF THE DIFFERENCE IN PG CATEGORY OBTAINED FROM MIXED ASOS DATA AND CONVENTIONAL DATA.

ΔPG	ALB*	MCI**	MKE**	MGM*	PDT*	TUS*	ALL6***
-2	0.30	0.13	0	0.94	0.20	0.20	0.32
-1	2.22	4.17	2.15	3.90	1.61	2.15	2.61
0	93.08	88.58	86.96	84.61	90.52	90.19	89.23
1	4.50	7.12	10.35	10.48	7.53	7.46	7.74
2	0	0	0.54	0.07	0.13	0	0.09

* N=1,488 observations ** N=744 observations *** N=7,440 observations

A two-way distribution by PG category for all stations and hours is shown in Table 4.9. The shaded cells indicate agreement between ASOS-based and observer-based stability categories. About 11% of the differences are nonzero and range from 1% for category 7 to 20% for category 5.

TABLE 4.9

PG CATEGORY OBTAINED WITH MIXED ASOS DATA COMPARED TO PG CATEGORY OBTAINED WITH CONVENTIONAL DATA.

	ASOS							Total Nonzero	All
ConvObs	1	2	3	4	5	6	7		
1	21	1						1	22
2	1	465	11	2				14	479
3	1	36	789	41				78	867
4		19	97	2990	234	4		354	3344
5				41	999	207	1	249	1248
6				4	14	1004	82	100	1104
7						5	371	5	376
All	23	521	897	3078	1247	1220	454	801	7440

Figure 4.5 shows the difference between PG categories obtained from conventional and full ASOS observations. There is no change for about 70% of the hours. For the non-zero differences, ASOS data tends to increase the stability. Table 4.10 shows the distribution of the difference in PG category by station. The column labeled ALL6 is the distribution of all stations combined, in percent, that appears in Figure 4.5. Overall, the distributions between stations are very similar. Compared to the distributions in Table 4.8, there are 10-20% fewer zero differences with a cooresponding increase in 1-category differences, although Tuscon showed a larger drop in zero differences.

TABLE 4.10

DISTRIBUTION, IN PERCENT, BY STATION OF THE DIFFERENCE IN PG CATEGORY OBTAINED FROM FULL ASOS DATA AND CONVENTIONAL DATA.

ΔPG	ALL6***	ALB*	MCI**	MKE**	MGM**	PDT*	TUS*
-3	0.03	0	0	0	0.13	0	0
-2	0.52	0.20	0.67	0.13	1.14	0.34	0.54
-1	12.19	7.86	13.17	5.78	12.57	16.06	14.72
0	71.34	77.55	70.70	75.81	70.90	73.99	61.02
1	14.46	13.84	13.17	16.53	13.91	9.07	20.63
2	1.41	0.54	1.75	1.34	1.34	0.54	3.09
3	0.04	0	0	0.40	0	0	0

* N=1,488 observations   ** N=744 observations   *** N=7,440 observations

The distribution by PG category for all stations and hours is shown in Table 4.11. The shaded cells indicate agreement between ASOS-based and observer-based stability categories. The percentage of nonzero differences ranges from 20% for category 4 to 44% for category 5.

TABLE 4.11

COMPARISON OF PG CATEGORY OBTAINED WITH FULL ASOS DATA TO PG CATEGORIES OBTAINED WITH CONVENTIONAL DATA.

ASOS								Total Nonzero	All
ConvObs	1	2	3	4	5	6	7		
1	9	13						13	22
2	43	350	80	6				129	479
3	6	177	574	107	3			293	867
4	2	25	271	2675	311	57	3	669	3344
5				137	698	374	39	550	1248
6				5	188	720	191	384	1104
7					3	91	282	94	376
All	60	565	925	2930	1203	1242	515	1637	7440

Figure 4.6 shows the difference between rural mixing heights estimated with the mixed ASOS data and the mixing heights estimated with the conventionally observed data. The mixed ASOS data tends to produce lower mixing heights. Figure 4.7 shows the difference for urban mixing heights with a similar, but stronger, tendency for lower mixing heights. When full ASOS data are used, there are more nonzero differences, but the tendencies and trends are the same (Figures 4.8 and 4.9).

Most notable are the large negative differences. The reason is that the interpolation scheme in PCRAMMET to compute the mixing heights beginning at sunrise depends on atmospheric stability for the hour immediately before sunrise (EPA, 1977). If the hour is stable (PG categories 5-7), the interpolation for rural mixing heights is between the surface and the current day's afternoon maximum. If the hour is neutral (PG category 4), then the scheme continues the interpolation from the previous day's maximum to the current day's maximum. For very large mixing heights on the previous day, the mixing height can remain very large at sunrise if the atmosphere for the hour before was neutral. The largest negative values (< -2500 meters) all occur for Tucson. This suggests that the atmosphere likely was neutral with the conventional observations and stable with ASOS observations. For the four cases in Figure 4.6 where the difference is less than -2500 meters, three occurred on September 20, 1994 and the other occurred on September 25. For the hour before sunrise on the 20th, the conventionally observed clouds indicated overcast skies with a ceiling of 13,000 feet and ASOS reported unlimited ceiling and clear skies. A similar situation existed on the 25th. The sky conditions yielded a neutral atmosphere with the conventionally observed data and a stable atmosphere with the ASOS observed data.

The large negative differences of urban mixing heights are also the result of stability, but between sunset of the previous day and sunrise of the current day. If the atmosphere is stable for a particular hour in this period, the interpolation is between the previous day's maximum and the current day's minimum mixing height. However, if the atmosphere is neutral for the hour, then the interpolation is between the previous day's maximum and the current day's maximum. If the atmosphere switches stability from hour to hour, then the method of determining the stability category (stable or neutral) switches also. Again, the largest negative differences (< -2500 meters) in Figure 4.6 are for Tucson, with many of those differences occurring on September 20. Conventional observations reported the atmosphere as overcast with 12,000-13,000 foot ceilings but the ASOS reported clear skies and unlimited ceiling for the hours between midnight and sunrise.

Table 4.12 shows the distribution of the absolute difference in rural mixing heights between mixed ASOS and conventional observations. There is a tendency for positive differences in eastern U.S. climates and negative differences in western U.S. climates. For Pendleton, however, there were no differences for the 1,488 hours of data and for Tucson, all the differences are negative (ASOS-based estimates are smaller) . The reasons for this trend is not known and would require analyses with additional stations and periods of data to determine if the trend is actual or coincidental.

TABLE 4.12

DISTRIBUTION, IN PERCENT, OF THE ABSOLUTE DIFFERENCE IN RURAL MIXING HEIGHTS BETWEEN MIXED ASOS DATA AND CONVENTIONAL OBSERVATIONS FOR ALL STATIONS AND FOR EACH STATION.

Range	ALL***	ALB*	MCI**	MKE**	MGM*	PDT*	TUS*
$-4000 \leq \Delta Z_I < -3500$	0.01	0	0	0	0	0	0.07
$-3500 \leq \Delta Z_I < -3000$	0.01	0	0	0	0	0	0.07
$-3000 \leq \Delta Z_I < -2500$	0.03	0	0	0	0	0	0.13
$-2500 \leq \Delta Z_I < -2000$	0.05	0	0	0.13	0	0	0.20
$-2000 \leq \Delta Z_I < -1500$	0.11	0	0	0.27	0.13	0	0.27
$-1500 \leq \Delta Z_I < -1000$	0.30	0.07	0.27	0.67	0.67	0	0.27
$-1000 \leq \Delta Z_I < -500$	0.59	0.54	0.94	1.48	0.94	0	0.27
$-500 \leq \Delta Z_I < 0$	0.71	0.40	0.67	3.63	0.87	0	0.13
$0 \leq \Delta Z_I < 500$	97.98	98.19	97.72	93.82	97.38	100.0	98.59
$500 \leq \Delta Z_I < 1000$	0.11	0.34	0.40	0	0	0	0
$1000 \leq \Delta Z_I < 1500$	0.08	0.40	0	0	0	0	0
$1500 \leq \Delta Z_I < 2000$	0.01	0.07	0	0	0	0	0

* N=1,488 observations ** N=744 observations *** N=7,440 observations

Table 4.13 is similar to Table 4.12 except that full ASOS data were used to estimate mixing heights. There is less tendency for a trend between parts of the country, although the differences for Tucson are still all negative and there only five nonzero differences for Pendleton.

TABLE 4.13

DISTRIBUTION, IN PERCENT, OF THE ABSOLUTE DIFFERENCE IN RURAL MIXING HEIGHTS BETWEEN FULL ASOS DATA AND CONVENTIONAL OBSERVATIONS FOR ALL STATIONS AND FOR EACH STATION.

Range	ALL6***	ALB*	MCI**	MKE**	MGM*	PDT*	TUS*
$-4000 \le \Delta Z_I < -3500$	0.03	0	0	0	0	0	0.13
$-3500 \le \Delta Z_I < -3000$	0.03	0	0	0	0	0	0.13
$-3000 \le \Delta Z_I < -2500$	0.04	0	0	0	0	0	0.20
$-2500 \le \Delta Z_I < -2000$	0.12	0.13	0	0.13	0	0	0.40
$-2000 \le \Delta Z_I < -1500$	0.23	0.27	0	0.27	0.13	0	0.60
$-1500 \le \Delta Z_I < -1000$	0.48	0.47	0.27	0.40	0.87	0	0.74
$-1000 \le \Delta Z_I < -500$	0.97	1.34	1.75	1.08	1.41	0	0.67
$-500 \le \Delta Z_I < 0$	1.09	1.28	1.75	3.23	1.28	0	0.40
$0 \le \Delta Z_I < 500$	96.68	96.10	95.70	94.35	95.90	99.66	96.71
$500 \le \Delta Z_I < 1000$	0.19	0.13	0.54	0.54	0.13	0.13	0
$1000 \le \Delta Z_I < 1500$	0.12	0.20	0	0	0.20	0.20	0
$1500 \le \Delta Z_I < 2000$	0.03	0.07	0	0	0.07	0	0

* N=1,488 observations ** N=744 observations *** N=7,440 observations

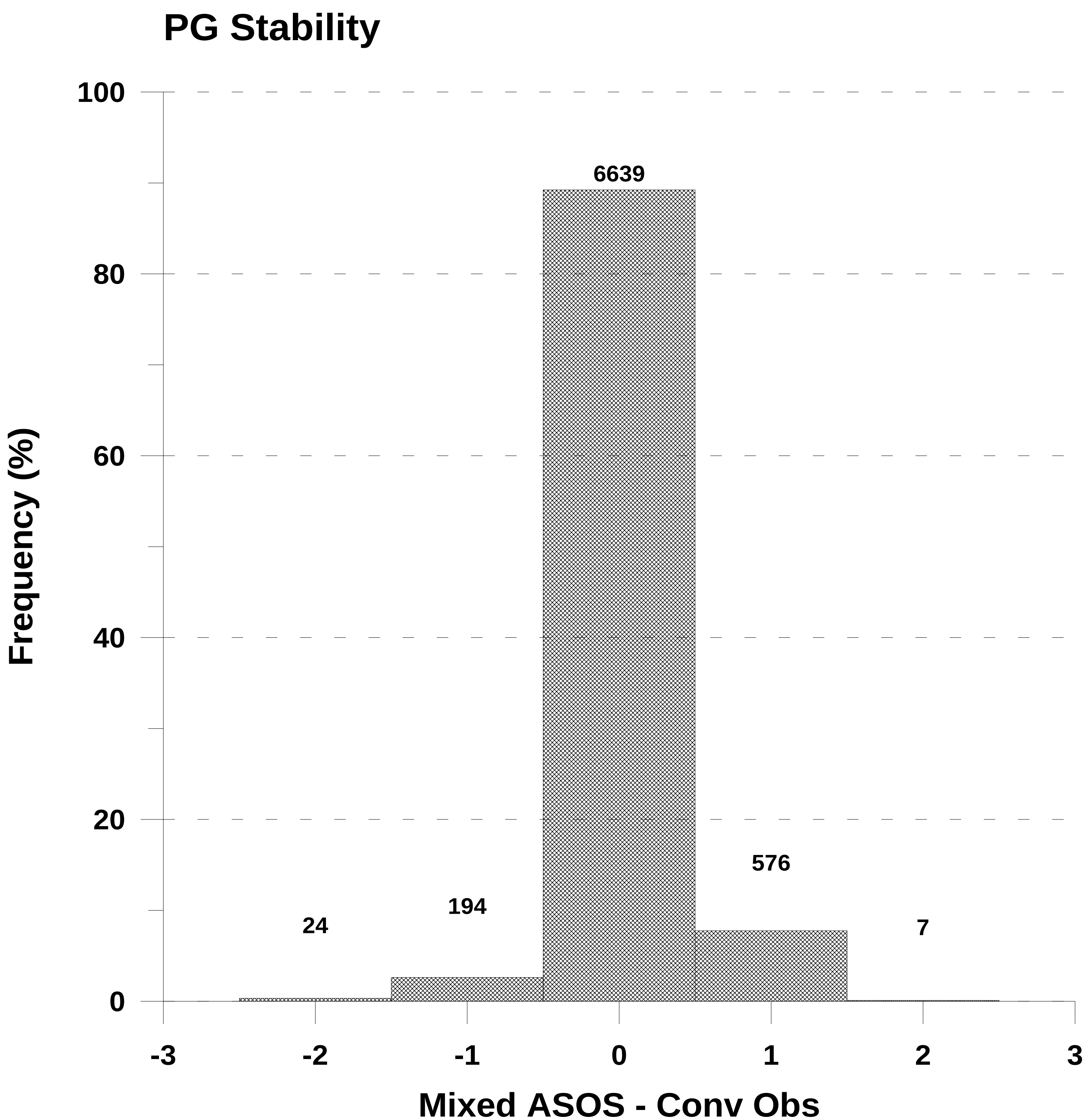

Figure 4.4 Difference in PG stability category between mixed ASOS observations and conventional (human) observations for all six stations (# observations = 7,440).

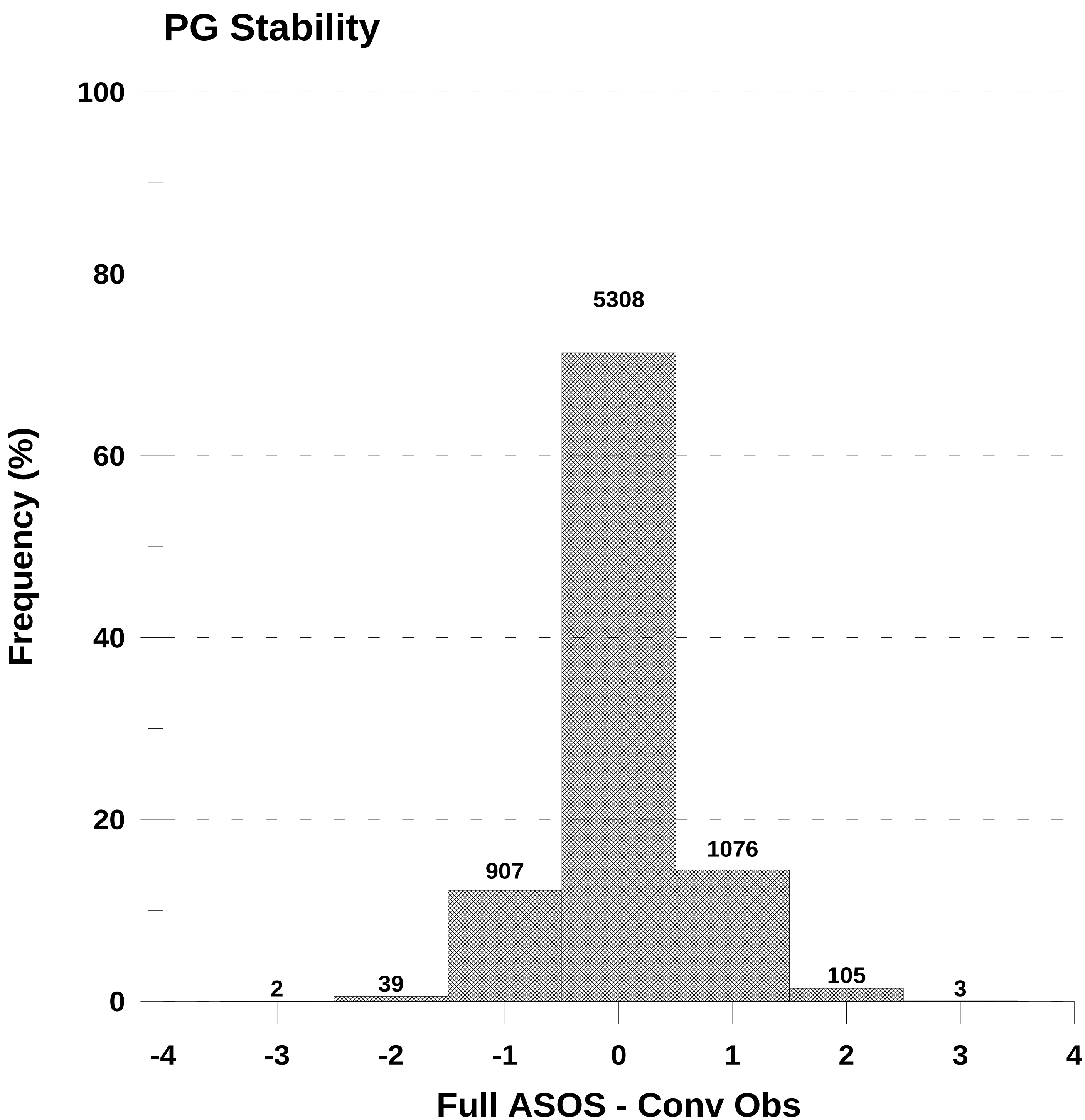

Figure 4.5 Difference in PG stability category between full ASOS observations and conventional (human) observations for all six stations (# observations = 7,440).

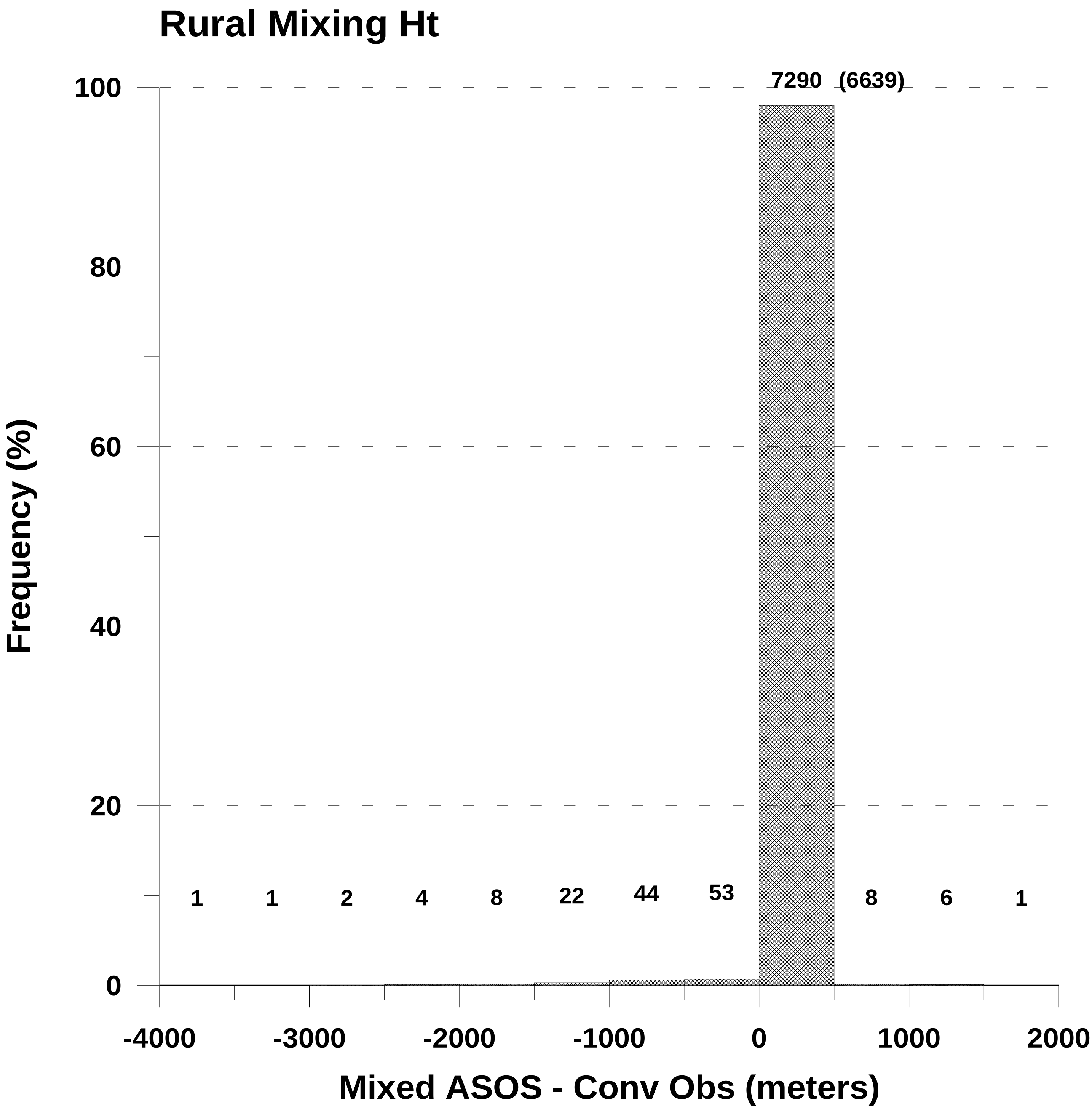

Figure 4.6 Difference in rural mixing heights between mixed ASOS observations and conventional (human) observations for all six stations (# observations = 7,440).

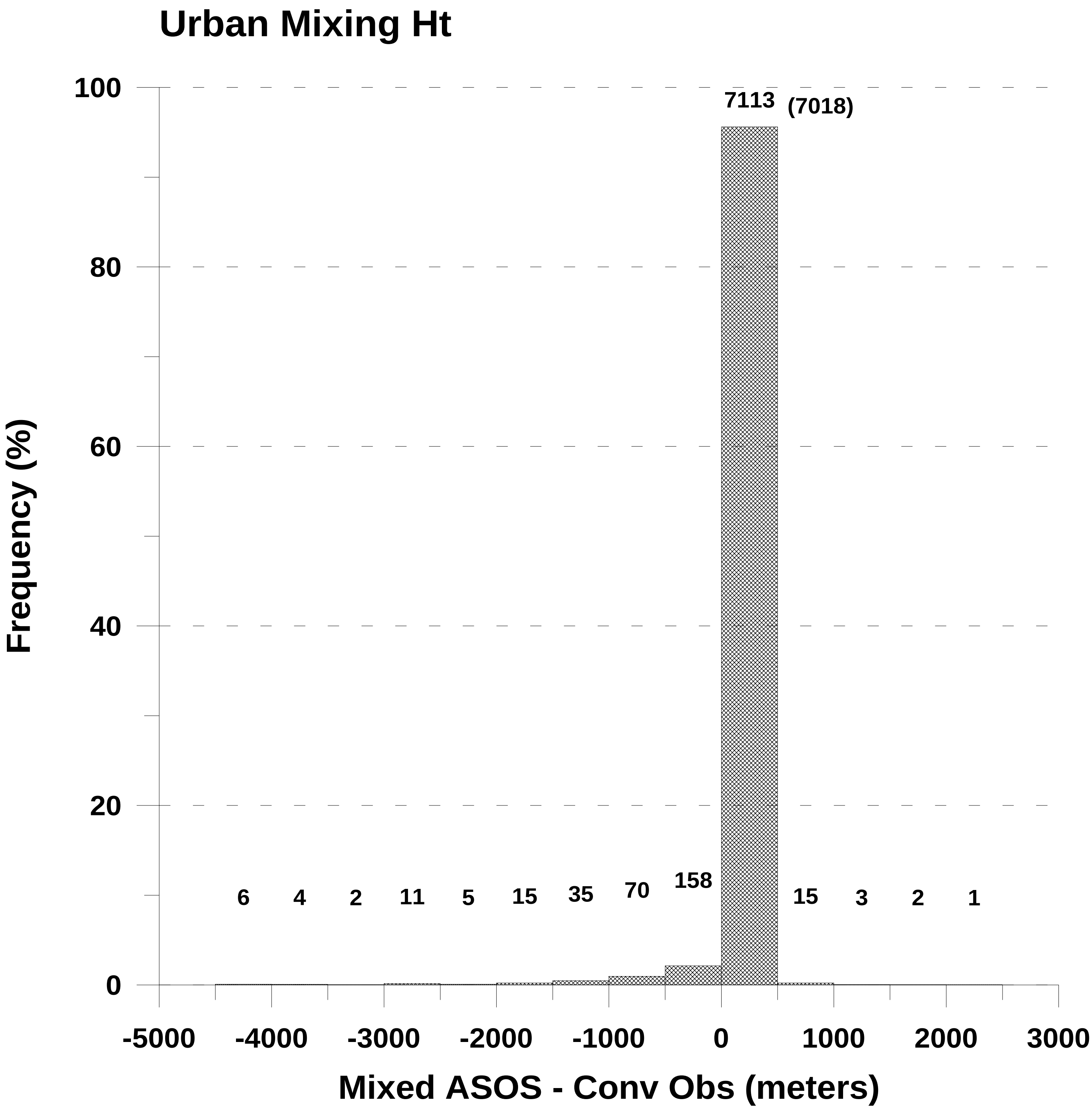

Figure 4.7 Difference in urban mixing heights between mixed ASOS observations and conventional (human) observations for all six stations (# observations = 7,440).

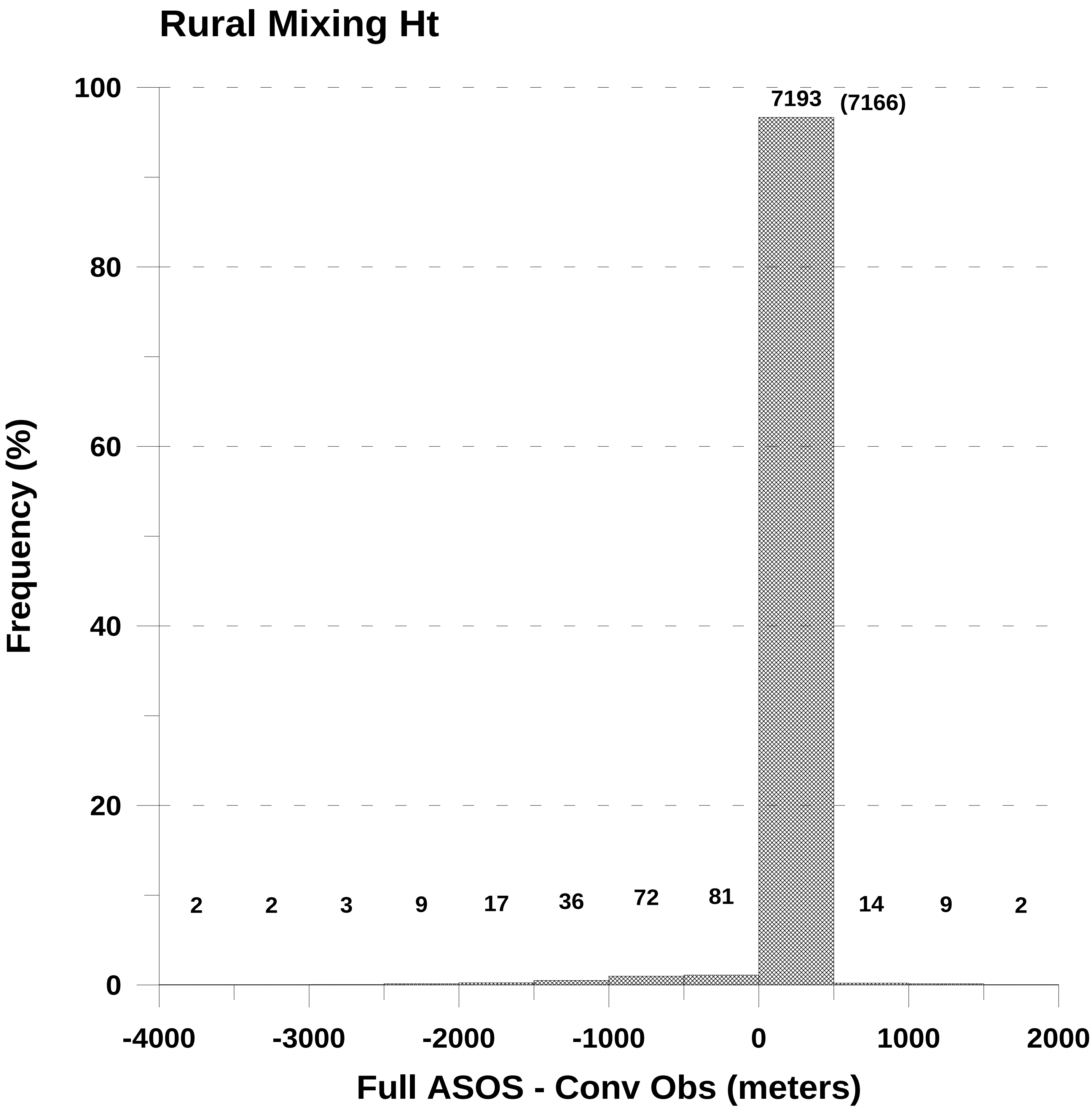

Figure 4.8 Difference in rural mixing height between full ASOS observations and conventional (human) observations for all six stations (# observations = 7,440).

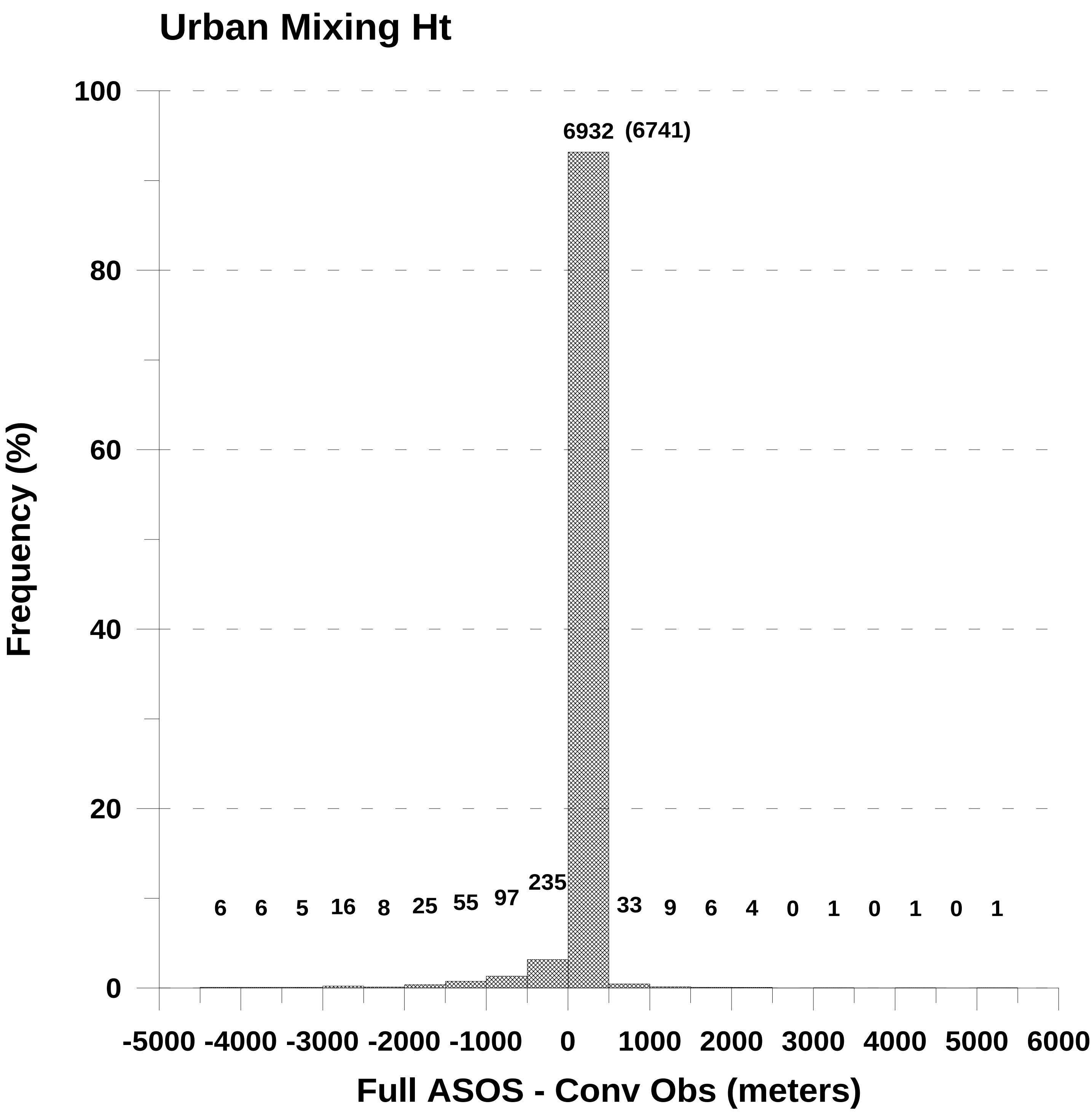

Figure 4.9 Difference in urban mixing heights between full ASOS observations and conventional (human) observations for all six stations (# observations = 7,440).

5.0 ISCST3 MODEL INPUT

The model input options, the sources data, and the receptor network are presented in this section.

5.1 Model Options

For all the ISCST3 runs, the following model options were implemented:

DFAULT -	implements all the regulatory default options
RURAL -	utilize rural dispersion coefficients
FLAT -	run without the effects of terrain elevation

Only ambient concentrations were estimated; there was no dry or wet deposition or depletion options in effect.

Concentrations were estimated for 1-hr, 3-hr, 8-hr, and 24-hr averages. Period averages were also computed. For Albany, Montgomery, Pendleton, and Tucson, the period was about two months. For Kansas City and Milwaukee, the period is one month because the data for 1995 were not used due to extended periods of missing meteorological data.

5.2 Source Characterization

A standard set of source parameters was used in this analysis that have been used in previous sensitivity tests by the EPA. These sources and parameters are shown in Table 5.1. All sources were located at or centered on the origin (0,0) of the receptor network described in the next section.

Building downwash effects were modeled for two point sources. For the 55-meter point source, the building dimensions were specified to utilize the Huber-Snyder algorithms. For the 35-meter point source, the building dimensions were specified to exercise the Schulman-Scire algorithms.

TABLE 5.1

SOURCE CHARACTERIZATION

Point Sources							
Source ID	Stack height (m)	Stack diameter (m)	Exit velocity (m s^{-1})	Exit temp. (K)	Bldg. ht. (m)	Bldg. width (m)	Emission rate (g s^{-1})
P1	10.0	2.4	11.7	432	NM	NM	100.0
P2	35.0	2.4	11.7	432	NM	NM	100.0
P3	35.0	2.4	11.7	432	34	60	100.0
P4	55.0	2.4	11.7	432	34	60	100.0
P5	100.0	4.6	18.8	416	NM	NM	100.0
P6	200.0	5.6	26.5	425	NM	NM	100.0
Volume Source							
Source ID	Release height (m)	Initial lateral dimension (m)	Initial vertical dimension (m)				Emission rate (g s^{-1})
VOL1	35.0	14.0	16.0				100.0
Area Source							
Source ID	Release height (m)	Area (m^2)	Length (m)	Width (m)			Emission rate (g s^{-1} m^{-2})
AREA1	0.01	250,000	500	500			0.0004

NM = not modeled

5.3 Receptor Network

A polar grid network was utilized for all sources. The network consisted of 36 radials, from 10° to 360° every 10° at distances (in meters) of 100, 500, 1000, 1500, 2000, 2500, 3000, 4000, 5000, 10000. There are 360 receptors with this network. The receptors at 100 meters are inside the area source.

6.0 ISCST3 MODEL RESULTS

In analyzing the results from ISCST3, attention was focused on the high-1st-high (H1H) concentrations, with the results unpaired in space and time. Two sets of comparisons were made. The first, and the primary goal of this analysis, compares the design concentration estimates using conventionally-observed meteorological data (the MDMS data) to the design concentration estimates using ceiling height and cloud cover obtained from ASOS and all other variables (winds and temperature) the same as the conventionally-observed data. The second compares the design concentration estimates using conventionally-observed meteorological data to the design concentration estimates obtained using all ASOS data, including temperature and winds.

6.1 ASOS Cloud Cover vs Conventional Cloud Cover Observations

When the H1H concentration estimates using mixed ASOS data (ASOS cloud information with conventionally observed winds and temperature) are compared to estimates based entirely on conventionally observed data, nearly 60% of the comparisons for all combinations of averaging period/source/station show no difference. Figures 6.1- 6.8 show the relative difference (computed as the difference between the ASOS-based estimate and the conventional estimate divided by the conventional estimate) with positive values indicating that the ASOS-based H1H estimates are higher. The nonzero differences generally are less than about 10%, with the H1H concentrations obtained with the mixed ASOS data generally higher for each averaging period and source type except for the volume source. Of the nonzero differences, 66 (27.5%) were associated with positive differences and 35 (14.5%) were associated with negative differences. The tables in Appendix B show the H1H and high-2nd-high (H2H) concentration estimates, absolute difference, and relative difference by station, source, and averaging period.

There are, however, several cases where the difference is much larger: 50% or more, as seen in Figures 6.2, 6.5, and 6.6. These differences occurred for different stations, but all occurred under convective conditions. Why did changing to ASOS-based cloud data make such a large difference? The 1-hour average for the 100-meter source (Point Source 5, Figure 6.1e) for Albany was 50% higher than the estimate using conventionally observed data and was examined more closely to determine what factor(s) caused such a large difference. Since the H1H results are unpaired, the date and time associated with the higher concentration determines which data to pair together for the case comparison. Thus, the input meteorology and derived parameters in ISCST3 (such as plume height and σ_z) for the date and time of the ASOS-based result were compared to the conventionally observed meteorology and derived parameters for the same date and time. The following table, for October 14, 1994 at 1200 Local Standard Time (LST), shows the differences in the meteorology:

	Cloud Cover	Ceiling Height (feet)	PG Category	σ_z (meters)	Plume Height (meters)	Mixing Height (meters)	Concentration ($\mu g\ m^{-3}$)
ASOS	0/10	Unlimited	2	308	372	378	60.6
Conventional	10/10	14,000	4	85	318	378	0.326

The ASOS-based observation reported an unlimited ceiling with no cloud cover, whereas the conventionally-based observation with the human observer indicated an overcast sky at 14,000 feet. Using the ASOS-based data resulted in a moderately unstable atmosphere (PG category 2), whereas the use of the conventional data resulted in a neutral stability (PG category 4). The difference in stabilities resulted in a σ_z that was 3.5 times larger with the ASOS data than with the conventional data, and resulted in a concentration estimate 200 times larger. Note that the plume height using the ASOS-based data is only six meters below the mixing height. Had the plume height been seven meters higher, ISCST3 would have predicted zero concentration using the ASOS-based data, since the plume would have been above the mixing height. If that had occurred, there would have been no difference between the two H1H estimates. This comparison clearly demonstrates the potential effect of limited cloud information on concentration estimates.

As noted above, for the volume source, there was a tendency for the concentration estimates to be lower using the mixed ASOS observations than the concentration using conventional observations. The 1-hour average, paired in time and in space, for Montgomery (see Figure 6.8) was examined in more detail. The H1H concentration occurred at 6 a.m. and the mixing height was 35.1 meters at Montgomery. The release height for the volume source was 35 meters. The PG stability category using the mixed ASOS data was 5. With this stability, there is unlimited mixing in ISCST3. Using conventional observations, the stability was category 4, which results in limited mixing in ISCST3. The concentrations using the conventional observations was 13885 $\mu g\ m^{-3}$ and 4628 $\mu g\ m^{-3}$ for the ASOS data. With the release height just below the mixing height, the result is higher concentrations using conventional observations.

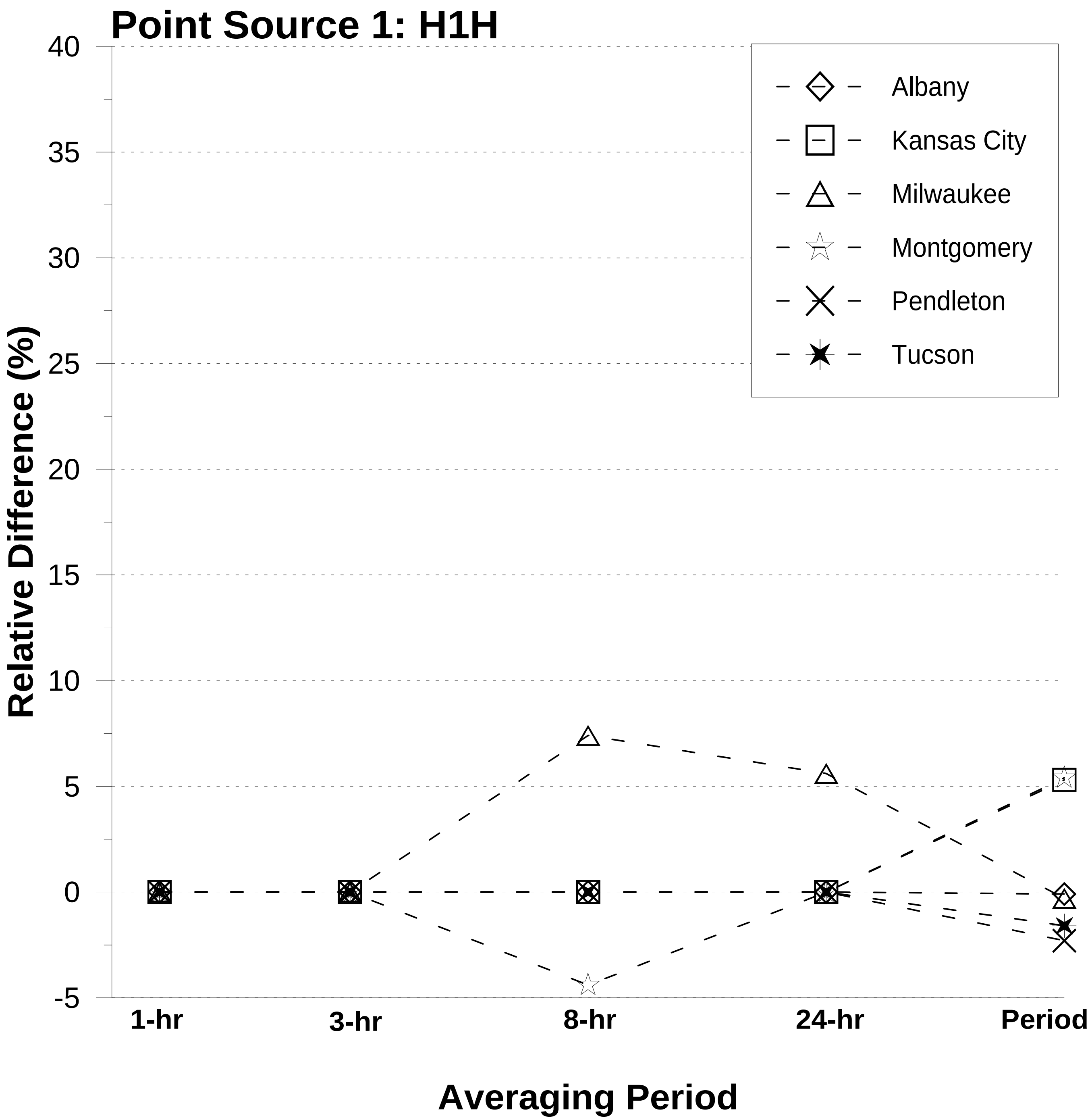

Figure 6.1 Relative difference between the high-1st-high concentrations using the mixed ASOS data and conventional data for the 10-meter point source.

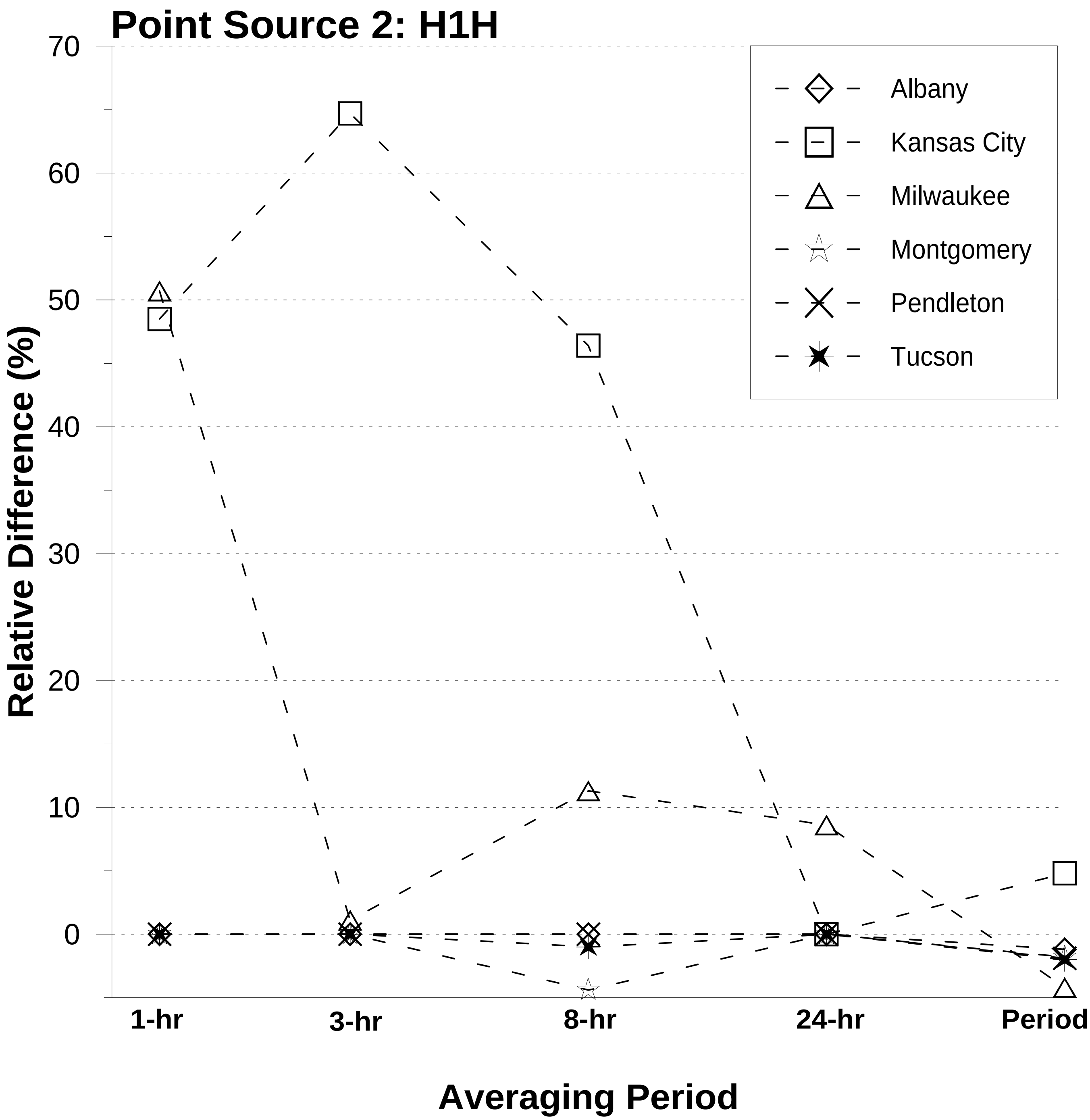

Figure 6.2 Relative difference between the high-1st-high concentrations using the mixed ASOS data and conventional data for the 35-meter point source.

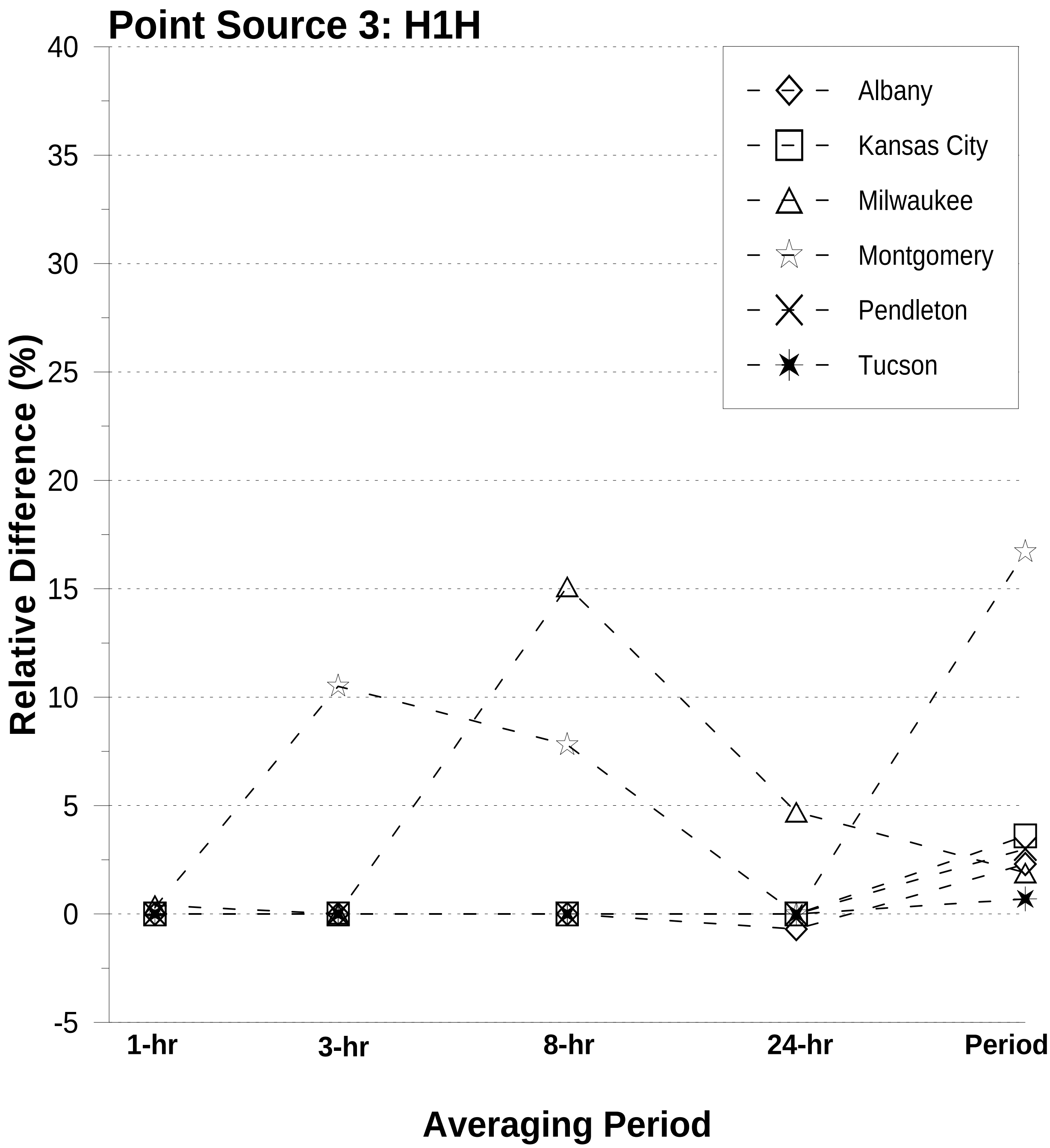

Figure 6.3 Relative difference between the high-1st-high concentrations using the mixed ASOS data and conventional data for the 35-meter point source with building downwash.

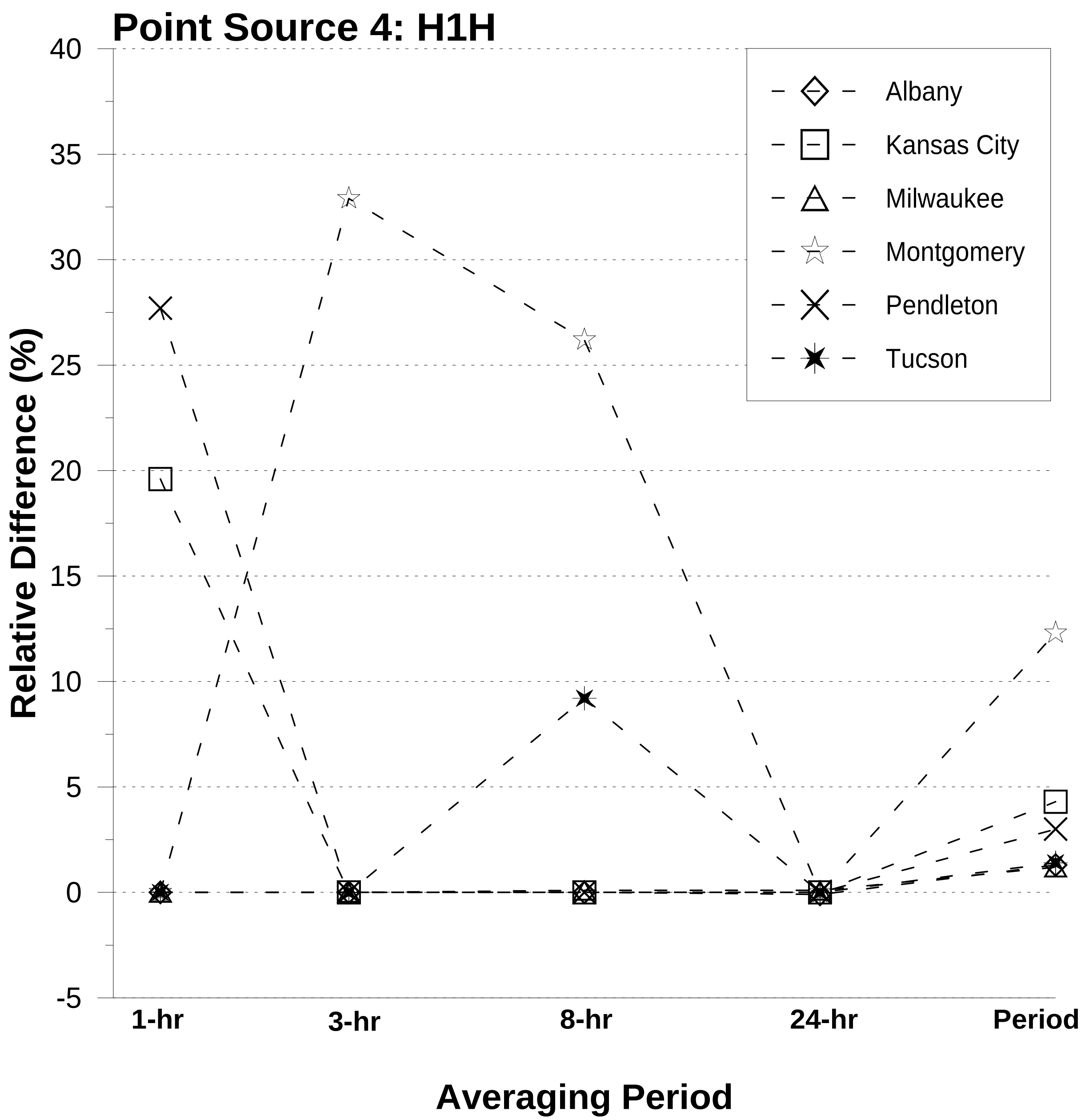

Figure 6.4 Relative difference between the high-1st-high concentrations using the mixed ASOS data and conventional data for the 55-meter point source with building downwash.

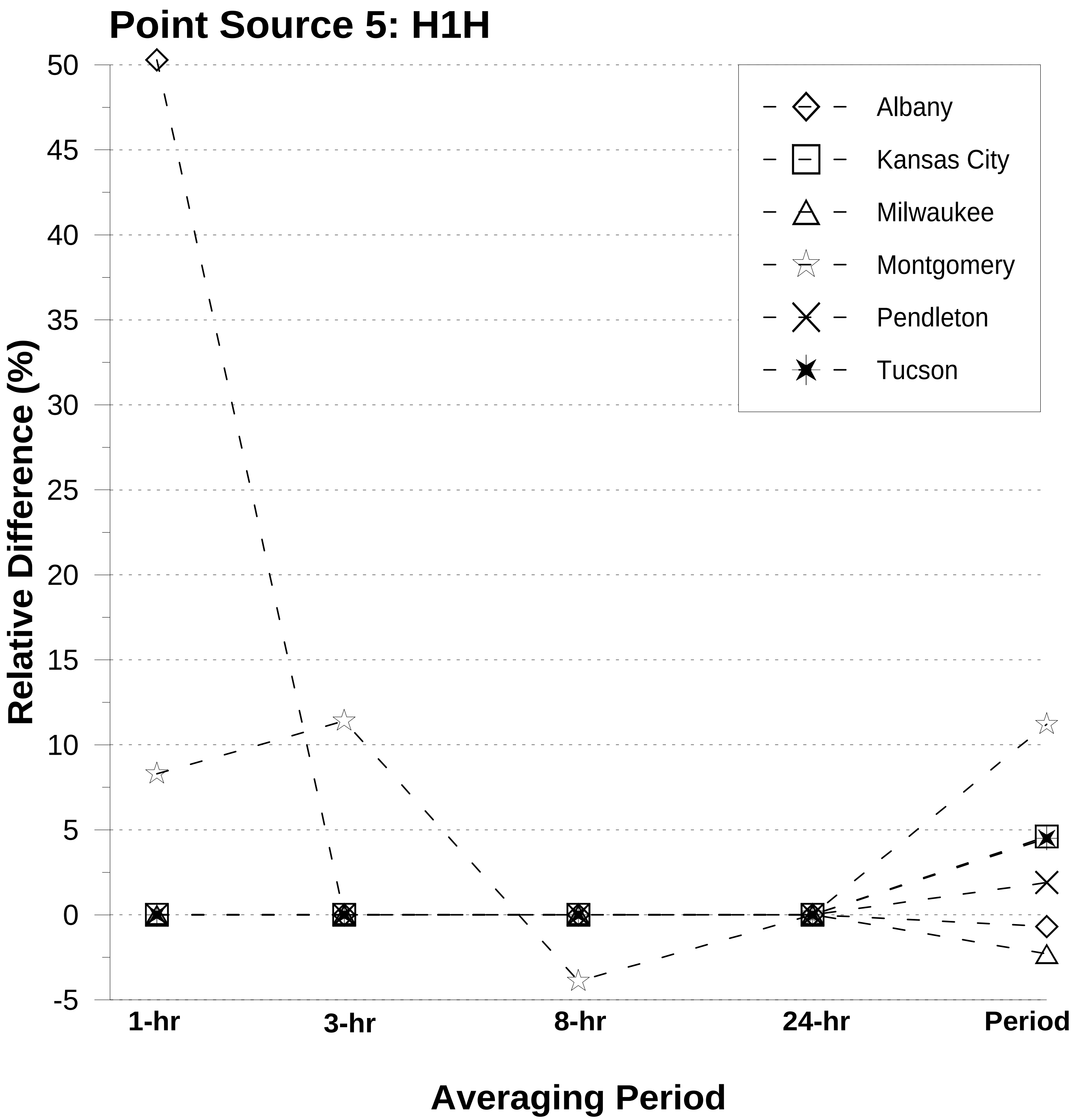

Figure 6.5 Relative difference between the high-1st-high concentrations using the mixed ASOS data and conventional data for the 100-meter point source.

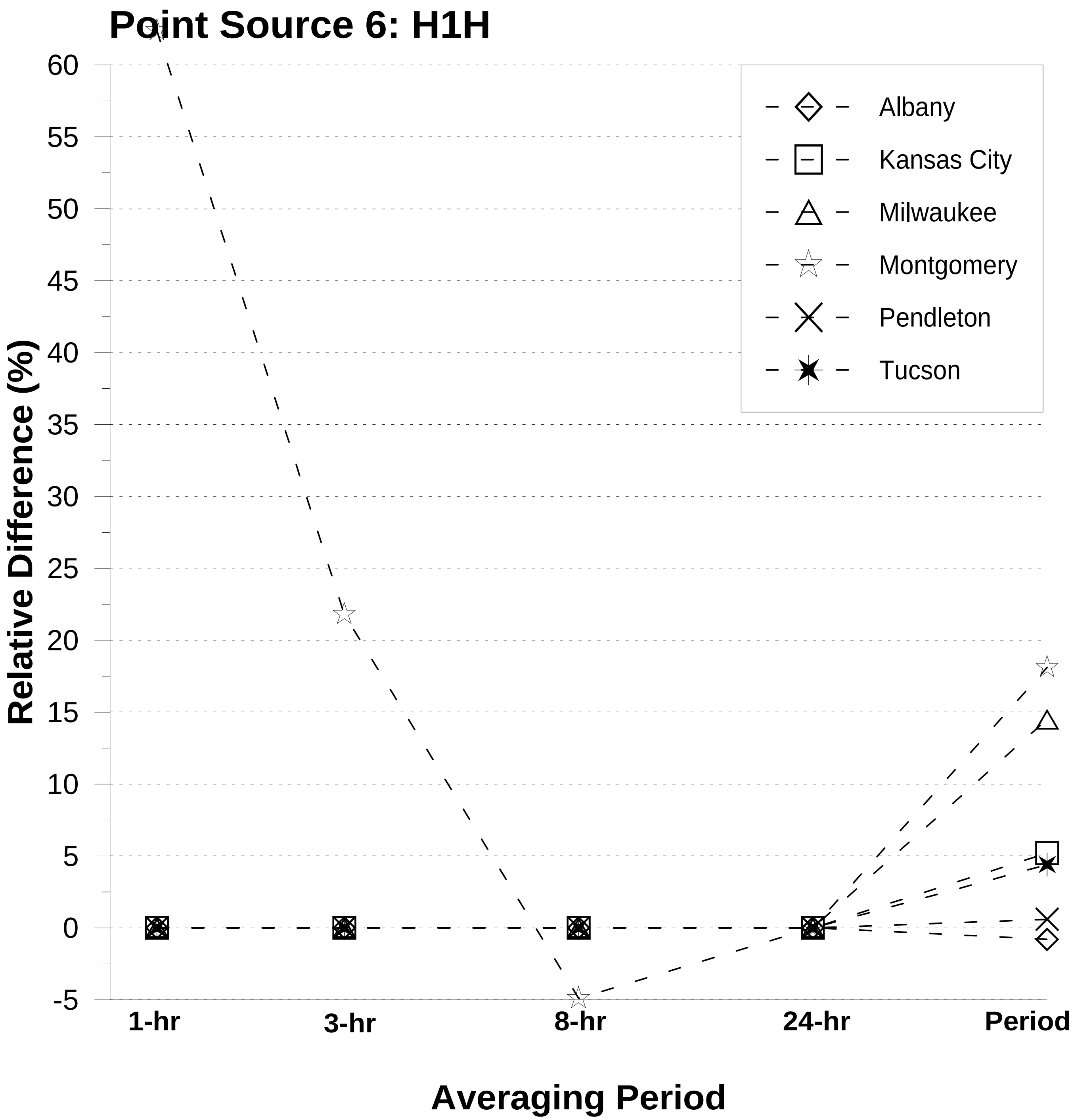

Figure 6.6 Relative difference between the high-1st-high concentrations using the mixed ASOS data and conventional data for the 200-meter point source.

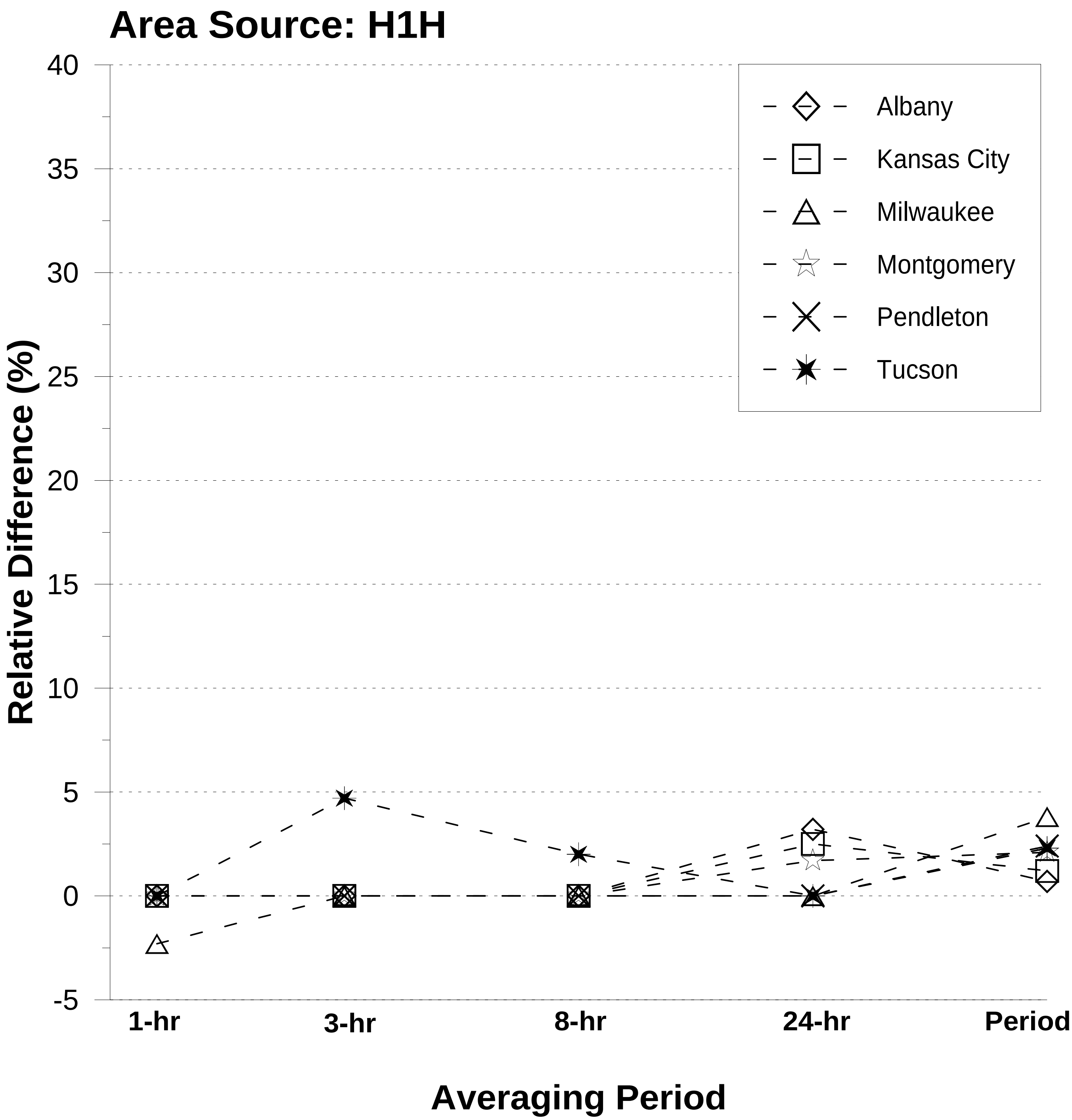

Figure 6.7 Relative difference between the high-1st-high concentrations using the mixed ASOS data and conventional data for the area source.

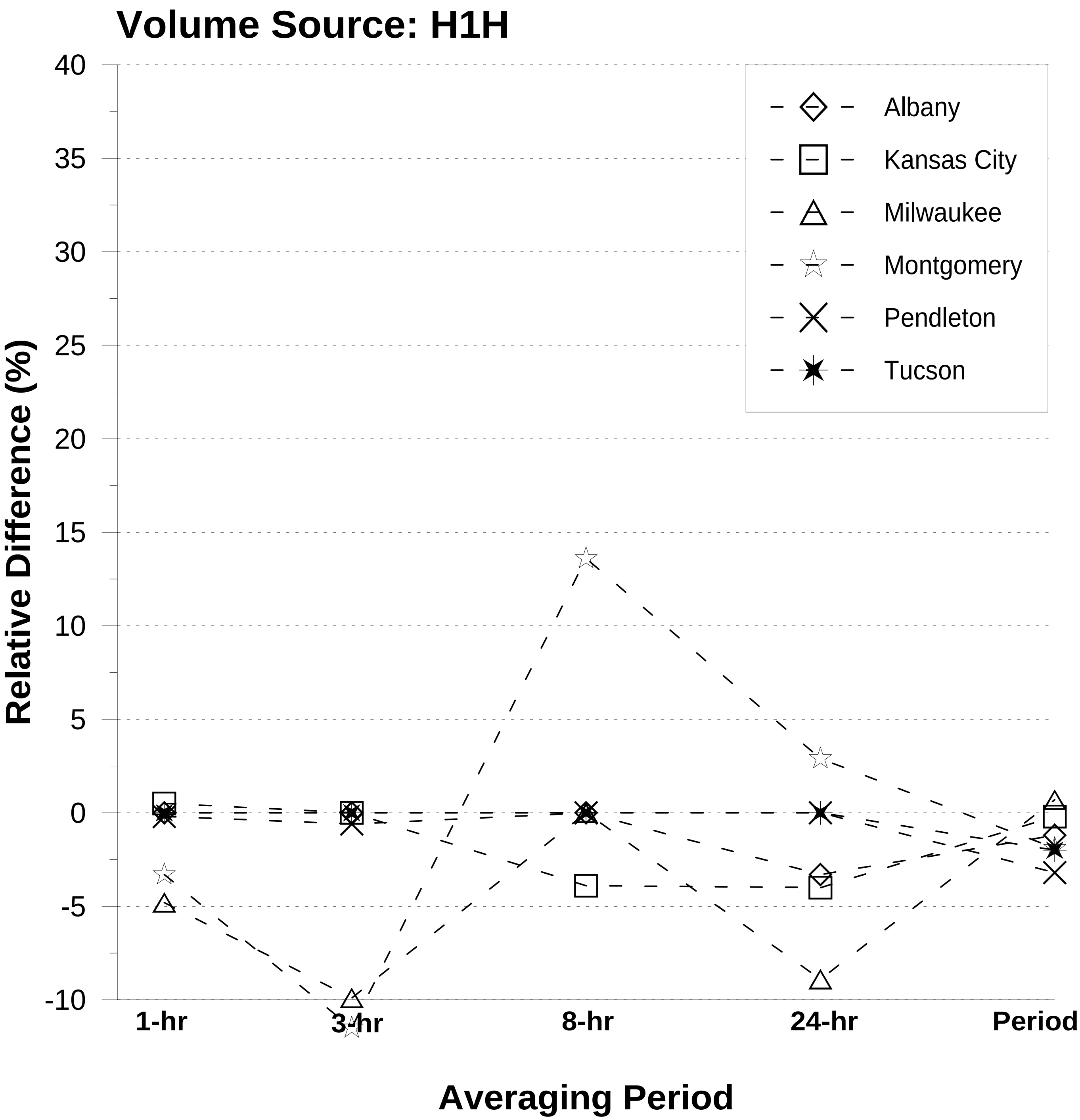

Figure 6.8 Relative difference between the high-1st-high concentrations using the mixed ASOS data and conventional data for the volume source.

6.2 Full ASOS vs Conventional Observations

When the concentration estimates using the full ASOS observation (clouds, winds, and temperature) are compared to the concentration estimates using the conventional data, a different picture emerges. The relative difference increases dramatically. Only 13 (5.5%) of the comparisons for all combinations of averaging period/source/station show no difference, while 125 (52%) show that the ASOS-derived H1H estimates are higher and 102 (42.5%) of the conventional-derived estimates are higher. There is no discernible trend by station or by averaging period, although the 1-hour average for the volume source (Figure 6.16) at Montgomery shows a large difference just as in the mixed ASOS results. The concentration estimates by station, averaging period, and source are shown in the tables in Appendix B.

To determine what factors may contribute to large differences, two cases were examined in more detail. The first is for Point Source 6 (200-meter release), 1-hr average for Montgomery in which the ASOS-derived H1H estimate was 55% higher than the estimate using conventional data. For this comparison, the input meteorology and derived parameters in ISCST3 for the date and time of the ASOS-based result (April 1, 1995 at 1200 LST) were compared to the conventionally observed meteorology and derived parameters for the same date and time.

	Cloud Cover	Ceiling Height (feet)	Wind Speed (knots)	PG	σ_z (meters)	Plume Height (meters)	Mixing Height (meters)	Concentration ($\mu g\ m^{-3}$)
ASOS	0/10	Unltd.	3	1	1982	1170	1323	35.61
Conventional	1/10	Unltd.	12	3	127	417	1323	0.0012

Unlike the case study with the mixed ASOS data, the ceiling is unlimited in both cases and the cloud cover is very similar. However, the wind speed is four times larger for the conventionally observed data than for the ASOS data, resulting in a two-category difference in the PG stability. The PG stability category for a wind speed of 3 knots and a net radiation index of 4 is category 1, but for a wind speed of 12 knots and net radiation index of 4, the stability category is 3. (The only way to obtain these two categories with these wind speeds is with net radiation index of 4 (EPA, 1987)). This wind speed difference, in turn, yields significantly different plume heights, but more importantly, the σ_z obtained from the ASOS data is more than an order of magnitude larger than the σ_z obtained from the conventional data.

The second case examined is for Point Source 5 (100-meter release), 1-hr average for Milwaukee in which the ASOS-derived H1H estimate was 30% lower than the estimate using conventional data. Since the H1H results are unpaired, the higher concentration determines the date and hour to pair together for the case comparison. Thus, the input meteorology and derived parameters in ISCST3 for the date and time of the conventionally-based concentration were compared to the ASOS data for the same date and time. The meteorology for this case, which is for October 13, 1994 at 1300 LST, is as follows:

	Cloud Cover	Ceiling Height (feet)	Wind Speed (knots)	PG	σ_z (meters)	Plume Height (meters)	Mixing Height (meters)	Concentration ($\mu g\ m^{-3}$)
ASOS	0/10	Unltd.	8	2	178	317	433	17.95
Conventional	5/10	Unltd.	7	3	373	368	433	48.85

Here, the observed meteorology is about the same but the stability is one category different. The 5/10 conventionally-observed cloud cover and 0/10 ASOS cloud cover do not affect the stability determination since Turner's method (EPA, 1987) only modifies stability if the cloud cover is greater than 5/10. The stability difference results from the wind speed difference, only this time, the ASOS observed wind is larger. This 1-knot increase in the ASOS wind speed produced a σ_z that is a factor of two smaller and a concentration that is about a factor of three smaller compared to using the conventionally-observed data.

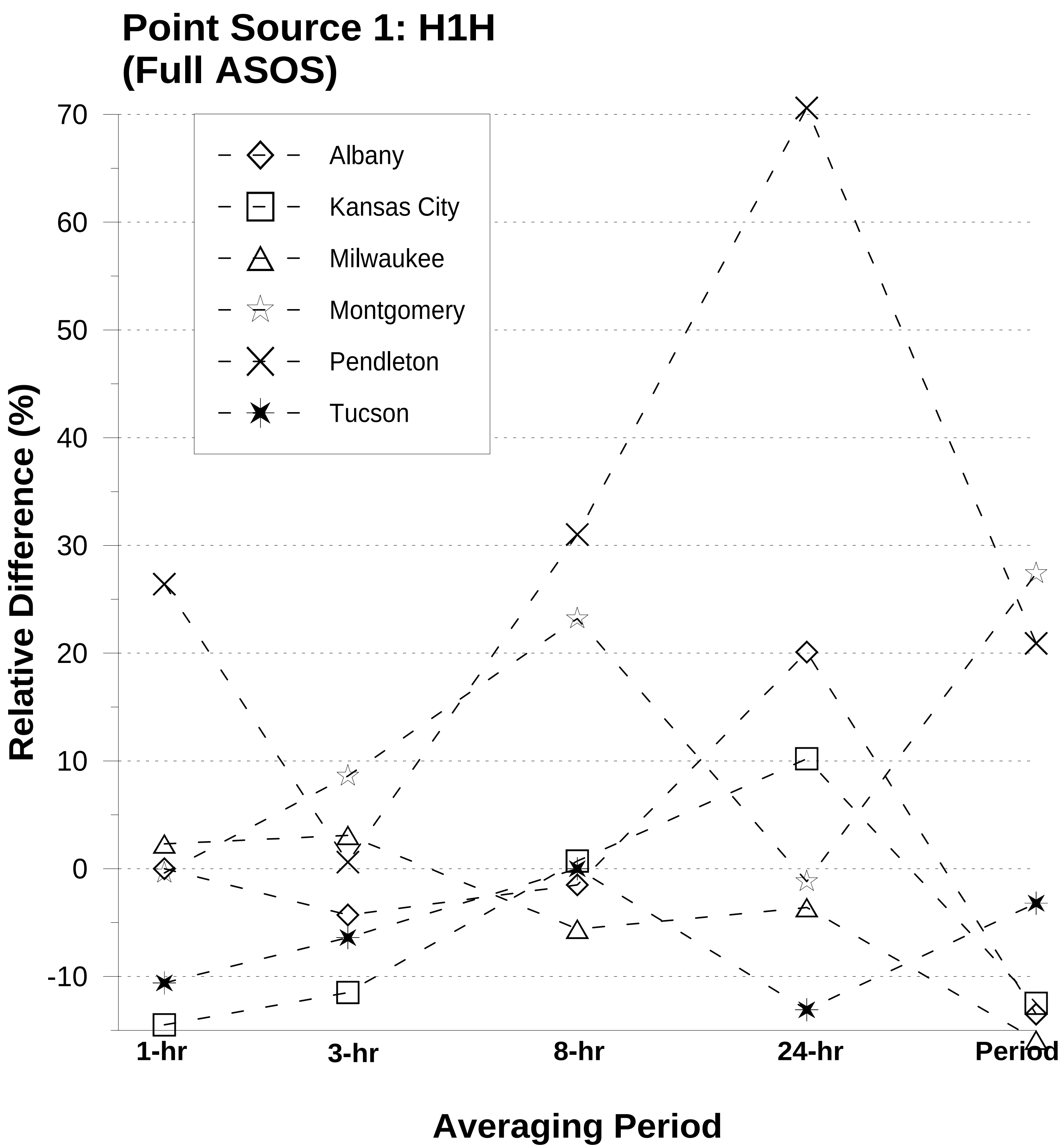

Figure 6.9 Relative difference between the high-1st-high concentrations using the full ASOS data and conventional data for the 10-meter point source.

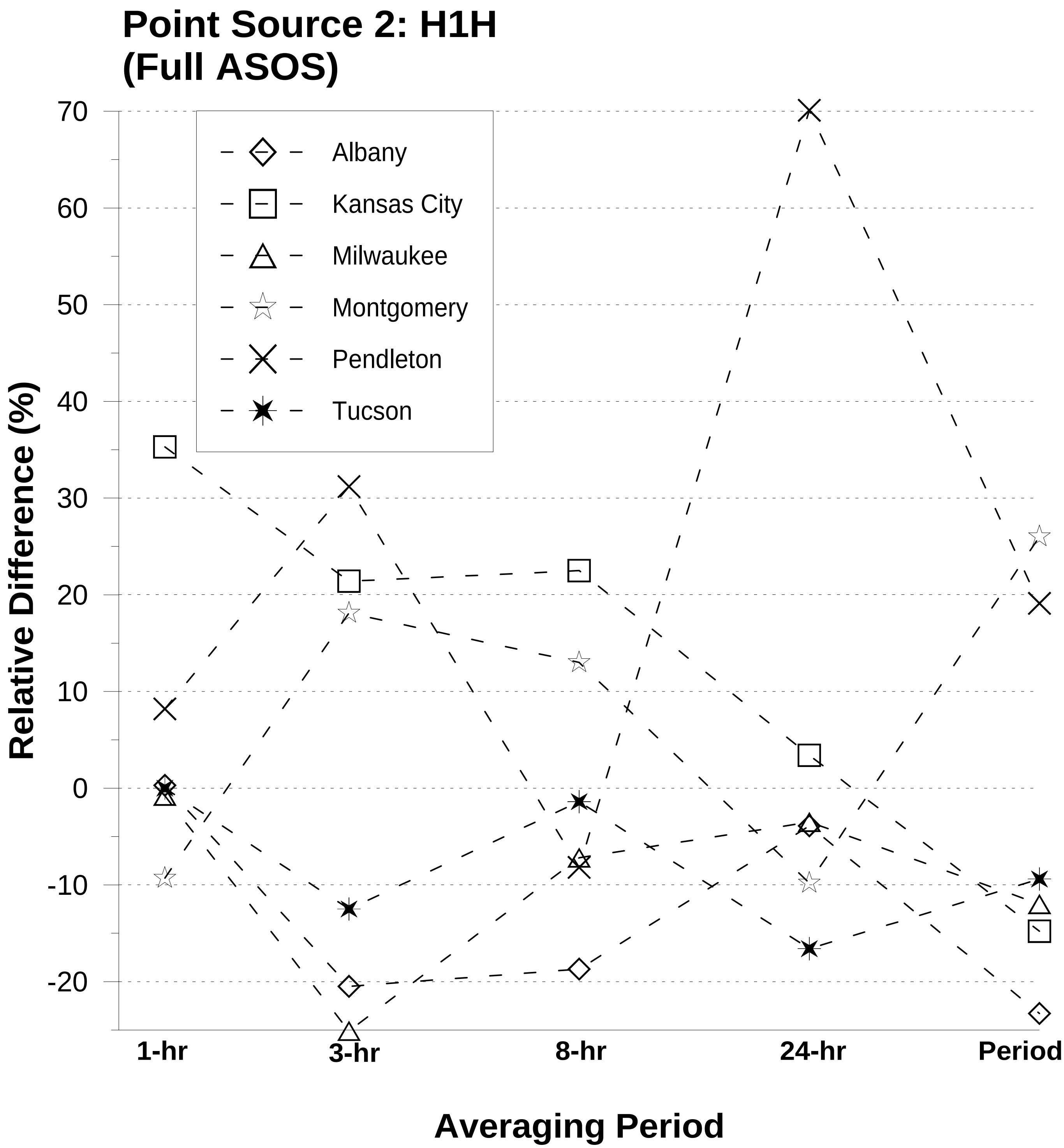

Figure 6.10 Relative difference between the high-1st-high concentrations using the full ASOS data and conventional data for the 35-meter point source.

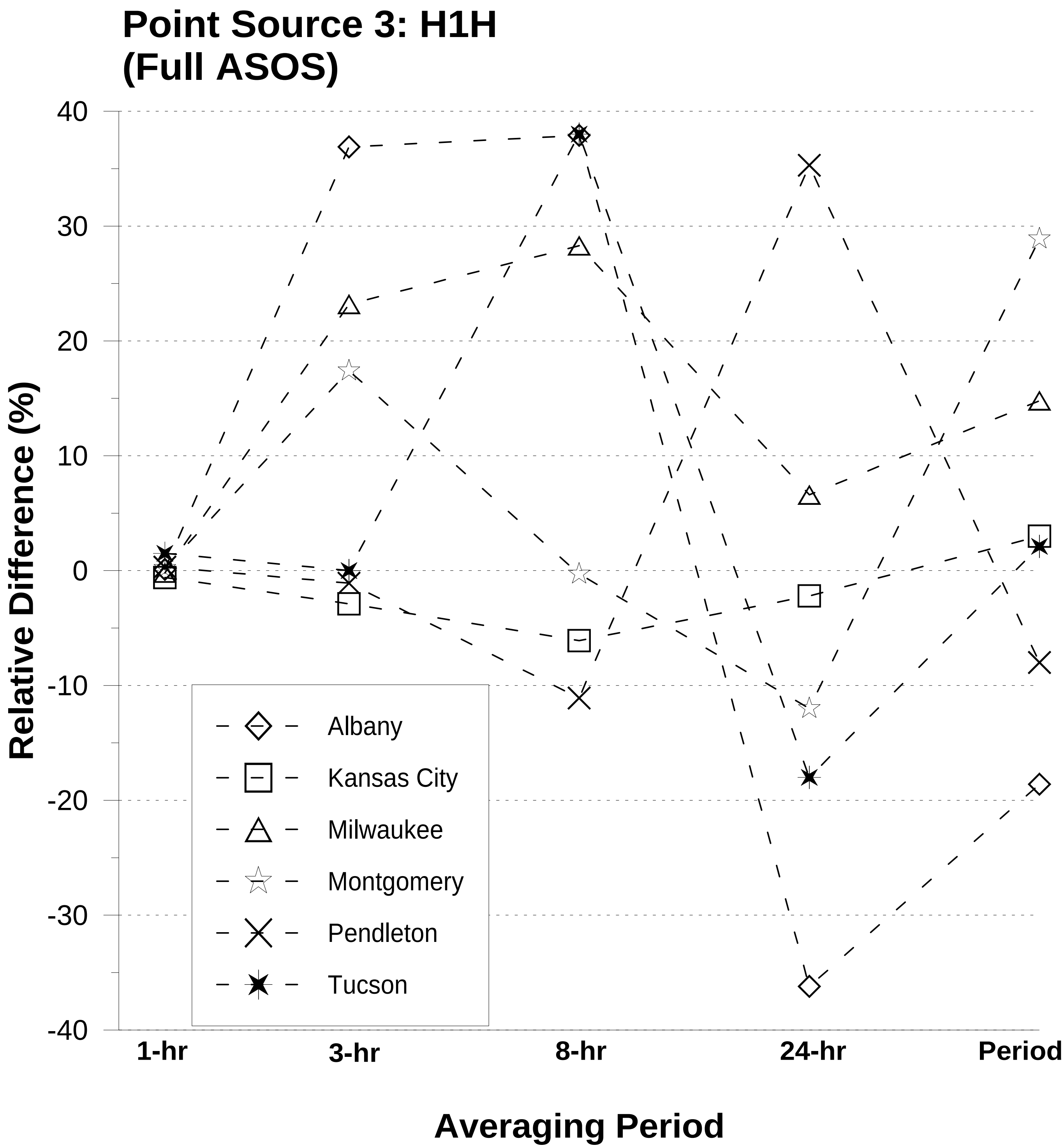

Figure 6.11 Relative difference between the high-1st-high concentrations using the full ASOS data and conventional data for the 35-meter point source with building downwash.

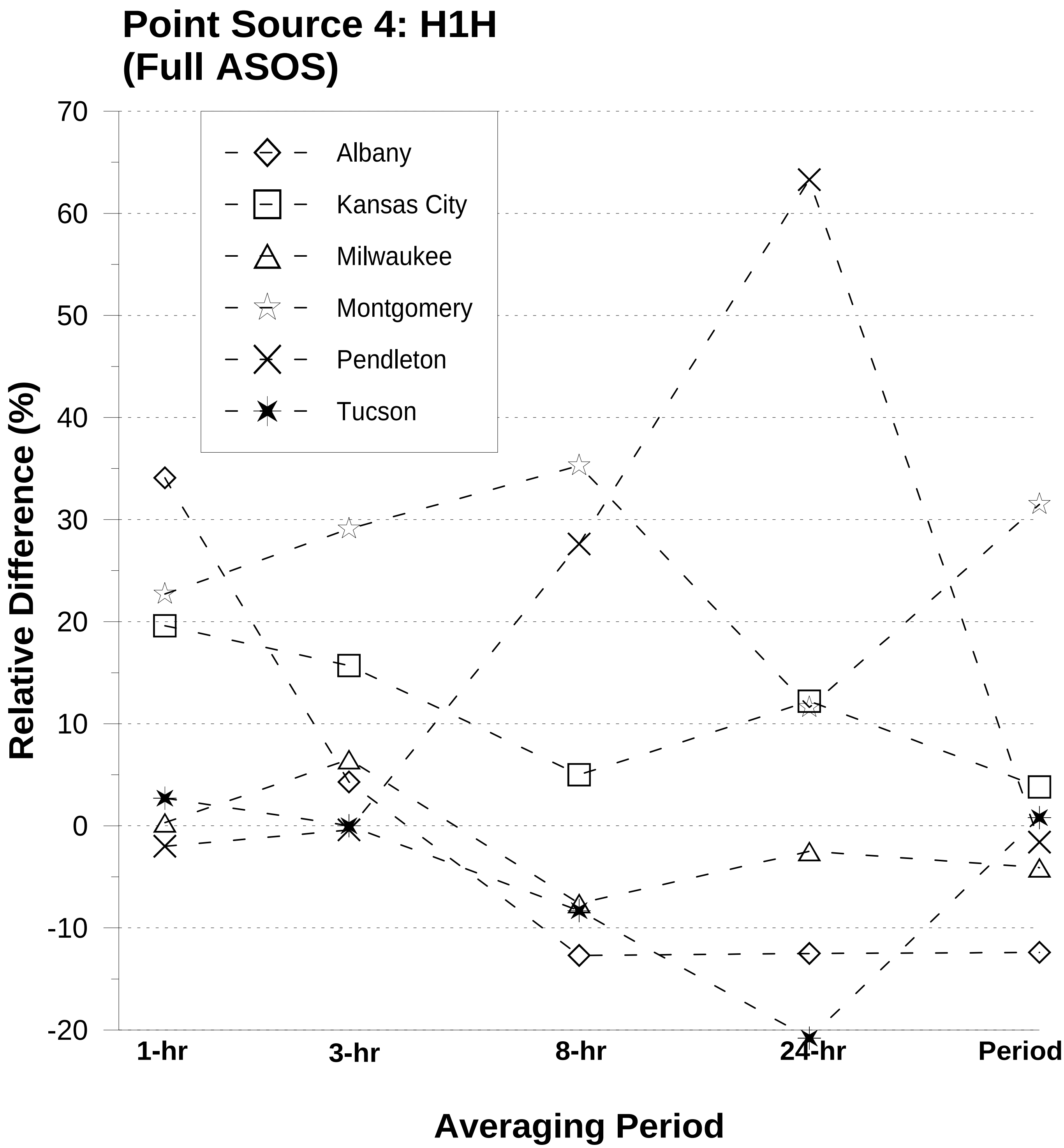

Figure 6.12 Relative difference between the high-1st-high concentrations using the full ASOS data and conventional data for the 55-meter point source with building downwash.

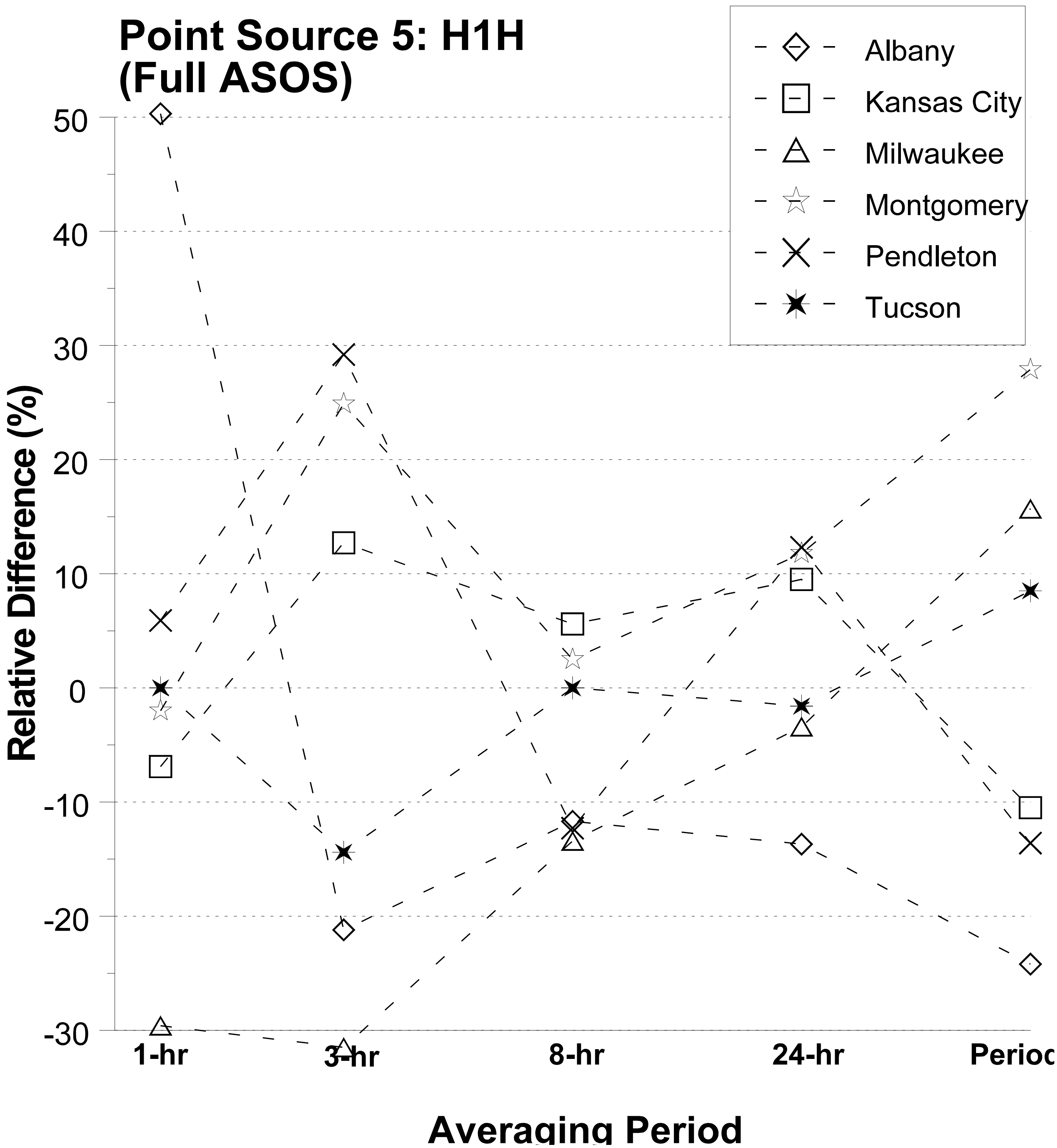

Figure 6.13 Relative difference between the high-1st-high concentrations using the full ASOS data and conventional data for the 100-meter point.

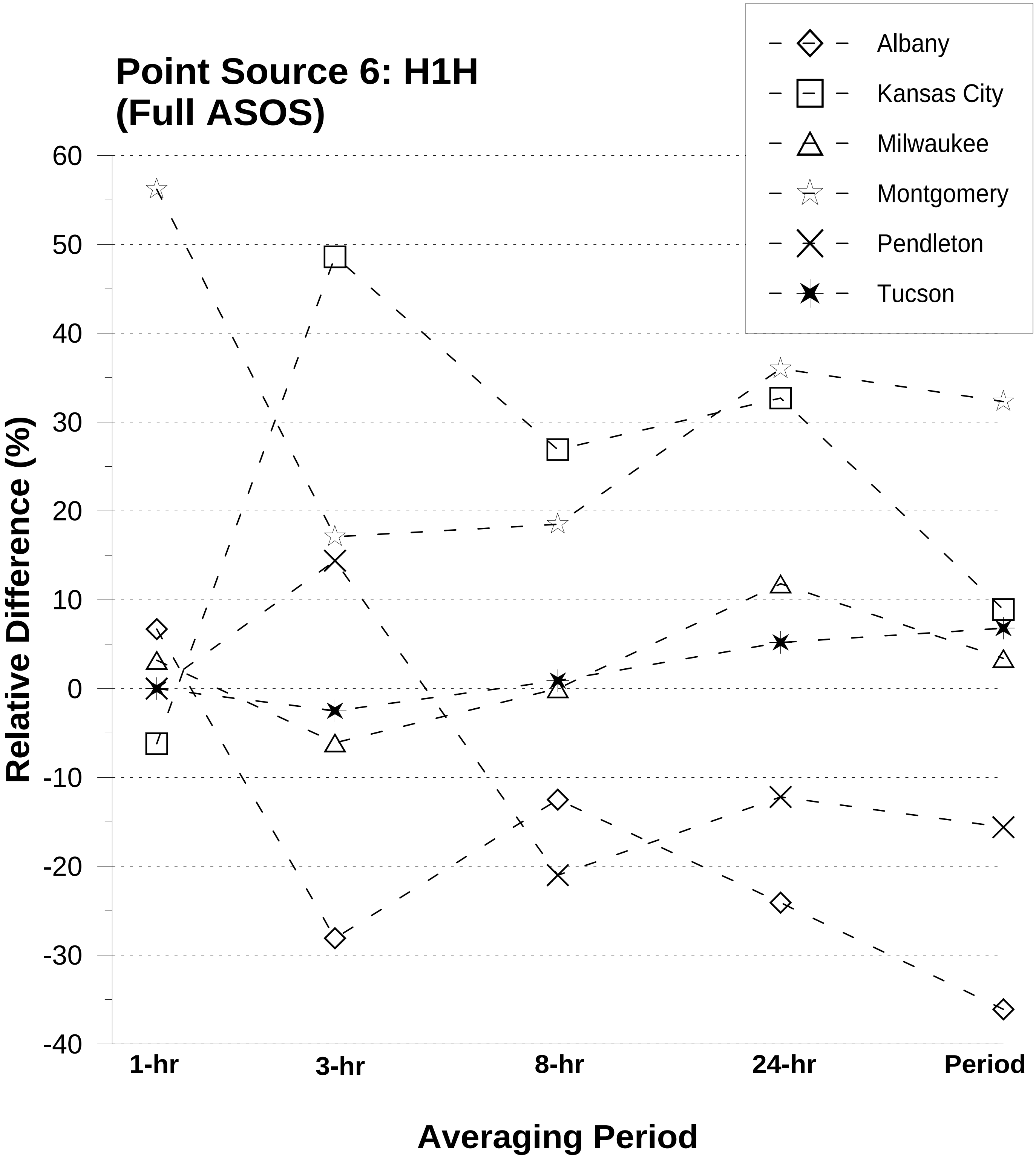

Figure 6.14 Relative difference between the high-1st-high concentrations using the full ASOS data and conventional data for the 200-meter point source.

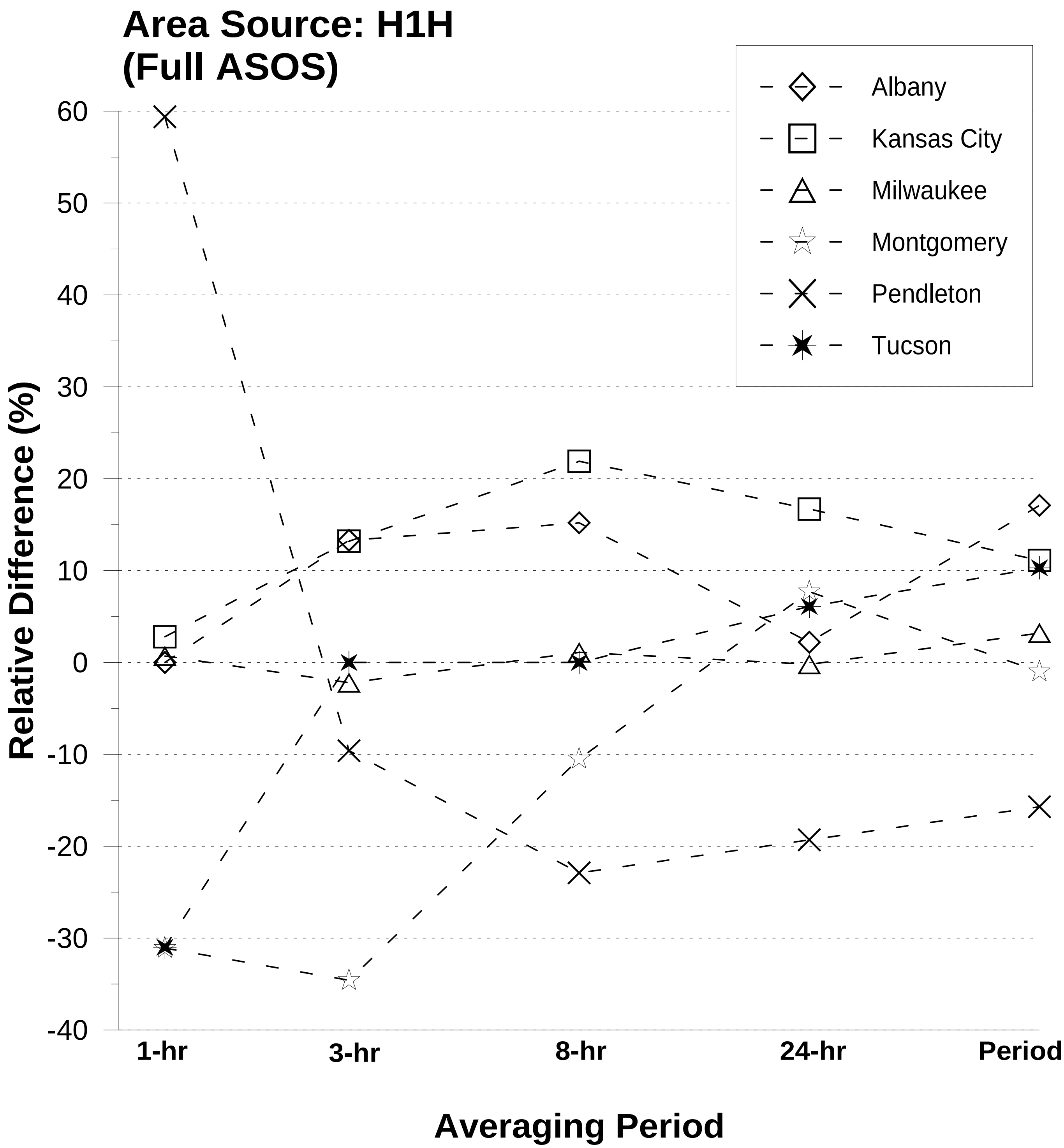

Figure 6.15 Relative difference between the high-1st-high concentrations using the full ASOS data and conventional data for the area source.

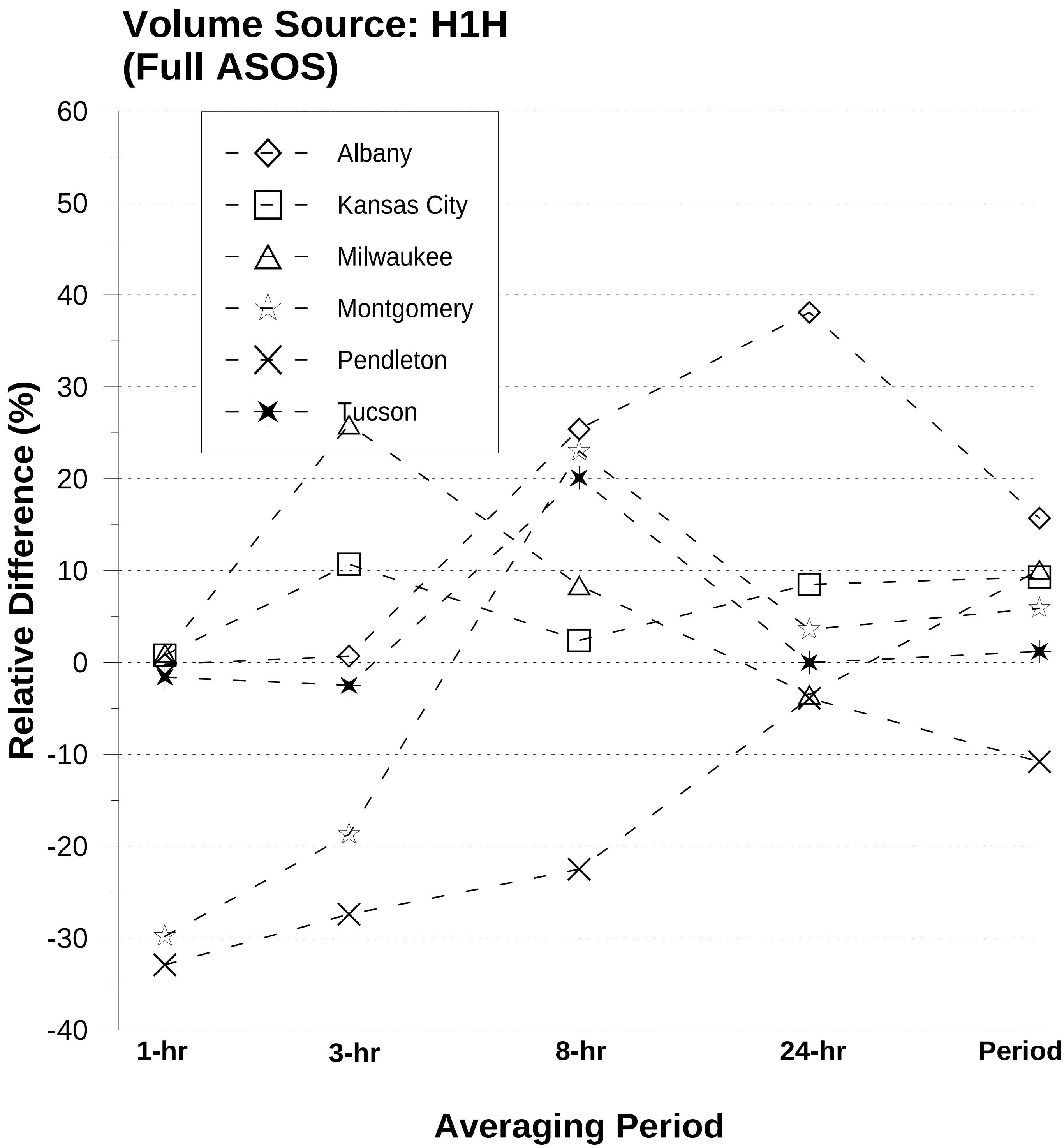

Figure 6.16 Relative difference between the high-1st-high concentrations using the full ASOS data and conventional data for the volume source.

7.0 CONCLUSIONS

This study demonstrates that the weather variables observed with an automated system can produce very different concentration estimates from the ISCST3 dispersion model when compared with concentrations derived with conventional (human observer) data. Differences in the meteorology, both the input to and output from PCRAMMET, were presented. General differences that the air quality modeling community might expect from a steady-state Gaussian model such as the ISCST3 were discussed, along with several case studies of extreme differences.

The study was divided into two parts: 1) isolating the effect of ASOS-derived cloud data on concentration estimates, and 2) the effect of a full ASOS observation (including winds, temperature, and pressure) on concentration estimates. In the first part, the high-1st-high concentrations were examined. More than half of the 240 comparisons [(6 stations) x (5 observation periods) x (8 sources)] produced no difference, while most of the nonzero differences were 10% or less. Overall, the ASOS-based concentration was higher for all sources, except the volume source. However, trends by station or averaging period could not be discerned. There were several cases where the ASOS-based concentrations were 35% or more larger than the conventionally-based concentration. In a case study for Albany, this difference was attributed directly to the 12,000-foot limit of the ASOS ceilometer.

In the second part, there were only 13 pairs with no difference, 125 differences where the ASOS-based concentration was larger than the conventional-based concentration, and 102 differences where the conventional-based concentration exceed the ASOS-based concentration. No clear trend could be discerned in these results.

These results are based on 2 months (late summer/early fall, later winter/early spring) of meteorological data, which was readily available. This data limitation impacts the amount of information that can be gathered. Should more data should become available for longer periods of time, additional conclusions may result.

8.0 REFERENCES

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APPENDIX A

ESTIMATING ATMOSPHERIC STABILITY IN PCRAMMET

The Turner (1964) method for estimating atmospheric stability is implemented in PCRAMMET. For those periods when the sun is above the horizon, the stability is a function of wind speed and a net radiation index, which is a function of solar elevation, cloud cover (CC), and ceiling height (CLHT). The net radiation index is determined from the following procedure (this description is taken directly from *On-Site Meteorological Program Guidance For Regulatory Modeling Applications* (EPA, 1987); the italics are added to identify direct quotation):

1. If the total cloud[1] cover is 10/10 and the ceiling is less than 7000 feet, use net radiation index equal to 0 (whether day or night).

2. For nighttime (from one hour before sunset to one hour after sunrise):

(a) If total cloud cover ≤ 4/10, use net radiation index equal to -2.

(b) If total cloud cover > 4/10, use net radiation index equal to -1.

3. For daytime:

(a) Determine the insolation class number as a function of solar altitude from Table 6-5.

(b) If total cloud cover ≤5/10, use the net radiation index in Table 6-4 corresponding to the insolation class number.

© If cloud cover >5/10, modify the insolation class number using the following six steps.

(l) Ceiling <7000 ft, subtract 2.

(2) Ceiling ≥7000 ft but <16000 ft, subtract 1.

(3) total cloud cover equal 10/10, subtract 1. (This will only apply to ceilings ≥7000 ft since cases with 10/10 coverage below 7000 ft are considered in item 1 above.)

(4) If insolation class number has not been modified by steps (1), (2), or (3) above, assume modified class number equal to insolation class number.

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1 *Although Turner indicates total cloud cover, opaque cloud cover is implied by Pasquill and is preferred.*

(5) *If modified insolation class number is less than 1, let it equal 1.*

(6) *Use the net radiation index in Table 6-4 corresponding to the modified insolation class number.*

Table 6-4

Turner's Key to P-G Stability Categories

Wind Speed		*Net Radiation Index*						
(knots)	*(m/s)*	*4*	*3*	*2*	*1*	*0*	*-1*	*-2*
0,1	*0 - 0.7*	*1*	*1*	*2*	*3*	*4*	*6*	*7*
2,3	*0.8 - 1.8*	*1*	*2*	*2*	*3*	*4*	*6*	*7*
4,5	*1.9 - 2.8*	*1*	*2*	*3*	*4*	*4*	*5*	*6*
6	*2.9 - 3.3*	*2*	*2*	*3*	*4*	*4*	*5*	*6*
7	*3.4 - 3.8*	*2*	*2*	*3*	*4*	*4*	*4*	*5*
8,9	*3.9 - 4.8*	*2*	*3*	*3*	*4*	*4*	*4*	*5*
10	*4.9 - 5.4*	*3*	*3*	*4*	*4*	*4*	*4*	*5*
11	*5.5 - 5.9*	*3*	*3*	*4*	*4*	*4*	*4*	*4*
≥ 12	*≥ 6.0*	*3*	*4*	*4*	*4*	*4*	*4*	*4*

Table 6-5

Insolation Class as a Function of Solar Altitude

Solar Altitude Φ *(degrees)*	*Insolation*	*Insolation Class Number*
$60 < \Phi$	*strong*	*4*
$35 < \Phi \leq 60$	*moderate*	*3*
$15 < \Phi \leq 35$	*slight*	*2*
$\Phi \leq 15$	*weak*	*1*

APPENDIX B

COMPARISONS OF THE H1H AND H2H CONCENTRATION ESTIMATES

This appendix contains the comparisons of the high-1st-high (H1H) and high-2nd-high (H2H) concentrations for each station. There two tables for each station: the first contains the H1H concentrations, and the second contains the H2H concentrations. The data are grouped in each table by averaging period. For each averaging period, the data are reported by source category. Source identifiers can be found in Table 5.1. For each averaging period, the ASOS data are grouped according to whether the estimate used the mixed ASOS or full ASOS data. The following definitions apply in these tables:

Conv Obs = concentration estimated using conventional data (μg m^{-3})

Mixed ASOS = concentration estimated using mixed ASOS data (μg $m^{-3)}$
Abs Diff = Mixed ASOS - Conv Obs (μg m^{-3})
Rel Diff = ((Mixed ASOS - Conv Obs) / Conv Obs) * 100 (percent)

Full ASOS = concentration estimated using full ASOS data (μg m^{-3})
Abs Diff = Full ASOS - Conv Obs (μg m^{-3})
Rel Diff = ((Full ASOS - Conv Obs) / Conv Obs) * 100 (percent).

TABLE B.1

COMPARISON OF HIGH-1ST-HIGH CONCENTRATION ESTIMATES WITH CONVENTIONAL OBSERVATIONS TO ESTIMATES USING MIXED ASOS AND FULL ASOS FOR ALBANY, NY

Source	Conv Obs (μg m^{-3})	Mixed ASOS (μg m^{-3})	Abs Diff (μg m^{-3})	Rel Diff (%)	Full ASOS (μg m^{-3})	Abs Diff (μg m^{-3})	Rel Diff (%)
1-hour Average							
P1	484.15	484.15	0.00	0.0	484.15	0.00	0.0
P2	205.66	205.66	0.00	0.0	206.23	0.57	0.3
P3	3094.12	3094.12	0.00	0.0	3096.04	1.92	0.1
P4	327.29	327.29	0.00	0.0	438.96	111.68	34.1
P5	40.32	60.59	20.27	50.3	60.58	20.27	50.3
P6	21.36	21.36	0.00	0.0	22.78	1.43	6.7
VOL1	9080.98	9080.98	0.00	0.0	9067.07	-13.91	-0.2
AREA1	48505.05	48505.05	0.00	0.0	48505.05	0.00	0.0
3-hour Average							
P1	451.65	451.65	0.00	0.0	432.08	-19.58	-4.3
P2	202.23	202.23	0.00	0.0	160.78	-41.45	-20.5
P3	1521.23	1521.23	0.00	0.0	2082.01	560.78	36.9
P4	249.14	249.14	0.00	0.0	259.97	10.83	4.3
P5	27.41	27.41	0.00	0.0	21.61	-5.80	-21.2
P6	11.84	11.84	0.00	0.0	8.51	-3.32	-28.1
VOL1	5890.81	5890.81	0.00	0.0	5933.61	42.80	0.7
AREA1	34759.97	34759.97	0.00	0.0	39383.71	4623.74	13.3
8-hour Average							
P1	265.29	265.29	0.00	0.0	261.35	-3.94	-1.5
P2	114.99	114.99	0.00	0.0	93.52	-21.47	-18.7
P3	908.43	908.43	0.00	0.0	1252.55	344.12	37.9
P4	181.20	181.20	0.00	0.0	158.17	-23.03	-12.7
P5	14.43	14.43	0.00	0.0	12.74	-1.69	-11.7
P6	5.25	5.25	0.00	0.0	4.59	-0.66	-12.5
VOL1	3328.60	3328.60	0.00	0.0	4173.47	844.87	25.4
AREA1	30549.24	30549.24	0.00	0.0	35197.43	4648.19	15.2

TABLE B.1, CONCLUDED

Source	Conv Obs ($\mu g\ m^{-3}$)	Mixed ASOS ($\mu g\ m^{-3}$)	Abs Diff ($\mu g\ m^{-3}$)	Rel Diff (%)	Full ASOS ($\mu g\ m^{-3}$)	Abs Diff ($\mu g\ m^{-3}$)	Rel Diff (%)
24-hour Average							
P1	140.94	140.94	0.00	0.0	169.20	28.26	20.1
P2	66.44	66.44	0.00	0.0	63.84	-2.60	-3.9
P3	876.93	870.67	-6.26	-0.7	559.39	-317.54	-36.2
P4	129.10	128.94	-0.16	-0.1	113.00	-16.10	-12.5
P5	6.57	6.57	0.00	0.0	5.67	-0.90	-13.7
P6	2.33	2.33	0.00	0.0	1.77	-0.56	-24.1
VOL1	2148.34	2077.97	-70.37	-3.3	2966.77	818.43	38.1
AREA1	20899.02	21565.50	666.49	3.2	21351.89	452.87	2.2
Period Average							
P1	20.03	20.01	-0.02	-0.1	17.33	-2.70	-13.5
P2	10.22	10.10	-0.12	-1.2	7.84	-2.38	-23.3
P3	99.77	102.04	2.27	2.3	81.21	-18.56	-18.6
P4	16.91	17.14	0.23	1.3	14.82	-2.10	-12.4
P5	0.78	0.77	-0.01	-0.7	0.59	-0.19	-24.2
P6	0.14	0.14	0.00	-0.8	0.09	-0.05	-36.1
VOL1	531.32	525.15	-6.18	-1.2	614.48	83.15	15.7
AREA1	9031.12	9095.42	64.30	0.7	10579.92	1548.80	17.1

TABLE B.2

COMPARISON OF HIGH-2ND-HIGH CONCENTRATION ESTIMATES WITH CONVENTIONAL OBSERVATIONS TO ESTIMATES USING MIXED ASOS AND FULL ASOS FOR ALBANY, NY

Source	Conv Obs (µg m^{-3})	Mixed ASOS (µg m^{-3})	Abs Diff (µg m^{-3})	Rel Diff (%)	Full ASOS (µg m^{-3})	Abs Diff (µg m^{-3})	Rel Diff (%)
1-hour Average							
P1	472.88	472.88	0.00	0.0	475.57	2.69	0.6
P2	201.04	201.04	0.00	0.0	201.61	0.57	0.3
P3	2751.82	2751.82	0.00	0.0	2750.13	-1.69	-0.1
P4	305.80	316.27	10.47	3.4	318.33	12.53	4.1
P5	34.95	31.06	-3.89	-11.1	39.20	4.26	12.2
P6	15.02	15.02	0.00	0.0	12.25	-2.77	-18.4
VOL1	9025.45	9025.45	0.00	0.0	8956.48	-68.97	-0.8
AREA1	48505.05	48505.05	0.00	0.0	47726.78	-778.27	-1.6
3-hour Average							
P1	350.33	350.33	0.00	0.0	370.94	20.61	5.9
P2	141.86	141.86	0.00	0.0	152.94	11.08	7.8
P3	1185.85	1185.85	0.00	0.0	1147.84	-38.01	-3.2
P4	212.66	212.66	0.00	0.0	245.17	32.51	15.3
P5	17.27	17.27	0.00	0.0	14.07	-3.19	-18.5
P6	9.00	9.00	0.00	0.0	6.25	-2.74	-30.5
VOL1	5047.89	4806.61	-241.28	-4.8	5184.10	136.21	2.7
AREA1	32466.96	32466.96	0.00	0.0	36726.76	4259.80	13.1
8-hour Average							
P1	218.11	218.11	0.00	0.0	212.34	-5.77	-2.6
P2	109.27	109.27	0.00	0.0	78.11	-31.16	-28.5
P3	904.65	904.65	0.00	0.0	662.73	-241.92	-26.7
P4	146.38	146.38	0.00	0.0	139.52	-6.86	-4.7
P5	8.36	8.37	0.01	0.1	8.51	0.15	1.8
P6	4.47	4.47	0.00	0.0	2.90	-1.57	-35.1
VOL1	2795.84	2795.84	0.00	0.0	3763.83	967.99	34.6
AREA1	26388.61	26388.61	0.00	0.0	26662.97	274.36	1.0

TABLE B.2, CONCLUDED

Source	Conv Obs ($\mu g\ m^{-3}$)	Mixed ASOS ($\mu g\ m^{-3}$)	Abs Diff ($\mu g\ m^{-3}$)	Rel Diff (%)	Full ASOS ($\mu g\ m^{-3}$)	Abs Diff ($\mu g\ m^{-3}$)	Rel Diff (%)
24-hour Average							
P1	131.27	129.81	-1.46	-1.1	105.43	-25.84	-19.7
P2	55.93	55.93	0.00	0.0	39.57	-16.37	-29.3
P3	518.52	518.52	0.00	0.0	451.65	-66.87	-12.9
P4	98.93	98.93	0.00	0.0	69.79	-29.14	-29.5
P5	3.79	3.79	0.00	0.0	3.79	0.01	0.2
P6	1.89	1.89	0.00	0.0	1.07	-0.81	-43.1
VOL1	1873.87	1832.61	-41.25	-2.2	1870.63	-3.24	-0.2
AREA1	16461.07	16084.50	-376.58	-2.3	20066.87	3605.79	21.9
Period Average							
P1	18.97	18.97	0.00	0.0	16.54	-2.43	-12.8
P2	10.05	9.89	-0.16	-1.6	7.84	-2.22	-22.1
P3	88.44	91.77	3.33	3.8	80.62	-7.82	-8.8
P4	16.76	17.11	0.35	2.1	14.46	-2.30	-13.7
P5	0.63	0.65	0.01	2.4	0.54	-0.09	-13.8
P6	0.10	0.10	0.00	-0.1	0.08	-0.02	-18.1
VOL1	481.22	474.73	-6.49	-1.3	560.60	79.38	16.5
AREA1	9023.04	9080.30	57.26	0.6	10499.23	1476.19	16.4

TABLE B.3

COMPARISON OF HIGH-1ST-HIGH CONCENTRATION ESTIMATES WITH CONVENTIONAL OBSERVATIONS TO ESTIMATES USING MIXED ASOS AND FULL ASOS FOR KANSAS CITY, MO

Source	Conv Obs (µg m^{-3})	Mixed ASOS (µg m^{-3})	Abs Diff (µg m^{-3})	Rel Diff (%)	Full ASOS (µg m^{-3})	Abs Diff (µg m^{-3})	Rel Diff (%)
1-hour Average							
P1	542.29	542.29	0.00	0.0	463.39	-78.90	-14.5
P2	240.41	357.10	116.69	48.5	325.26	84.86	35.3
P3	3131.58	3131.58	0.00	0.0	3113.11	-18.47	-0.6
P4	275.53	329.51	53.99	19.6	329.51	53.99	19.6
P5	51.32	51.32	0.00	0.0	47.79	-3.53	-6.9
P6	23.14	23.14	0.00	0.0	21.70	-1.43	-6.2
VOL1	9370.34	9420.04	49.70	0.5	9442.90	72.57	0.8
AREA1	47301.91	47301.91	0.00	0.0	48608.82	1306.91	2.8
3-hour Average							
P1	371.43	371.43	0.00	0.0	328.68	-42.75	-11.5
P2	141.72	233.38	91.65	64.7	172.07	30.35	21.4
P3	2096.40	2096.40	0.00	0.0	2035.17	-61.22	-2.9
P4	212.54	212.54	0.00	0.0	245.95	33.41	15.7
P5	19.24	19.24	0.00	0.0	21.68	2.44	12.7
P6	7.86	7.86	0.00	0.0	11.69	3.82	48.6
VOL1	5019.56	5019.56	0.00	0.0	5555.32	535.77	10.7
AREA1	40844.07	40844.07	0.00	0.0	46245.97	5401.90	13.2
8-hour Average							
P1	208.32	208.32	0.00	0.0	209.78	1.45	0.7
P2	91.41	133.86	42.45	46.4	111.97	20.56	22.5
P3	1144.78	1144.78	0.00	0.0	1075.15	-69.63	-6.1
P4	132.89	132.89	0.00	0.0	139.53	6.64	5.0
P5	12.28	12.28	0.00	0.0	12.97	0.69	5.6
P6	4.48	4.48	0.00	0.0	5.69	1.21	26.9
VOL1	3635.21	3492.36	-142.85	-3.9	3721.59	86.38	2.4
AREA1	32626.49	32626.49	0.00	0.0	39774.34	7147.84	21.9

TABLE B.3, CONCLUDED

Source	Conv Obs (μg m^{-3})	Mixed ASOS (μg m^{-3})	Abs Diff (μg m^{-3})	Rel Diff (%)	Full ASOS (μg m^{-3})	Abs Diff (μg m^{-3})	Rel Diff (%)
24-hour Average							
P1	109.90	109.90	0.00	0.0	121.08	11.18	10.2
P2	57.92	57.92	0.00	0.0	59.90	1.98	3.4
P3	577.13	577.13	0.00	0.0	564.63	-12.50	-2.2
P4	82.13	82.13	0.00	0.0	92.13	10.00	12.2
P5	4.40	4.40	0.00	0.0	4.82	0.42	9.5
P6	1.56	1.56	0.00	0.0	2.07	0.51	32.7
VOL1	2197.01	2108.67	-88.33	-4.0	2384.19	187.19	8.5
AREA1	22058.43	22611.53	553.10	2.5	25739.81	3681.39	16.7
Period Average							
P1	13.83	14.55	0.73	5.3	12.09	-1.73	-12.5
P2	6.85	7.18	0.33	4.8	5.84	-1.01	-14.8
P3	69.65	72.19	2.54	3.6	71.77	2.12	3.0
P4	10.48	10.93	0.46	4.3	10.87	0.39	3.8
P5	0.52	0.54	0.02	4.6	0.46	-0.05	-10.5
P6	0.12	0.12	0.01	5.2	0.13	0.01	8.9
VOL1	418.84	418.08	-0.75	-0.2	457.92	39.08	9.3
AREA1	9796.43	9914.39	117.95	1.2	10886.16	1089.72	11.1

TABLE B.4

COMPARISON OF HIGH-2ND-HIGH CONCENTRATION ESTIMATES WITH CONVENTIONAL OBSERVATIONS TO ESTIMATES USING MIXED ASOS AND FULL ASOS FOR KANSAS CITY, MO

Source	Conv Obs (µg m^{-3})	Mixed ASOS (µg m^{-3})	Abs Diff (µg m^{-3})	Rel Diff (%)	Full ASOS (µg m^{-3})	Abs Diff (µg m^{-3})	Rel Diff (%)
1-hour Average							
P1	451.52	451.52	0.00	0.0	459.83	8.31	1.8
P2	220.37	319.76	99.39	45.1	214.61	-5.76	-2.6
P3	3060.63	3060.63	0.00	0.0	3050.21	-10.41	-0.3
P4	268.39	268.39	0.00	0.0	268.48	0.09	0.0
P5	33.43	33.43	0.00	0.0	37.24	3.81	11.4
P6	17.59	15.10	-2.49	-14.2	16.84	-0.75	-4.3
VOL1	7142.66	7142.66	0.00	0.0	9239.04	2096.38	29.4
AREA1	47272.51	47272.51	0.00	0.0	48353.98	1081.47	2.3
3-hour Average							
P1	293.55	293.55	0.00	0.0	267.64	-25.90	-8.8
P2	132.21	141.72	9.51	7.2	126.33	-5.88	-4.4
P3	1278.03	1278.03	0.00	0.0	1547.94	269.92	21.1
P4	204.60	204.60	0.00	0.0	192.25	-12.34	-6.0
P5	16.20	16.20	0.00	0.0	18.24	2.04	12.6
P6	6.32	6.11	-0.21	-3.3	7.10	0.78	12.4
VOL1	3943.42	3943.42	0.00	0.0	4274.32	330.90	8.4
AREA1	38089.55	38089.55	0.00	0.0	44979.18	6889.63	18.1
8-hour Average							
P1	144.29	158.78	14.49	10.0	149.25	4.96	3.4
P2	67.21	70.86	3.65	5.4	85.99	18.78	27.9
P3	706.18	706.18	0.00	0.0	954.38	248.20	35.1
P4	126.40	126.40	0.00	0.0	117.56	-8.83	-7.0
P5	7.83	7.83	0.00	0.0	11.07	3.24	41.3
P6	2.46	2.46	0.00	0.0	3.12	0.66	27.0
VOL1	2686.65	2497.58	-189.07	-7.0	2976.26	289.61	10.8
AREA1	27066.23	28687.34	1621.11	6.0	32292.20	5225.97	19.3

TABLE B.4, CONCLUDED

Source	Conv Obs (µg m^{-3})	Mixed ASOS (µg m^{-3})	Abs Diff (µg m^{-3})	Rel Diff (%)	Full ASOS (µg m^{-3})	Abs Diff (µg m^{-3})	Rel Diff (%)
24-hour Average							
P1	93.86	93.86	0.00	0.0	95.82	1.96	2.1
P2	38.24	38.47	0.23	0.6	43.48	5.24	13.7
P3	438.23	459.86	21.63	4.9	382.95	-55.28	-12.6
P4	66.46	67.00	0.54	0.8	71.76	5.31	8.0
P5	2.79	2.79	0.00	0.0	3.69	0.91	32.6
P6	0.95	0.95	0.00	0.0	1.09	0.14	14.6
VOL1	1653.60	1642.13	-11.47	-0.7	1726.01	72.41	4.4
AREA1	18198.37	18198.37	0.00	0.0	20332.68	2134.32	11.7
Period Average							
P1	13.42	14.03	0.62	4.6	11.96	-1.45	-10.8
P2	6.83	7.05	0.22	3.2	5.82	-1.01	-14.9
P3	65.71	67.19	1.49	2.3	68.03	2.33	3.5
P4	10.34	10.73	0.39	3.8	10.21	-0.13	-1.3
P5	0.49	0.51	0.03	5.4	0.45	-0.04	-7.7
P6	0.12	0.12	0.00	1.0	0.11	0.00	-2.5
VOL1	410.47	413.90	3.43	0.8	457.45	46.98	11.4
AREA1	9727.76	9838.43	110.67	1.1	10678.65	950.89	9.8

TABLE B.5

COMPARISON OF HIGH-1ST-HIGH CONCENTRATION ESTIMATES WITH CONVENTIONAL OBSERVATIONS TO ESTIMATES USING MIXED ASOS AND FULL ASOS FOR MONTGOMERY, AL

Source	Conv Obs (µg m^{-3})	Mixed ASOS (µg m^{-3})	Abs Diff (µg m^{-3})	Rel Diff (%)	Full ASOS (µg m^{-3})	Abs Diff (µg m^{-3})	Rel Diff (%)
1-hour Average							
P1	402.07	402.07	0.00	0.0	400.54	-1.53	-0.4
P2	264.68	264.68	0.00	0.0	240.13	-24.55	-9.3
P3	3111.64	3120.33	8.68	0.3	3117.22	5.58	0.2
P4	404.71	404.71	0.00	0.0	496.46	91.75	22.7
P5	55.89	60.51	4.62	8.3	54.78	-1.11	-2.0
P6	22.81	37.03	14.22	62.4	35.61	12.81	56.2
VOL1	13885.39	13421.34	-464.05	-3.3	9742.98	-4142.41	-29.8
AREA1	70534.76	70534.76	0.00	0.0	48592.17	-21942.59	-31.1
3-hour Average							
P1	271.89	271.89	0.00	0.0	295.37	23.48	8.6
P2	164.22	164.22	0.00	0.0	194.01	29.78	18.1
P3	1925.89	2127.38	201.49	10.5	2260.34	334.44	17.4
P4	197.46	262.42	64.96	32.9	254.89	57.44	29.1
P5	21.98	24.50	2.51	11.4	27.45	5.47	24.9
P6	10.13	12.34	2.21	21.8	11.87	1.74	17.1
VOL1	7120.59	6302.63	-817.96	-11.5	5785.95	-1334.63	-18.7
AREA1	70227.18	70227.18	0.00	0.0	45927.36	-24299.82	-34.6
8-hour Average							
P1	176.13	168.35	-7.78	-4.4	217.02	40.89	23.2
P2	108.11	103.35	-4.76	-4.4	122.13	14.02	13.0
P3	1094.12	1179.21	85.09	7.8	1090.34	-3.78	-0.3
P4	116.45	146.97	30.52	26.2	157.51	41.06	35.3
P5	14.46	13.89	-0.57	-3.9	14.82	0.36	2.5
P6	4.98	4.73	-0.24	-4.9	5.90	0.92	18.5
VOL1	3541.93	4021.97	480.04	13.6	4356.89	814.96	23.0
AREA1	38356.22	38356.22	0.00	0.0	34338.97	-4017.25	-10.5

TABLE B.5, CONCLUDED

Source	Conv Obs ($\mu g\ m^{-3}$)	Mixed ASOS ($\mu g\ m^{-3}$)	Abs Diff ($\mu g\ m^{-3}$)	Rel Diff (%)	Full ASOS ($\mu g\ m^{-3}$)	Abs Diff ($\mu g\ m^{-3}$)	Rel Diff (%)
24-hour Average							
P1	113.46	113.46	0.00	0.0	112.13	-1.33	-1.2
P2	57.93	57.93	0.00	0.0	52.24	-5.69	-9.8
P3	714.25	714.25	0.00	0.0	628.48	-85.77	-12.0
P4	83.08	83.08	0.00	0.0	92.70	9.62	11.6
P5	5.45	5.45	0.00	0.0	6.09	0.64	11.8
P6	1.76	1.76	0.00	0.0	2.40	0.63	36.0
VOL1	2464.76	2535.72	70.96	2.9	2554.53	89.77	3.6
AREA1	21893.69	22260.57	366.88	1.7	23576.49	1682.80	7.7
Period Average							
P1	13.11	13.81	0.70	5.4	16.71	3.59	27.4
P2	6.74	6.62	-0.12	-1.8	8.49	1.75	26.0
P3	76.72	89.56	12.84	16.7	98.92	22.20	28.9
P4	11.96	13.44	1.48	12.3	15.73	3.77	31.5
P5	0.58	0.64	0.06	11.2	0.74	0.16	27.9
P6	0.16	0.19	0.03	18.1	0.22	0.05	32.3
VOL1	678.91	665.83	-13.08	-1.9	719.06	40.16	5.9
AREA1	12426.46	12685.42	258.96	2.1	12302.00	-124.45	-1.0

TABLE B.6

COMPARISON OF HIGH-2ND-HIGH CONCENTRATION ESTIMATES WITH CONVENTIONAL OBSERVATIONS TO ESTIMATES USING MIXED ASOS AND FULL ASOS FOR MONTGOMERY, AL

Source	Conv Obs (µg m^{-3})	Mixed ASOS (µg m^{-3})	Abs Diff (µg m^{-3})	Rel Diff (%)	Full ASOS (µg m^{-3})	Abs Diff (µg m^{-3})	Rel Diff (%)
1-hour Average							
P1	358.54	358.54	0.00	0.0	391.47	32.93	9.2
P2	216.16	216.16	0.00	0.0	223.13	6.96	3.2
P3	3058.88	3058.88	0.00	0.0	3074.25	15.38	0.5
P4	335.62	335.62	0.00	0.0	336.34	0.72	0.2
P5	33.41	42.79	9.38	28.1	36.73	3.31	9.9
P6	17.53	20.86	3.33	19.0	17.72	0.19	1.1
VOL1	9044.54	9114.18	69.65	0.8	9114.03	69.49	0.8
AREA1	70296.98	70296.98	0.00	0.0	48303.98	-21993.00	-31.3
3-hour Average							
P1	229.96	229.96	0.00	0.0	252.00	22.05	9.6
P2	143.71	146.04	2.33	1.6	151.69	7.98	5.6
P3	1431.74	1511.42	79.68	5.6	1732.57	300.84	21.0
P4	162.87	167.56	4.69	2.9	192.31	29.44	18.1
P5	19.26	20.30	1.04	5.4	21.10	1.83	9.5
P6	9.67	9.67	0.00	0.0	8.00	-1.67	-17.3
VOL1	4642.91	4698.30	55.39	1.2	5244.81	601.90	13.0
AREA1	49794.24	49794.24	0.00	0.0	40791.47	-9002.77	-18.1
8-hour Average							
P1	162.88	162.88	0.00	0.0	156.38	-6.50	-4.0
P2	103.09	101.87	-1.22	-1.2	101.56	-1.53	-1.5
P3	850.32	958.57	108.25	12.7	1062.86	212.54	25.0
P4	107.51	113.14	5.63	5.2	146.94	39.43	36.7
P5	13.16	13.16	0.00	0.0	14.45	1.29	9.8
P6	4.25	4.25	0.00	0.0	5.65	1.40	32.9
VOL1	3040.70	3278.41	237.71	7.8	3863.80	823.10	27.1
AREA1	34940.96	34940.96	0.00	0.0	32488.06	-2452.90	-7.0

TABLE B.6, CONCLUDED

Source	Conv Obs ($\mu g\ m^{-3}$)	Mixed ASOS ($\mu g\ m^{-3}$)	Abs Diff ($\mu g\ m^{-3}$)	Rel Diff (%)	Full ASOS ($\mu g\ m^{-3}$)	Abs Diff ($\mu g\ m^{-3}$)	Rel Diff (%)
24-hour Average							
P1	78.76	78.76	0.00	0.0	91.63	12.86	16.3
P2	46.44	46.44	0.00	0.0	46.44	0.00	0.0
P3	516.58	514.98	-1.59	-0.3	456.83	-59.74	-11.6
P4	65.09	67.64	2.55	3.9	81.97	16.87	25.9
P5	5.19	5.19	0.00	0.0	5.17	-0.03	-0.5
P6	1.70	1.70	0.00	0.0	1.98	0.28	16.4
VOL1	2429.36	2464.76	35.40	1.5	2171.26	-258.10	-10.6
AREA1	20870.34	21219.30	348.96	1.7	20246.15	-624.19	-3.0
Period Average							
P1	12.91	13.62	0.71	5.5	16.27	3.37	26.1
P2	6.71	6.53	-0.18	-2.6	8.48	1.78	26.5
P3	71.85	74.32	2.47	3.4	95.31	23.46	32.7
P4	10.48	11.16	0.68	6.5	14.70	4.21	40.2
P5	0.56	0.64	0.08	13.4	0.73	0.17	29.4
P6	0.15	0.18	0.03	19.8	0.21	0.05	34.1
VOL1	659.81	642.08	-17.73	-2.7	667.02	7.21	1.1
AREA1	12352.01	12627.85	275.83	2.2	12165.54	-186.47	-1.5

TABLE B.7

COMPARISON OF HIGH-1ST-HIGH CONCENTRATION ESTIMATES WITH CONVENTIONAL OBSERVATIONS TO ESTIMATES USING MIXED ASOS AND FULL ASOS FOR MILWAUKEE, WI

Source	Conv Obs (μg m^{-3})	Mixed ASOS (μg m^{-3})	Abs Diff (μg m^{-3})	Rel Diff (%)	Full ASOS (μg m^{-3})	Abs Diff (μg m^{-3})	Rel Diff (%)
1-hour Average							
P1	488.17	488.17	0.00	0.0	499.51	11.34	2.3
P2	233.78	352.32	118.54	50.7	232.00	-1.77	-0.8
P3	3121.51	3134.49	12.97	0.4	3116.64	-4.87	-0.2
P4	368.38	368.38	0.00	0.0	369.36	0.98	0.3
P5	48.85	48.85	0.00	0.0	34.41	-14.44	-29.6
P6	17.26	17.26	0.00	0.0	17.82	0.56	3.2
VOL1	8772.27	8347.83	-424.44	-4.8	8860.73	88.46	1.0
AREA1	48303.98	47189.77	-1114.21	-2.3	48641.17	337.19	0.7
3-hour Average							
P1	349.70	349.70	0.00	0.0	360.38	10.67	3.1
P2	191.14	193.17	2.03	1.1	143.14	-48.00	-25.1
P3	1875.05	1875.05	0.00	0.0	2310.10	435.05	23.2
P4	229.18	229.18	0.00	0.0	244.08	14.89	6.5
P5	26.00	26.00	0.00	0.0	17.80	-8.20	-31.5
P6	8.09	8.09	0.00	0.0	7.60	-0.49	-6.1
VOL1	4053.01	3652.17	-400.85	-9.9	5102.92	1049.91	25.9
AREA1	45006.59	45006.59	0.00	0.0	44031.21	-975.39	-2.2
8-hour Average							
P1	306.06	328.80	22.75	7.4	288.85	-17.20	-5.6
P2	124.85	138.99	14.14	11.3	115.81	-9.04	-7.2
P3	788.92	908.43	119.51	15.1	1011.93	223.00	28.3
P4	200.99	201.22	0.23	0.1	185.64	-15.35	-7.6
P5	13.62	13.62	0.00	0.0	11.80	-1.82	-13.4
P6	4.47	4.47	0.00	0.0	4.47	0.00	0.0
VOL1	2776.83	2776.83	0.00	0.0	3009.17	232.34	8.4
AREA1	37113.01	37113.01	0.00	0.0	37529.57	416.56	1.1

TABLE B.7, CONCLUDED

Source	Conv Obs ($\mu g\ m^{-3}$)	Mixed ASOS ($\mu g\ m^{-3}$)	Abs Diff ($\mu g\ m^{-3}$)	Rel Diff (%)	Full ASOS ($\mu g\ m^{-3}$)	Abs Diff ($\mu g\ m^{-3}$)	Rel Diff (%)
24-hour Average							
P1	134.23	141.81	7.58	5.6	129.44	-4.79	-3.6
P2	54.95	59.66	4.71	8.6	53.05	-1.90	-3.5
P3	517.45	541.90	24.45	4.7	551.69	34.24	6.6
P4	89.05	89.11	0.07	0.1	86.78	-2.27	-2.5
P5	4.75	4.75	0.00	0.0	4.59	-0.16	-3.4
P6	1.55	1.55	0.00	0.0	1.74	0.18	11.8
VOL1	1683.33	1534.21	-149.11	-8.9	1623.94	-59.39	-3.5
AREA1	20058.30	20058.30	0.00	0.0	20009.35	-48.95	-0.2
Period Average							
P1	12.27	12.23	-0.03	-0.3	10.32	-1.95	-15.9
P2	5.62	5.38	-0.24	-4.2	4.95	-0.68	-12.0
P3	66.44	67.73	1.29	1.9	76.29	9.86	14.8
P4	11.70	11.84	0.14	1.2	11.22	-0.48	-4.1
P5	0.40	0.39	-0.01	-2.3	0.47	0.06	15.7
P6	0.10	0.12	0.02	14.5	0.11	0.00	3.4
VOL1	306.90	309.01	2.11	0.7	337.81	30.91	10.1
AREA1	9943.92	10325.45	381.52	3.8	10265.46	321.53	3.2

TABLE B.8

COMPARISON OF HIGH-2ND-HIGH CONCENTRATION ESTIMATES WITH CONVENTIONAL OBSERVATIONS TO ESTIMATES USING MIXED ASOS AND FULL ASOS FOR MILWAUKEE, WI

Source	Conv Obs (µg m^{-3})	Mixed ASOS (µg m^{-3})	Abs Diff (µg m^{-3})	Rel Diff (%)	Full ASOS (µg m^{-3})	Abs Diff (µg m^{-3})	Rel Diff (%)
1-hour Average							
P1	441.63	441.63	0.00	0.0	458.24	16.61	3.8
P2	207.92	210.14	2.22	1.1	209.33	1.41	0.7
P3	2773.37	2800.54	27.17	1.0	2776.88	3.52	0.1
P4	338.36	338.36	0.00	0.0	338.36	0.00	0.0
P5	29.22	29.22	0.00	0.0	31.84	2.62	9.0
P6	11.84	11.84	0.00	0.0	11.74	-0.10	-0.9
VOL1	5353.37	5316.37	-36.99	-0.7	6410.32	1056.95	19.7
AREA1	47189.77	46522.03	-667.73	-1.4	48303.98	1114.21	2.4
3-hour Average							
P1	343.59	343.59	0.00	0.0	338.05	-5.54	-1.6
P2	143.51	143.51	0.00	0.0	141.26	-2.25	-1.6
P3	1273.43	1273.43	0.00	0.0	1534.70	261.28	20.5
P4	228.65	228.65	0.00	0.0	226.44	-2.20	-1.0
P5	13.48	14.12	0.65	4.8	15.97	2.49	18.5
P6	5.56	5.56	0.00	0.0	5.06	-0.50	-9.0
VOL1	3264.00	3264.00	0.00	0.0	3436.52	172.52	5.3
AREA1	41362.13	41362.13	0.00	0.0	35083.26	-6278.87	-15.2
8-hour Average							
P1	161.67	161.67	0.00	0.0	127.95	-33.72	-20.9
P2	81.00	81.00	0.00	0.0	56.31	-24.70	-30.5
P3	751.57	749.11	-2.47	-0.3	987.31	235.73	31.4
P4	128.02	128.02	0.00	0.0	106.14	-21.88	-17.1
P5	7.30	7.32	0.02	0.3	7.11	-0.19	-2.6
P6	2.55	2.55	0.00	0.0	2.52	-0.03	-1.3
VOL1	2150.25	2087.27	-62.99	-2.9	2487.24	336.99	15.7
AREA1	35945.66	35945.66	0.00	0.0	37410.01	1464.34	4.1

TABLE B.8, CONCLUDED

Source	Conv Obs (µg m^{-3})	Mixed ASOS (µg m^{-3})	Abs Diff (µg m^{-3})	Rel Diff (%)	Full ASOS (µg m^{-3})	Abs Diff (µg m^{-3})	Rel Diff (%)
24-hour Average							
P1	101.64	98.42	-3.22	-3.2	61.35	-40.30	-39.6
P2	52.31	49.37	-2.94	-5.6	26.76	-25.55	-48.8
P3	359.77	346.48	-13.30	-3.7	428.88	69.11	19.2
P4	83.49	84.35	0.86	1.0	63.72	-19.78	-23.7
P5	3.72	3.62	-0.11	-2.9	2.48	-1.25	-33.5
P6	1.13	1.13	0.00	0.0	1.01	-0.13	-11.3
VOL1	1260.58	1151.92	-108.66	-8.6	1439.85	179.27	14.2
AREA1	17558.32	17558.32	0.00	0.0	18237.12	678.79	3.9
Period Average							
P1	12.11	12.20	0.09	0.7	10.29	-1.82	-15.0
P2	5.50	5.19	-0.31	-5.7	4.81	-0.69	-12.6
P3	65.57	67.14	1.56	2.4	75.66	10.09	15.4
P4	10.36	10.74	0.38	3.7	11.06	0.70	6.7
P5	0.34	0.35	0.01	2.9	0.45	0.11	30.9
P6	0.10	0.11	0.01	11.6	0.10	0.00	1.8
VOL1	300.58	287.65	-12.93	-4.3	314.58	14.00	4.7
AREA1	9908.17	10255.73	347.56	3.5	10209.32	301.14	3.0

TABLE B.9

COMPARISON OF HIGH-1ST-HIGH CONCENTRATION ESTIMATES WITH CONVENTIONAL OBSERVATIONS TO ESTIMATES USING MIXED ASOS AND FULL ASOS FOR PENDLETON, OR

Source	Conv Obs (µg m^{-3})	Mixed ASOS (µg m^{-3})	Abs Diff (µg m^{-3})	Rel Diff (%)	Full ASOS (µg m^{-3})	Abs Diff (µg m^{-3})	Rel Diff (%)
1-hour Average							
P1	598.21	598.21	0.00	0.0	756.33	158.12	26.4
P2	216.25	216.25	0.00	0.0	233.98	17.73	8.2
P3	3126.51	3126.51	0.00	0.0	3134.49	7.98	0.3
P4	369.36	471.68	102.32	27.7	362.12	-7.24	-2.0
P5	39.54	39.54	0.00	0.0	41.87	2.33	5.9
P6	20.50	20.50	0.00	0.0	20.50	0.00	0.0
VOL1	13537.74	13513.59	-24.15	-0.2	9080.98	-4456.76	-32.9
AREA1	69369.86	69369.86	0.00	0.0	110589.66	41219.80	59.4
3-hour Average							
P1	386.22	386.22	0.00	0.0	388.35	2.13	0.6
P2	147.73	147.73	0.00	0.0	193.78	46.05	31.2
P3	1626.77	1626.77	0.00	0.0	1609.43	-17.34	-1.1
P4	225.88	225.88	0.00	0.0	225.07	-0.81	-0.4
P5	20.34	20.34	0.00	0.0	26.28	5.94	29.2
P6	8.22	8.22	0.00	0.0	9.40	1.18	14.4
VOL1	8570.55	8519.02	-51.53	-0.6	6225.58	-2344.97	-27.4
AREA1	47479.30	47479.30	0.00	0.0	42907.42	-4571.88	-9.6
8-hour Average							
P1	215.97	215.97	0.00	0.0	282.92	66.95	31.0
P2	126.05	126.05	0.00	0.0	115.69	-10.36	-8.2
P3	989.46	989.46	0.00	0.0	879.36	-110.11	-11.1
P4	140.62	140.62	0.00	0.0	179.47	38.85	27.6
P5	17.57	17.57	0.00	0.0	15.40	-2.16	-12.3
P6	6.73	6.73	0.00	0.0	5.31	-1.41	-21.0
VOL1	4525.16	4525.16	0.00	0.0	3508.63	-1016.52	-22.5
AREA1	36980.24	36980.24	0.00	0.0	28507.95	-8472.29	-22.9

TABLE B.9, CONCLUDED

Source	Conv Obs ($\mu g\ m^{-3}$)	Mixed ASOS ($\mu g\ m^{-3}$)	Abs Diff ($\mu g\ m^{-3}$)	Rel Diff (%)	Full ASOS ($\mu g\ m^{-3}$)	Abs Diff ($\mu g\ m^{-3}$)	Rel Diff (%)
24-hour Average							
P1	125.88	125.88	0.00	0.0	214.78	88.90	70.6
P2	52.94	52.94	0.00	0.0	90.05	37.11	70.1
P3	508.78	508.78	0.00	0.0	688.15	179.37	35.3
P4	96.74	96.74	0.00	0.0	157.99	61.24	63.3
P5	5.27	5.27	0.00	0.0	5.92	0.65	12.3
P6	2.02	2.02	0.00	0.0	1.77	-0.25	-12.2
VOL1	1544.96	1544.96	0.00	0.0	1485.00	-59.97	-3.9
AREA1	20943.94	20943.94	0.00	0.0	16902.25	-4041.69	-19.3
Period Average							
P1	13.14	12.84	-0.30	-2.3	15.89	2.74	20.9
P2	6.42	6.30	-0.12	-1.9	7.65	1.23	19.1
P3	90.34	93.05	2.72	3.0	83.10	-7.24	-8.0
P4	12.51	12.90	0.38	3.0	12.31	-0.20	-1.6
P5	0.84	0.85	0.02	1.9	0.72	-0.11	-13.6
P6	0.31	0.31	0.00	0.6	0.26	-0.05	-15.6
VOL1	518.24	501.65	-16.60	-3.2	462.49	-55.75	-10.8
AREA1	12469.97	12771.49	301.52	2.4	10507.61	-1962.36	-15.7

TABLE B.10

COMPARISON OF HIGH-2ND-HIGH CONCENTRATION ESTIMATES WITH CONVENTIONAL OBSERVATIONS TO ESTIMATES USING MIXED ASOS AND FULL ASOS FOR PENDLETON, OR

Source	Conv Obs (μg m^{-3})	Mixed ASOS (μg m^{-3})	Abs Diff (μg m^{-3})	Rel Diff (%)	Full ASOS (μg m^{-3})	Abs Diff (μg m^{-3})	Rel Diff (%)
1-hour Average							
P1	443.47	443.47	0.00	0.0	504.03	60.55	13.7
P2	213.92	213.92	0.00	0.0	213.92	0.00	0.0
P3	3079.97	3094.12	14.15	0.5	3085.59	5.63	0.2
P4	364.82	364.82	0.00	0.0	351.99	-12.84	-3.5
P5	32.95	32.95	0.00	0.0	33.26	0.30	0.9
P6	14.99	14.99	0.00	0.0	13.67	-1.32	-8.8
VOL1	9067.07	9067.07	0.00	0.0	9025.45	-41.62	-0.5
AREA1	67860.33	67860.33	0.00	0.0	48642.56	-19217.77	-28.3
3-hour Average							
P1	288.90	288.90	0.00	0.0	302.20	13.30	4.6
P2	135.09	135.09	0.00	0.0	163.99	28.90	21.4
P3	1387.23	1387.23	0.00	0.0	1418.77	31.54	2.3
P4	184.52	184.52	0.00	0.0	199.12	14.59	7.9
P5	19.45	19.45	0.00	0.0	23.28	3.83	19.7
P6	7.56	7.56	0.00	0.0	8.50	0.94	12.5
VOL1	7563.98	7544.01	-19.97	-0.3	4676.19	-2887.80	-38.2
AREA1	42916.54	42916.54	0.00	0.0	35815.73	-7100.81	-16.5
8-hour Average							
P1	206.34	206.34	0.00	0.0	211.18	4.84	2.3
P2	79.71	79.71	0.00	0.0	95.12	15.41	19.3
P3	676.69	819.69	143.00	21.1	685.73	9.04	1.3
P4	139.12	139.12	0.00	0.0	159.47	20.35	14.6
P5	10.68	10.68	0.00	0.0	11.25	0.57	5.3
P6	4.16	4.16	0.00	0.0	3.95	-0.21	-5.0
VOL1	3990.63	3990.63	0.00	0.0	3159.75	-830.88	-20.8
AREA1	34589.76	34589.76	0.00	0.0	27078.06	-7511.70	-21.7

TABLE B.10, CONCLUDED

Source	Conv Obs (µg m^{-3})	Mixed ASOS (µg m^{-3})	Abs Diff (µg m^{-3})	Rel Diff (%)	Full ASOS (µg m^{-3})	Abs Diff (µg m^{-3})	Rel Diff (%)
24-hour Average							
P1	111.35	111.35	0.00	0.0	145.53	34.17	30.7
P2	45.01	45.01	0.00	0.0	61.61	16.60	36.9
P3	379.85	379.85	0.00	0.0	395.05	15.19	4.0
P4	78.57	78.57	0.00	0.0	95.50	16.94	21.6
P5	3.50	3.50	0.00	0.0	4.43	0.93	26.5
P6	1.44	1.44	0.00	0.0	1.51	0.07	5.1
VOL1	1511.57	1497.05	-14.52	-1.0	1215.77	-295.80	-19.6
AREA1	19168.63	19599.36	430.73	2.2	16543.30	-2625.32	-13.7
Period Average							
P1	12.04	11.72	-0.32	-2.7	15.36	3.32	27.6
P2	6.23	6.19	-0.04	-0.7	7.58	1.36	21.8
P3	78.12	79.77	1.65	2.1	73.50	-4.62	-5.9
P4	11.36	11.45	0.09	0.8	11.30	-0.05	-0.5
P5	0.80	0.81	0.01	1.2	0.70	-0.11	-13.4
P6	0.29	0.30	0.00	1.4	0.24	-0.06	-19.8
VOL1	493.44	494.60	1.16	0.2	450.40	-43.04	-8.7
AREA1	12405.17	12697.93	292.77	2.4	10442.54	-1962.63	-15.8

TABLE B.11

COMPARISON OF HIGH-1ST-HIGH CONCENTRATION ESTIMATES WITH CONVENTIONAL OBSERVATIONS TO ESTIMATES USING MIXED ASOS AND FULL ASOS FOR TUCSON, AZ

Source	Conv Obs (µg m^{-3})	Mixed ASOS (µg m^{-3})	Abs Diff (µg m^{-3})	Rel Diff (%)	Full ASOS (µg m^{-3})	Abs Diff (µg m^{-3})	Rel Diff (%)
1-hour Average							
P1	588.06	588.06	0.00	0.0	525.75	-62.31	-10.6
P2	250.58	250.58	0.00	0.0	250.58	0.00	0.0
P3	3137.37	3137.37	0.00	0.0	3184.21	46.84	1.5
P4	477.19	477.19	0.00	0.0	490.02	12.83	2.7
P5	57.32	57.32	0.00	0.0	57.32	0.00	0.0
P6	23.20	23.20	0.00	0.0	23.20	0.00	0.0
VOL1	13513.59	13513.59	0.00	0.0	13290.68	-222.91	-1.6
AREA1	70467.91	70467.91	0.00	0.0	48592.17	-21875.74	-31.0
3-hour Average							
P1	424.79	424.79	0.00	0.0	397.70	-27.09	-6.4
P2	186.58	186.58	0.00	0.0	163.27	-23.31	-12.5
P3	2063.02	2063.02	0.00	0.0	2063.02	0.00	0.0
P4	278.06	278.06	0.00	0.0	278.06	0.00	0.0
P5	25.48	25.48	0.00	0.0	21.82	-3.66	-14.4
P6	8.52	8.52	0.00	0.0	8.31	-0.21	-2.5
VOL1	5407.82	5407.82	0.00	0.0	5273.64	-134.18	-2.5
AREA1	40951.27	42881.61	1930.34	4.7	40951.27	0.00	0.0
8-hour Average							
P1	234.22	234.22	0.00	0.0	234.22	0.00	0.0
P2	99.09	98.13	-0.97	-1.0	97.74	-1.35	-1.4
P3	1027.07	1027.07	0.00	0.0	1417.26	390.19	38.0
P4	162.82	177.84	15.01	9.2	149.35	-13.47	-8.3
P5	14.16	14.16	0.00	0.0	14.16	0.00	0.0
P6	5.09	5.09	0.00	0.0	5.13	0.04	0.9
VOL1	2915.85	2915.85	0.00	0.0	3502.45	586.60	20.1
AREA1	32991.43	33646.06	654.63	2.0	32991.43	0.00	0.0

TABLE B.11, CONCLUDED

Source	Conv Obs ($\mu g\ m^{-3}$)	Mixed ASOS ($\mu g\ m^{-3}$)	Abs Diff ($\mu g\ m^{-3}$)	Rel Diff (%)	Full ASOS ($\mu g\ m^{-3}$)	Abs Diff ($\mu g\ m^{-3}$)	Rel Diff (%)
24-hour Average							
P1	146.83	146.83	0.00	0.0	127.58	-19.26	-13.1
P2	64.34	64.34	0.00	0.0	53.69	-10.65	-16.6
P3	640.23	640.23	0.00	0.0	524.96	-115.27	-18.0
P4	119.55	119.55	0.00	0.0	94.70	-24.85	-20.8
P5	4.79	4.79	0.00	0.0	4.72	-0.07	-1.6
P6	1.70	1.70	0.00	0.0	1.78	0.09	5.2
VOL1	1415.62	1415.62	0.00	0.0	1415.62	0.00	0.0
AREA1	17498.47	17498.47	0.00	0.0	18573.82	1075.35	6.1
Period Average							
P1	14.14	13.92	-0.22	-1.6	13.69	-0.46	-3.2
P2	6.27	6.15	-0.13	-2.0	5.68	-0.59	-9.4
P3	109.17	109.91	0.73	0.7	111.42	2.25	2.1
P4	16.02	16.24	0.22	1.4	16.16	0.14	0.8
P5	0.65	0.68	0.03	4.5	0.71	0.06	8.5
P6	0.22	0.23	0.01	4.4	0.24	0.02	6.8
VOL1	549.97	538.77	-11.20	-2.0	556.30	6.33	1.2
AREA1	10722.61	10967.82	245.21	2.3	11830.82	1108.21	10.3

TABLE B.12

COMPARISON OF HIGH-2ND-HIGH CONCENTRATION ESTIMATES WITH CONVENTIONAL OBSERVATIONS TO ESTIMATES USING MIXED ASOS AND FULL ASOS FOR TUCSON, AZ

Source	Conv Obs ($\mu g\ m^{-3}$)	Mixed ASOS ($\mu g\ m^{-3}$)	Abs Diff ($\mu g\ m^{-3}$)	Rel Diff (%)	Full ASOS ($\mu g\ m^{-3}$)	Abs Diff ($\mu g\ m^{-3}$)	Rel Diff (%)
1-hour Average							
P1	503.35	503.35	0.00	0.0	480.65	-22.70	-4.5
P2	225.92	225.92	0.00	0.0	221.26	-4.66	-2.1
P3	2822.07	2822.07	0.00	0.0	3165.65	343.58	12.2
P4	371.18	371.18	0.00	0.0	377.76	6.58	1.8
P5	35.48	35.48	0.00	0.0	34.94	-0.54	-1.5
P6	13.14	13.14	0.00	0.0	12.73	-0.41	-3.1
VOL1	9080.98	9080.98	0.00	0.0	9080.98	0.00	0.0
AREA1	58856.02	58856.02	0.00	0.0	48505.06	-10350.96	-17.6
3-hour Average							
P1	335.24	335.24	0.00	0.0	311.14	-24.10	-7.2
P2	137.60	137.60	0.00	0.0	136.21	-1.39	-1.0
P3	1514.49	1514.49	0.00	0.0	1514.49	0.00	0.0
P4	210.85	219.22	8.37	4.0	203.59	-7.26	-3.4
P5	17.84	17.84	0.00	0.0	17.21	-0.63	-3.6
P6	7.32	7.32	0.00	0.0	6.92	-0.40	-5.5
VOL1	4850.03	4850.03	0.00	0.0	4296.01	-554.02	-11.4
AREA1	36504.00	38227.32	1723.31	4.7	36271.45	-232.55	-0.6
8-hour Average							
P1	207.06	203.62	-3.44	-1.7	195.01	-12.05	-5.8
P2	90.67	86.98	-3.68	-4.1	83.52	-7.15	-7.9
P3	876.39	876.39	0.00	0.0	876.39	0.00	0.0
P4	149.35	149.35	0.00	0.0	127.32	-22.03	-14.8
P5	11.51	11.51	0.00	0.0	11.62	0.11	1.0
P6	3.80	3.80	0.00	0.0	4.27	0.47	12.3
VOL1	2534.55	2534.55	0.00	0.0	2702.28	167.73	6.6
AREA1	28221.59	30380.88	2159.28	7.7	29478.13	1256.54	4.5

TABLE B.12, CONCLUDED

Source	Conv Obs (µg m^{-3})	Mixed ASOS (µg m^{-3})	Abs Diff (µg m^{-3})	Rel Diff (%)	Full ASOS (µg m^{-3})	Abs Diff (µg m^{-3})	Rel Diff (%)
24-hour Average							
P1	127.18	123.46	-3.72	-2.9	85.17	-42.00	-33.0
P2	53.69	50.23	-3.46	-6.4	38.09	-15.60	-29.1
P3	474.95	528.14	53.18	11.2	440.61	-34.34	-7.2
P4	94.70	101.14	6.44	6.8	67.42	-27.28	-28.8
P5	3.99	3.99	0.00	0.0	3.91	-0.08	-2.0
P6	1.29	1.29	0.00	0.0	1.29	0.00	0.0
VOL1	1283.99	1283.99	0.00	0.0	1283.99	0.00	0.0
AREA1	15910.70	16449.66	538.97	3.4	17341.93	1431.24	9.0
Period Average							
P1	13.84	13.63	-0.21	-1.5	13.56	-0.27	-2.0
P2	6.25	6.07	-0.18	-2.9	5.46	-0.78	-12.5
P3	89.14	90.03	0.89	1.0	87.75	-1.39	-1.6
P4	14.22	14.40	0.17	1.2	13.86	-0.36	-2.5
P5	0.65	0.68	0.04	5.5	0.67	0.03	4.4
P6	0.21	0.22	0.01	5.9	0.22	0.01	3.2
VOL1	520.84	509.24	-11.61	-2.2	531.74	10.90	2.1
AREA1	10638.10	10876.40	238.30	2.2	11717.09	1079.00	10.1

TECHNICAL REPORT DATA

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1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO.
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15. SUPPLEMENTARY NOTES

16. ABSTRACT

This document presents the results of a study which examined the affects of the Automated Surface Observing System (ASOS) data on refined air dispersion modeling. This study compares Industrial Source Complex Short Term 3 (ISCST3) output using ASOS and standard (manual) meteorological data taken concurrently for 2 months (during 1994 and 1995) at 6 sites across the United States. The ASOS station conversion, which began in 1991, lacks some significant information required in air dispersion modeling, namely ceiling height and cloud cover. This document compiles results from ISCST3 execution runs for 6 point sources, 1 area source, and 1 volume source.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air Pollution Meteorological Data Air Dispersion Models	Meteorology Dispersion	

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