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A Climatological Digest for the Susquehanna Nuclear Power Plant

C. S. Glantz
C. G. Lindsey

March 1987

Prepared for the
U.S. Nuclear Regulatory Commission
under Contract DE-AC06-76RLO 1830
NRC FIN B2182 and
Pennsylvania Power and Light
Allentown, Pennsylvania
under Contract 231126934E

Battelle

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PACIFIC NORTHWEST LABORATORY
operated by
BATTELLE MEMORIAL INSTITUTE
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under Contract DE-AC06-76RLO 1830

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The material published in the digest portion of this document was originally prepared for the Nuclear Regulatory Commission as an unpublished supplement to A Method to Characterize Local Meteorology at Nuclear Facilities for Application to Emergency Response Needs (NUREG/CR-3882). Permission for Pennsylvania Power and Light Co. to sponsor the publication of this document was obtained from the offices of Mr. Harold R. Denton of the NRC, Mr. Daniel L. Sours of the Department of Energy's Richland Operations Office, and Mr. Robert J. Sorenson of Pacific Northwest Laboratory.

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INTRODUCTION

To model atmospheric dispersion for emergency-response or other purposes, estimates of current and forecast meteorological conditions are required. Model operators need to know if the current meteorological conditions will persist for the time period of interest or if they will change appreciably. Local meteorology may change as a result of changes in the synoptic (i.e., large-scale; on the order of 100 to thousands of km) meteorological conditions dominating the region or because of a change in or development of a mesoscale (i.e., medium-scale; on the order of tens of km) or local (i.e., on the order of of less than 10 km) circulation. If changes are expected, model operators need to realistically estimate when local conditions are likely to change and what the changes will be.

For a site at which meteorological data have been collected for a number of years, a statistical description of how the local winds and atmospheric stability behave under the influence of various synoptic conditions can be prepared. It is proposed that such a statistical description can aid meteorologists in forecasting local winds and atmospheric stability. In particular, such a statistical description may be especially useful at sites located in complex terrain or along shorelines, locations subject to mesoscale and local circulations that produce winds and stabilities significantly different from those experienced at neighboring sites at the same time.

The authors have prepared preliminary statistical descriptions of the meteorology at the sites of the Susquehanna, Nine Mile Point, and South Texas nuclear power plants. These plants are located in complex terrain or shoreline environments. Detailed discussion of the techniques employed in this study and the information obtained for the three sites have been presented by Lindsey and Glantz (1984, 1986).

This document presents preliminary statistical descriptions of the local meteorology at the Susquehanna site using figures displaying charts and histograms. The following sections briefly describe the Susquehanna site and discuss how the data were obtained for this study and how they are presented. An example is presented that illustrates how the digest can be used in an emergency-response situation. The final section of this document is the climatological digest itself and contains the statistical descriptions of meteorology at the Susquehanna site.

SITE DESCRIPTION

The Susquehanna Nuclear Power Plant (41.1° N / 76.1° W) is located in Luzerne County, in eastern Pennsylvania, on the western bank of the Susquehanna River (Figure 1). The plant is situated on a plateau approximately 0.8 km (0.5 miles) from the west bank of the river. The river has a mean elevation of 160 m (530 ft) above mean sea level (MSL) as it passes the site. The maximum elevation on the plant site is 270 m (900 ft) MSL; the minimum elevation is 240 m (800 ft) MSL.

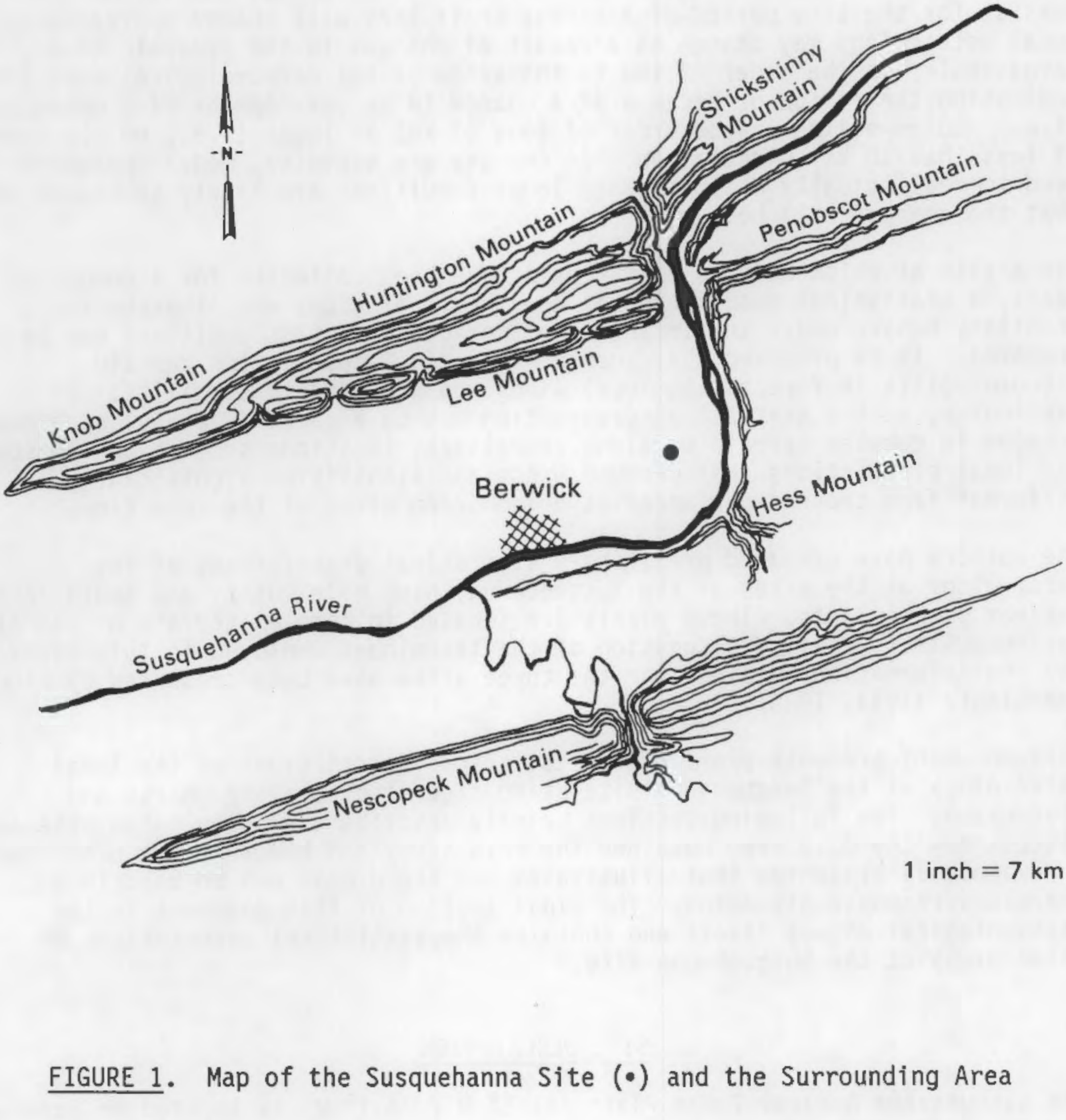


FIGURE 1. Map of the Susquehanna Site (•) and the Surrounding Area

Within 40 km (25 mi) of the Susquehanna facility, the river generally flows from the east-northeast to the west-southwest. Eight km (5 mi) north (upriver) of the site, the Susquehanna River makes an abrupt turn toward the south. There the river passes through a deep, steeply sloped gorge between Lee Mountain to the west and Penobscot Mountain to the east. From that point, the river flows south, toward the plant, through a valley 0.8 km (0.5 mile) wide. In this stretch, the valley is bounded by terrain often rising 150 m (500 ft) above the river's surface. One kilometer (0.6 mi) south of the plant, the Susquehanna River turns toward the west-southwest. The river flows in this direction for over 24 km (15 mi). Along this stretch, the river valley widens and is bounded by Knob and Lee mountains, 8 km (5 mi) to the north, and Nescopeck Mountain, 5 km (3 mi) to the south. East of the Susquehanna plant, the terrain is very complex, with elevations rising steadily, reaching a mean of 600 m (2000 ft) MSL 24 km (15 mi) away.

The population center closest to the Susquehanna plant is the town of Berwick. Berwick is located 8 km (5 mi) west-southwest of the plant. The cities of Wilkes-Barre and Scranton are northeast of the plant. Wilkes-Barre is 27 km (17 mi) from the plant; Scranton is situated to the northeast of Wilkes-Barre.

DATA USED IN PREPARING THE DIGEST

Two years of measurements of Susquehanna site meteorology were used in the preparation of the climatological digest. These observations were recorded on the facility's original 90-m (≈300-ft) instrumented tower [now replaced by a 60-m (≈200-ft) tower]. The data used for the analysis are for the period January 1, 1974, through December 31, 1975. These data were provided by the U.S. Nuclear Regulatory Commission. The data set included hourly averaged observations of wind speed, wind direction, and temperature recorded at 90 m (≈300 ft) and 10 m (≈30 ft) above ground level. Wind speeds were reported in meters per second, wind directions in degrees from true north, and temperatures in degrees Celsius.

For this study, the wind recorded at the 90-m level on the tower was assumed to govern atmospheric transport at the site. Wind data from this level are therefore used to represent the site wind. Temperature lapse rates, Richardson numbers, and power law exponents for the variation of wind speed with height were computed to represent the stability and wind structure of the lower atmosphere at the site. These parameters are computed using wind and temperature differences between the upper and lower instrument levels. The temperature lapse rate is the difference in atmospheric temperature over a specified vertical distance. The Richardson number is used as a stability criterion; it is the ratio of the work done against gravity by vertical motions to the available kinetic energy of the wind shear (Wallace and Hobbs 1977). The transition from stable to unstable atmospheric conditions generally begins when the Richardson number drops below 0.25. However, once unstable conditions are established, they will persist for a time even after the Richardson number rises above 0.25. The power law exponent is the exponent α in the equation

$$U_2 = U_1 \cdot (Z_2/Z_1)^{\alpha} \qquad (1)$$

where $U_x \equiv$ the wind speed (m/s) at level x
$Z_x \equiv$ the height (m) above the ground of level x

Synoptic weather conditions during the observation period were determined by applying a weather-typing model (Lindsey and Glantz 1986) to surface weather maps issued by the National Weather Service. These surface charts were obtained on microfilm from the National Climatic Data Center. For each day during the observation period, charts were available for the eight regular synoptic observation times: 00Z, 03Z, 06Z, 09Z, 12Z, 15Z, 18Z and 21Z.[a] To determine the synoptic weather conditions, the Susquehanna site location was identified on each chart, and the synoptic conditions at that point were observed and recorded. The site data and synoptic observations were subsequently merged into a single data set for analysis.

The data were categorized for analysis as belonging to only two seasons, winter and summer. Winter was defined as the period from October 1 to April 30, and summer as the period from May 1 to September 30. Synoptic conditions at the Susquehanna site were categorized into five major classes, as defined in the weather-typing model (see Figure 2 and Table 1). The observations of the direction of the geostrophic wind[b] at the site, as determined from the surface weather map, were categorized into eight direction classes. Observations were assigned to eight time periods, each 4 hours long and measured from the time of the previous sunrise or sunset (see Table 2). Eight time periods, rather than six, are needed because summer days and winter nights are more than 12 hours long.

In addition to these categorizations, an additional parameter can be used to subdivide the data. This parameter is the strength of the synoptic pressure gradient. However, data from the 2-year period used in this study were insufficient to allow for the strength of the pressure gradient to be included in this preliminary digest.

(a) Z denotes Greenwich Mean Time.
(b) A hypothetical wind that blows parallel to the local isobars and thus perpendicular to the orientation of the local pressure gradient. This hypothetical wind reflects the balance between the pressure gradient and the Coriolis forces in the atmosphere. The actual wind near the surface of the earth tends to have a component of motion across the pressure gradient (towards lower pressure) because friction acts to upset geostrophic balance; however, the geostrophic wind is useful for estimating the direction in which the synoptic pressure gradient will tend to steer winds near the surface.

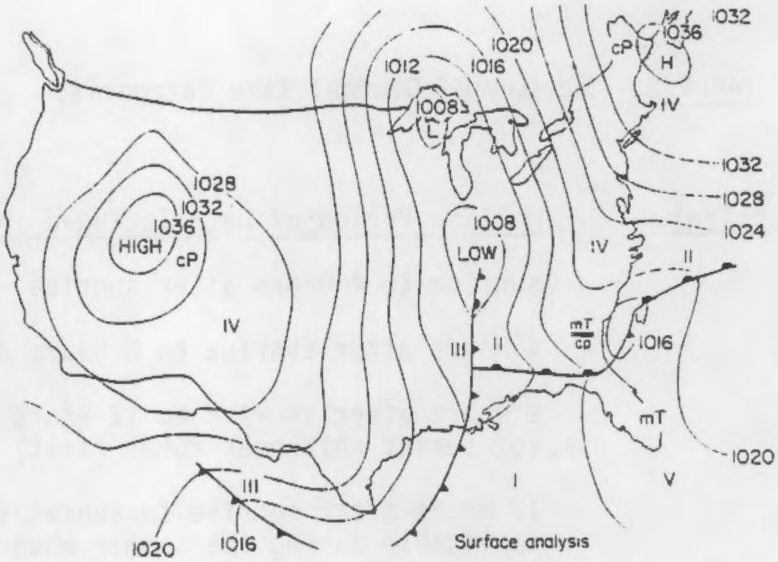


FIGURE 2. Synoptic Categories Applied to Surface Weather Charts

TABLE 1. Summary of the Characteristics of the Synoptic Categories in the Weather-Typing Model

Synoptic Category	Brief Description
I Warm Sector	In the warm sector of an extratropical cyclone. Characterized by cyclonic curvature of the isobars, limited low-level convergence, and a tendency for subsidence.
II Warm Front	Ahead of the warm front in the region of cyclonic curvature to the surface. Characterized by cyclonic curvature of the isobars, vertical lifting, and warm advection.
III Cold Front	Behind the cold front in the region of cyclonic curvature to the surface isobars. Characterized by cold advection and gusty winds.
IV Cold Core Ridge	Under a polar high in a region of anticyclonic curvature to the surface isobars. Characterized by low-level subsidence.
V Warm Core Ridge	In the vicinity of a subtropical ridge. Characterized by anticyclonic curvature and weak but persistent subsidence.

TABLE 2. Summary of Diurnal Time Categories

Time Code (Hours Since Sunrise)	Time Period of Data Included in Category
SR	sunrise to 4 hours after sunrise
+4	4 hours after sunrise to 8 hours after sunrise
+8	8 hours after sunrise to 12 hours after sunrise (or sunset whichever comes first)
+12	12 hours after sunrise to sunset (only applicable during the summer when the day is longer than 12 hours)

Time Code (Hours Since Sunset)	Time Period of Data Included in Category
SS	sunset to 4 hours after sunset
+4	4 hours after sunset to 8 hours after sunset
+8	8 hours after sunset to 12 hours after sunset (or sunset whichever comes first)
+12	12 hours after sunset to sunset (only applicable during the winter when the night is longer than 12 hours)

DIGEST ORGANIZATION AND FORMAT

The digest for the Susquehanna site is divided into three main sections. In the first section, site meteorological data are presented independently of the time of year the data were collected, first for all the data in the study and then distinguished down by synoptic weather category. In the next section, only data collected during the defined winter season are presented. In the final section, only data collected during the defined summer season are presented. Within these final two sections, site meteorological data are examined as functions of the synoptic weather category, the direction of the geostrophic wind, and the time of day the data were measured. All the data for a given synoptic weather category are presented before the next category is considered.

Some combinations of conditions did not occur often enough for the observed meteorological data to be presented in the digest as a function of the direction of the geostrophic wind and the time of day. Data presentations that are not statistically significant are omitted from the digest.

Five types of figures are presented in the climatological digest (these are referred to as figure types A, B, C, D, and E). The headings of all the figures in the digest follow a standard format. The heading includes the name of the site, the season, the synoptic weather classification, the direction class and strength of the geostrophic wind, a section code, and the percentage of the time that the stated season, synoptic category, direction of the geostrophic wind, and pressure gradient occur together. A sample heading and information on how to interpret it are presented in Figure 3.

Figure type A is illustrated by Figure 4. This figure consists of 3 graphs and a "Diurnal Cross Reference Index." Such a figure is included in the digest for each combination of season and synoptic weather category. The first graph, "Site Wind Statistics," depicts the means and standard deviations of the wind directions and speeds measured at the site (during the season and under the synoptic conditions listed in the heading) as a function of the geostrophic wind direction. The mean wind directions measured at the site are indicated by an 'X' and the mean wind speeds are marked by an 'O'. Standard deviations are represented by the overbars. The second graph, "Frequency Geostrophic Wind Direction," gives the frequency of occurrence of each of the eight geostrophic wind-direction classes used in the weather-typing model. The frequencies sum to 100%. The third graph on this figure, "Frequency Site Wind Direction," presents wind-direction frequencies and mean wind speeds obtained from site measurements. These values are presented independently of geostrophic wind direction. The percent occurrence of site winds from all directions is 100%. The mean wind speeds are given in meters per second, and standard deviations are indicated by the overbars.

The diurnal cross reference index, presented at the bottom of this figure, refers the reader to subsequent figures that present detailed information on the variation of wind direction and speed as a function of the time of day. It uses all or the final portion of the section code for the figure being referenced; if a only portion of the section code is listed, the rest of the code is identical to the code in the heading at the top of the page. Plots of diurnal variations are not presented for all synoptic conditions because many situations have percentages of occurrence that will not produce statistically significant results.

SITE: Susquehanna PA.	SECTION: S-II- 5 - 0
	SEASON: Summer
	CATEGORY: Warm Front
% Occurrence = 1.43	Vg (dir/mag): S / All

SITE gives the name of the site and the state in which it is located.

SECTION contains 4 coded entries to facilitate data base storage and easy reference. The 4 entries, in order of appearance, are:

- season:
  - A = annual
  - S = summer
  - W = winter
- synoptic weather category:
  - I = warm sector
  - II = warm front
  - III = cold front
  - IV = cold core ridge
  - V = warm core ridge
- geostrophic wind direction:
  - 1 = north 337.5° - 22.5°
  - 2 = northeast 22.5° - 67.5°
  - 3 = east 67.5° - 112.5°
  - 4 = southeast 112.5° - 157.5°
  - 5 = south 157.5° - 202.5°
  - 6 = southwest 202.5° - 247.5°
  - 7 = west 247.5° - 292.5°
  - 8 = northwest 292.5° - 337.5°
- magnitude of synoptic pressure gradient: 0 is used for all cases (in this preliminary study the strength of the pressure gradient was not considered)

SEASON contains the name of the defined season during which the data were collected: Annual, Summer, or Winter

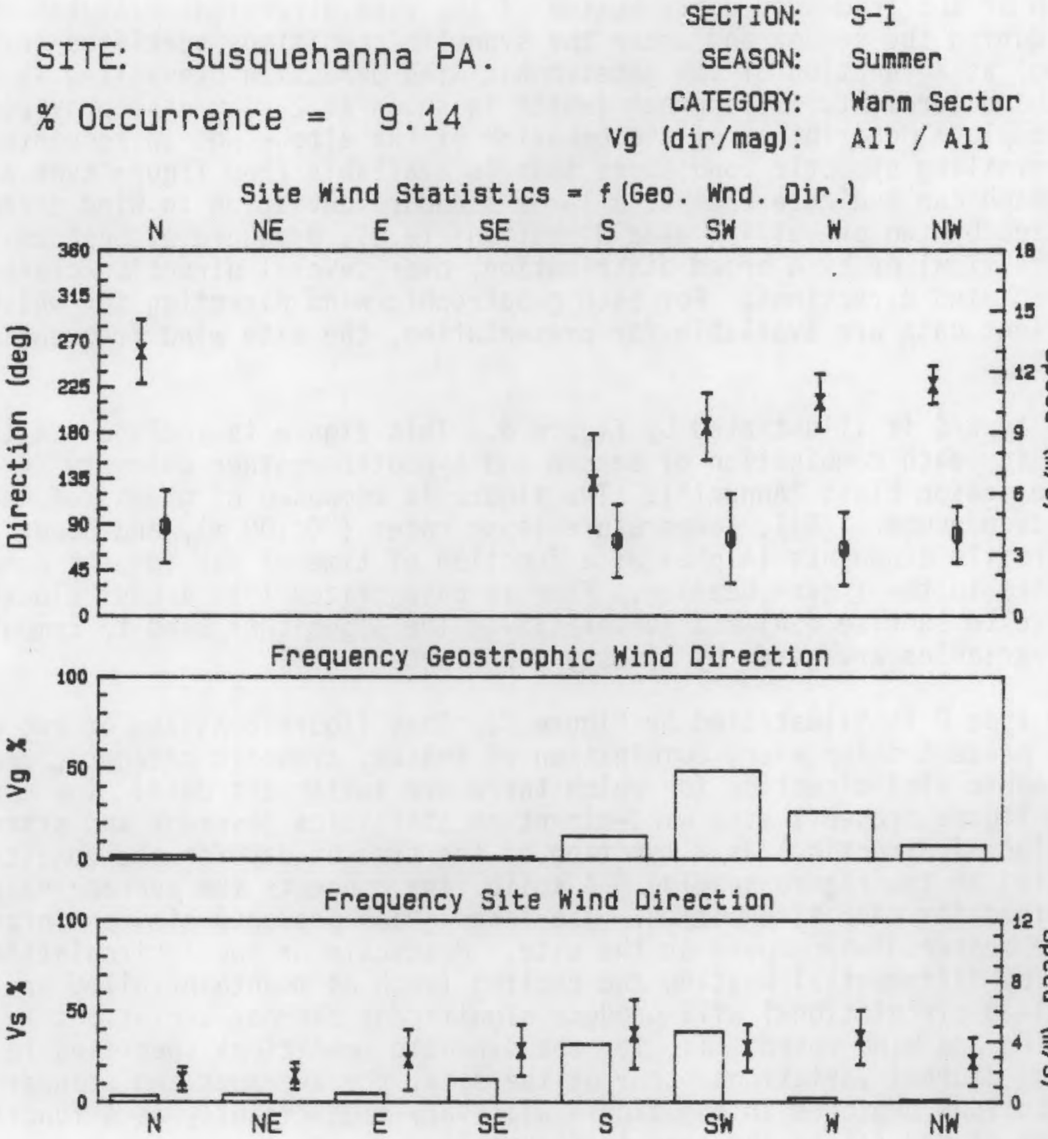
CATEGORY contains the name of the synoptic category: Warm Sector, Warm Front, Cold Front, Cold Core Ridge, and Warm Core Ridge

Vg (dir/mag) contains two items of information:

- direction of the geostrophic wind: N, NE, E, SE, S, SW, W, and NW.
- magnitude of the synoptic pressure gradient: All is used for all cases (in this preliminary study the strength of the pressure gradient was not considered)

% Occurrence presents the percentage of time the stated season, synoptic category, direction of the geostrophic wind, and pressure gradient occur simultaneously.

FIGURE 3. A Sample Heading for the Digest's Figures and an Explanation of Each Item in the Heading.



Diurnal Cross Reference Index

Pressure Gradient Orientation X Magnitude

	N	NE	E	SE	S	SW	W	NW
All					-5-0	-6-0	-7-0	
Strong								
Weak								

FIGURE 4. Example of the Climatological Digest's Type A Figure

Figure type B is illustrated by Figure 5. This figure is included in the digest for each combination of season and synoptic weather category. It shows a graph of the frequency distribution of the wind directions measured at the site (during the season and under the synoptic conditions specified in the heading) as a function of the geostrophic wind direction prevailing at the time of each measurement. This graph (which is shown as 2 segments) provides a more complete description of the behavior of the site winds in response to the prevailing synoptic conditions than is available from figure type A. This graph can indicate whether a large standard deviation in wind direction is caused by two prevailing wind directions (e.g., produced by onshore versus offshore flow) or by a broad distribution, over several direction classes, of measured wind directions. For each geostrophic wind direction for which sufficient data are available for presentation, the site wind frequencies sum to 100%.

Figure type C is illustrated by Figure 6. This figure is included in the digest for each combination of season and synoptic weather category (except for the season class "Annual"). The figure is composed of graphs of the mean Richardson numbers (Ri), temperature lapse rates (°C/100 m), and power law wind profile exponents (Alpha) as a function of time of day for the conditions specified in the figure heading. Time is categorized into 4-hour blocks relative to sunrise (SR) and sunset (SS). The algorithms used to compute these variables are given by Lindsey and Glantz (1986).

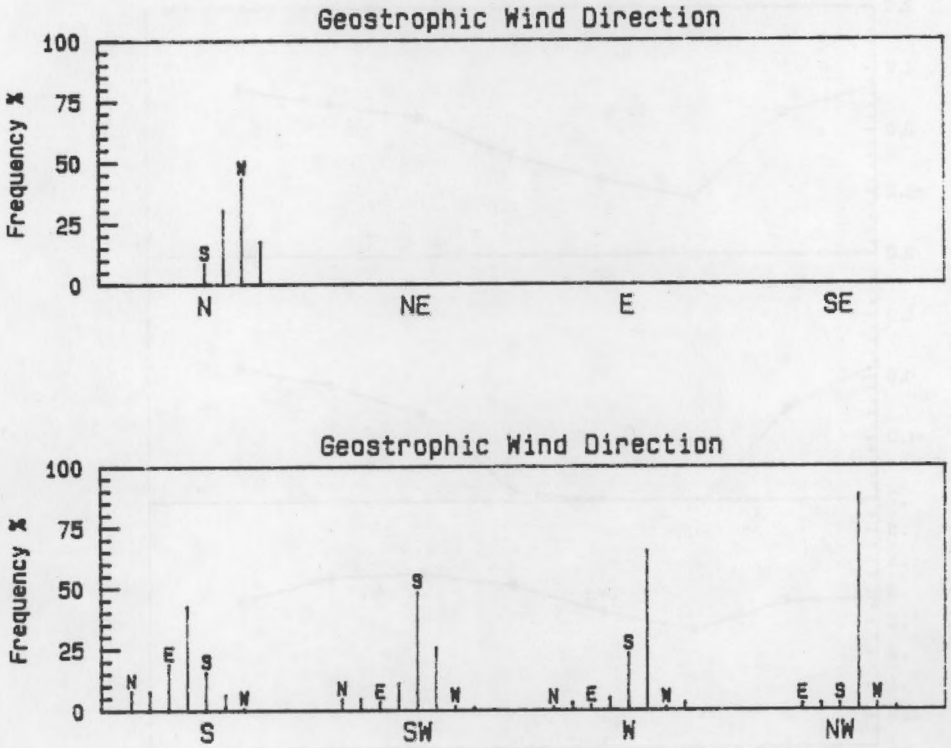
Figure type D is illustrated by Figure 7. This figure consists of two graphs and is presented for every combination of season, synoptic category, and geostrophic wind direction for which there are sufficient data. The upper graph in the figure presents site wind-direction statistics (average and standard deviation of direction) as a function of the time of day for the conditions specified in the figure heading. A solid line connects the average values determined for each time period. The lower graph presents similar information for the measured wind speed at the site. Mesoscale or local circulations caused by differential heating and cooling (such as mountain/valley or ocean/land circulations) will produce significant diurnal variations in wind direction and wind speed. If, for the synoptic conditions specified in the heading, diurnal variations occur at the site, the averages and standard distributions depicted in the figure will vary significantly as a function of the time of day (as is the case in Figure 7).

Figure type E is illustrated by Figure 8. This figure is presented for every combination of season, synoptic category, and geostrophic wind direction for which there are sufficient data. It is always presented in sequence after figure type D. The figure consists of a graph of the frequency distribution of the measured wind direction as a function of the time of day for the conditions specified in the figure heading. The sum of the frequencies of occurrence for each time period for which data are available is 100%. When the standard deviation of a wind direction presented in figure type D is large, the actual distribution of wind directions can be examined in this figure (note the diurnal variation in Figure 8). The data in this type of figure are stratified in four-hour increments; phenomena associated with shorter time periods may be blurred by the 4-hour averaging period.

SITE: Susquehanna PA.

% Occurrence = 9.14

SECTION: S-I
SEASON: Summer
CATEGORY: Warm Sector
Vg (dir/mag): All / All



Site Wind Direction Frequencies as a Function of

Geostrophic Wind Direction

FIGURE 5. Example of the Climatological Digest's Type B Figure

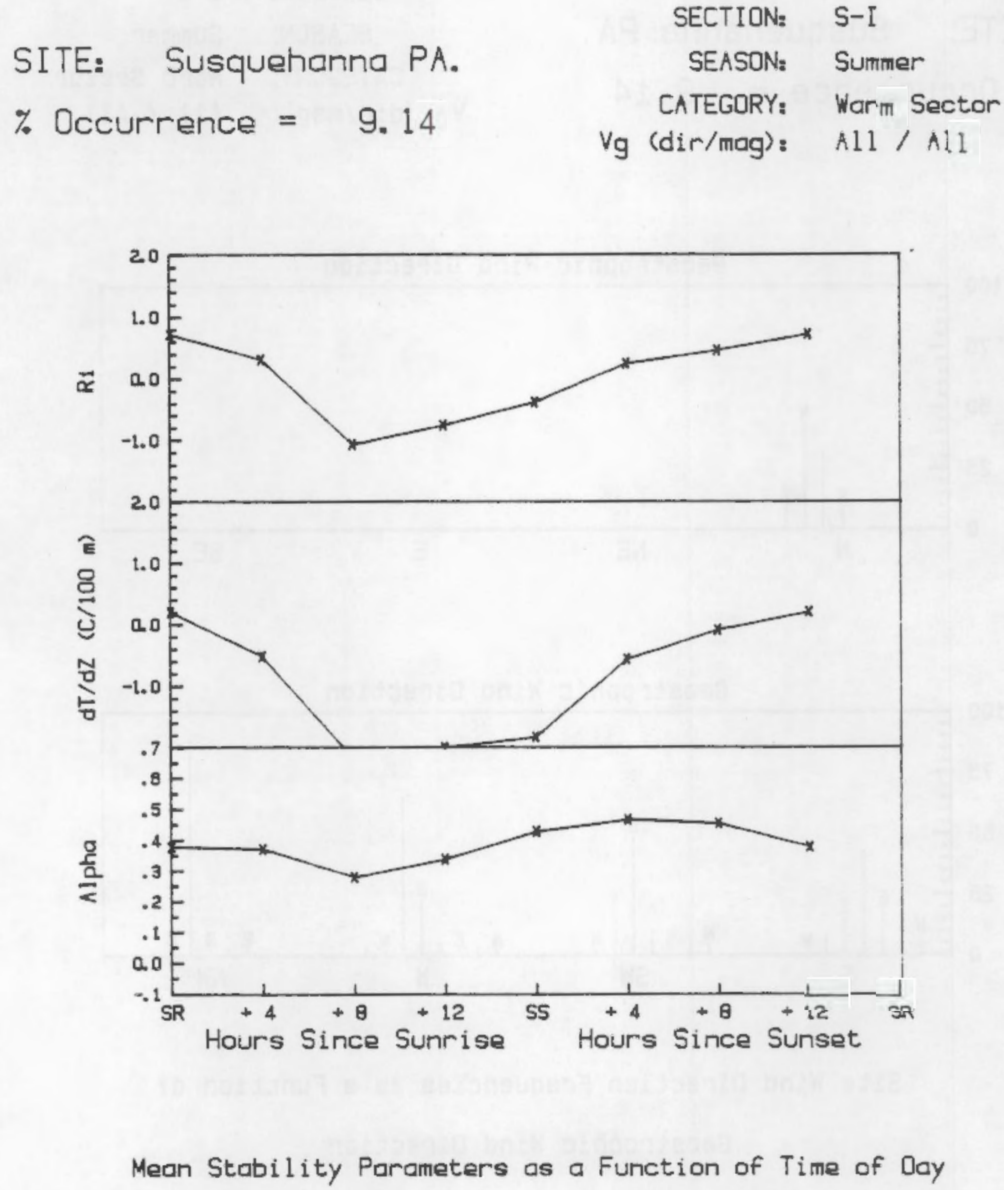


FIGURE 6. Example of the Climatological Digest's Type C Figure

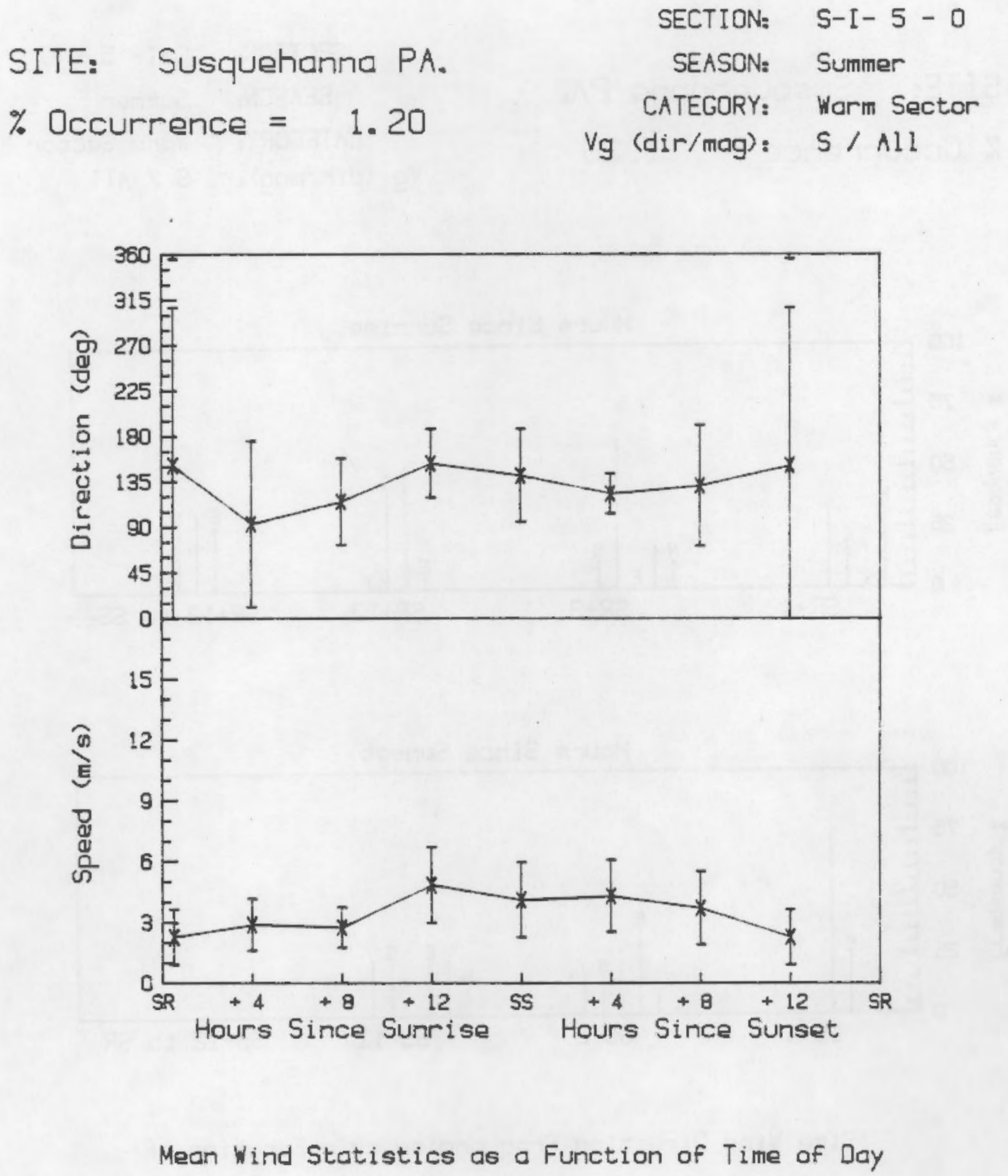


FIGURE 7. Example of the Climatological Digest's Type D Figure

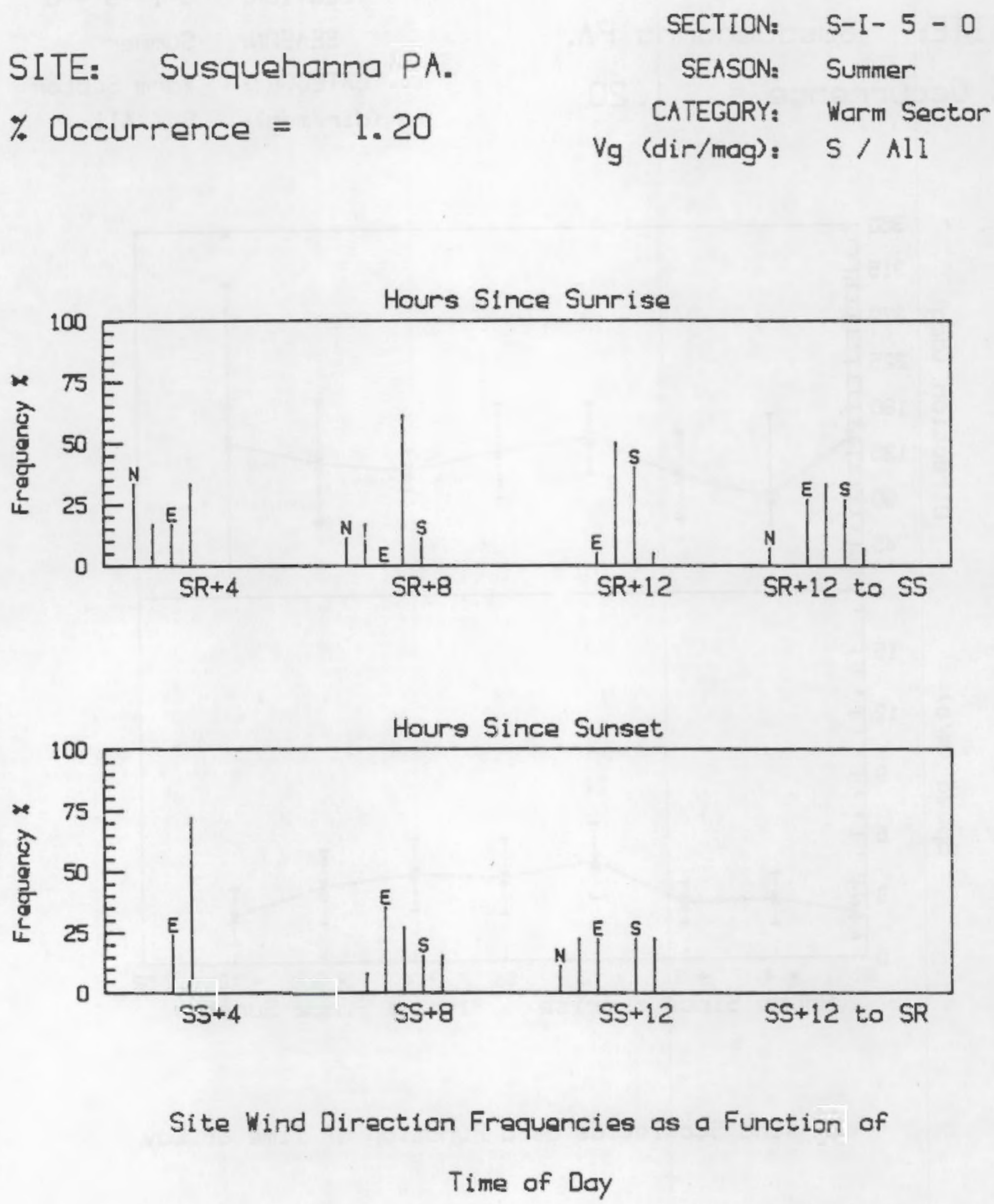


FIGURE 8. Example of the Climatological Digest's Type E Figure

One variation can occur in the formats of figure types D and E. In some instances, the number of observations may be insufficient to permit the use of 4-hour time periods. However, in some of these cases, the data can still be sufficiently stratified by day versus night periods. In such cases, the diurnal summaries will present one set of values for sunrise to sunset, and another for sunset to sunrise conditions.

USING THE DIGEST

Before the meteorologist uses the digest, he needs to identify the synoptic condition or conditions of interest. If only interested in general conditions, the meteorologist should start with the first section of the digest and study the response of local meteorology to various synoptic conditions, independent of the seasons. If interested in a specific season, synoptic weather category, and geostrophic wind, the meteorologist should turn to that season's section of the digest and find the figures representing the conditions of interest. The "Digest Directory" (see page 23) and the section code should help quickly locate the appropriate material. The following example illustrates how the digest might be used by a meteorologist in an emergency-response situation at the Susquehanna site.

Scenario

It is 5 p.m. on August 2 and an emergency situation has developed at the Susquehanna plant. A controlled release of radioactive gases to the atmosphere may be necessary sometime during the coming evening or night. Estimates of atmospheric dispersion are required for potential release times of 6 p.m., 10 p.m., 2 a.m., and 6 a.m. An effective release height of between 50 and 75 m is estimated. Currently, the winds measured at the 61-m level on the site meteorological tower are from the south at 4 m/s. The atmospheric stability is slightly unstable. On the synoptic level, a warm front (synoptic category I) is rapidly approaching from the southwest. On the surface weather chart, the isobars near the site indicate a geostrophic wind from the southwest.

Response

After beginning an initial run of the atmospheric-dispersion model that assumes the persistence of the current meteorology, we want to prepare a better forecast of site winds for the next model runs. We consult the climatological digest and examine page 49 for the meteorological conditions that historically occur during the summer season ahead of a warm front. This is a figure that we classified as type A (from our discussion on page 7). We read that a summer warm front occurs about 4.5% of the time during the year. The upper graph indicates that, under the influence of a southwesterly geostrophic wind, the average wind direction is southerly and the average wind speed is approximately 3 m/s; however, there are significant standard deviations about these mean values. The currently measured wind (southerly at 4 m/s) falls well within historical norms. The next graph indicates that the southwesterly geostrophic wind observed is common when the site is under the influence of a summer season warm front. The third graph indicates that for a summer warm front (not considering the geostrophic wind direction) a broad distribution of winds is possible, although winds from the west and northwest occur rarely. The Diurnal Cross Reference Index indicates that detailed information is available for four to eight geostrophic wind directions. However, before skipping through the digest and examining the detailed information related to the southwesterly geostrophic wind, we should first examine the associated figures on the next two pages.

In the next figure (figure type B) we see that for a southwesterly geostrophic wind, the prevailing wind at the site is from the south (the same direction currently being measured on the meteorological tower), although the wind frequently blows from other directions.

Turning the page to the next figure (figure type C), we obtain stability and wind shear information. The current (approximately 11 hours since sunrise) slightly unstable atmosphere seems to be in line with historical observations. According to this figure, at the first potential time of release (6 p.m., approximately 12 hours after sunrise), the average atmospheric stability should remain slightly unstable. Because the predicted effective release height (50-75 m) is close to our measurement height (61 m), vertical wind shear is not an important parameter; at any rate, the graph of power law wind profile exponents (alpha) indicates little diurnal variation in this parameter.

We now turn to page 55 to examine figure type D for the more detailed information referred to in the Diurnal Cross Reference Index. We read that a summer warm front with a geostrophic wind from the southwest occurs 1.4% of the time during the year, a relatively high frequency of occurrence for this level of data stratification. We see that there is little diurnal variation in wind direction for these conditions, although wind speeds tend to increase during the latter part of the day. Turning the page, we see that additional diurnal information are not presented (i.e., there is no type E figure) for the current synoptic conditions.

In summary, the four figures examined indicate that

- the measured wind direction, wind speed, and atmospheric stability are common for the current synoptic conditions
- by the first potential time of release (6 p.m.), assuming no change in synoptic conditions, a significant change in wind direction and speed should not occur; however, the rate of diffusion may decrease slightly as the atmosphere becomes somewhat more stable as sunset approaches.

Synoptic Forecast

National Weather Service (NWS) meteorologists forecast that the warm front rapidly approaching from the southwest will pass by the Susquehanna site sometime between 7 p.m. and 9 p.m., putting the site in the warm sector behind the warm front (synoptic category II). On the NWS charts that forecast surface conditions for the coming evening and night, the orientation of the isobars in the warm sector indicates a southerly geostrophic wind.

We consult the climatological digest and examine the meteorological conditions that historically occur during the summer in the warm sector (page 41). We read that summer-season, warm-sector conditions occur about 9.1% of the time during the year. The upper graph indicates that under the influence of a southerly geostrophic wind, the average wind direction is fairly close to southeasterly and the average wind speed is slightly above 3 m/s; however, there are significant standard deviations about these values. The next graph indicates that the southerly geostrophic wind only occurs 10-15% of the time when the site is experiencing summer-season, warm-sector conditions. The third graph indicates that for these conditions (not considering the geostrophic wind direction), winds from the southeast through southwest dominate. The Diurnal Cross Reference Index indicates that detailed information is available for three of the geostrophic wind directions, including the forecast southerly geostrophic wind. However, before skipping through the digest and examining this detailed information related to the southerly geostrophic wind, we should first examine the associated figures on the next two pages.

In the next figure, we see that for a southerly geostrophic wind, the prevailing wind is from the southeast; however the wind frequently blows from other directions, especially the east and south.

Turning the page to the next figure, we obtain stability and wind shear information. The Richardson numbers and temperature lapse rates both indicate that historically atmospheric stability increases during the night. Using this figure and our knowledge of current conditions, we can predict neutral to stable conditions for the 10 p.m. and stable conditions for the 2 a.m. and 6 a.m. release options. Little change in the vertical wind shear is indicated in the graph of power law wind profile exponents (alpha).

We now turn to page 44 to examine the more detailed information referred to in the Diurnal Cross Reference Index. We read that summer, warm-sector conditions with a geostrophic wind from the south occur 1.2% of the time during the year, a relatively high frequency of occurrence for this level of data stratification. We see little diurnal variation in average wind direction for these conditions, although average wind speed tends to increase during the latter part of the day. However, the large change in the standard deviation of the wind direction as a function of the time of day indicates a strong diurnal effect.

Turning the page, we see in the next figure (figure type E) a significant diurnal impact on the frequency distribution of winds. For the projected release at 10 p.m. (2-3 hours after sunset), winds historically are from the southeast 75% of the time and from the east 25% of the time; no other wind directions are typically observed. However, for 2 a.m. and 6 a.m., the frequency distribution of wind directions is dramatically different. For 2 a.m. (6-7 hours after sunset), winds from the northeast, east, southeast, south, and southwest have been observed. For 6 a.m. (10-11 hours after sunset), winds from the north, northeast, east, south, and southwest have been observed. Winds from the southeast have not been observed during this period. These distributions indicate that the observed winds reflect both a combination of mountain/valley circulations (northerly, northeasterly, and easterly winds) and a synoptically dominated flow (southerly and southwesterly winds).

Putting the information from these five figures together, we can conclude that

- by 10 p.m., with the transition to warm-sector conditions and a southerly geostrophic wind, winds at the site will probably shift to a southeasterly or easterly direction
- by 2 a.m., a mountain/valley circulation may dominate local winds. If this circulation develops, winds will come from an easterly, northeasterly, or northerly direction
- by 6 a.m., if the mountain/valley circulation has developed, winds should come from the an easterly, northeasterly, or northerly direction. If this circulation does not develop, winds from the south or southwest are indicated
- emergency-response personnel must consider the likelihood of a mountain/valley circulation developing during the evening or night. This circulation can produce atmospheric transport estimates that are dramatically different from those predicted using current meteorological data
- the rate of atmospheric diffusion should decrease after sunset because the atmosphere should become somewhat more stable.

CONCLUSIONS AND RECOMMENDATIONS

A climatological digest can be a valuable resource for improving and refining local meteorological forecasts. It provides the meteorologist with an indication of how the local meteorology may respond to large-scale influences, information that is not currently available from any other source.

The preliminary climatological digest presented in this document is for the Susquehanna Nuclear Power Plant. The data presented are applicable only onsite; they may not be representative of nearby, offsite conditions (e.g., in Berwick or Wilkes-Barre). Also, the wind directions and speeds presented in the digest are based on measurements made at 90 m (300 ft) above the ground; these winds may not be representative of the conditions that would be encountered at ground-level.

Additional work is needed to quantify the benefits of using a climatological digest for forecasting local meteorology and other purposes. A fully operational climatological digest should be based on a minimum of 5 years of meteorological data; the preliminary digest presented in this document is based on only 2 years of data. Because only 2 years of data were used, the level of data representativeness may not be satisfactory for certain applications or synoptic conditions. It must be emphasized that the climatological digest presented in this document is preliminary and should only be used as a guide for meteorologists and not as a stand-alone forecasting method.

REFERENCES

Lindsey, C. G., and C. S. Glantz. 1984. "A Method to Characterize Local Meteorology for Air Pollution Studies and Emergency Response Needs." In Fourth Joint Conference on Applications of Air Pollution Meteorology, pp. 260-263. American Meteorological Society, Boston, Massachusetts.

Lindsey, C. G., and C. S. Glantz. 1986. A Method to Characterize Local Meteorology at Nuclear Facilities for Application to Emergency Response Needs. NUREG/CR-3882, U.S. Nuclear Regulatory Commission, Washington, D.C.

Wallace, J. M., and P. V. Hobbs. 1977. Atmospheric Science: An Introductory Survey. Academic Press, New York.

CLIMATOLOGICAL DIGEST FOR THE SUSQUEHANNA SITE

CLIMATOLOGICAL DIGEST FOR THE SUSQUEHANNA SITE

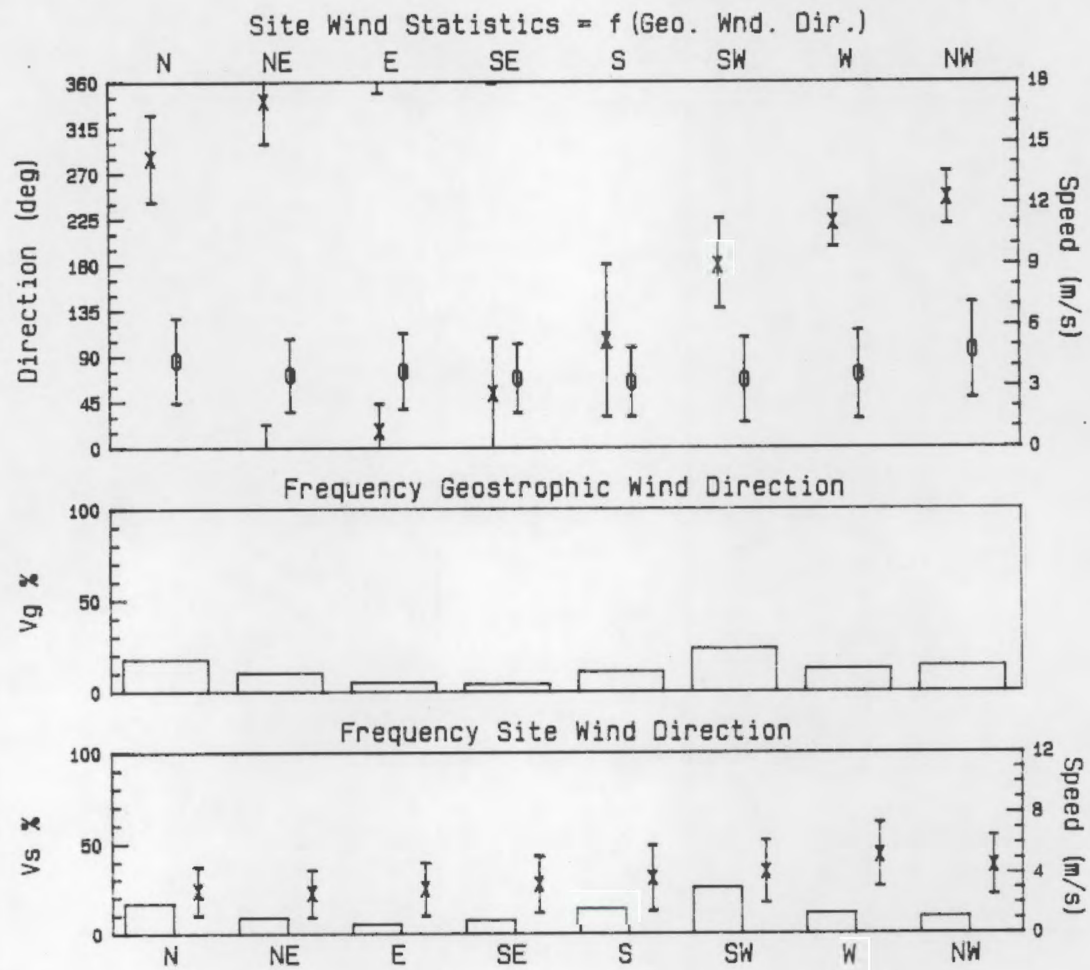
DIGEST DIRECTORY

DIGEST DIRECTORY (cont.)

SITE: Susquehanna PA.

% Occurrence = 100.00

SECTION: A-ALL
SEASON: Annual
CATEGORY: All
Vg (dir/mag): All / All



Diurnal Cross Reference Index

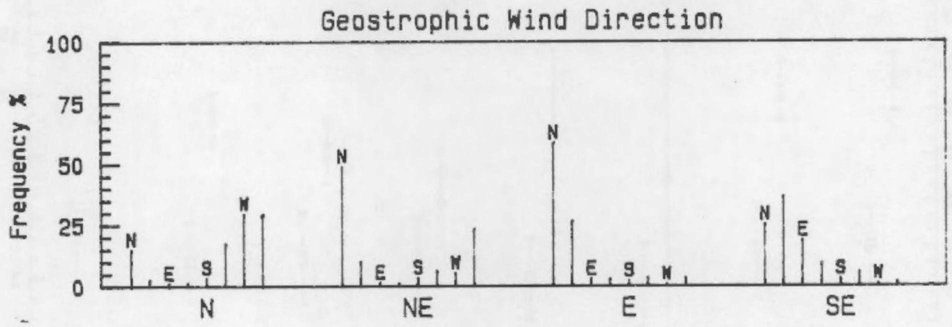
Pressure Gradient Orientation

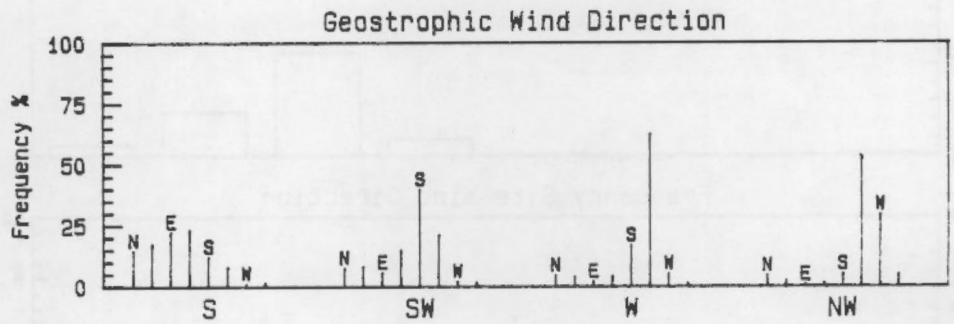
	N	NE	E	SE	S	SW	W	NW
All	S-III-1-0 S-IV -1-0 S- V-1-0	W-III-2-0 W-IV -2-0 S-IV -2-0	S-IV -3-0	W-II -4-0 W-IV -4-0 S-II-4-0 S-IV-4-0	S-I -5-0 W-II -5-0 S-II -5-0 W-IV -5-0 S-IV -5-0 S-III-5-0 S- V-5-0	W-I -6-0 S-I -6-0 W-II -6-0 S-II -6-0 W-IV -6-0 S-IV -6-0 W-V -6-0 S-V -6-0 S-III-6-0	W-IV -7-0 S-IV -7-0 S-V -7-0 S-I -7-0 S-II-7-0 W-II-7-0 S-IV-7-0	S-IV -8-0 W-IV -8-0 S- V-8-0

SITE: Susquehanna PA.

% Occurrence = 100.00

SECTION: A-ALL
SEASON: Annual
CATEGORY: All
Vg (dir/mag): All / All





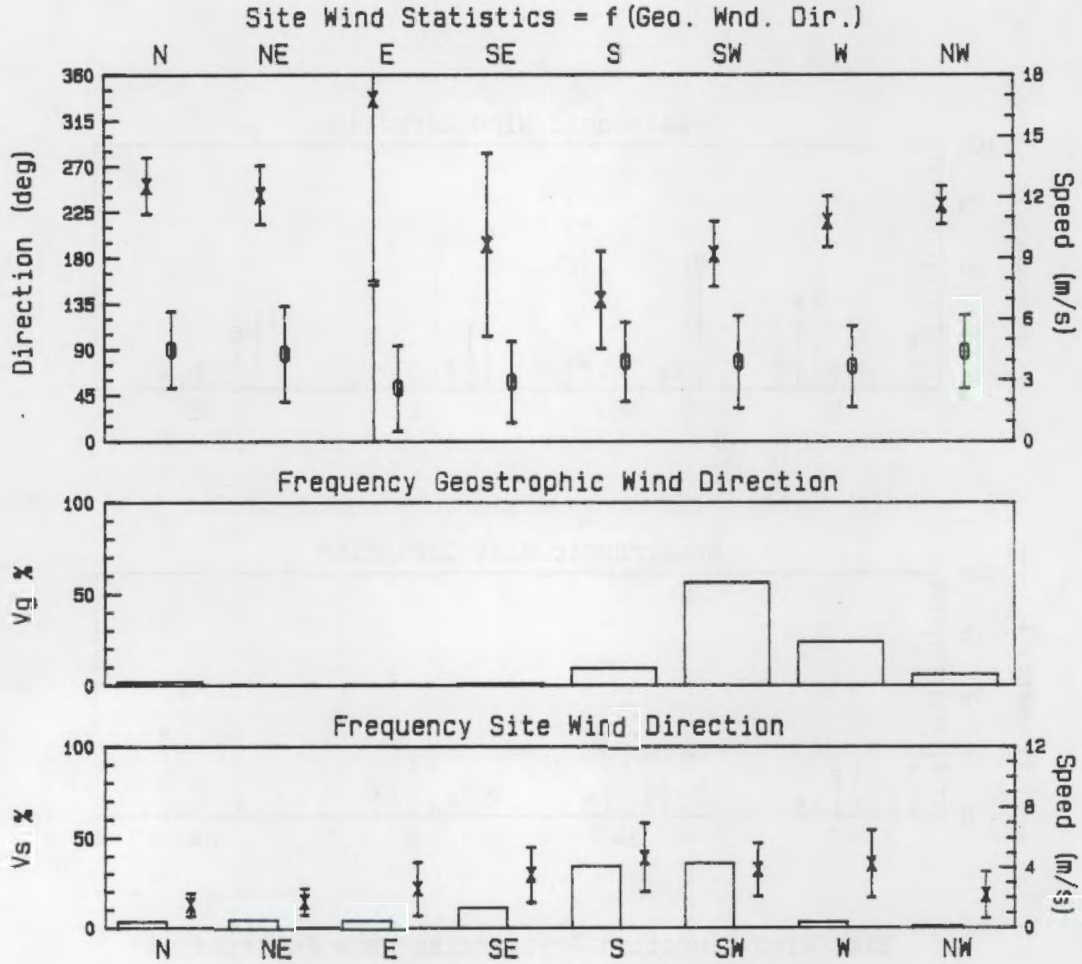
Site Wind Direction Frequencies as a Function of

Geostrophic Wind Direction

SITE: Susquehanna PA.

% Occurrence = 15.96

SECTION: A-I
SEASON: Annual
CATEGORY: Warm Sector
Vg (dir/mag): All / All



Diurnal Cross Reference Index

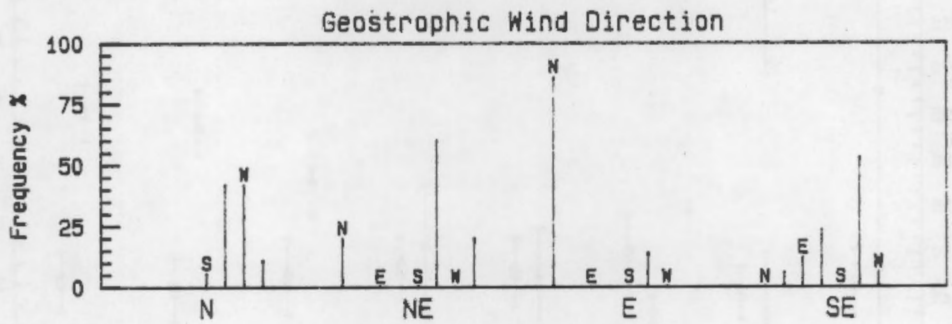
Pressure Gradient Orientation X Magnitude

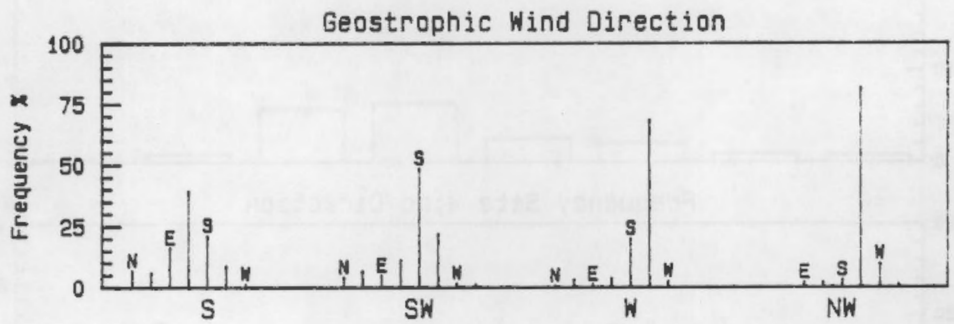
	N	NE	E	SE	S	SW	W	NW
All					S-I -S-O	N-I -S-O S-I -S-O		
Strong								
Weak								

SITE: Susquehanna PA.

% Occurrence = 15.96

SECTION: A-I
SEASON: Annual
CATEGORY: Warm Sector
Vg (dir/mag): All / All





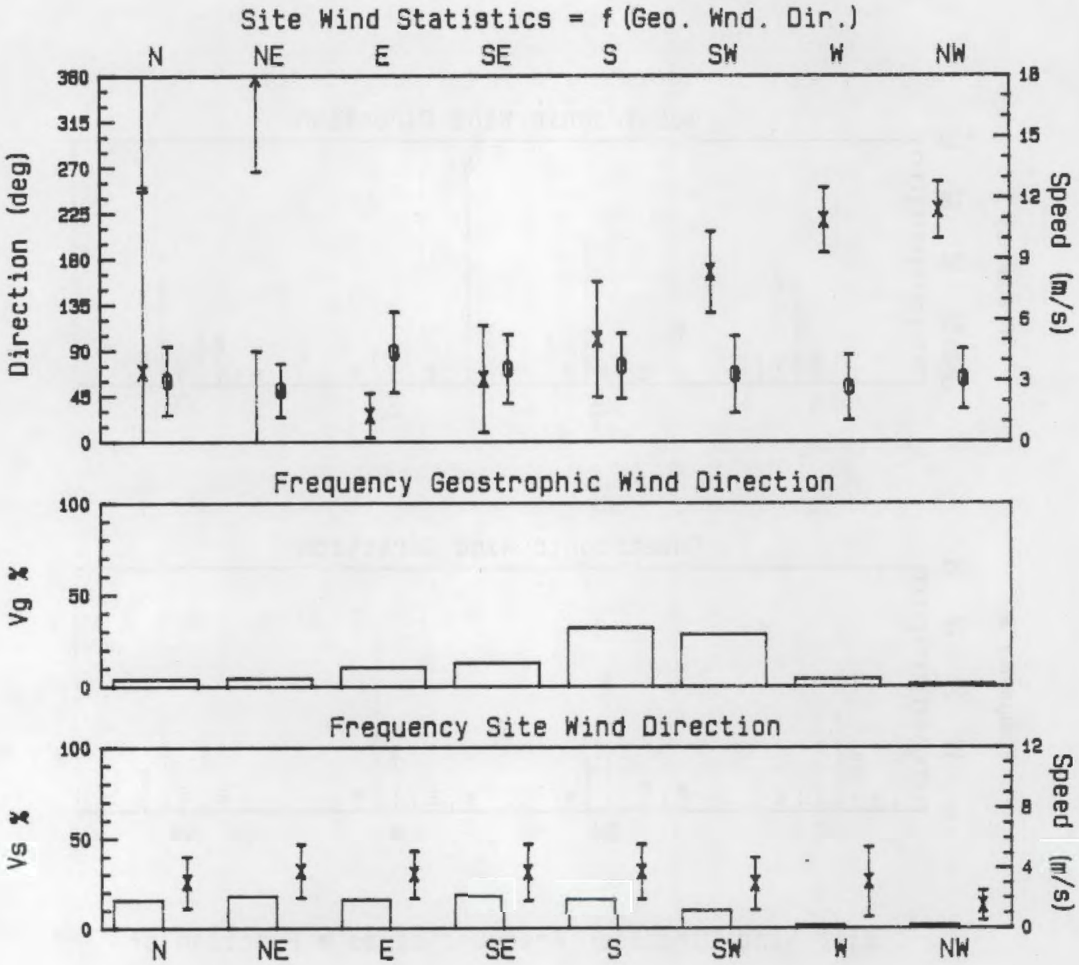
Site Wind Direction Frequencies as a Function of

Geostrophic Wind Direction

SITE: Susquehanna PA.

% Occurrence = 13.68

SECTION: A-II
SEASON: Annual
CATEGORY: Warm Front
Vg (dir/mag): All / All



Diurnal Cross Reference Index

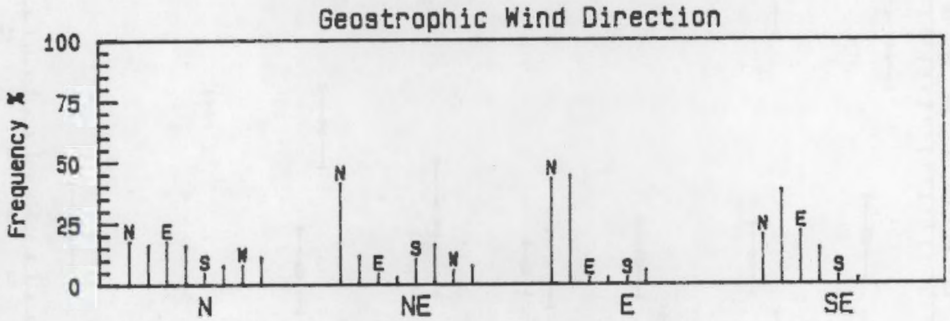
Pressure Gradient Orientation X Magnitude

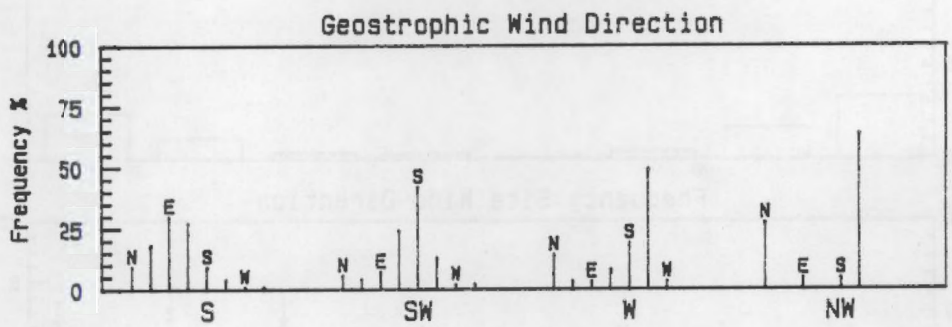
	N	NE	E	SE	S	SW	W	NW
All				W-II -4-0	W-II -5-0 S-II -5-0	W-II -6-0 S-II -6-0		
Strong								
Weak								

SITE: Susquehanna PA.

% Occurrence = 13.68

SECTION: A-II
SEASON: Annual
CATEGORY: Warm Front
Vg (dir/mag): All / All





Site Wind Direction Frequencies as a Function of

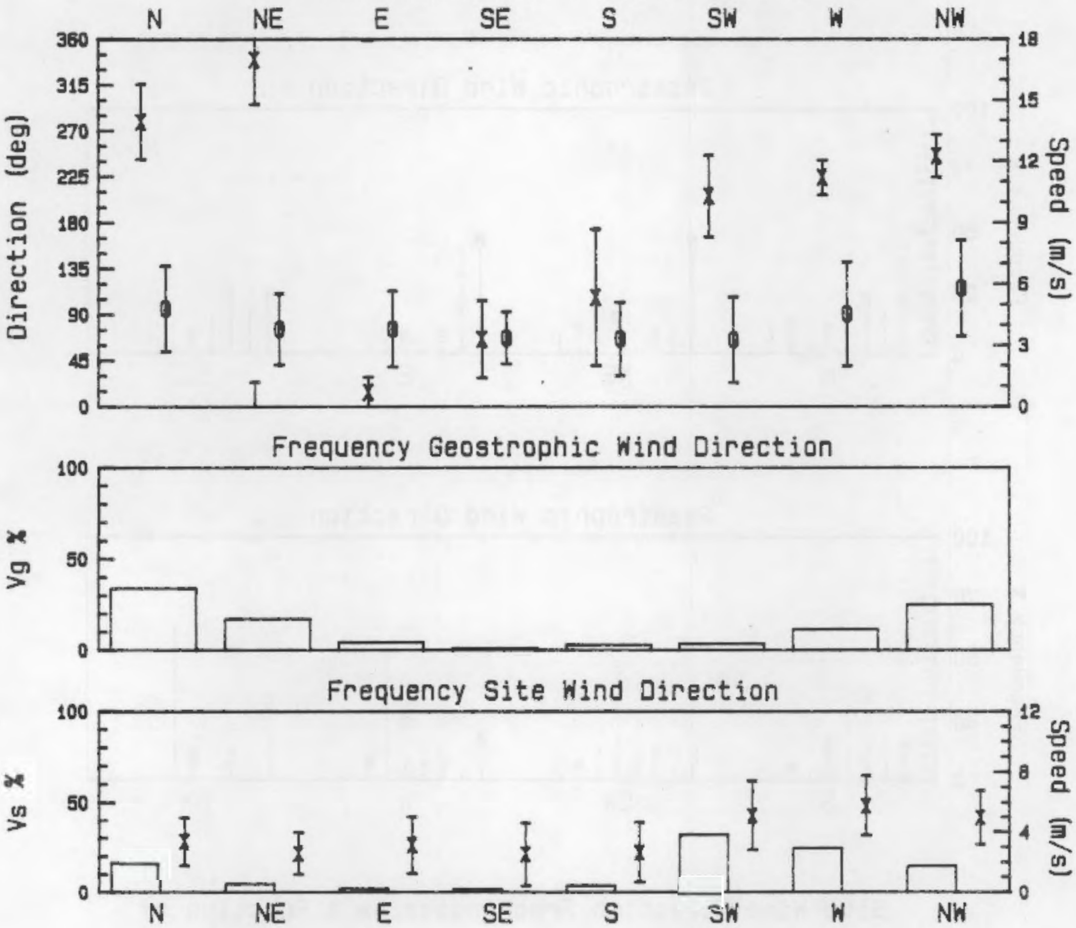
Geostrophic Wind Direction

SITE: Susquehanna PA.

% Occurrence = 23.56

SECTION: A-III
SEASON: Annual
CATEGORY: Cold Front
Vg (dir/mag): All / All

Site Wind Statistics = f(Geo. Wnd. Dir.)



Diurnal Cross Reference Index

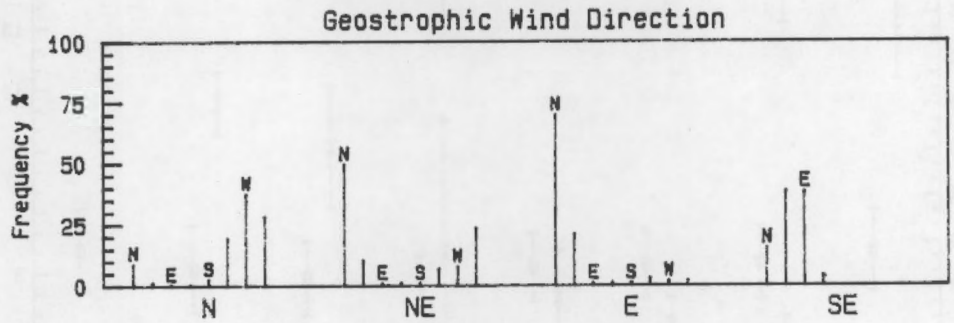
Pressure Gradient Orientation X Magnitude

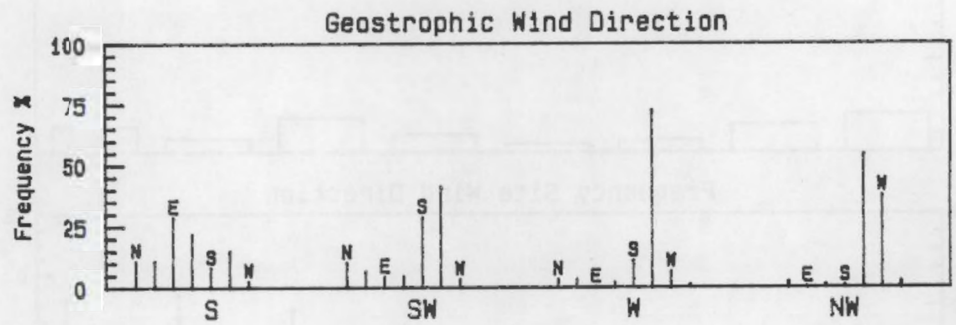
	N	NE	E	SE	S	SW	W	NW
All	S-III-1-0	W-III-2-0						
Strong								
Weak								

SITE: Susquehanna PA.

% Occurrence = 23.56

SECTION: A-III
SEASON: Annual
CATEGORY: Cold Front
Vg (dir/mag): All / All





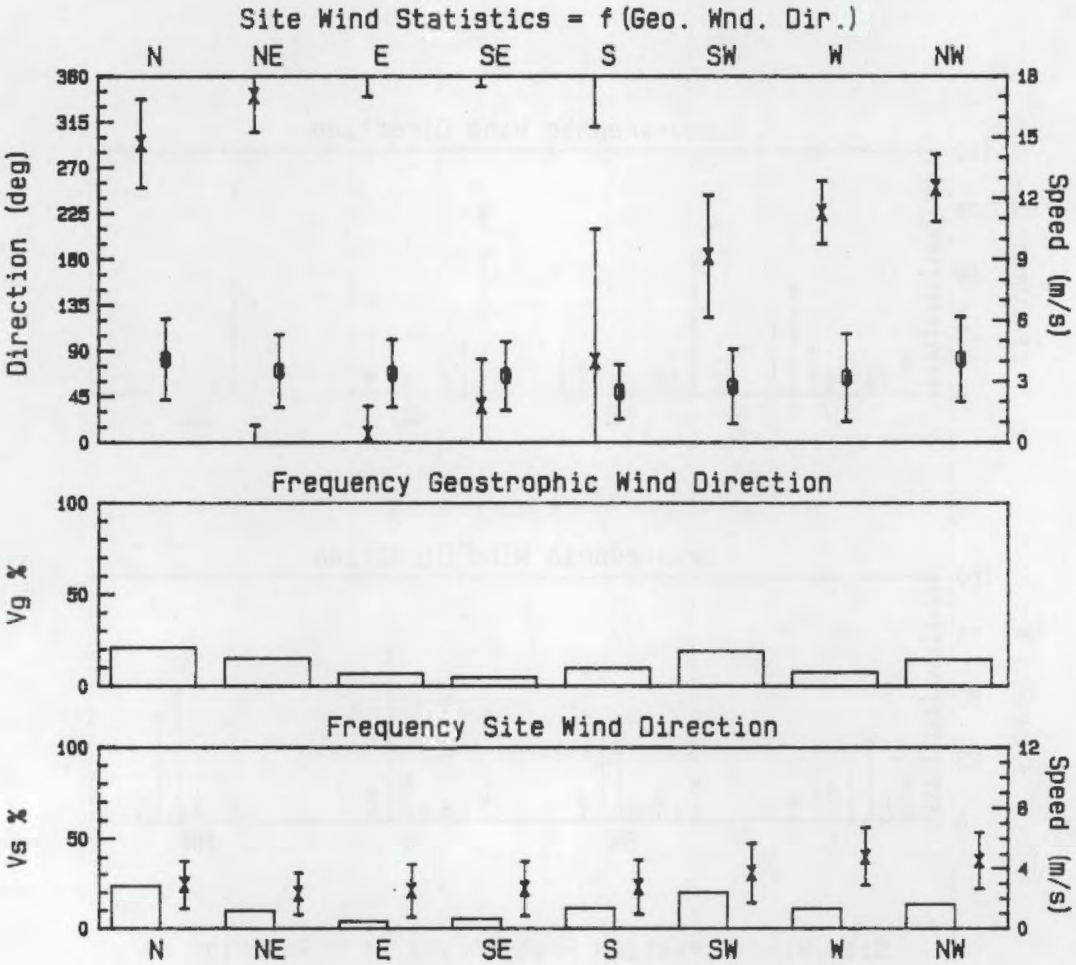
Site Wind Direction Frequencies as a Function of

Geostrophic Wind Direction

SITE: Susquehanna PA.

% Occurrence = 38.13

SECTION: A-IV
SEASON: Annual
CATEGORY: cP/cA Ridge
Vg (dir/mag): All / All



Diurnal Cross Reference Index

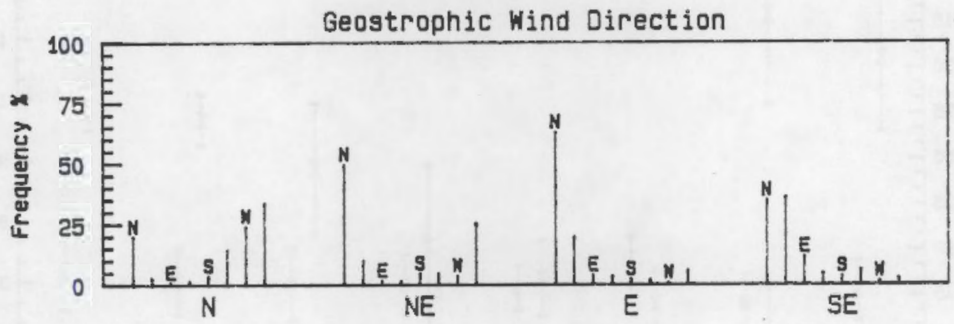
Pressure Gradient Orientation X Magnitude

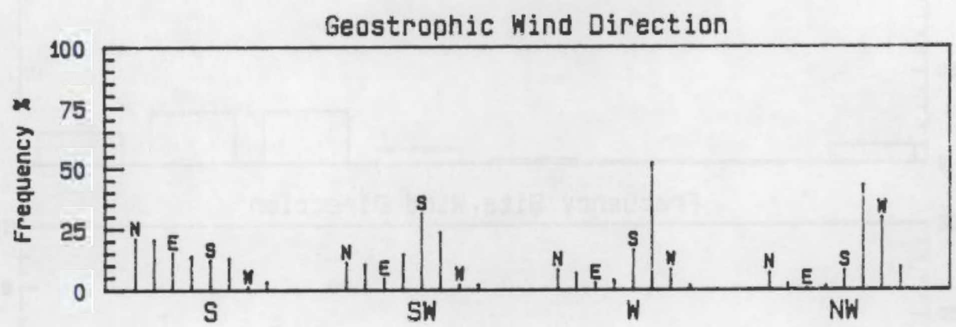
	N	NE	E	SE	S	SW	W	NW
All	S-IV -1-0	N-IV -2-0 S-IV -2-0	S-IV -3-0	N-IV -4-0	N-IV -5-0 S-IV -5-0	N-IV -6-0 S-IV -6-0	N-IV -7-0	S-IV -8-0
Strong								
Weak								

SITE: Susquehanna PA.

% Occurrence = 38.13

SECTION: A-IV
SEASON: Annual
CATEGORY: cP/cA Ridge
Vg (dir/mag): All / All

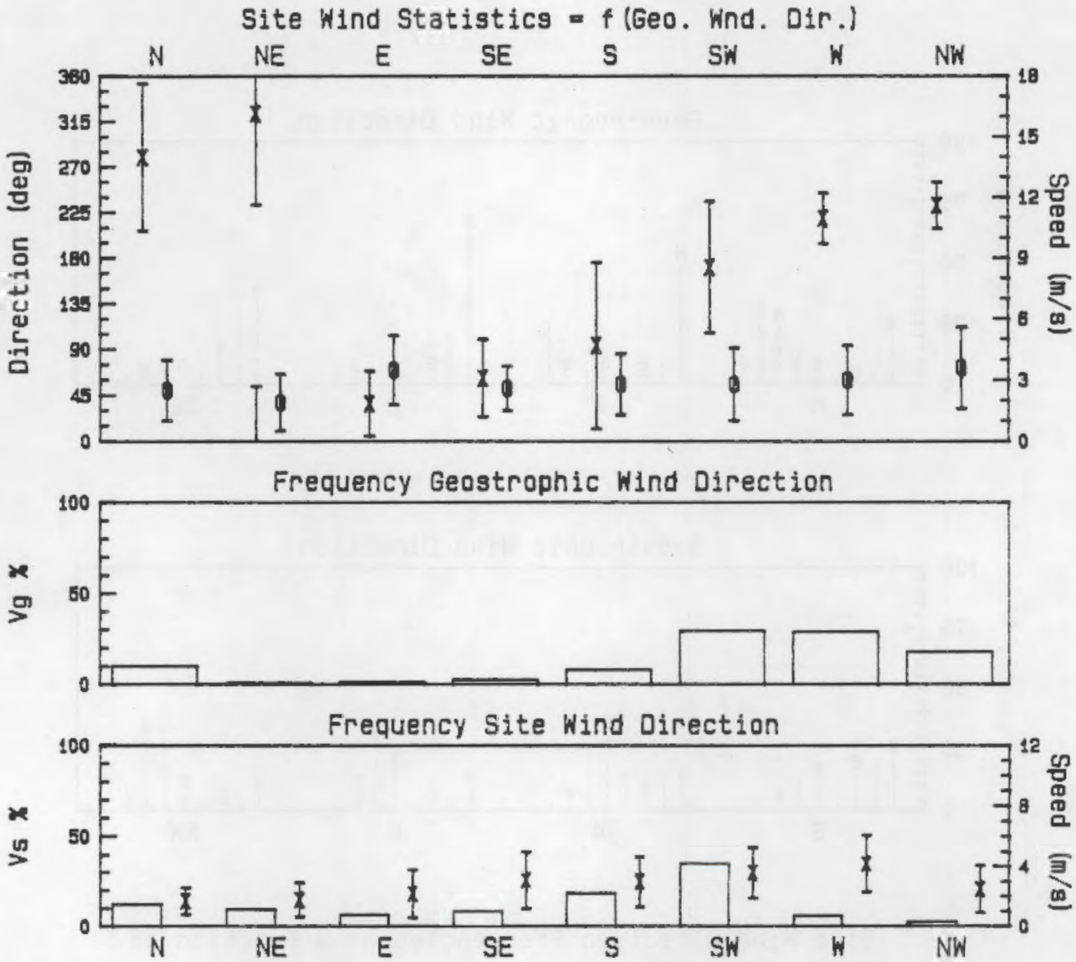




Site Wind Direction Frequencies as a Function of

Geostrophic Wind Direction

	SECTION: A-V
SITE: Susquehanna PA.	SEASON: Annual
% Occurrence = 8.67	CATEGORY: mT Ridge
	Vg (dir/mag): All / All



Diurnal Cross Reference Index

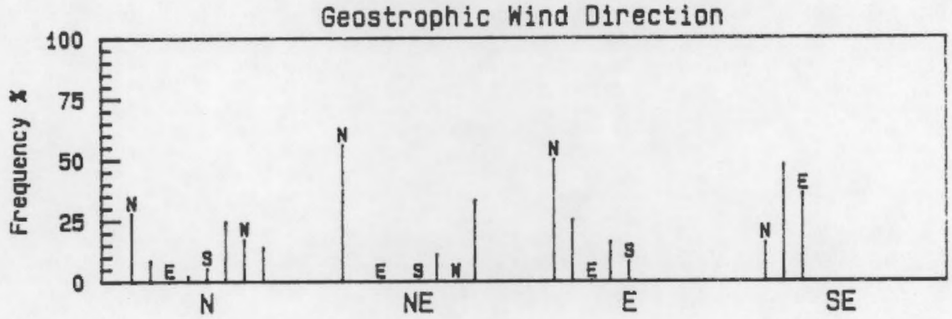
Pressure Gradient Orientation X Magnitude

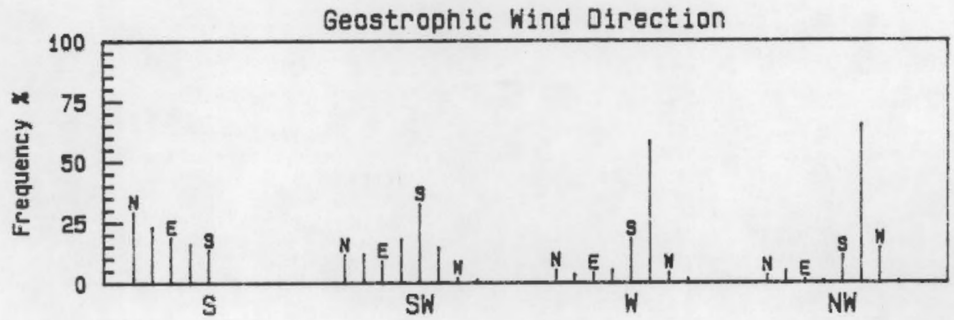
	N	NE	E	SE	S	SW	W	NW
All						W-V -6-0 S-V -6-0	S-V -7-0	
Strong								
Weak								

SITE: Susquehanna PA.

% Occurrence = 8.67

SECTION: A-V
SEASON: Annual
CATEGORY: mT Ridge
Vg (dir/mag): All / All





Site Wind Direction Frequencies as a Function of

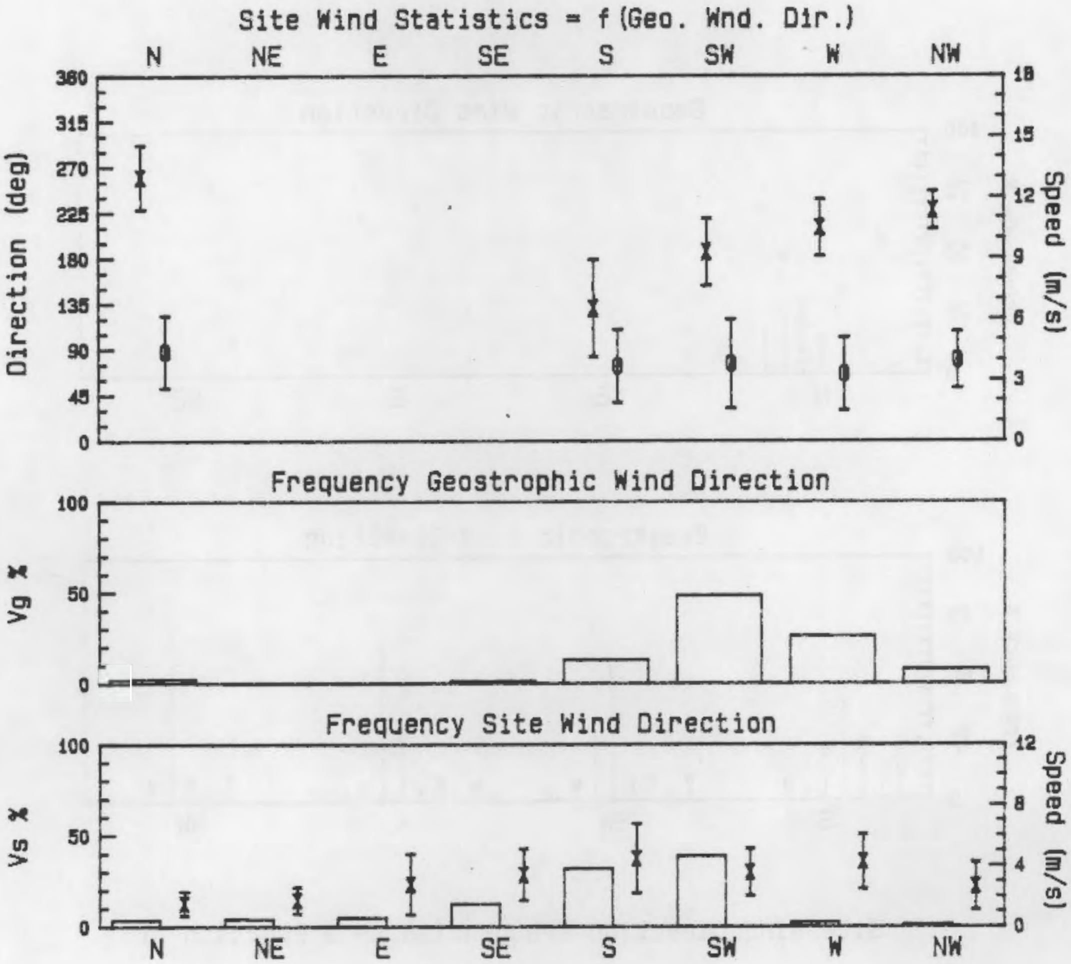
Geostrophic Wind Direction

SECTION: S-I

SITE: Susquehanna PA. SEASON: Summer

% Occurrence = 9.14 CATEGORY: Warm Sector

Vg (dir/mag): All / All



Diurnal Cross Reference Index

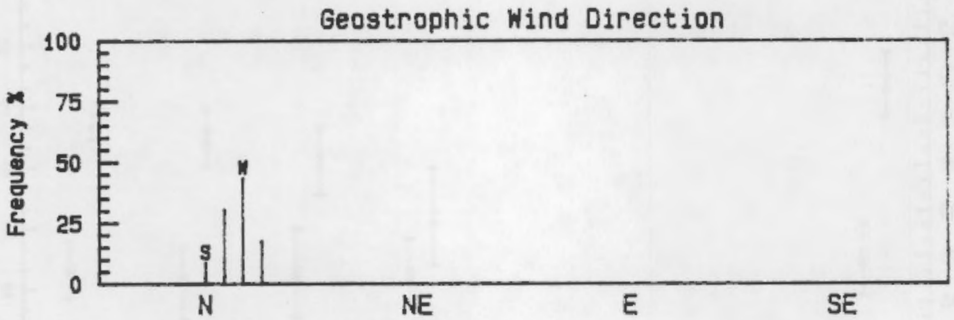
Pressure Gradient Orientation X Magnitude

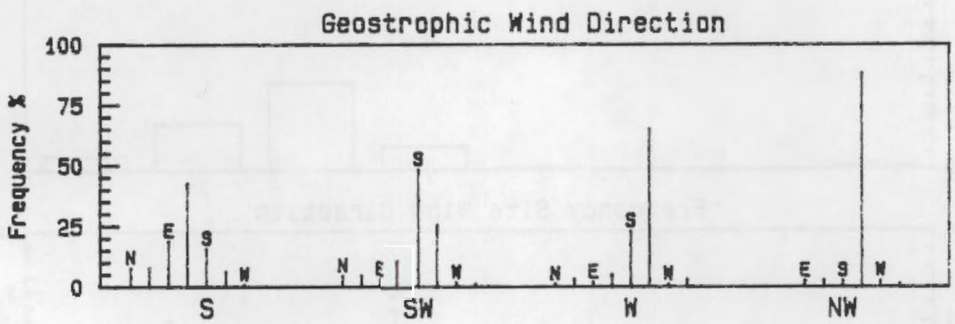
	N	NE	E	SE	S	SW	W	NW
All					-5-0	-6-0	-7-0	
Strorg								
Weak								

SITE: Susquehanna PA.

% Occurrence = 9.14

SECTION: S-I
SEASON: Summer
CATEGORY: Warm Sector
Vg (dir/mag): All / All





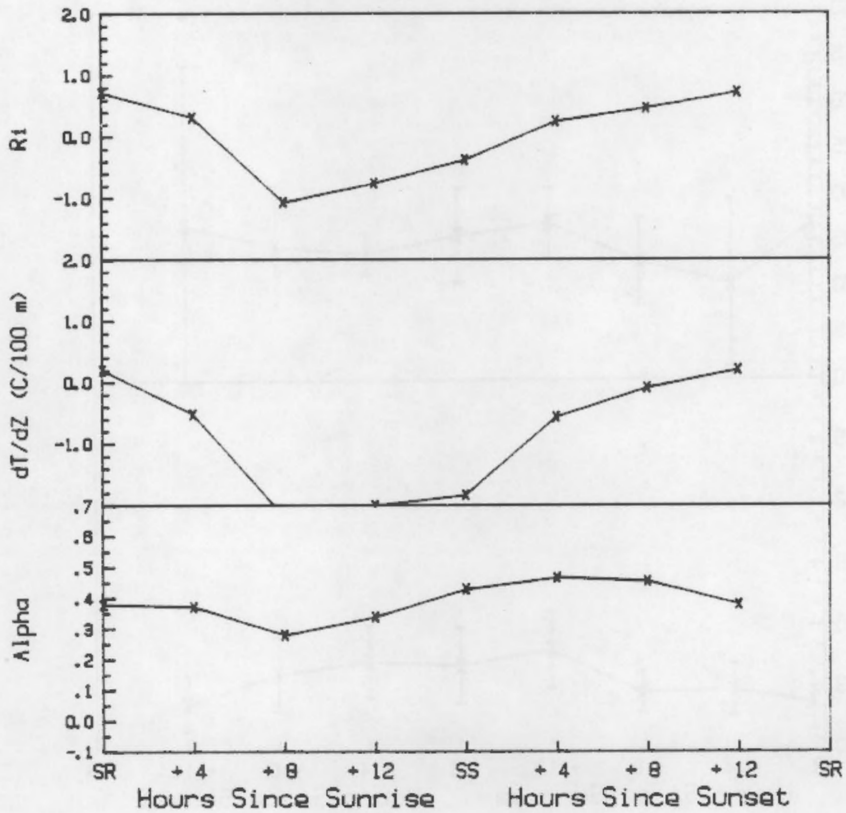
Site Wind Direction Frequencies as a Function of

Geostrophic Wind Direction

SITE: Susquehanna PA.

% Occurrence = 9.14

SECTION: S-I
SEASON: Summer
CATEGORY: Warm Sector
Vg (dir/mag): All / All



Mean Stability Parameters as a Function of Time of Day

SITE: Susquehanna PA.

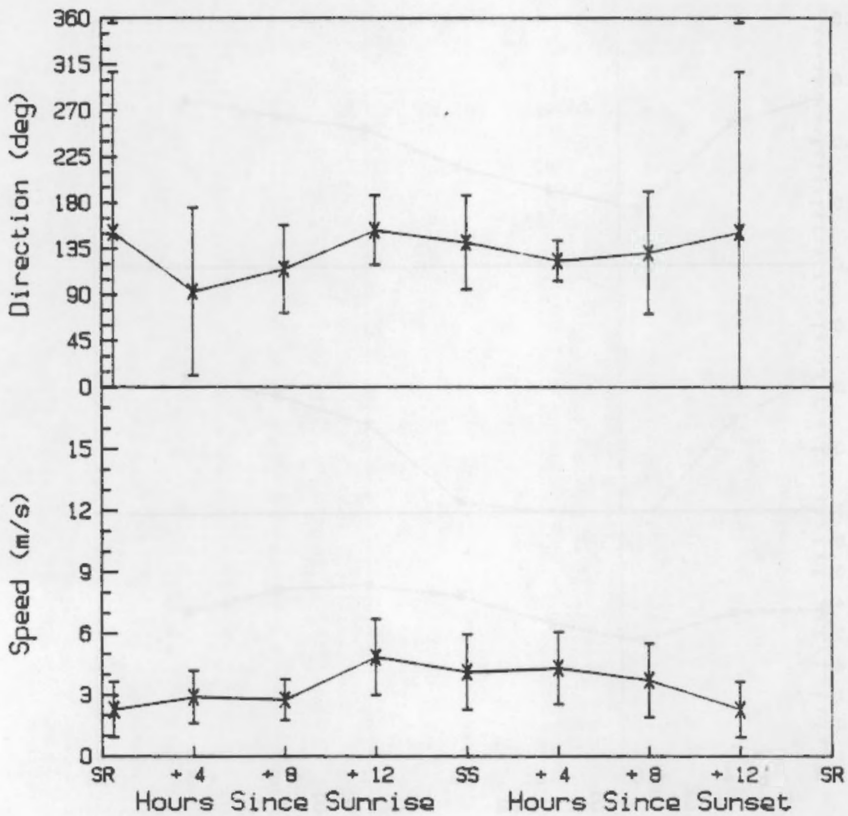
% Occurrence = 1.20

SECTION: S-I- 5 - 0

SEASON: Summer

CATEGORY: Warm Sector

Vg (dir/mag): S / All



Mean Wind Statistics as a Function of Time of Day

SITE: Susquehanna PA.

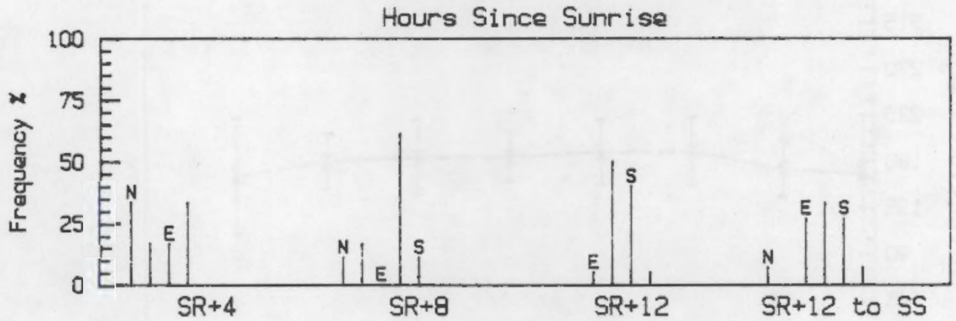
% Occurrence = 1.20

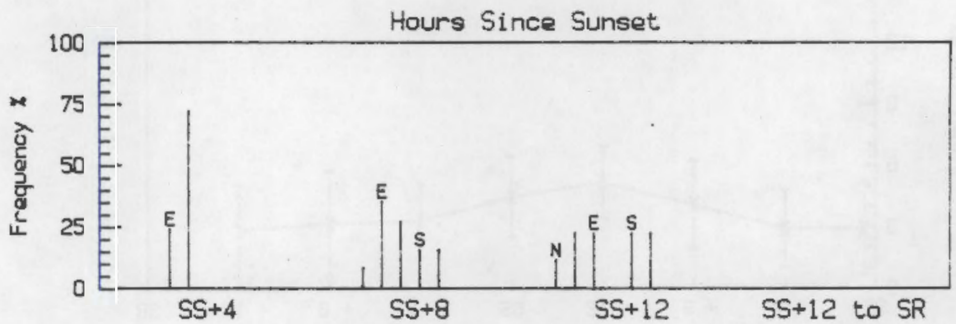
SECTION: S-I- 5 - 0

SEASON: Summer

CATEGORY: Warm Sector

Vg (dir/mag): S / All





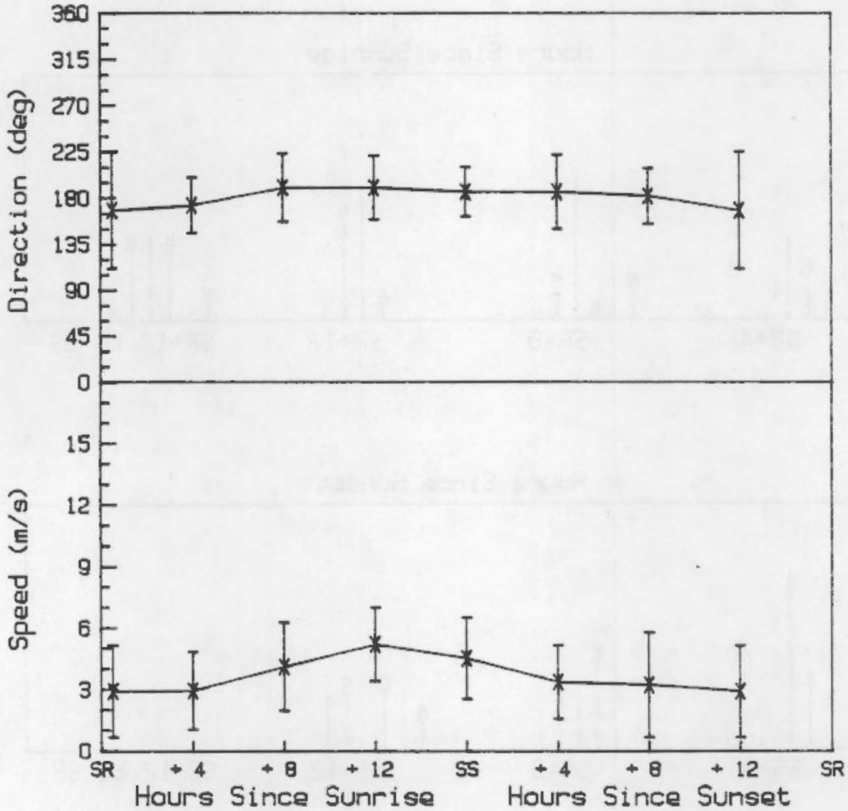
Site Wind Direction Frequencies as a Function of

Time of Day

SITE: Susquehanna PA.

% Occurrence = 4.44

SECTION: S-I- 6 - 0
SEASON: Summer
CATEGORY: Warm Sector
Vg (dir/mag): SW / All



Mean Wind Statistics as a Function of Time of Day

SITE: Susquehanna

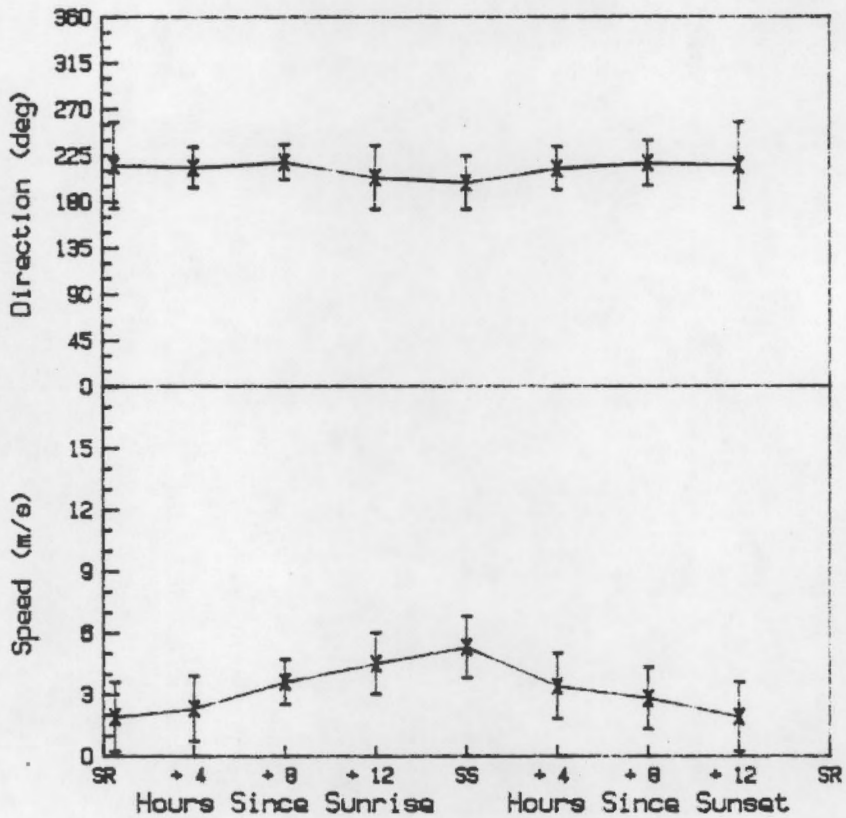
% Occurrence = 2.41

SECTION: S-I- 7 - 0

SEASON: Summer

CATEGORY: Warm Sector

Vg (dir/mag): W / All



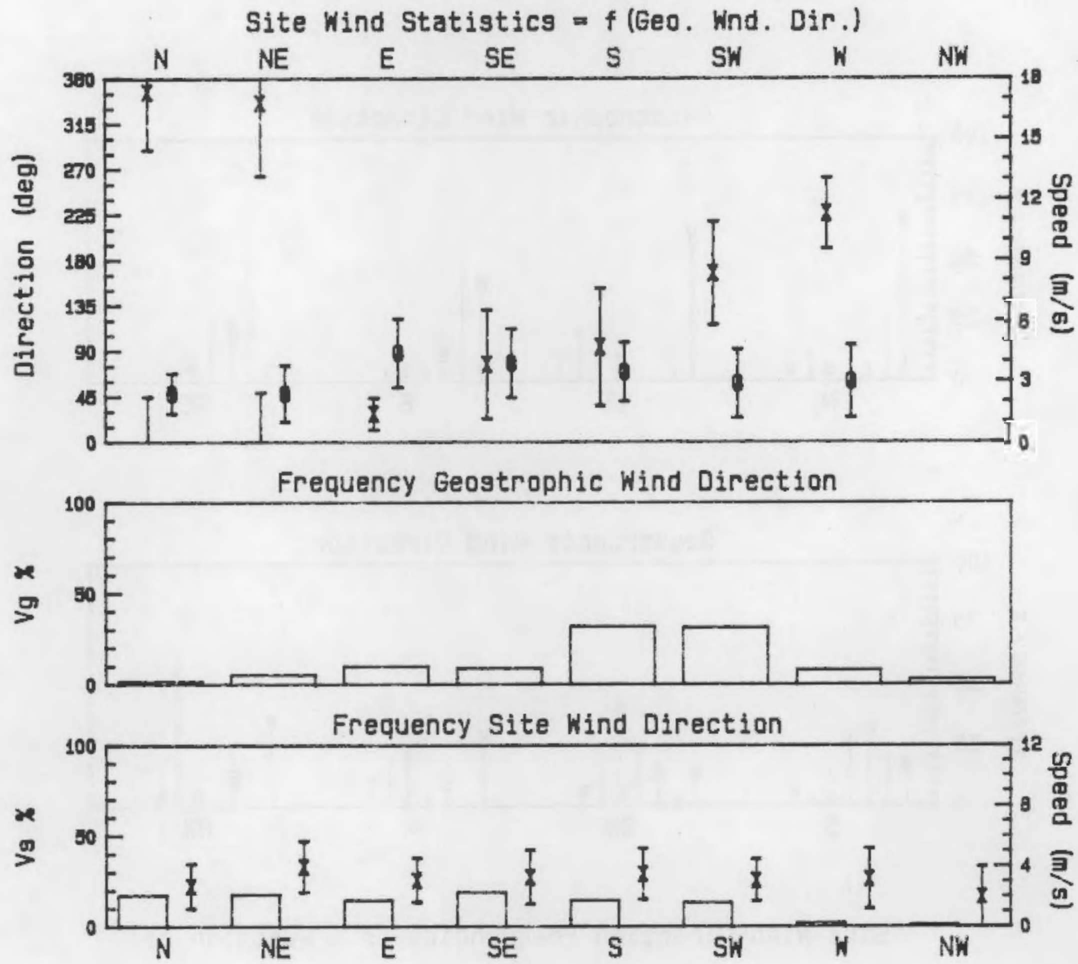
Mean Wind Statistics as a Function of Time of Day

SECTION: S-II

SITE: Susquehanna PA. SEASON: Summer

% Occurrence = 4.46 CATEGORY: Warm Front

Vg (dir/mag): All / All



Diurnal Cross Reference Index

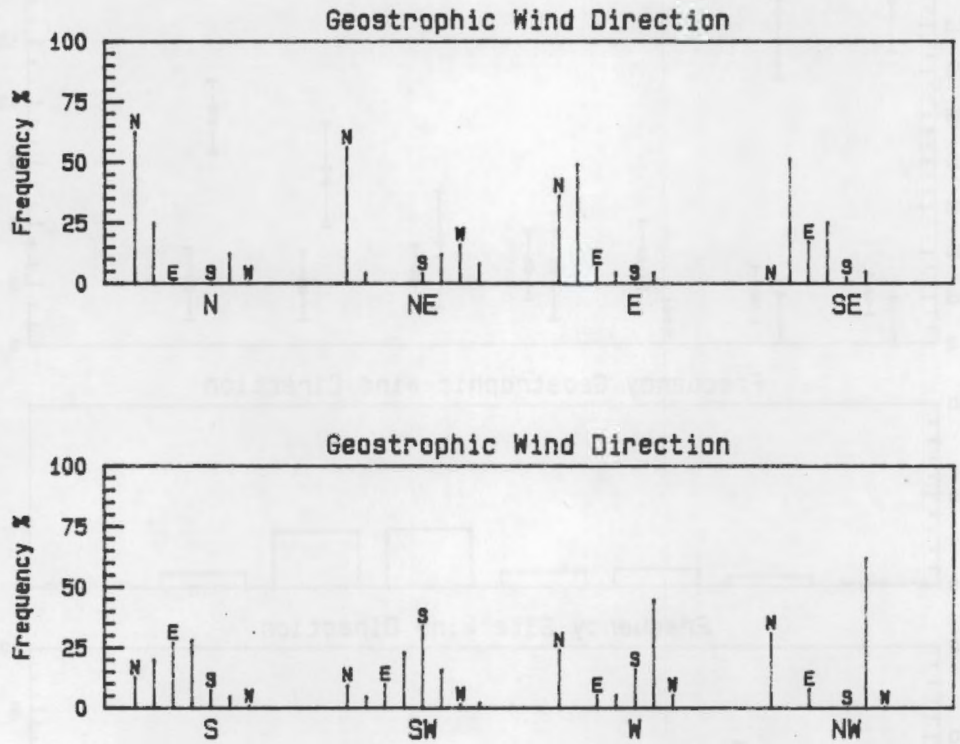
Pressure Gradient Orientation X Magnitude

	N	NE	E	SE	S	SW	W	NW
All				-4-0	-5-0	-6-0	-7-0	
Strong								
Weak								

SITE: Susquehanna PA.

% Occurrence = 4.46

SECTION: S-II
SEASON: Summer
CATEGORY: Warm Front
Vg (dir/mag): All / All

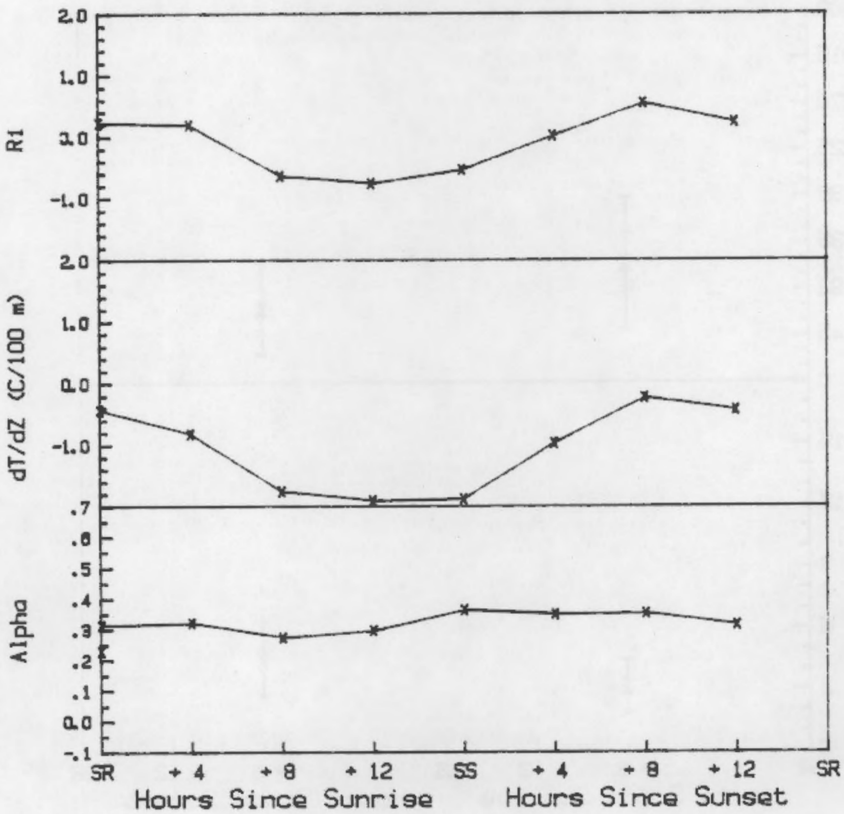


Site Wind Direction Frequencies as a Function of Geostrophic Wind Direction

SITE: Susquehanna PA.

% Occurrence = 4.46

SECTION: S-II
SEASON: Summer
CATEGORY: Warm Front
Vg (dir/mag): All / All

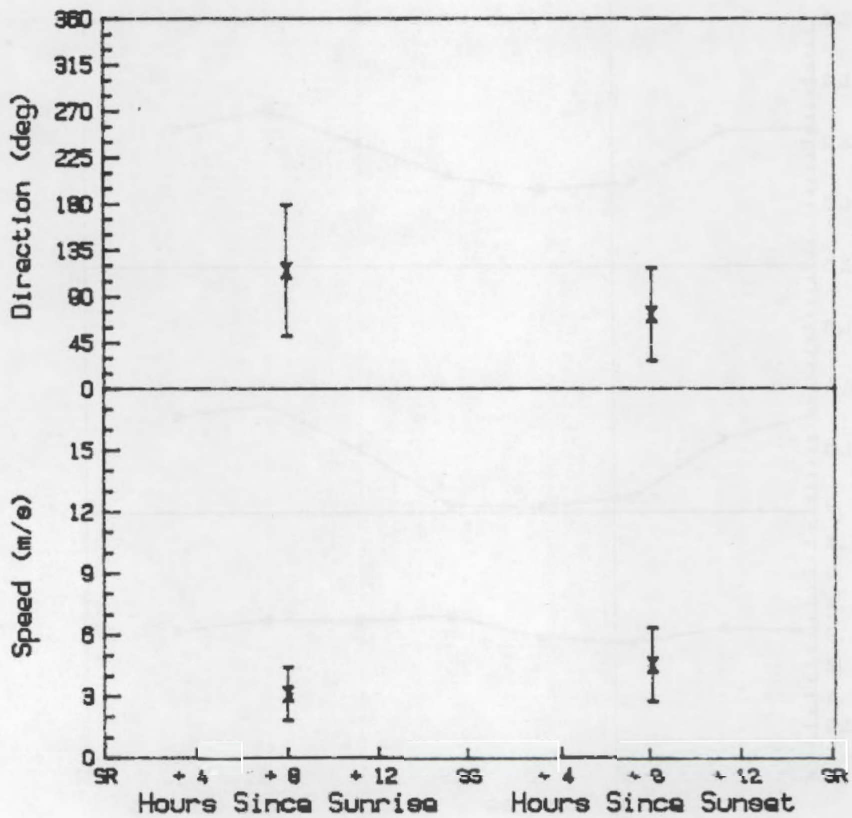


Mean Stability Parameters as a Function of Time of Day

SITE: Susquehanna

% Occurrence = .39

SECTION: S-II- 4 - 0
SEASON: Summer
CATEGORY: Warm Front
Vg (dir/mag): SE / All



Mean Wind Statistics as a Function of Time of Day

SITE: Susquehanna

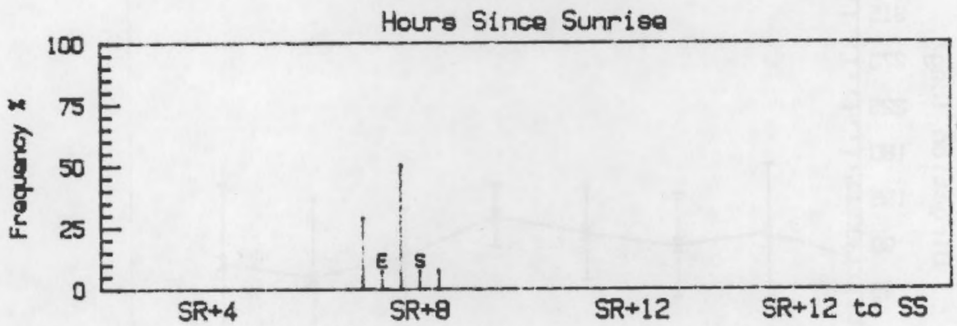
% Occurrence = .39

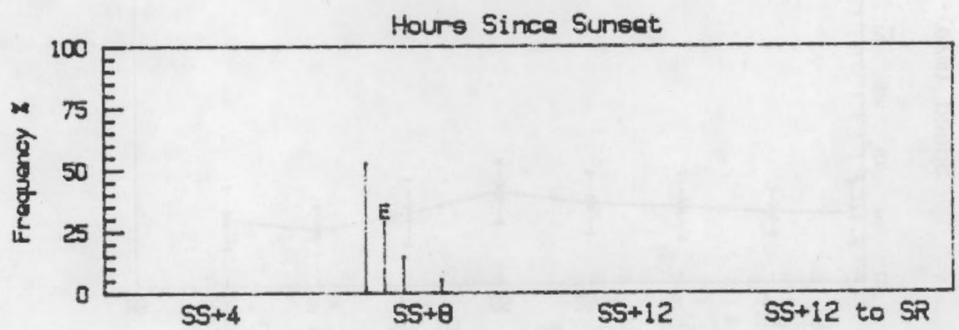
SECTION: S-II- 4 - 0

SEASON: Summer

CATEGORY: Warm Front

Vg (dir/mag): SE / All





Site Wind Direction Frequencies as a Function of Time of Day

SECTION: S-II- 5 - 0

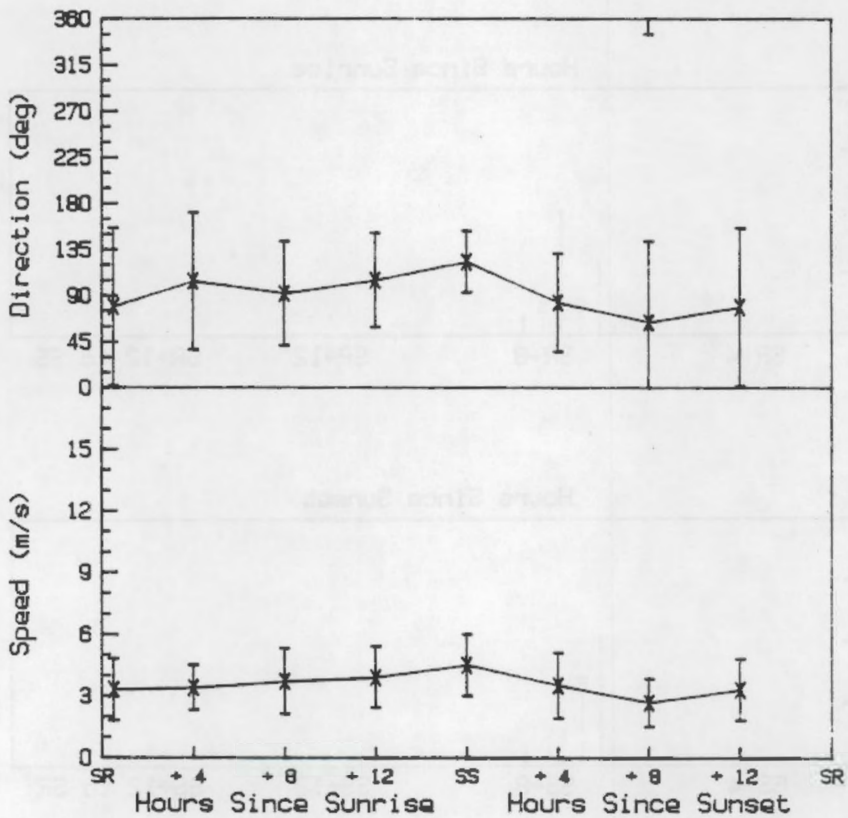
SITE: Susquehanna PA.

SEASON: Summer

% Occurrence = 1. 43

CATEGORY: Warm Front

Vg (dir/mag): S / All

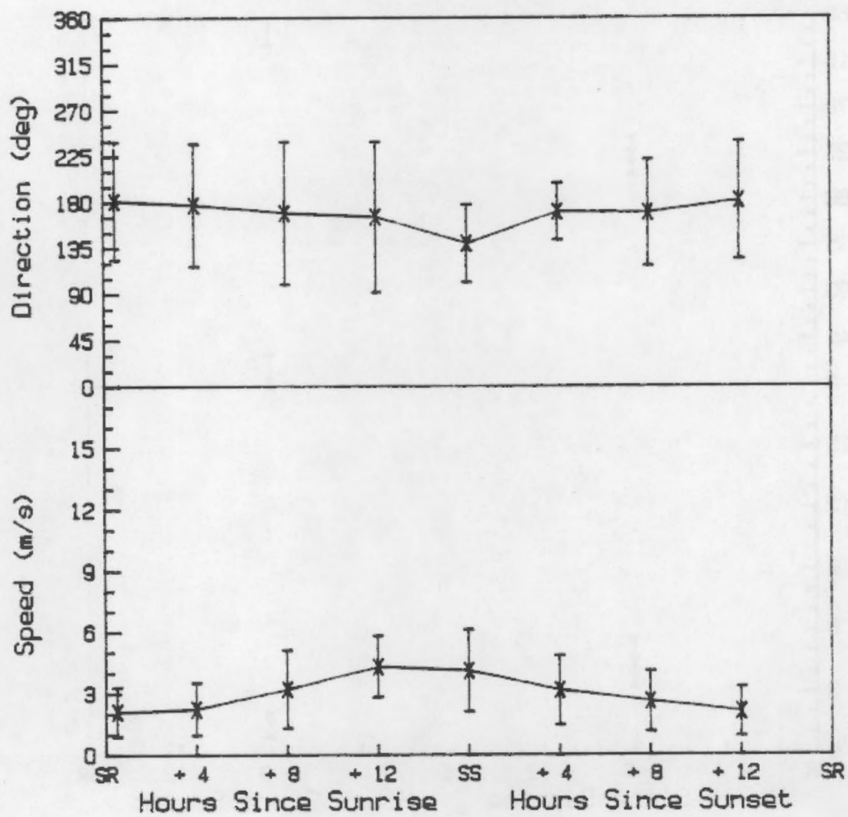


Mean Wind Statistics as a Function of Time of Day

SITE: Susquehanna PA.

% Occurrence = 1.40

SECTION: S-II- 6 - 0
SEASON: Summer
CATEGORY: Warm Front
Vg (dir/mag): SW / All

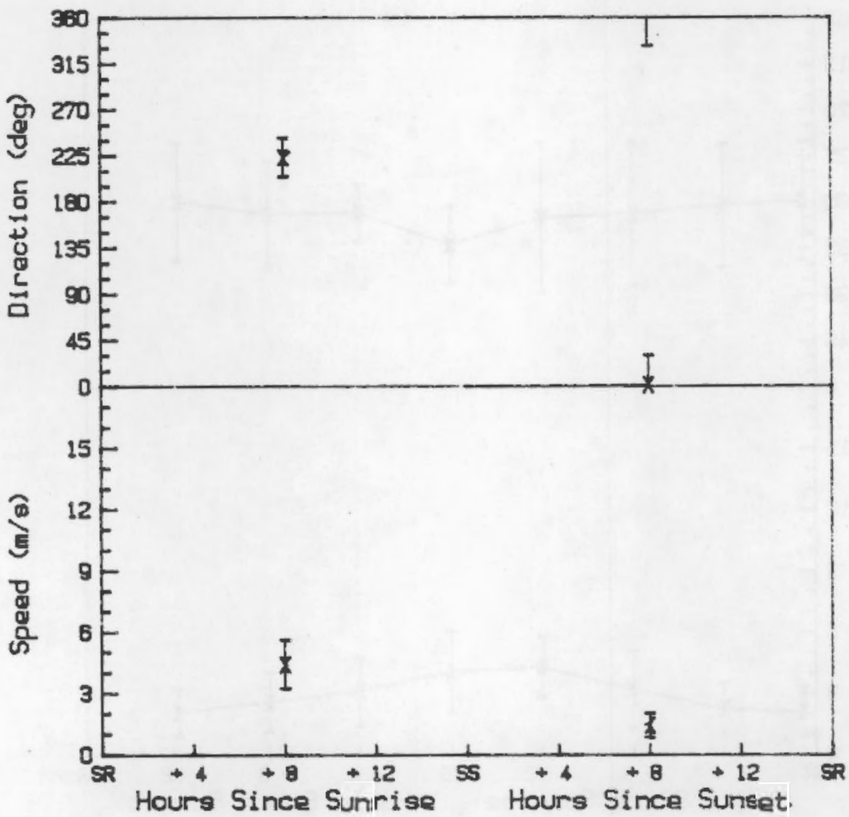


Mean Wind Statistics as a Function of Time of Day

SITE: Susquehanna

% Occurrence = .36

SECTION: S-II- 7 - 0
SEASON: Summer
CATEGORY: Warm Front
Vg (dir/mag): W / All

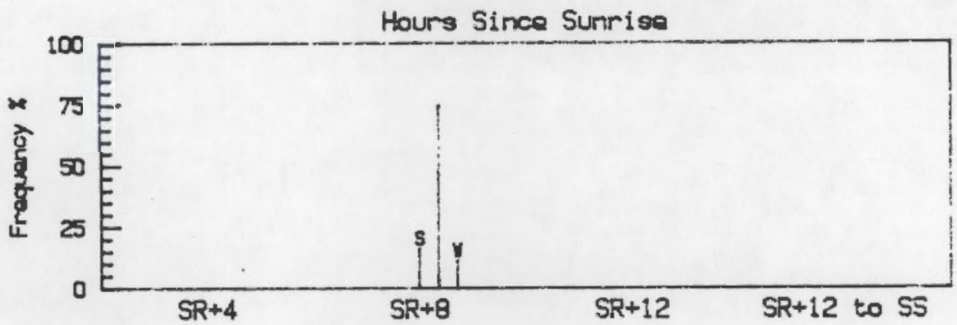


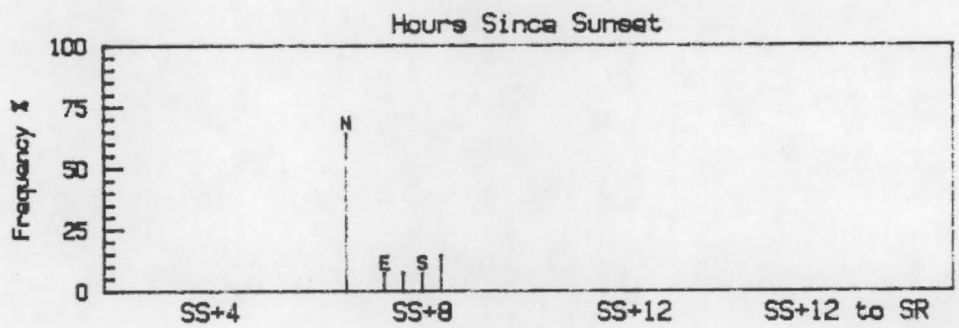
Mean Wind Statistics as a Function of Time of Day

SITE: Susquehanna

% Occurrence = .36

SECTION: S-II- 7 - 0
SEASON: Summer
CATEGORY: Warm Front
Vg (dir/mag): W / All





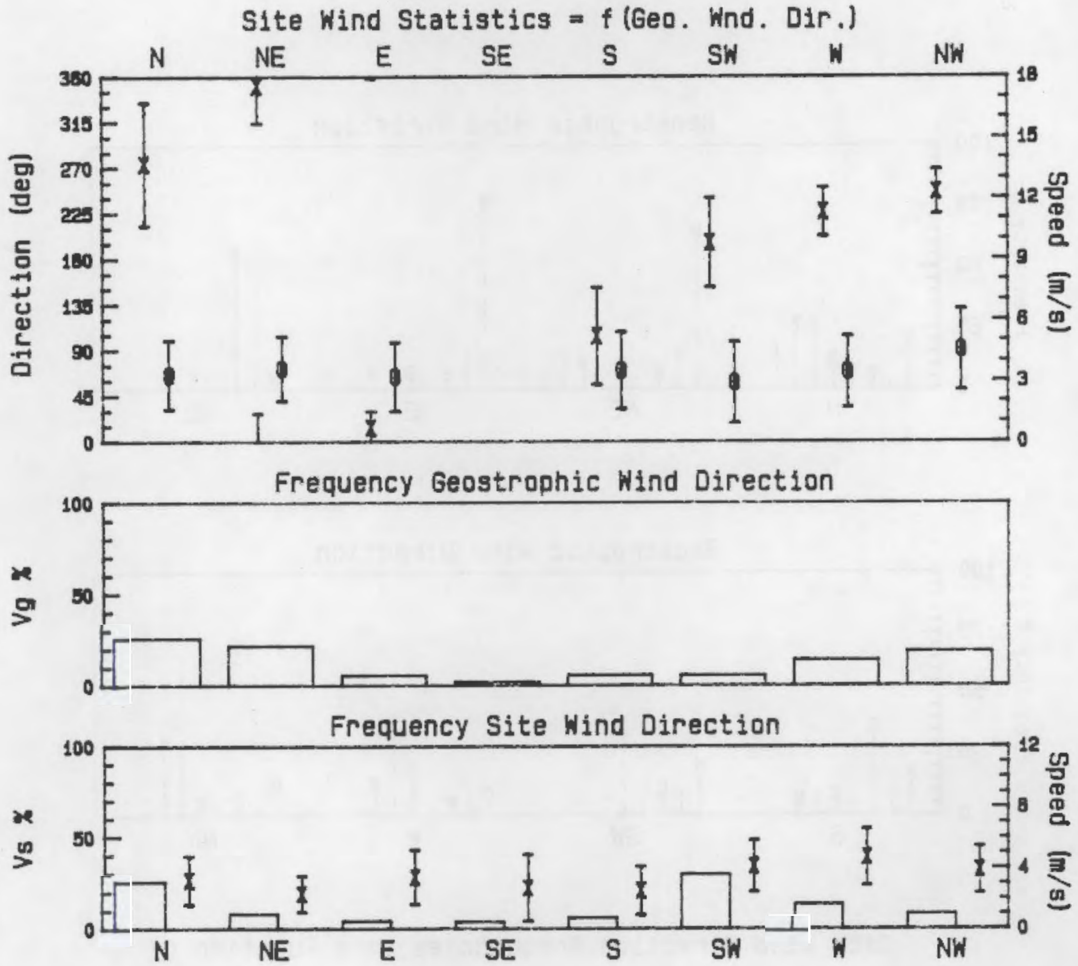
Site Wind Direction Frequencies as a Function of

Time of Day

SITE: Susquehanna PA.

% Occurrence = 8.71

SECTION: S-III
SEASON: Summer
CATEGORY: Cold Front
Vg (dir/mag): All / All



Diurnal Cross Reference Index

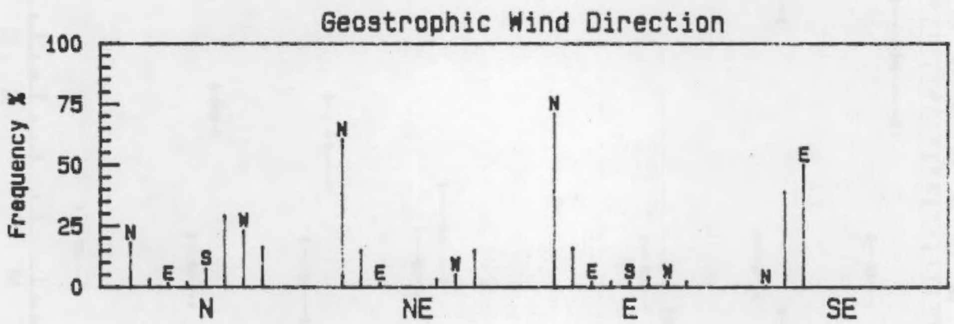
Pressure Gradient Orientation X Magnitude

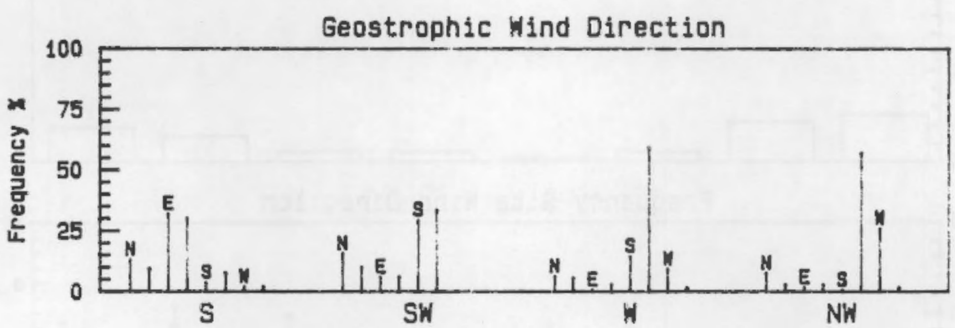
	N	NE	E	SE	S	SW	W	NW
All	-1-0				-5-0	-6-0		
Strong								
Weak								

SITE: Susquehanna PA.

% Occurrence = 8.71

SECTION: S-III
SEASON: Summer
CATEGORY: Cold Front
Vg (dir/mag): All / All





Site Wind Direction Frequencies as a Function of

Geostrophic Wind Direction

SITE: Susquehanna PA.

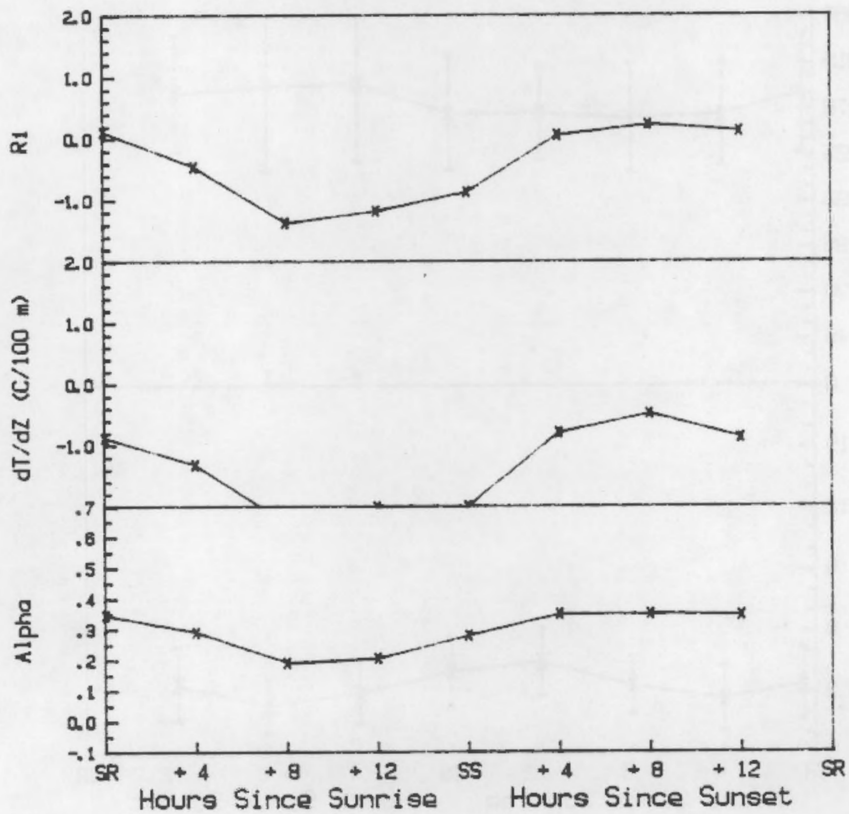
% Occurrence = 8.71

SECTION: S-III

SEASON: Summer

CATEGORY: Cold Front

Vg (dir/mag): All / All

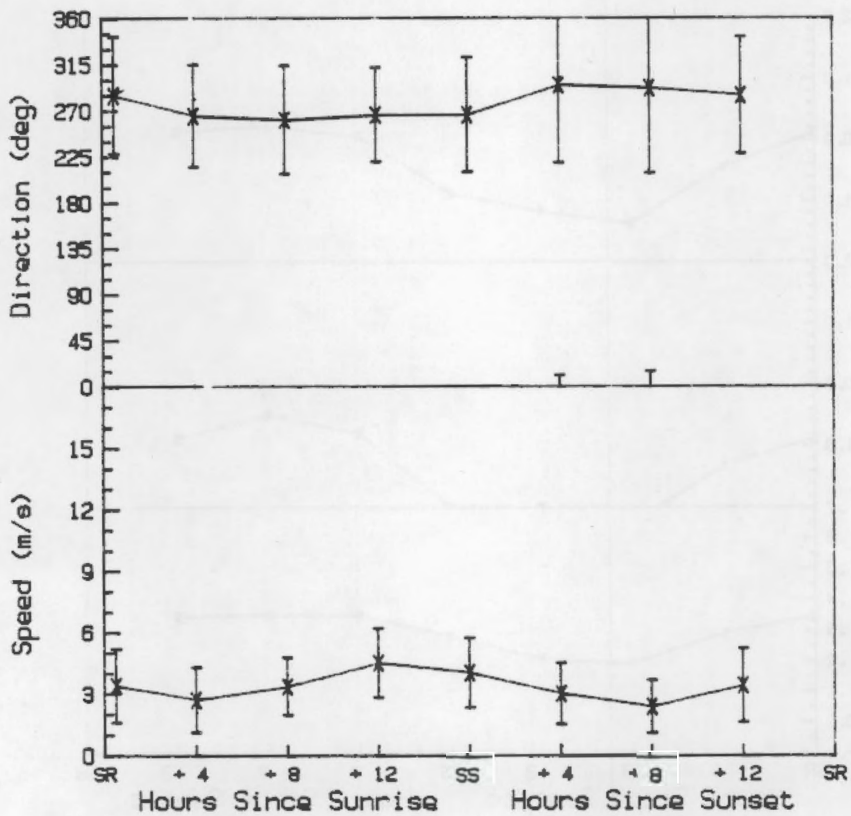


Mean Stability Parameters as a Function of Time of Day

SITE: Susquehanna PA.

% Occurrence = 2.27

SECTION: S-III- 1 - 0
SEASON: Summer
CATEGORY: Cold Front
Vg (dir/mag): N / All

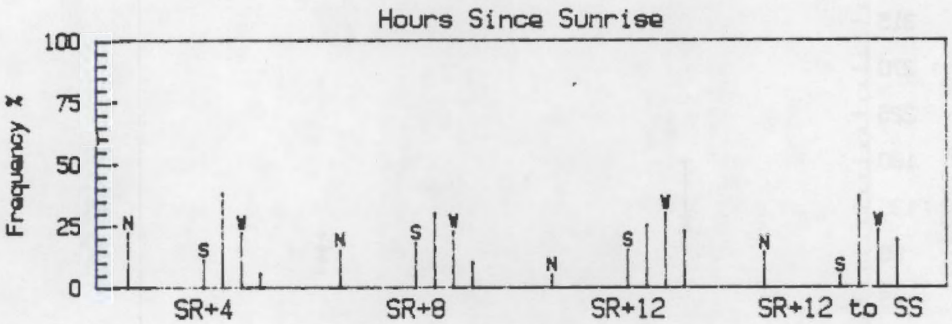


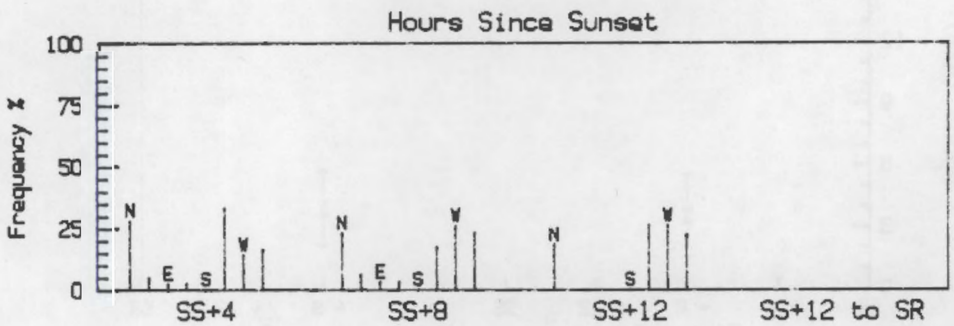
Mean Wind Statistics as a Function of Time of Day

SITE: Susquehanna PA

% Occurrence = 2.27

SECTION: S-III- 1 - 0
SEASON: Summer
CATEGORY: Cold Front
Vg (dir/mag): N / All



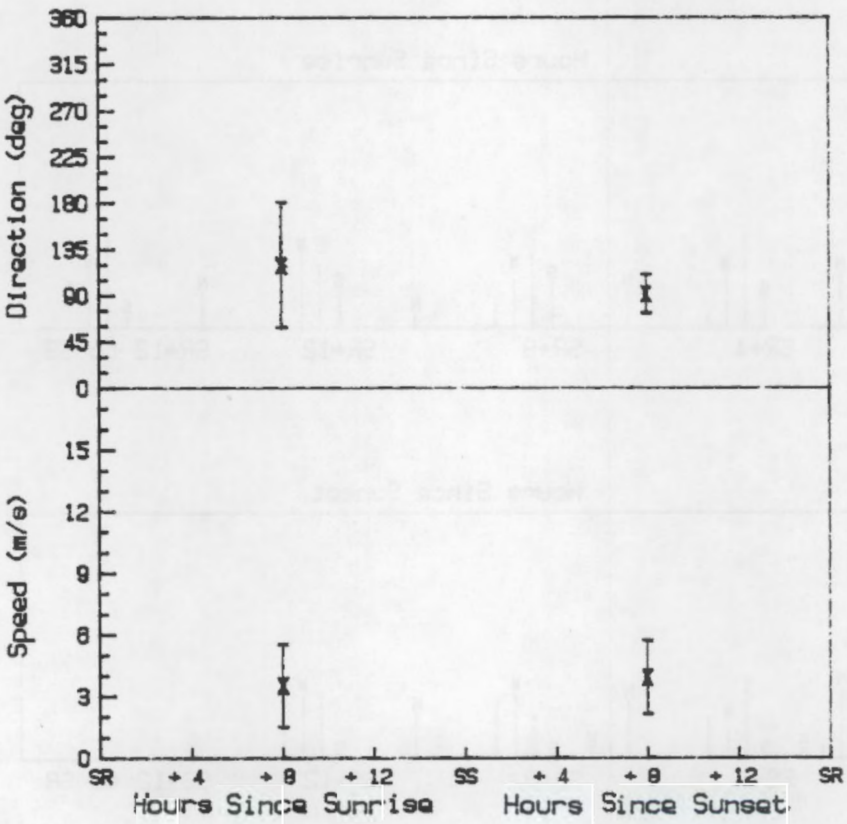


Site Wind Direction Frequencies as a Function of Time of Day

SITE: Susquehanna

% Occurrence = .50

SECTION: S-III- 5 - 0
SEASON: Summer
CATEGORY: Cold Front
Vg (dir/mag): S / All

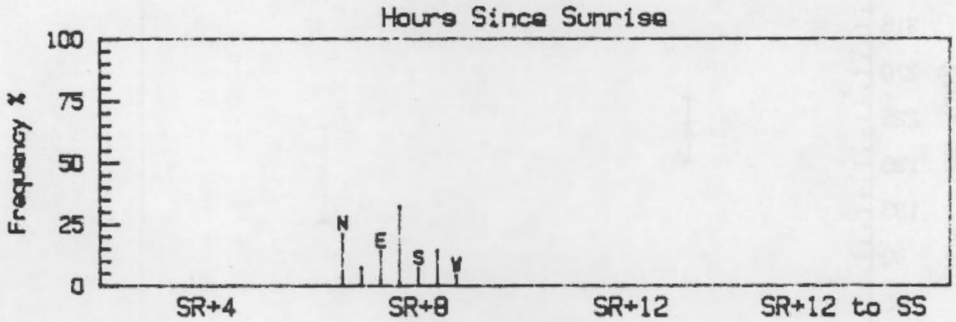


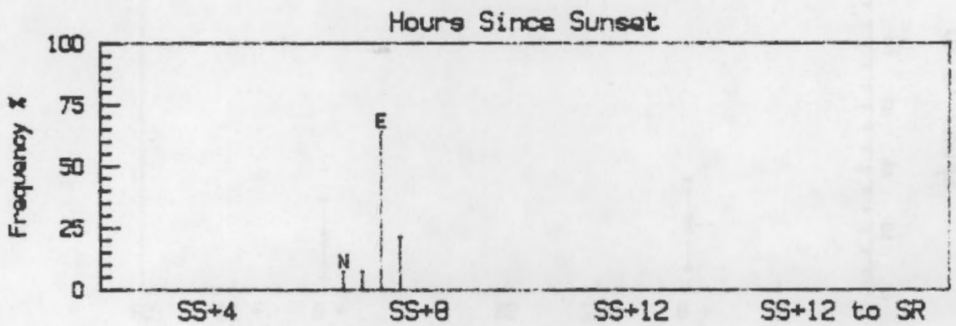
Mean Wind Statistics as a Function of Time of Day

SITE: Susquehanna

% Occurrence = .50

SECTION: S-III- 5 - 0
SEASON: Summer
CATEGORY: Cold Front
Vg (dir/mag): S / All





Site Wind Direction Frequencies as a Function of

Time of Day

SITE: Susquehanna

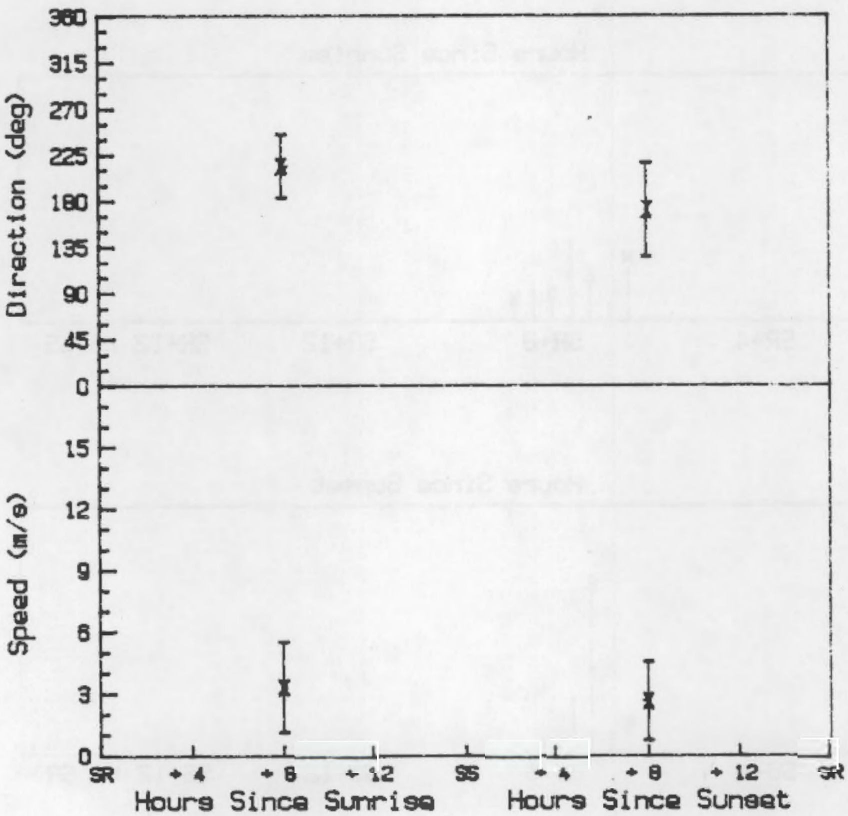
% Occurrence = .48

SECTION: S-III- 6 - 0

SEASON: Summer

CATEGORY: Cold Front

Vg (dir/mag): SW / All

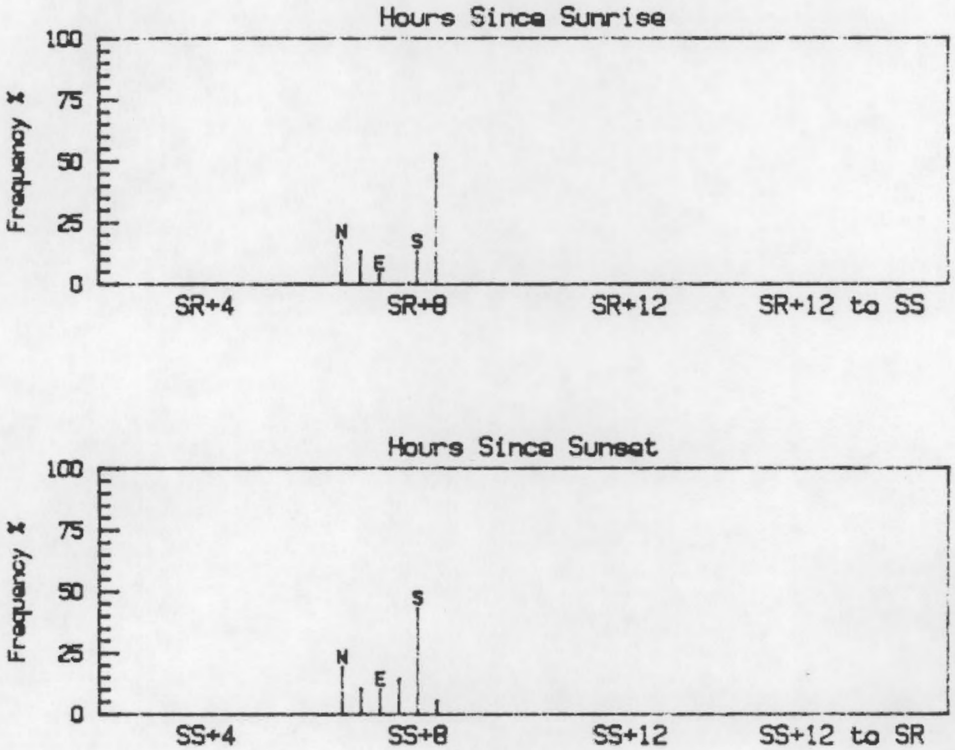


Mean Wind Statistics as a Function of Time of Day

SITE: Susquehanna

% Occurrence = .48

SECTION: S-III- 6 - 0
SEASON: Summer
CATEGORY: Cold Front
Vg (dir/mag): SW / All



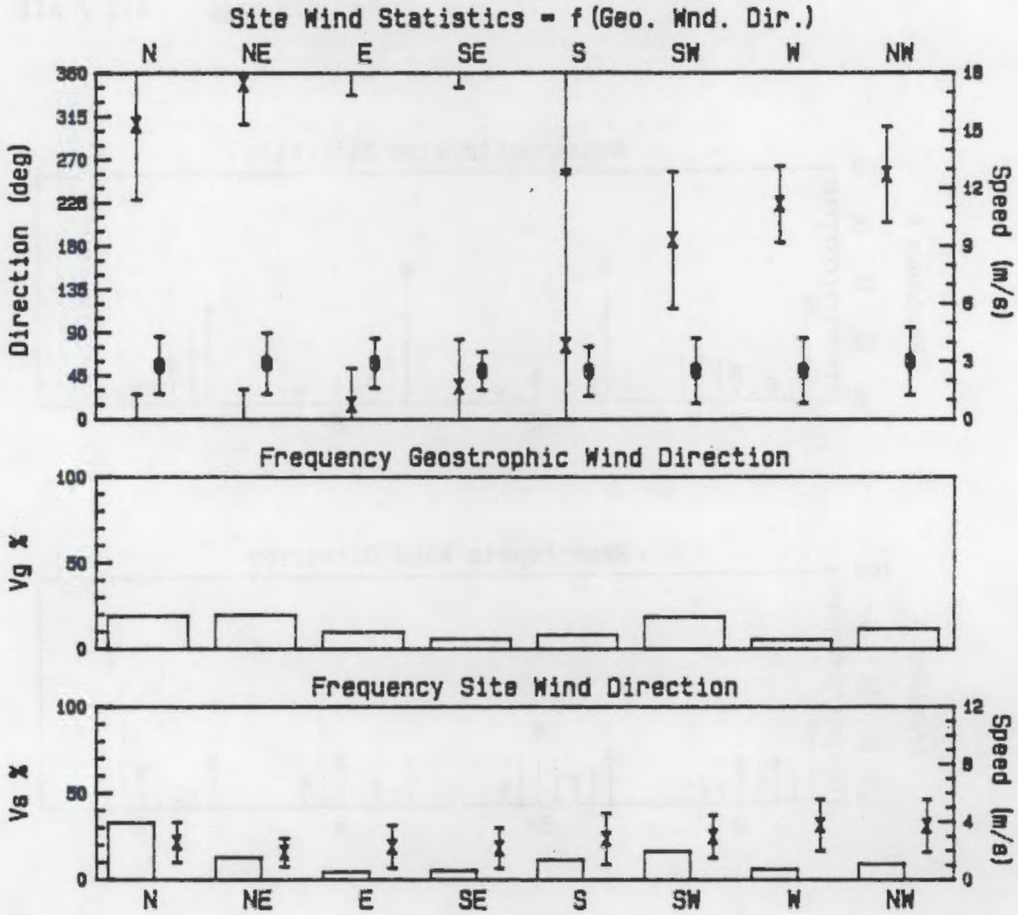
Site Wind Direction Frequencies as a Function of

Time of Day

SITE: Susquehanna PA.

% Occurrence = 12.56

SECTION: S-IV
SEASON: Summer
CATEGORY: cP/cA Ridge
Vg (dir/mag): All / All



Diurnal Cross Reference Index

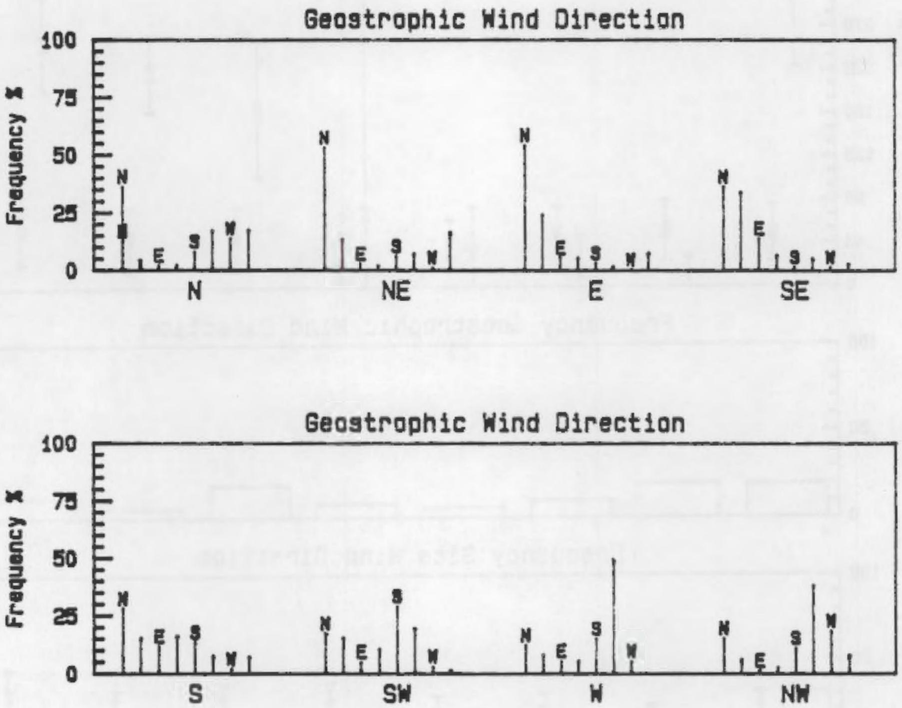
Pressure Gradient Orientation X Magnitude

	N	NE	E	SE	S	SW	W	NW
All	-1-0	-2-0	-3-0	-4-0	-5-0	-6-0	-7-0	-8-0
Strong								
Weak								

SITE: Susquehanna PA.

% Occurrence = 12.56

SECTION: S-IV
SEASON: Summer
CATEGORY: cP/cA Ridge
Vg (dir/mag): All / All



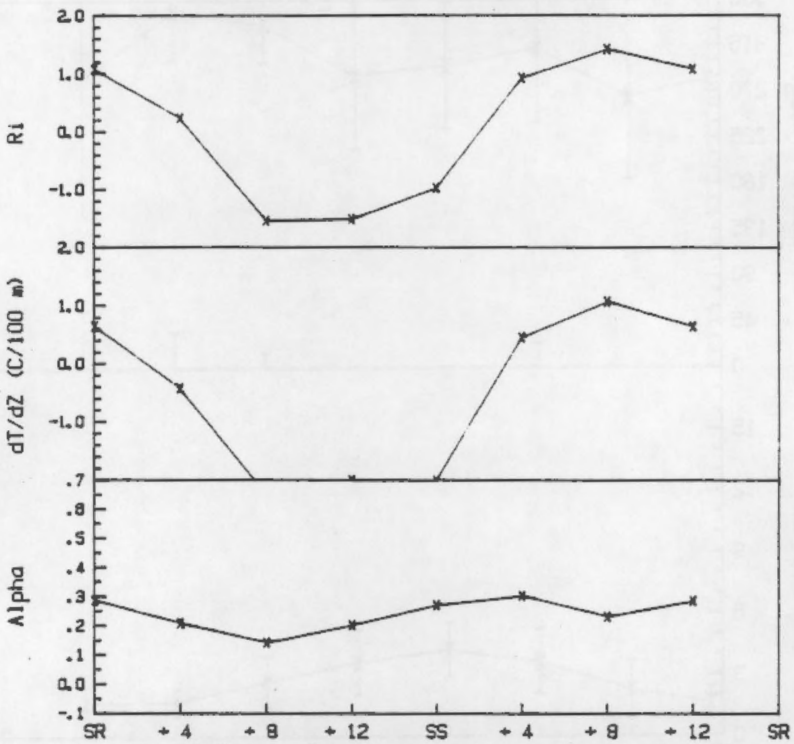
Site Wind Direction Frequencies as a Function of

Geostrophic Wind Direction

SITE: Susquehanna PA.

% Occurrence = 12.56

SECTION: S-IV
SEASON: Summer
CATEGORY: cP/cA Ridge
Vg (dir/mag): All / All

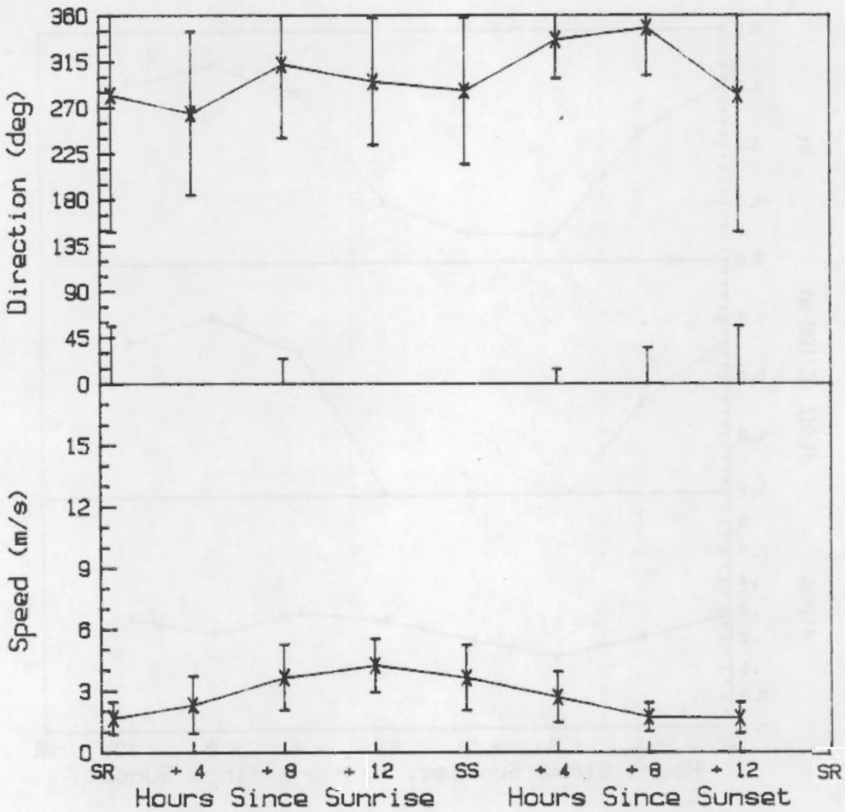


Mean Stability Parameters as a Function of Time of Day

SITE: Susquehanna PA.

% Occurrence = 2.43

SECTION: S-IV- 1 - 0
SEASON: Summer
CATEGORY: cP/cA Ridge
Vg (dir/mag): N / All

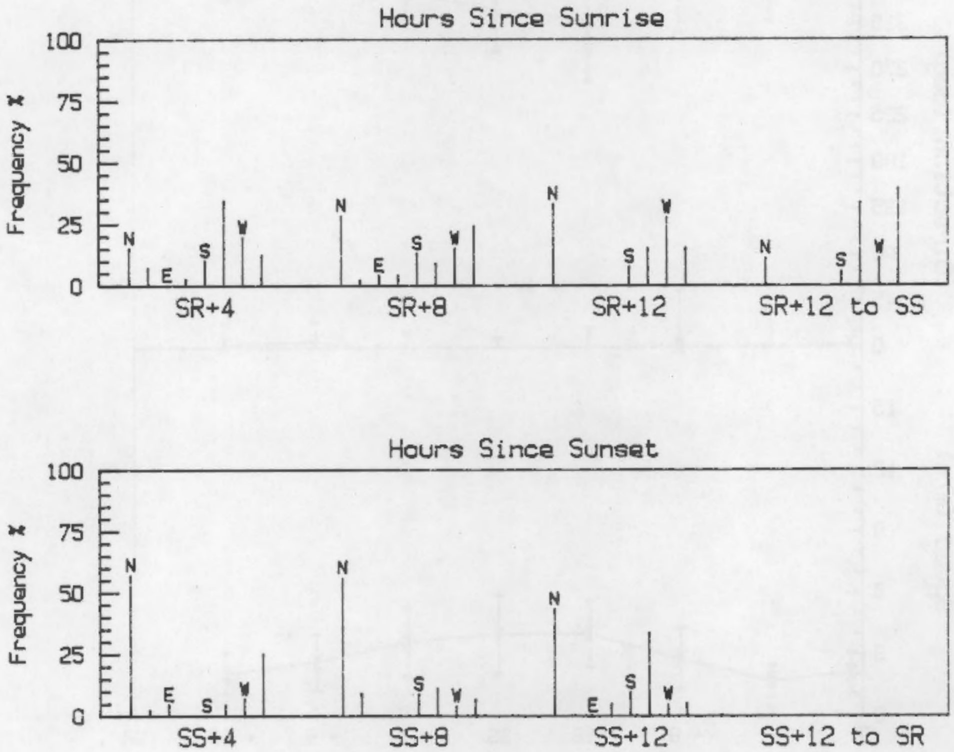


Mean Wind Statistics as a Function of Time of Day

SITE: Susquehanna PA.

% Occurrence = 2.43

SECTION: S-IV- 1 - 0
SEASON: Summer
CATEGORY: cP/cA Ridge
Vg (dir/mag): N / All



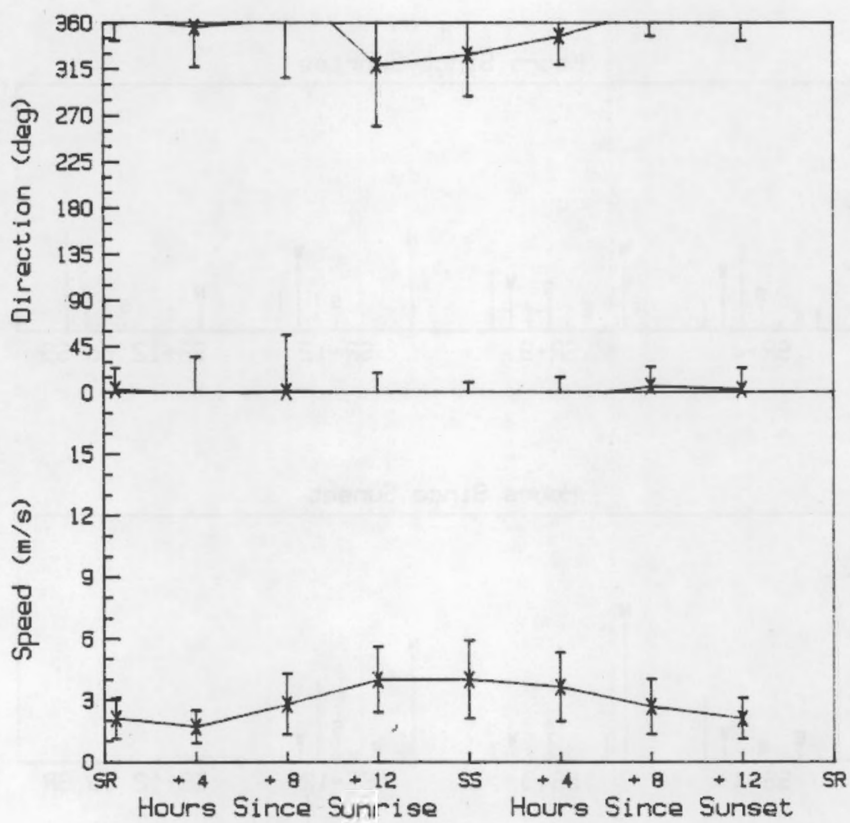
Site Wind Direction Frequencies as a Function of

Time of Day

SITE: Susquehanna PA.

% Occurrence = 2.50

SECTION: S-IV- 2 - 0
SEASON: Summer
CATEGORY: cP/cA Ridge
Vg (dir/mag): NE / All

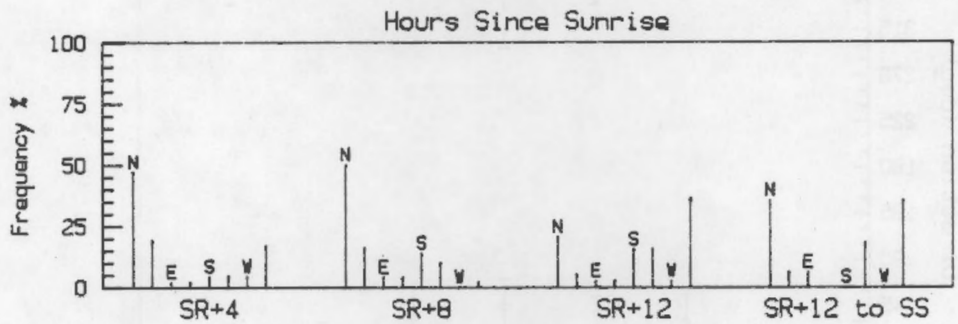


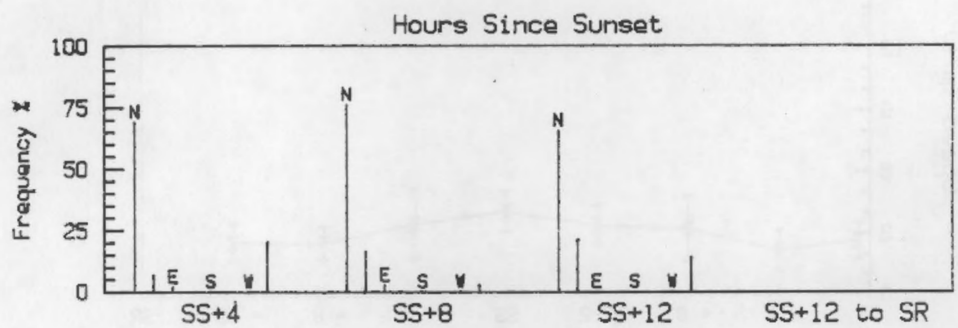
Mean Wind Statistics as a Function of Time of Day

SITE: Susquehanna PA.

% Occurrence = 2.50

SECTION: S-IV- 2 - 0
SEASON: Summer
CATEGORY: cP/cA Ridge
Vg (dir/mag): NE / All





Site Wind Direction Frequencies as a Function of Time of Day

SITE: Susquehanna PA.

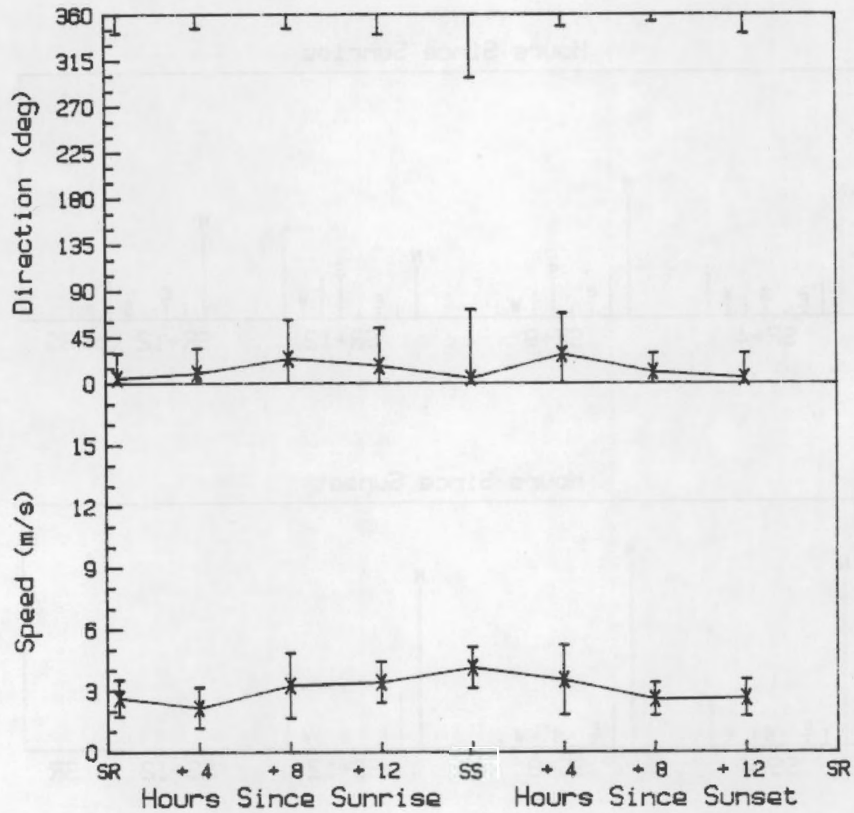
% Occurrence = 1.26

SECTION: S-IV- 3 - 0

SEASON: Summer

CATEGORY: cP/cA Ridge

Vg (dir/mag): E / All



Mean Wind Statistics as a Function of Time of Day

SITE: Susquehanna

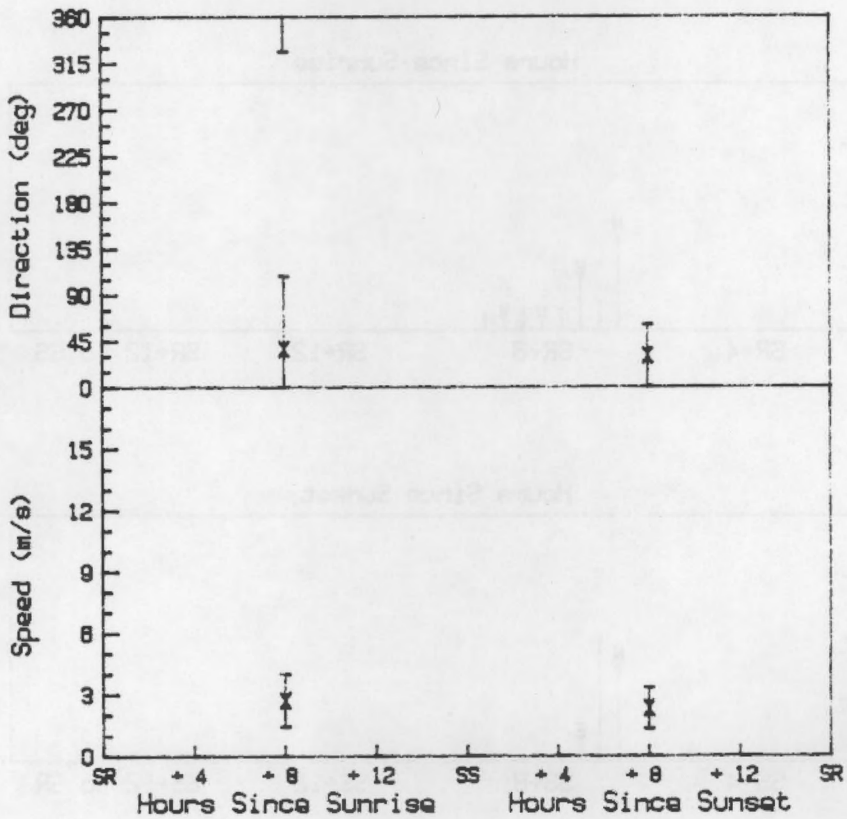
% Occurrence = .76

SECTION: S-IV- 4 - 0

SEASON: Summer

CATEGORY: cP/cA Ridge

Vg (dir/mag): SE / All

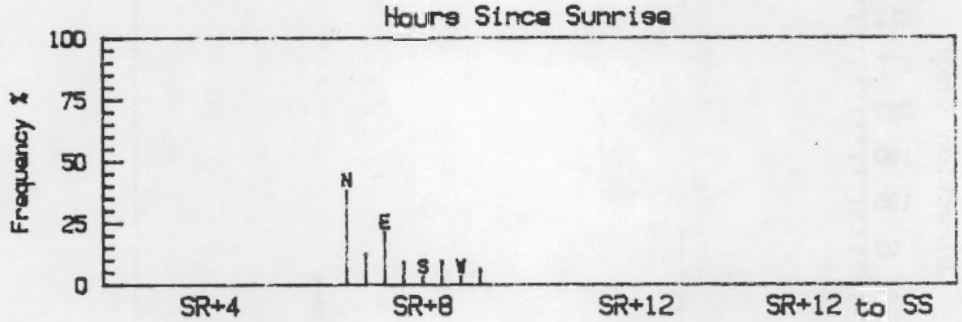


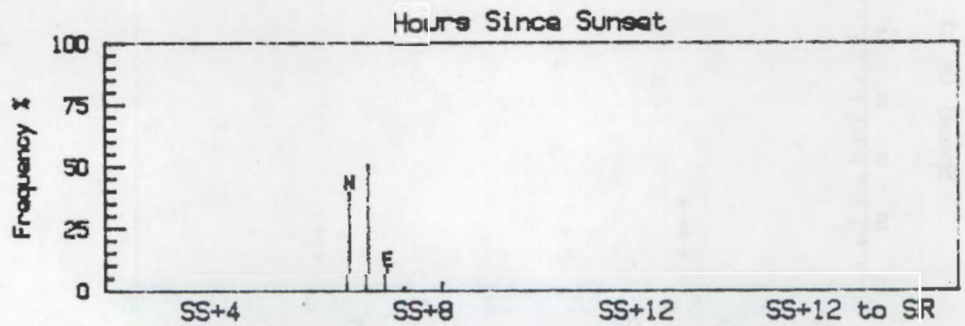
Mean Wind Statistics as a Function of Time of Day

SITE: Susquehanna

% Occurrence = .76

SECTION: S-IV- 4 - 0
SEASON: Summer
CATEGORY: cP/cA Ridge
Vg (dir/mag): SE / All



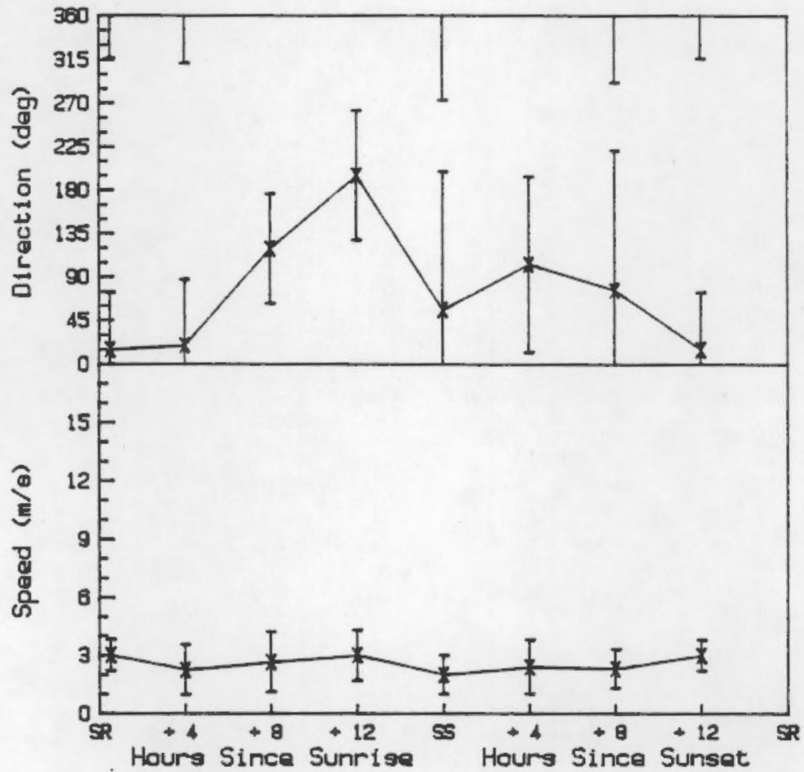


Site Wind Direction Frequencies as a Function of Time of Day

SITE: Susquehanna PA.

% Occurrence = 1.06

SECTION: S-IV- 5 - 0
SEASON: Summer
CATEGORY: cP/cA Ridge
Vg (dir/mag): S / All

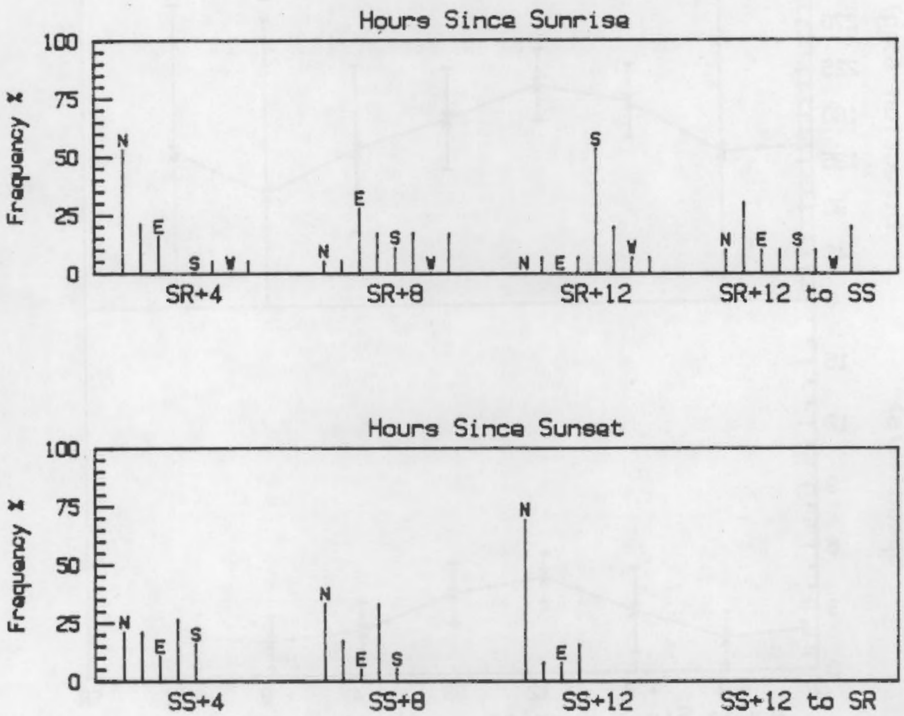


Mean Wind Statistics as a Function of Time of Day

SITE: Susquehanna PA.

% Occurrence = 1.06

SECTION: S-IV- 5 - 0
SEASON: Summer
CATEGORY: cP/cA Ridge
Vg (dir/mag): S / All

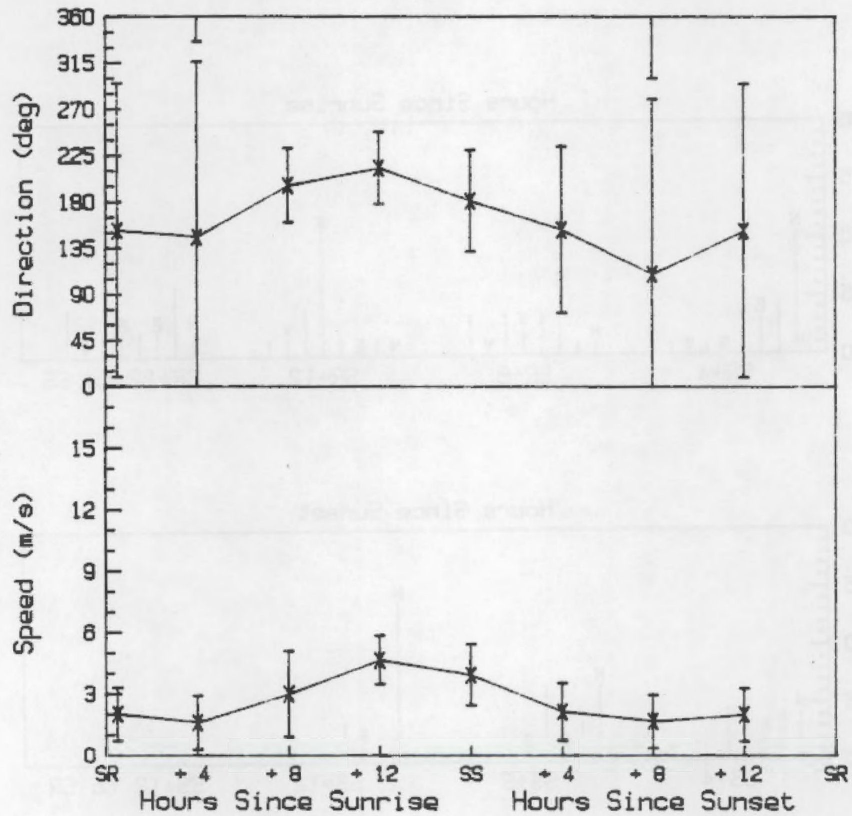


Site Wind Direction Frequencies as a Function of Time of Day

SITE: Susquehanna PA.

% Occurrence = 2.36

SECTION: S-IV- 6 - 0
SEASON: Summer
CATEGORY: cP/cA Ridge
Vg (dir/mag): SW / All

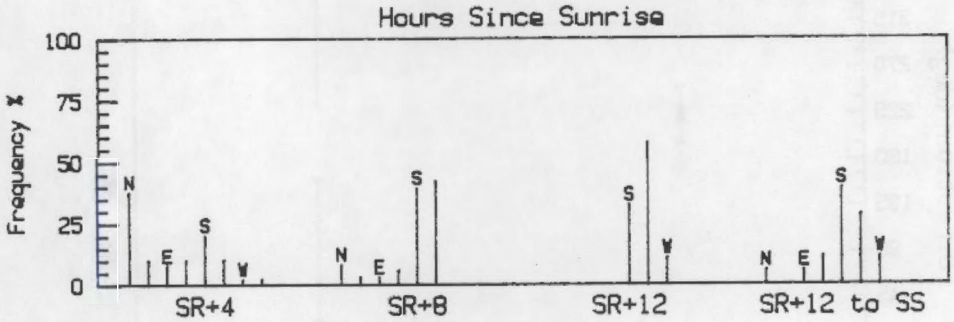


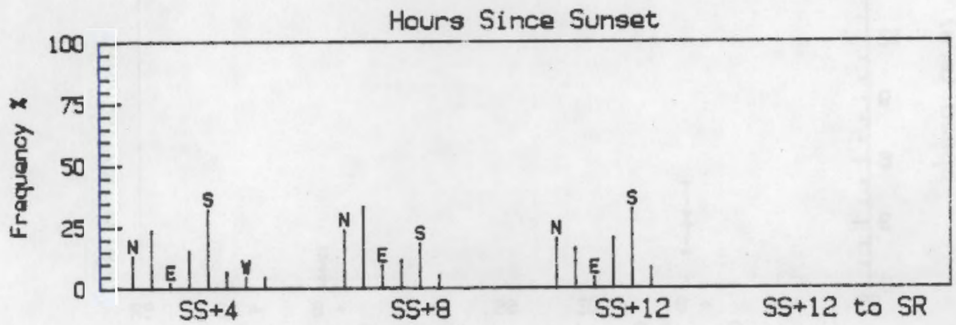
Mean Wind Statistics as a Function of Time of Day

SITE: Susquehanna PA.

% Occurrence = 2.36

SECTION: S-IV- 6 - 0
SEASON: Summer
CATEGORY: cP/cA Ridge
Vg (dir/mag): SW / All



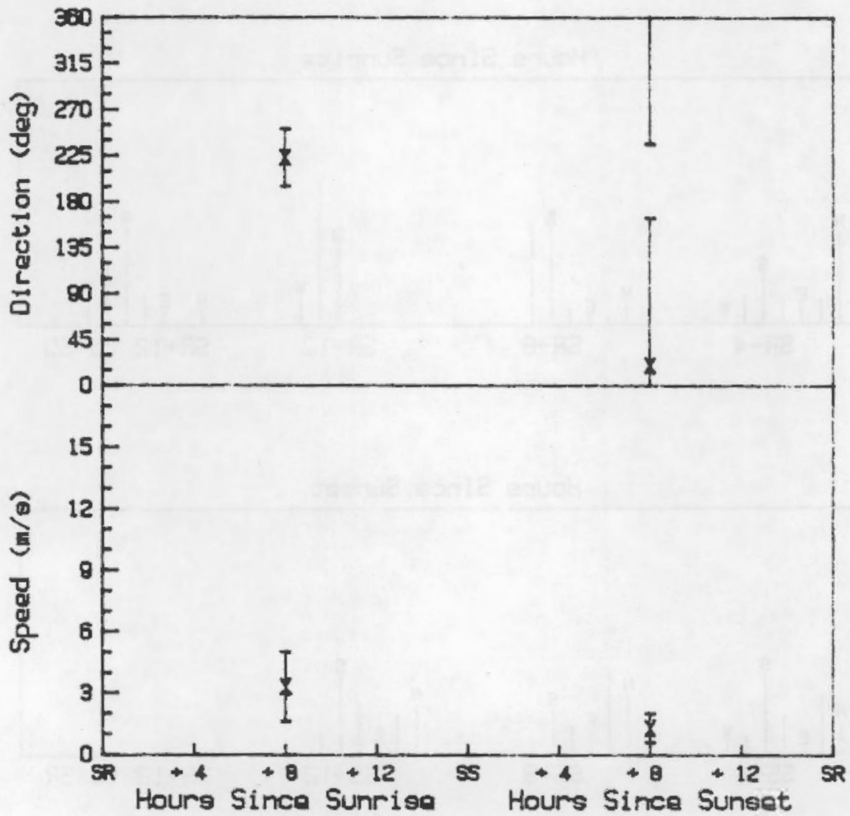


Site Wind Direction Frequencies as a Function of Time of Day

SITE: Susquehanna

% Occurrence = .70

SECTION: S-IV- 7 - 0
SEASON: Summer
CATEGORY: cP/cA Ridge
Vg (dir/mag): W / All



Mean Wind Statistics as a Function of Time of Day

SECTION: S-IV- 7 - 0

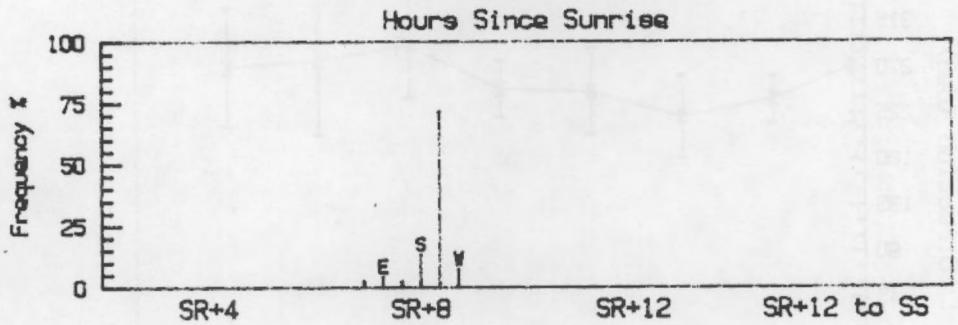
SITE: Susquehanna

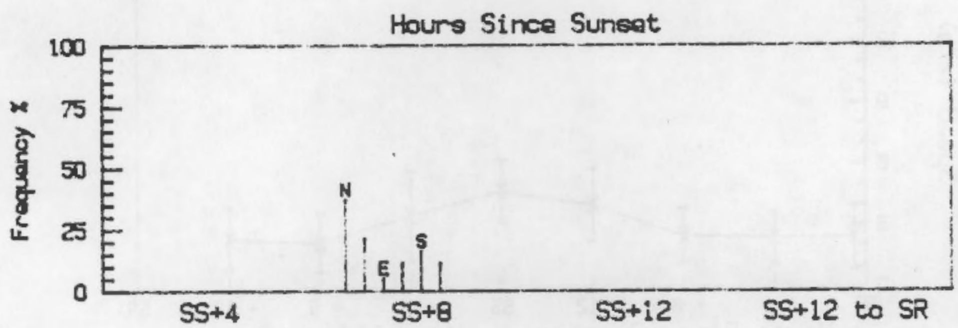
SEASON: Summer

CATEGORY: cP/cA Ridge

% Occurrence = .70

Vg (dir/mag): W / All





Site Wind Direction Frequencies as a Function of Time of Day

SITE: Susquehanna PA.

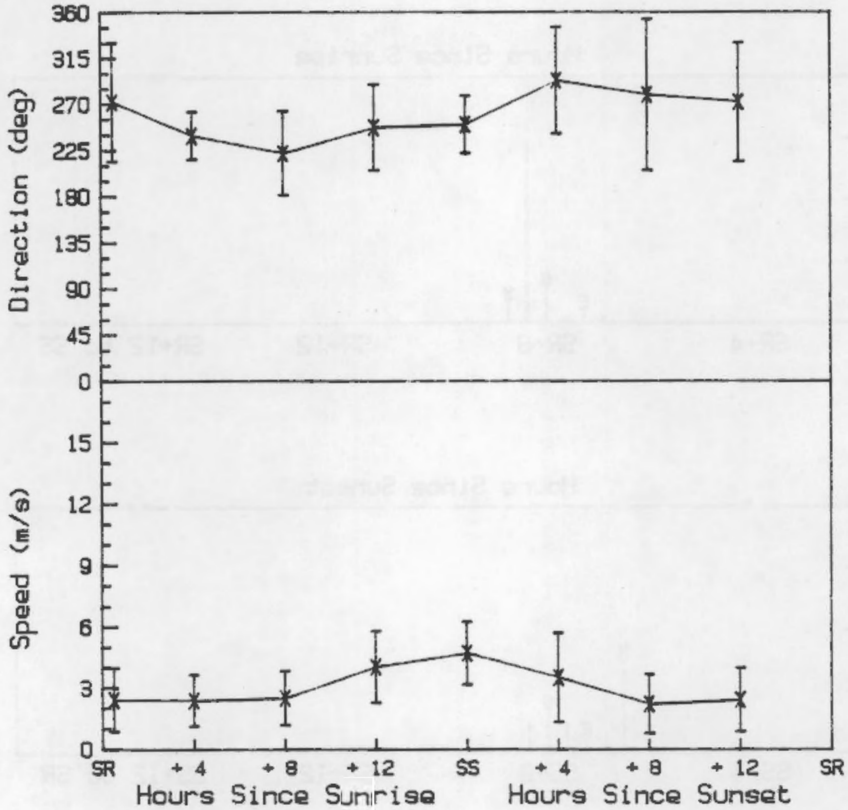
% Occurrence = 1.49

SECTION: S-IV- 8 - 0

SEASON: Summer

CATEGORY: cP/cA Ridge

Vg (dir/mag): NW / All

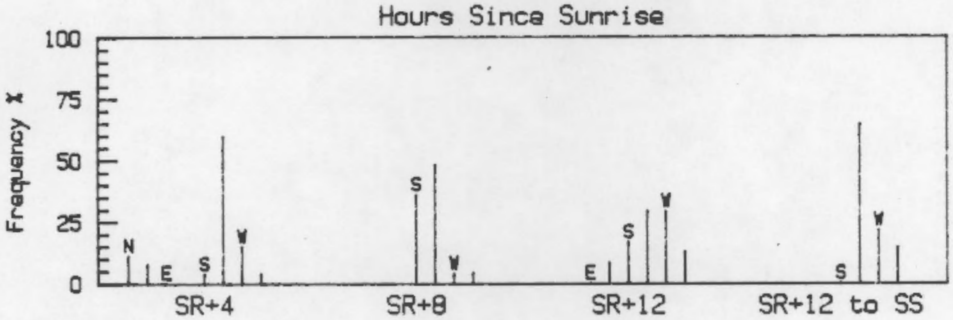


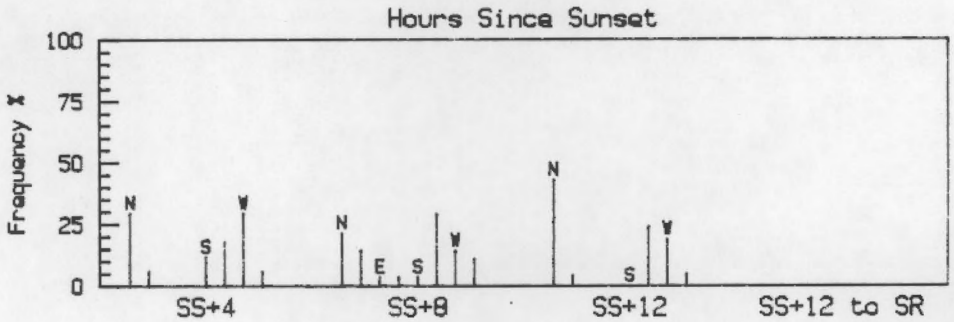
Mean Wind Statistics as a Function of Time of Day

SECTION:	S-IV- 8 - 0
SEASON:	Summer
CATEGORY:	cP/cA Ridge
Vg (dir/mag):	NW / All

SITE: Susquehanna PA.

% Occurrence = 1.49





Site Wind Direction Frequencies as a Function of

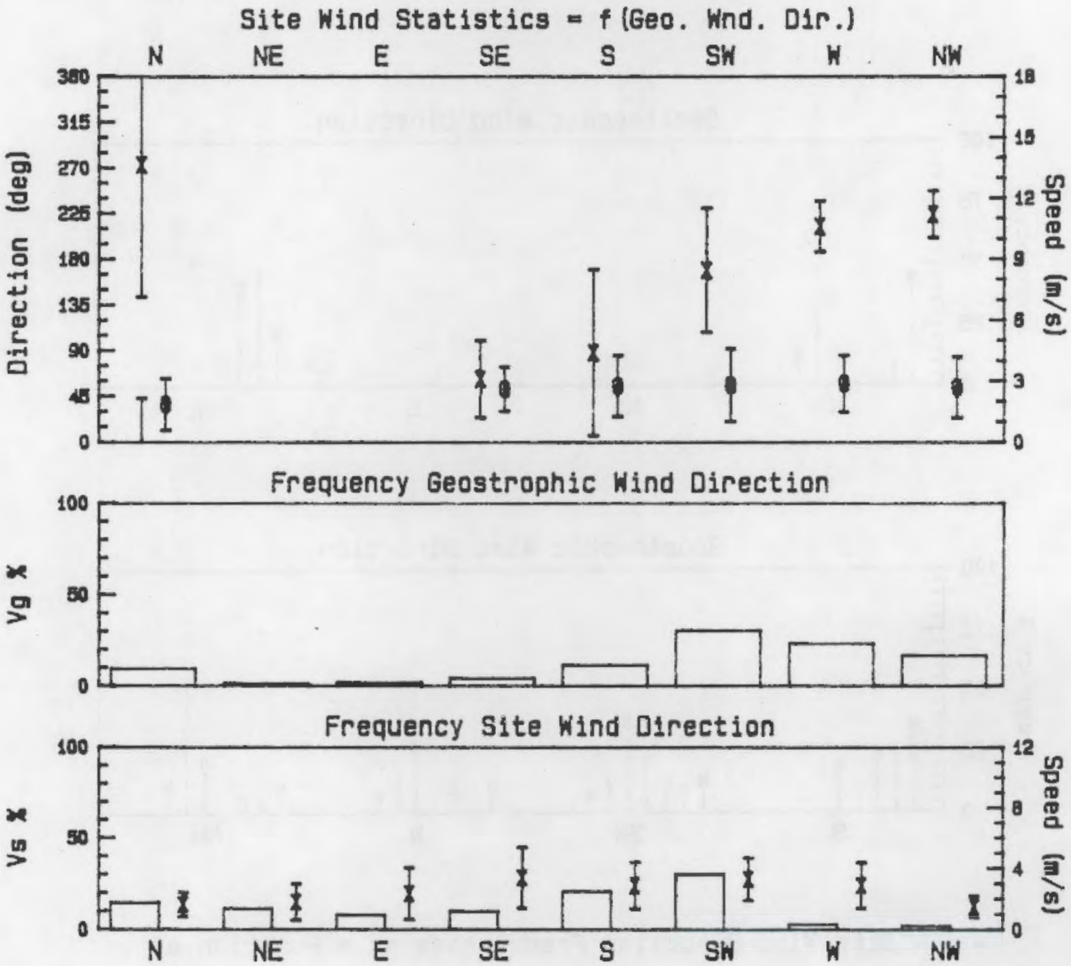
Time of Day

SECTION: S-V

SITE: Susquehanna PA. SEASON: Summer

% Occurrence = 5.67 CATEGORY: mT Ridge

Vg (dir/mag): All / All



Diurnal Cross Reference Index

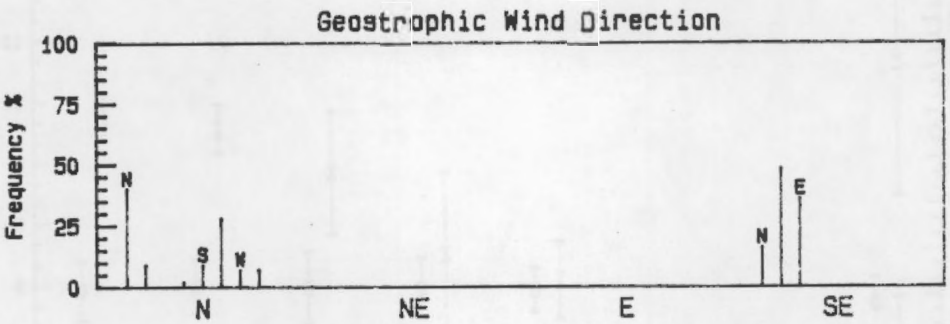
Pressure Gradient Orientation X Magnitude

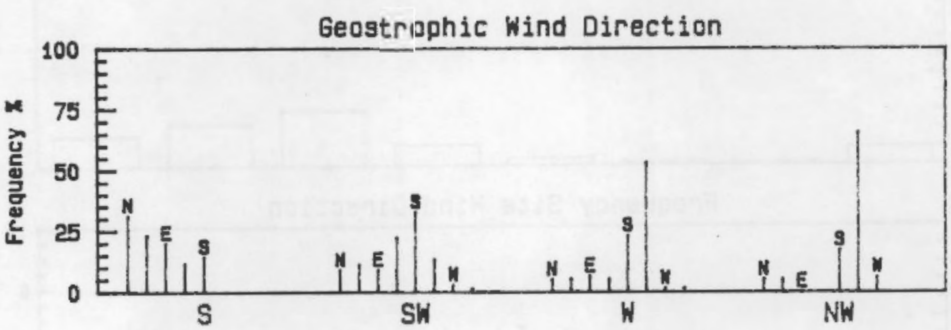
	N	NE	E	SE	S	SW	W	NW
All	-1-0				-5-0	-6-0	-7-0	-8-0
Strong								
Weak								

SITE: Susquehanna PA.

% Occurrence = 5.67

SECTION: S-V
SEASON: Summer
CATEGORY: mT Ridge
Vg (dir/mag): All / All





Site Wind Direction Frequencies as a Function of

Geostrophic Wind Direction

SITE: Susquehanna PA.

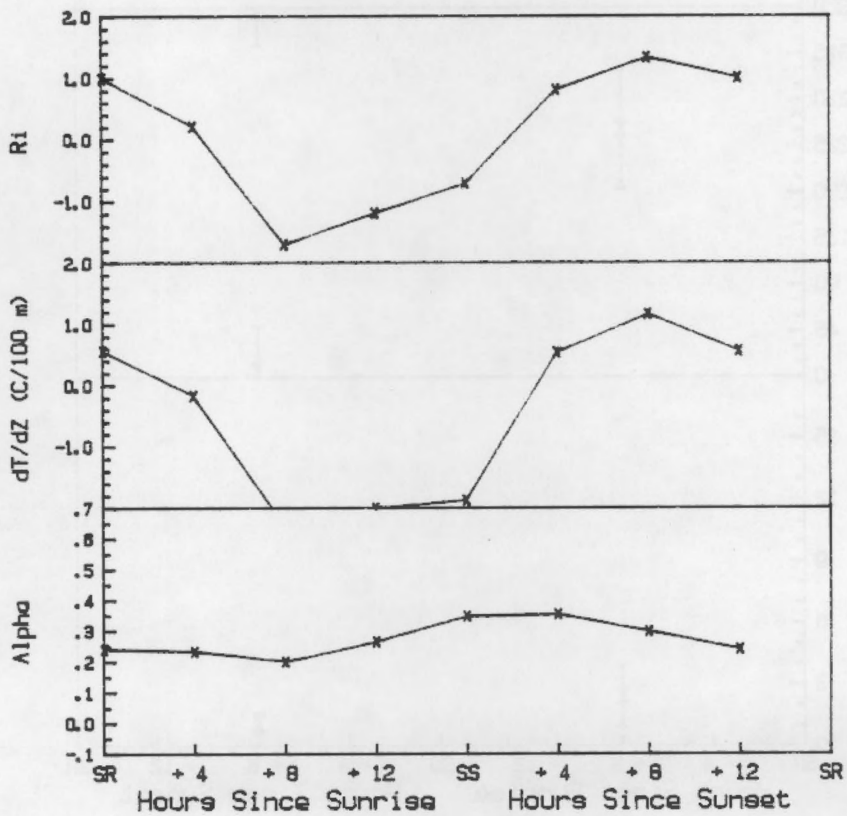
% Occurrence = 5.67

SECTION: S-V

SEASON: Summer

CATEGORY: mT Ridge

Vg (dir/mag): All / All

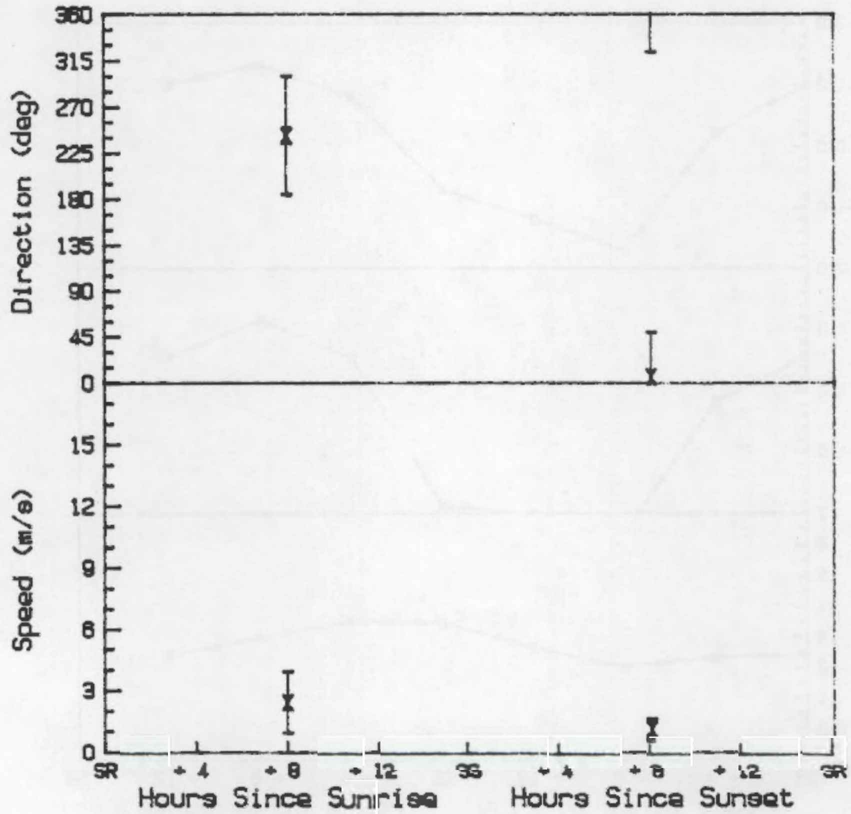


Mean Stability Parameters as a Function of Time of Day

SITE: Susquehanna

% Occurrence = .55

SECTION: S-V- 1 - 0
SEASON: Summer
CATEGORY: mT Ridge
Vg (dir/mag): N / All

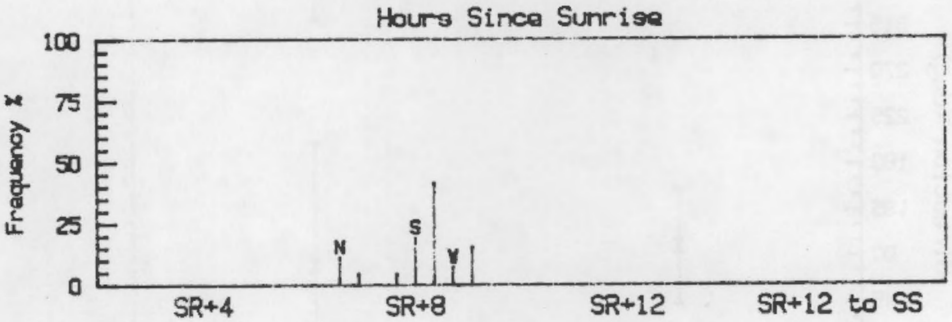


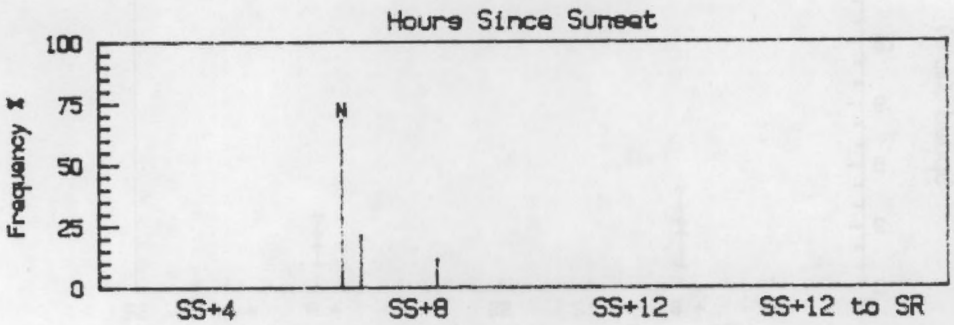
Mean Wind Statistics as a Function of Time of Day

SITE: Susquehanna

% Occurrence = .55

SECTION: S-V- 1 - 0
SEASON: Summer
CATEGORY: mT Ridge
Vg (dir/mag): N / All



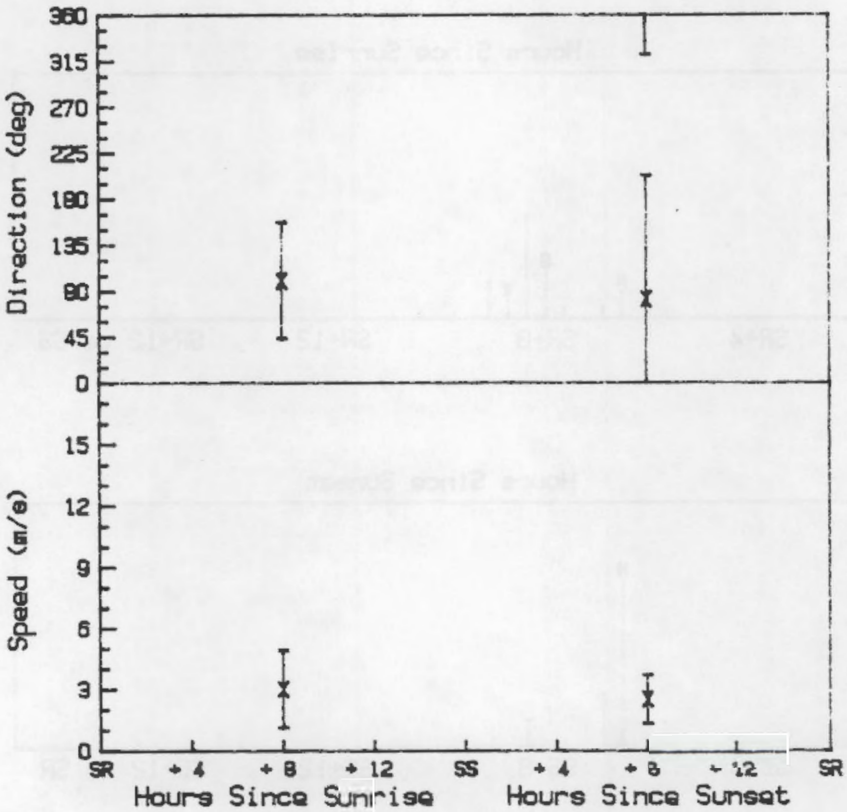


Site Wind Direction Frequencies as a Function of Time of Day

SITE: Susquehanna

% Occurrence = .66

SECTION: S-V- 5 - 0
SEASON: Summer
CATEGORY: mT Ridge
Vg (dir/mag): S / All

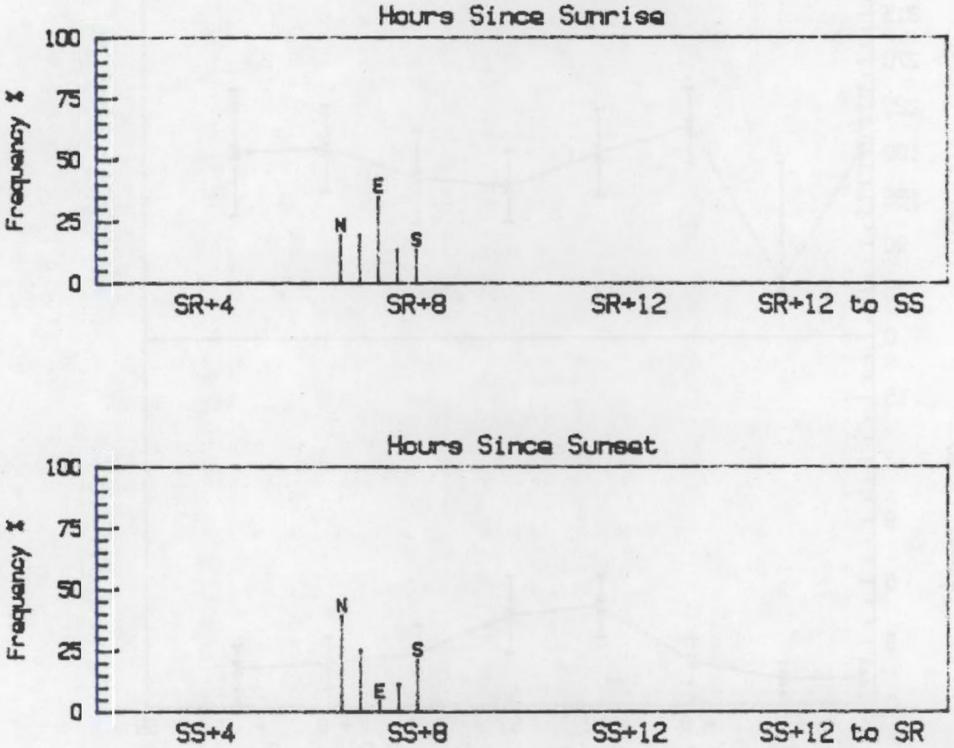


Mean Wind Statistics as a Function of Time of Day

SITE: Susquehanna

% Occurrence = .66

SECTION: S-V- 5 - 0
SEASON: Summer
CATEGORY: mT Ridge
Vg (dir/mag): S / All

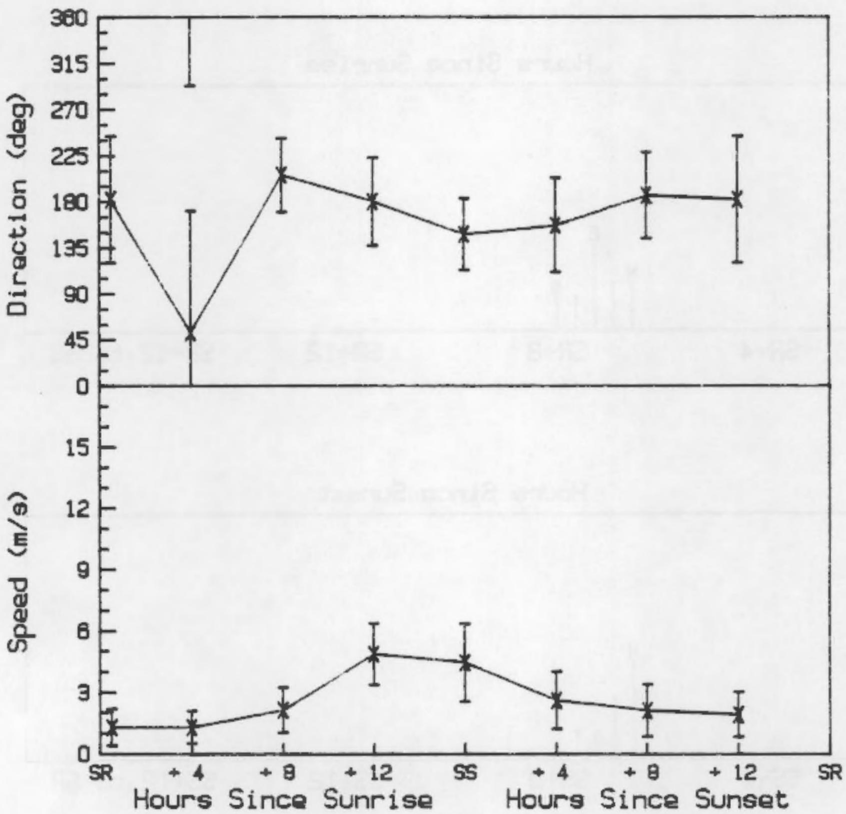


Site Wind Direction Frequencies as a Function of Time of Day

SITE: Susquehanna PA.

% Occurrence = 1.74

SECTION: S-V- 6 - 0
SEASON: Summer
CATEGORY: mT Ridge
Vg (dir/mag): SW / All



Mean Wind Statistics as a Function of Time of Day

SITE: Susquehanna PA.

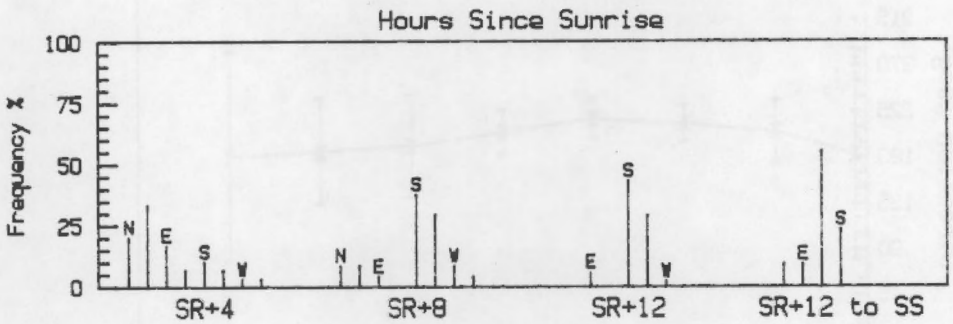
% Occurrence = 1.74

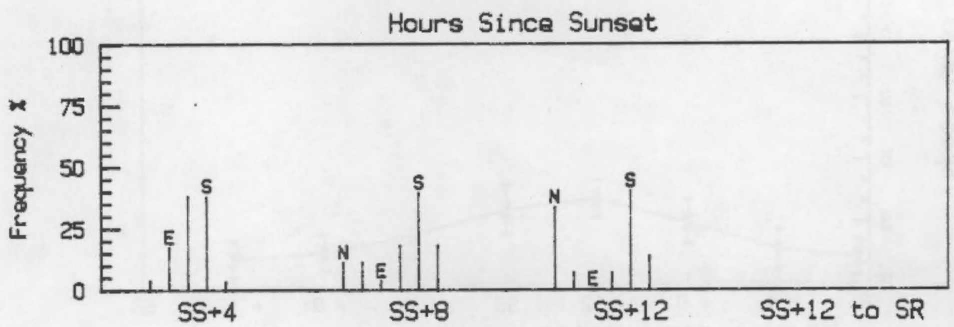
SECTION: S-V- 6 - 0

SEASON: Summer

CATEGORY: mT Ridge

Vg (dir/mag): SW / All



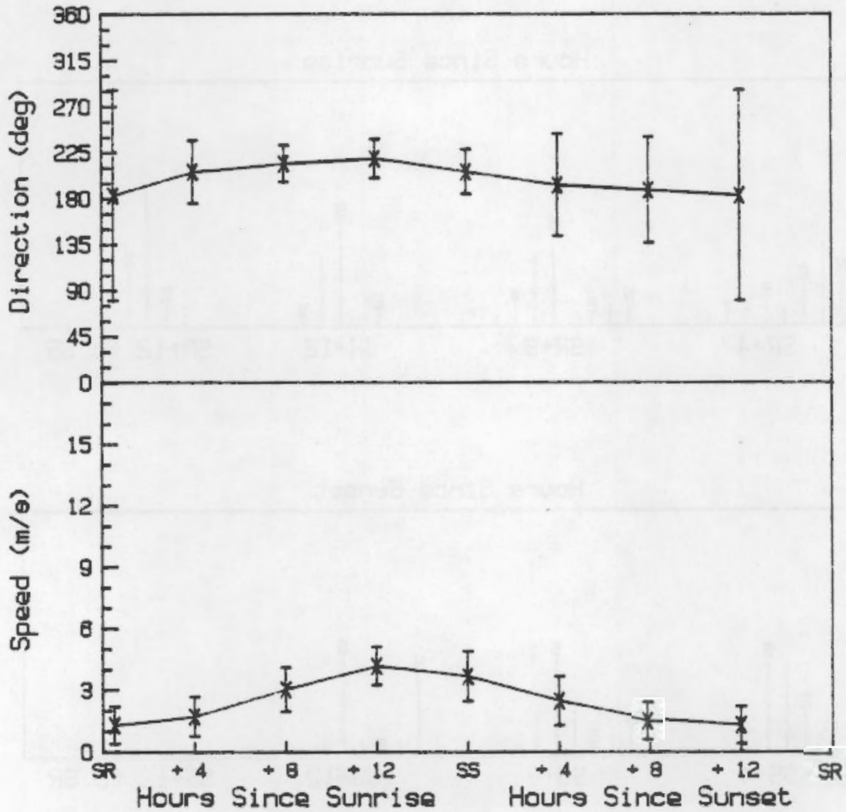


Site Wind Direction Frequencies as a Function of Time of Day

SITE: Susquehanna PA.

% Occurrence = 1.34

SECTION: S-V- 7 - 0
SEASON: Summer
CATEGORY: mT Ridge
Vg (dir/mag): W / All

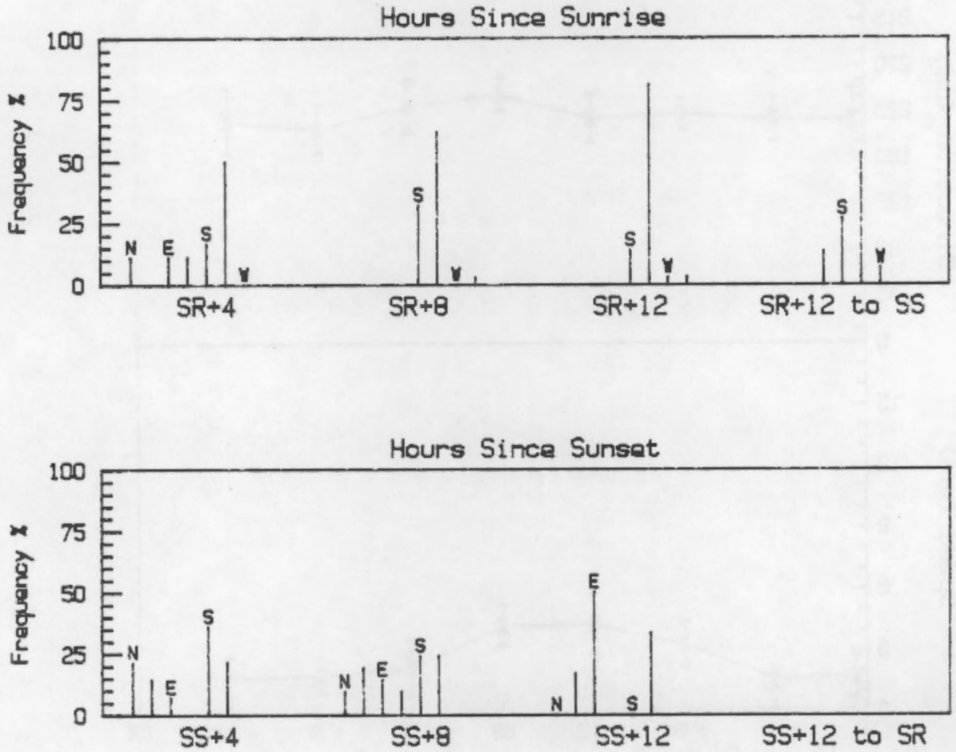


Mean Wind Statistics as a Function of Time of Day

SITE: Susquehanna PA.

% Occurrence = 1.34

SECTION: S-V- 7 - 0
SEASON: Summer
CATEGORY: mT Ridge
Vg (dir/mag): W / All

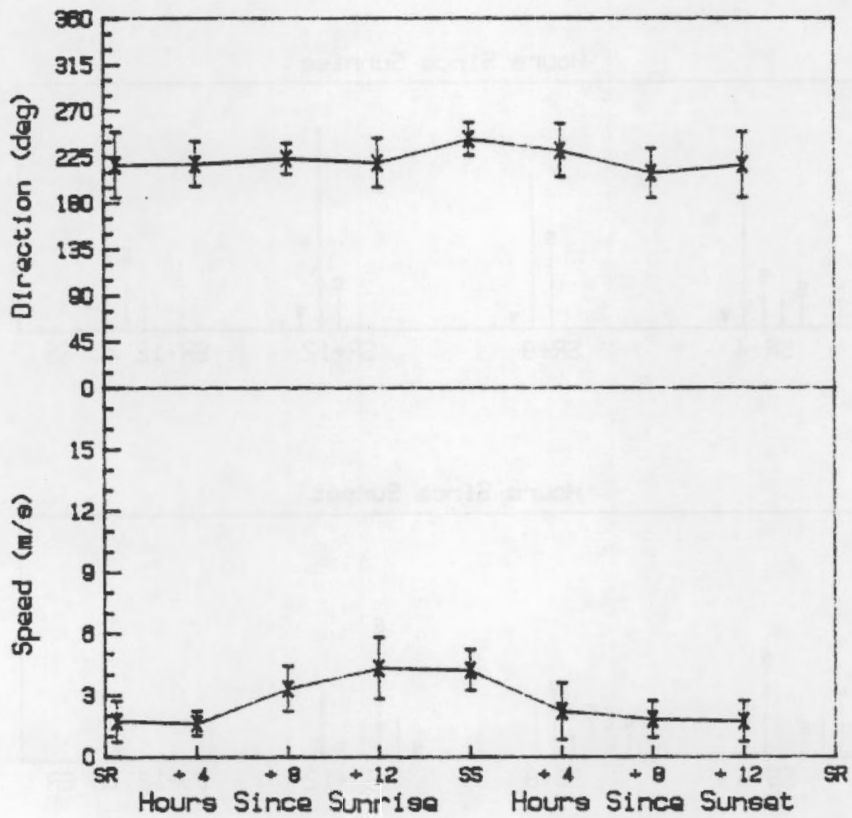


Site Wind Direction Frequencies as a Function of Time of Day

SITE: Susquehanna

% Occurrence = .96

SECTION: S-V- 8 - 0
SEASON: Summer
CATEGORY: mT Ridge
Vg (dir/mag): NW / All

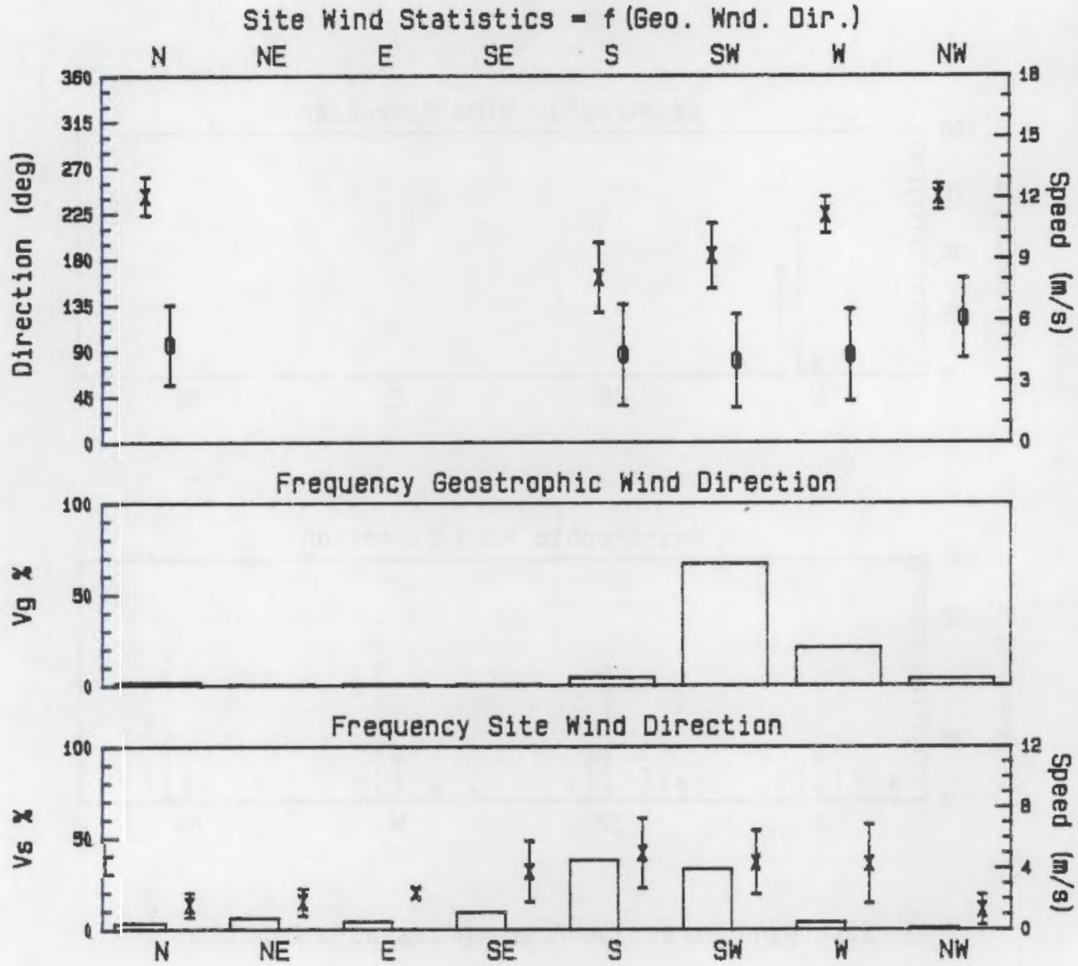


Mean Wind Statistics as a Function of Time of Day

SITE: Susquehanna PA.

% Occurrence = 6.82

SECTION: W-I
SEASON: Winter
CATEGORY: Warm Sector
Vg (dir/mag): All / All



Diurnal Cross Reference Index

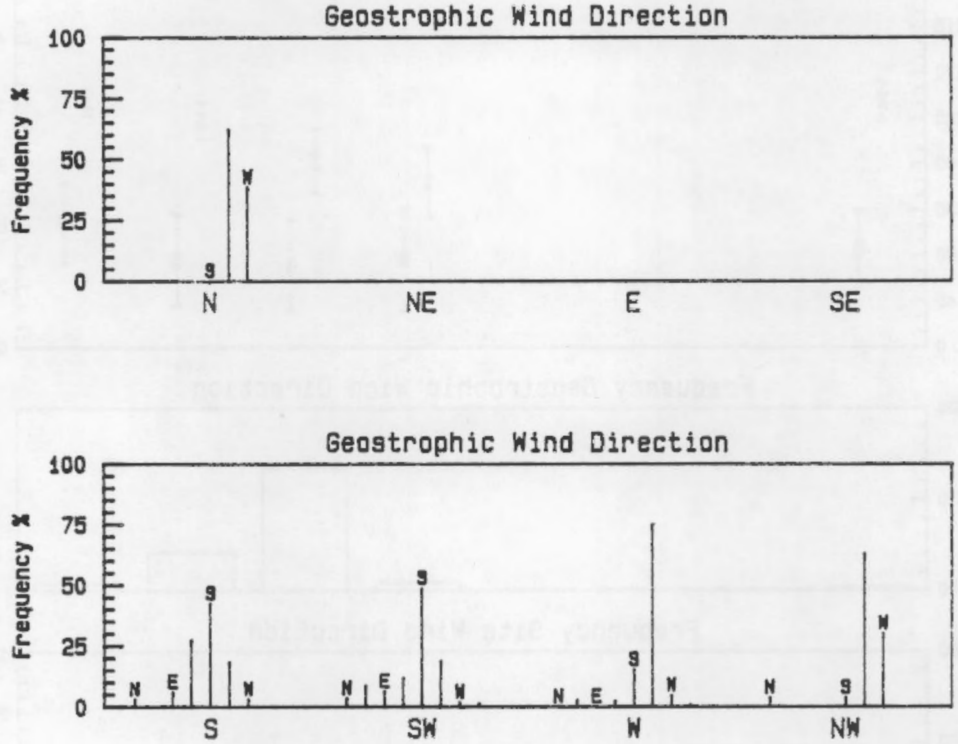
Pressure Gradient Orientation X Magnitude

	N	NE	E	SE	S	SW	W	NW
All					S-I -5-0	-6-0		
Strong								
Weak								

SITE: Susquehanna PA.

% Occurrence = 6.82

SECTION: W-I
SEASON: Winter
CATEGORY: Warm Sector
Vg (dir/mag): All / All

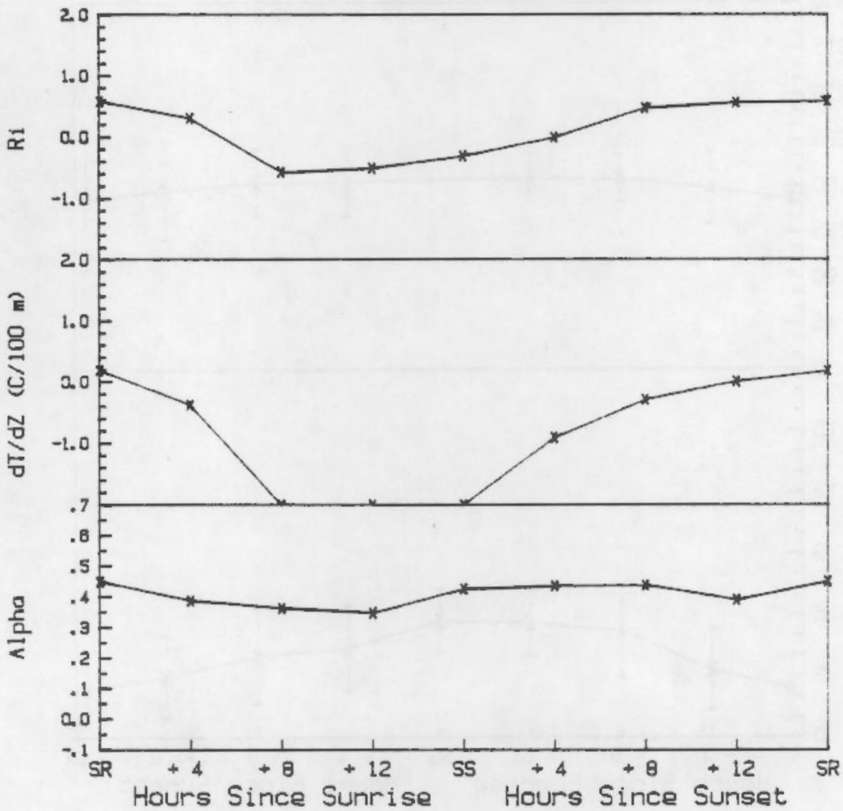


Site Wind Direction Frequencies as a Function of

Geostrophic Wind Direction

SITE: Susquehanna PA.
% Occurrence = 6.82

SECTION: W-I
SEASON: Winter
CATEGORY: Warm Sector
Vg (dir/mag): All / All



Mean Stability Parameters as a Function of Time of Day

SITE: Susquehanna PA.

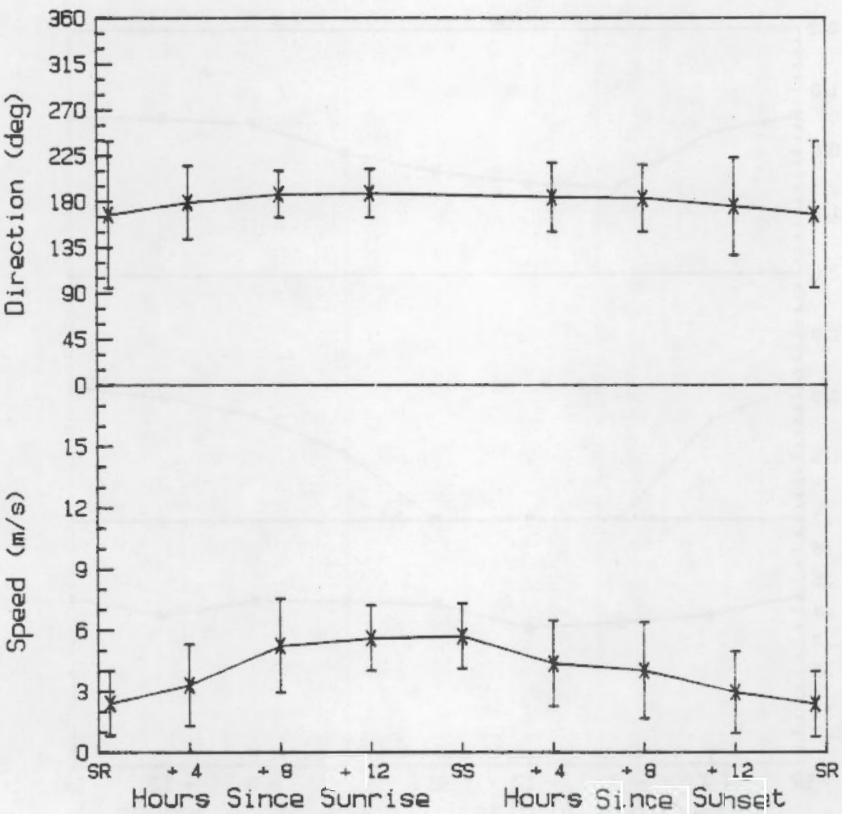
% Occurrence = 4.57

SECTION: W-I- 6 - 0

SEASON: Winter

CATEGORY: Warm Sector

Vg (dir/mag): SW / All

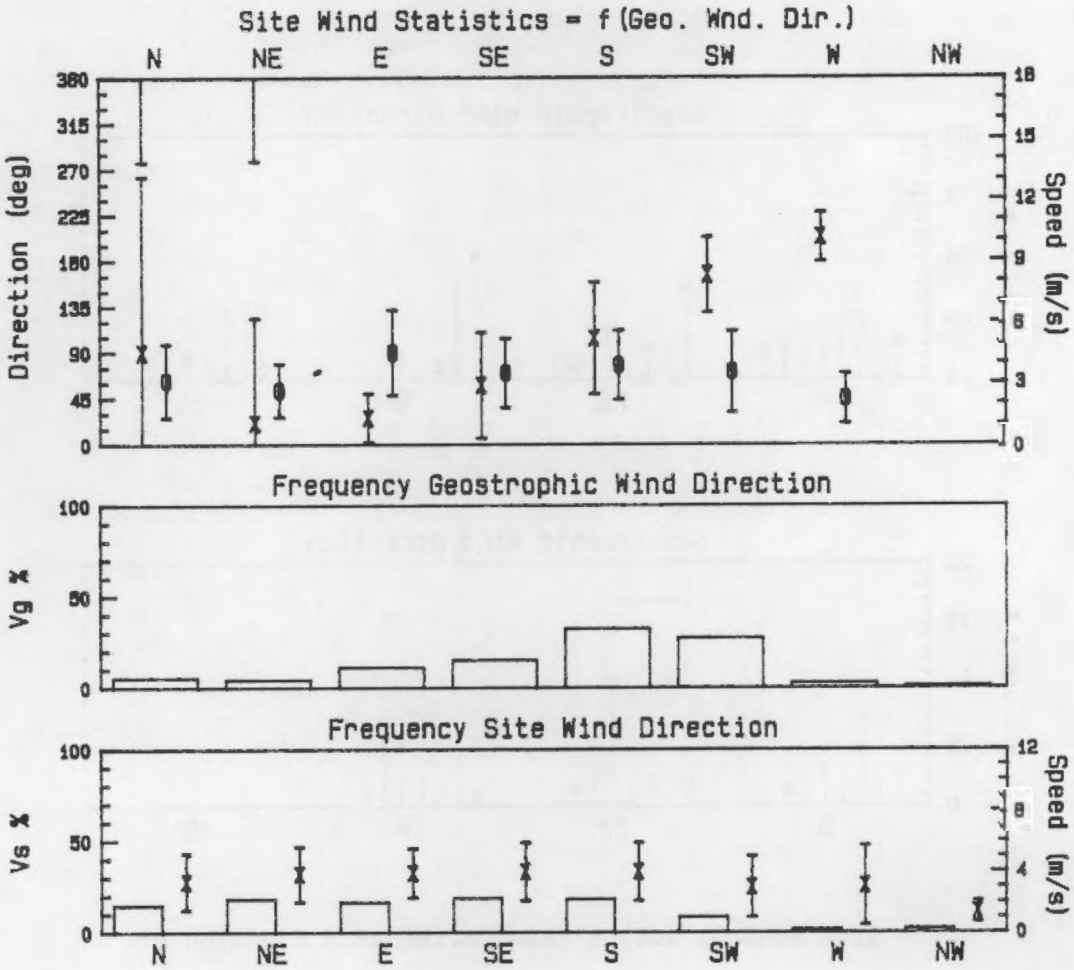


Mean Wind Statistics as a Function of Time of Day

SITE: Susquehanna PA.

% Occurrence = 9.22

SECTION: W-II
SEASON: Winter
CATEGORY: Warm Front
Vg (dir/mag): All / All



Diurnal Cross Reference Index

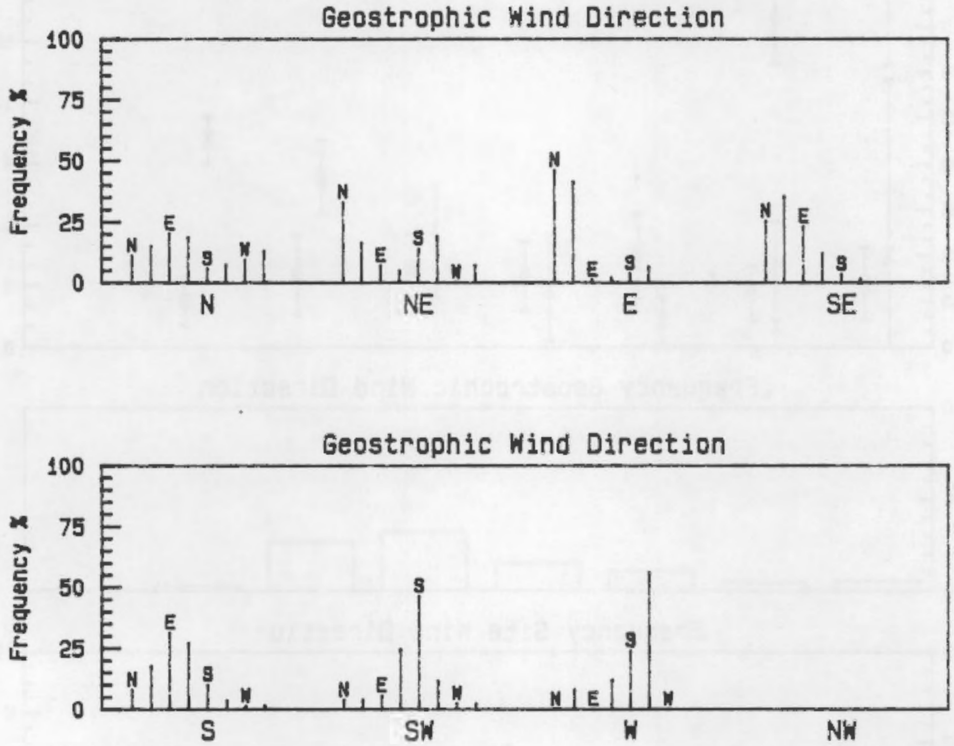
Pressure Gradient Orientation X Magnitude

	N	NE	E	SE	S	SW	W	NW
All				-4-0	-5-0	-6-0	-7-0	
Strong								
Weak								

SITE: Susquehanna PA.

% Occurrence = 9.22

SECTION: W-II
SEASON: Winter
CATEGORY: Warm Front
Vg (dir/mag): All / All



Site Wind Direction Frequencies as a Function of Geostrophic Wind Direction

SECTION: W-II

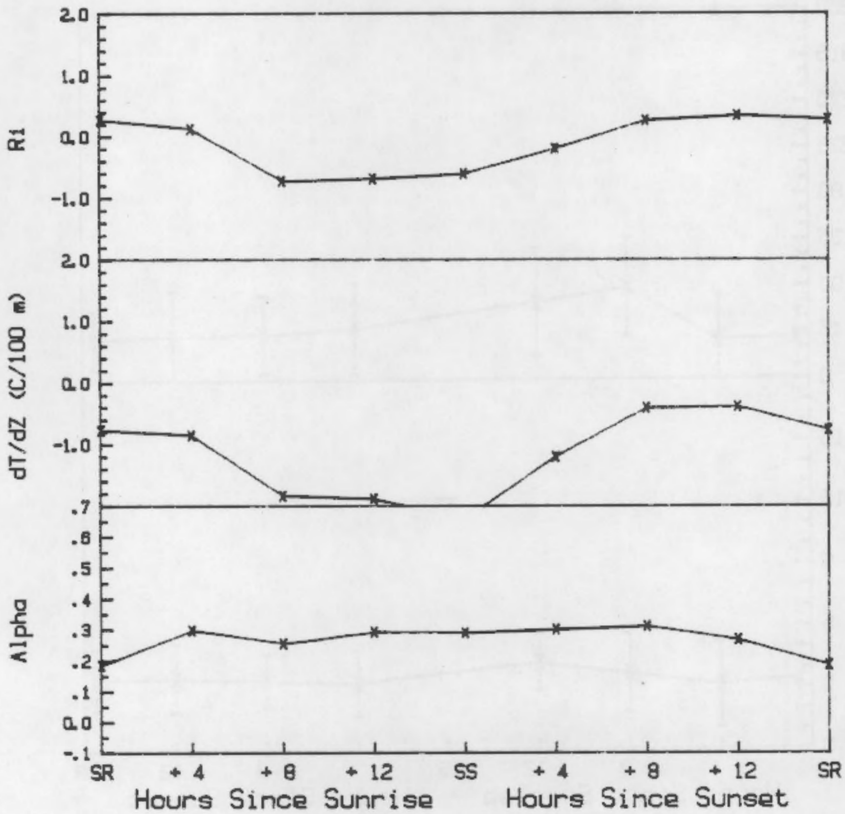
SITE: Susquehanna PA.

SEASON: Winter

CATEGORY: Warm Front

% Occurrence = 9.22

Vg (dir/mag): All / All

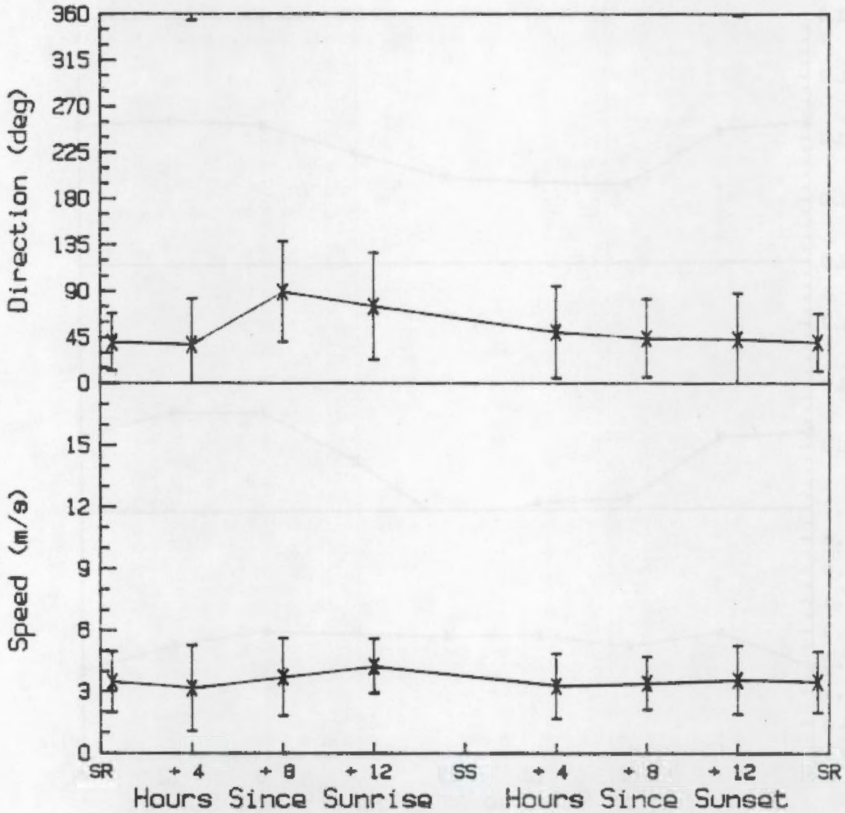


Mean Stability Parameters as a Function of Time of Day

SITE: Susquehanna PA.

% Occurrence = 1.42

SECTION: W-II- 4 - 0
SEASON: Winter
CATEGORY: Warm Front
Vg (dir/mag): SE / All

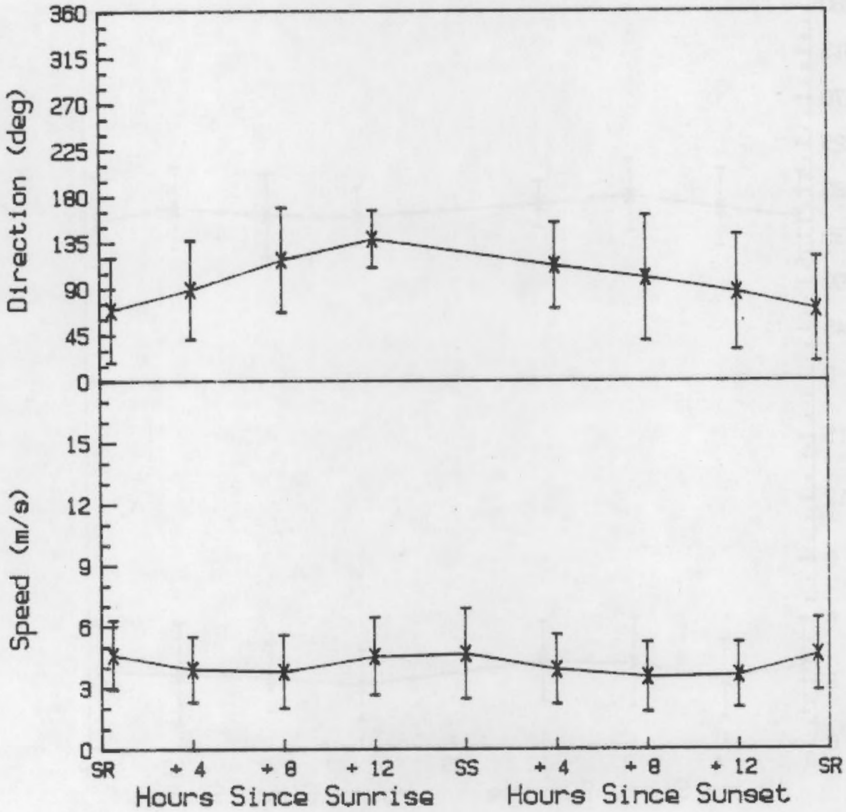


Mean Wind Statistics as a Function of Time of Day

SITE: Susquehanna PA.

% Occurrence = 2.99

SECTION: W-II- 5 - 0
SEASON: Winter
CATEGORY: Warm Front
Vg (dir/mag): S / All

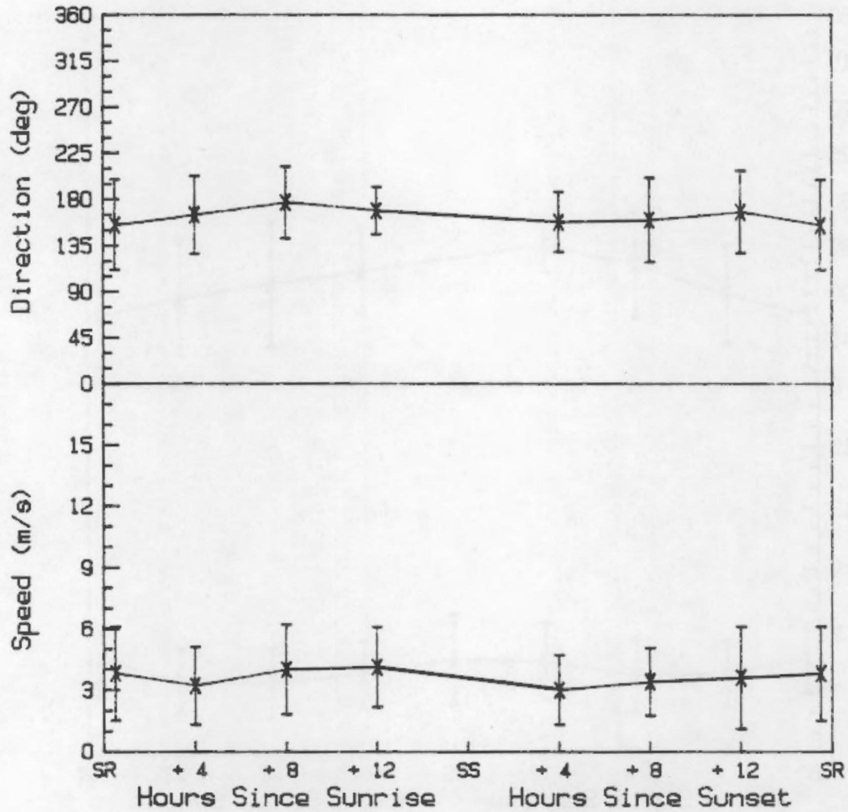


Mean Wind Statistics as a Function of Time of Day

SITE: Susquehanna PA.

% Occurrence = 2.52

SECTION: W-II- 6 - 0
SEASON: Winter
CATEGORY: Warm Front
Vg (dir/mag): SW / All

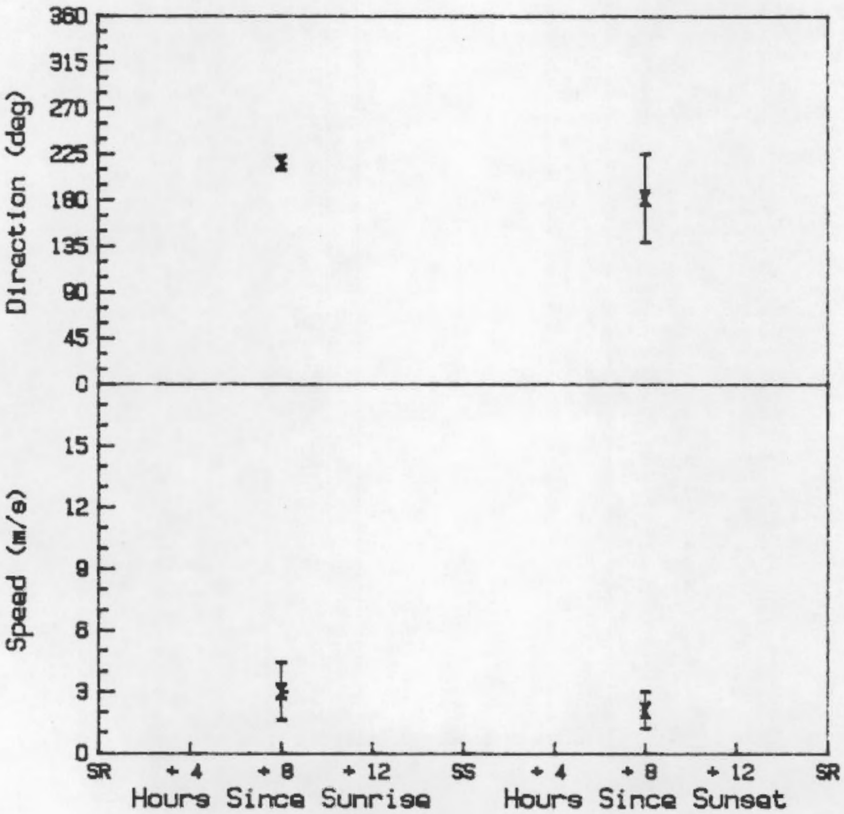


Mean Wind Statistics as a Function of Time of Day

SITE: Susquehanna

% Occurrence = .24

SECTION: W-II- 7 - 0
SEASON: Winter
CATEGORY: Warm Front
Vg (dir/mag): W / All

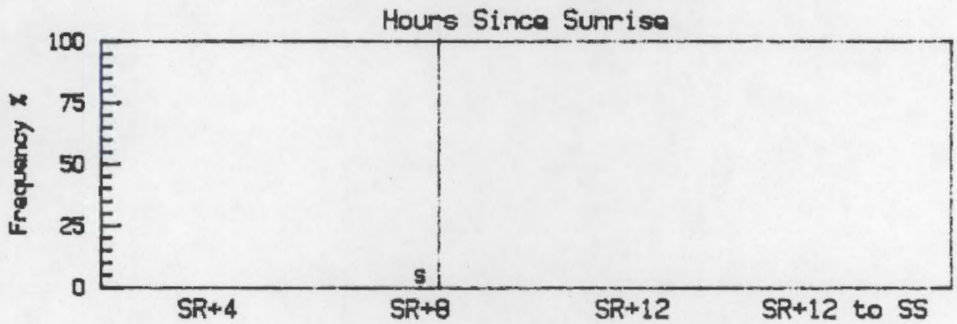


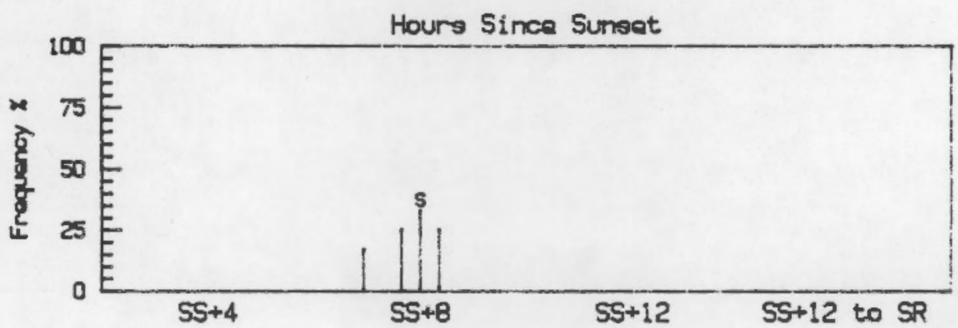
Mean Wind Statistics as a Function of Time of Day

SITE: Susquehanna

% Occurrence = .24

SECTION: W-II- 7 - 0
SEASON: Winter
CATEGORY: Warm Front
Vg (dir/mag): W / All





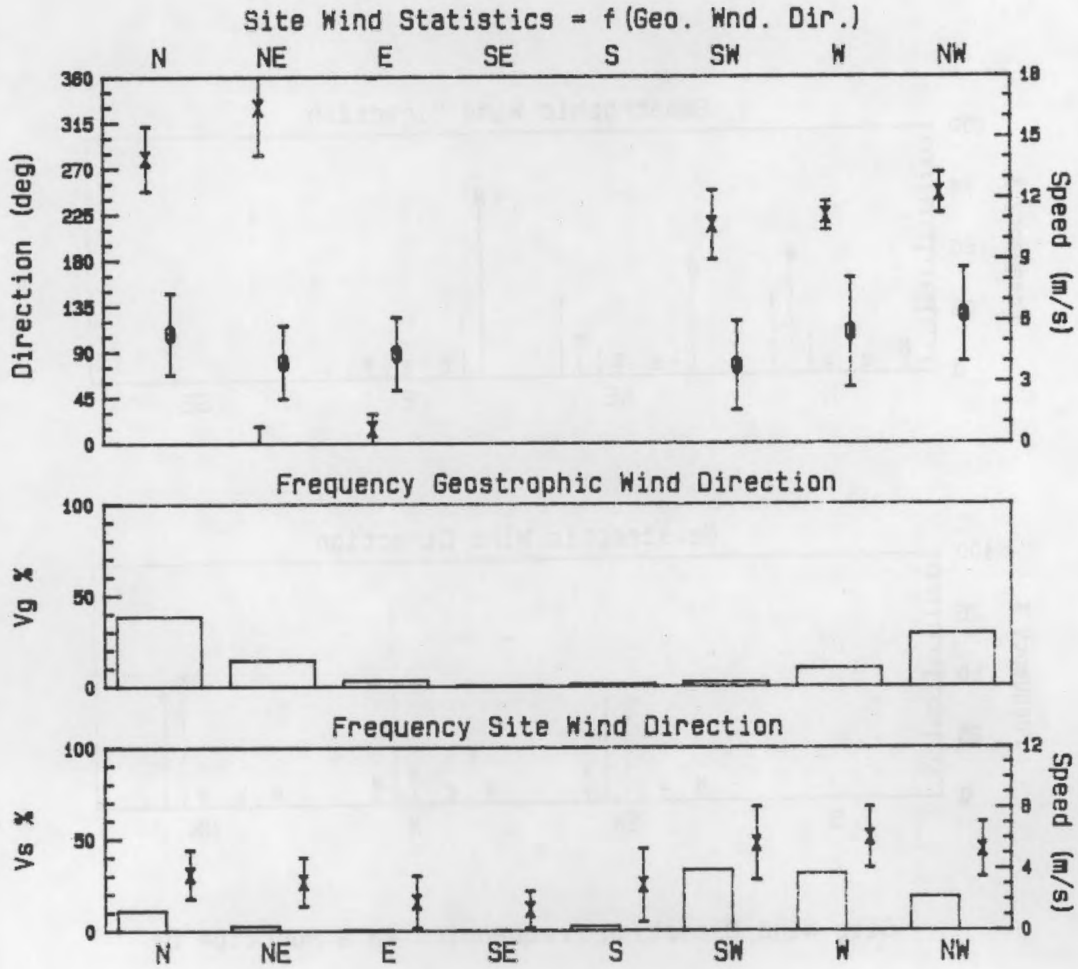
Site Wind Direction Frequencies as a Function of

Time of Day

SECTION: W-III
SEASON: Winter
CATEGORY: Cold Front
Vg (dir/mag): All / All

SITE: Susquehanna PA.

% Occurrence = 14.85



Diurnal Cross Reference Index

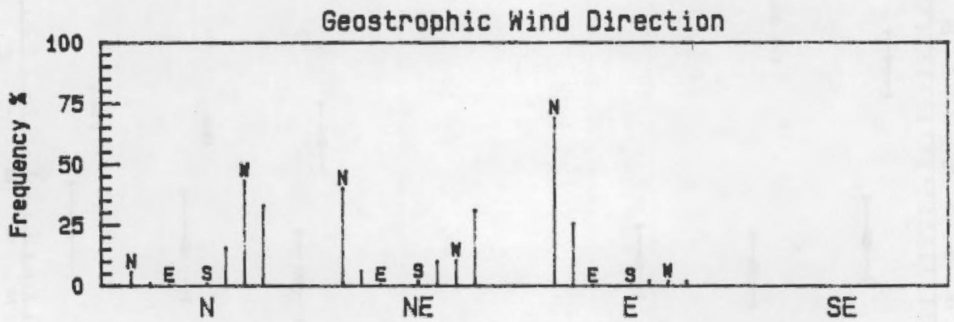
Pressure Gradient Orientation X Magnitude

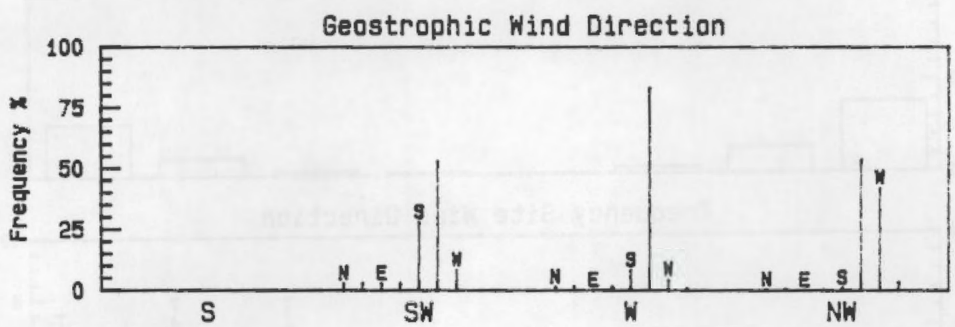
	N	NE	E	SE	S	SW	W	NW
All	S-III-1-0	-2-0						
Strong								
Weak								

SITE: Susquehanna PA.

% Occurrence = 14.85

SECTION: W-III
SEASON: Winter
CATEGORY: Cold Front
Vg (dir/mag): All / All





Site Wind Direction Frequencies as a Function of

Geostrophic Wind Direction

SITE: Susquehanna PA.

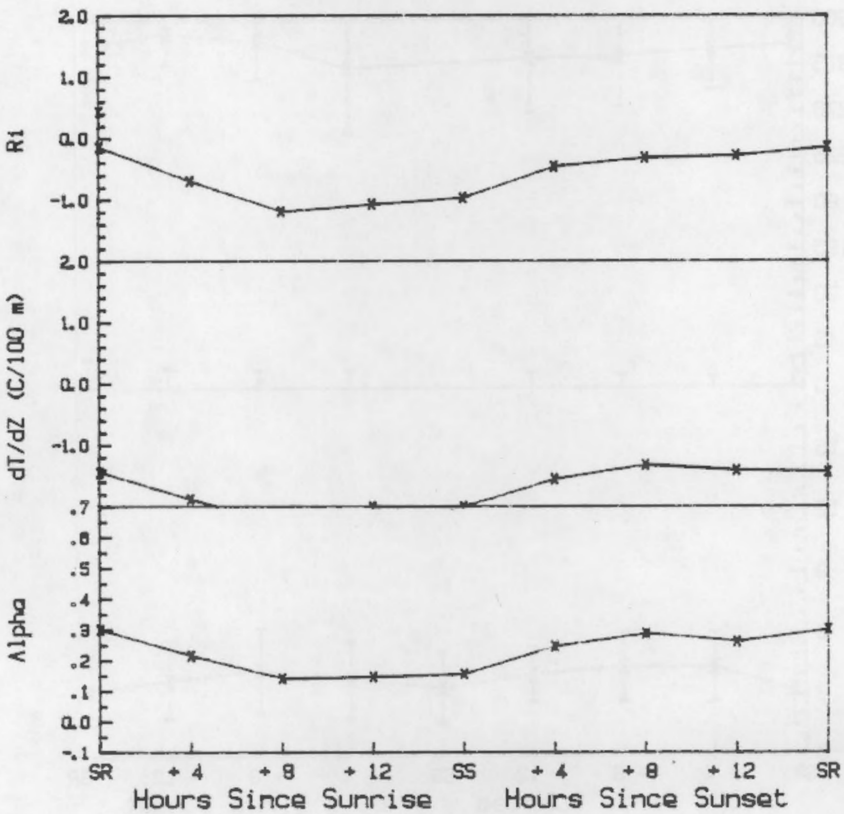
% Occurrence = 14.85

SECTION: W-III

SEASON: Winter

CATEGORY: Cold Front

Vg (dir/mag): All / All



Mean Stability Parameters as a Function of Time of Day

SITE: Susquehanna PA.

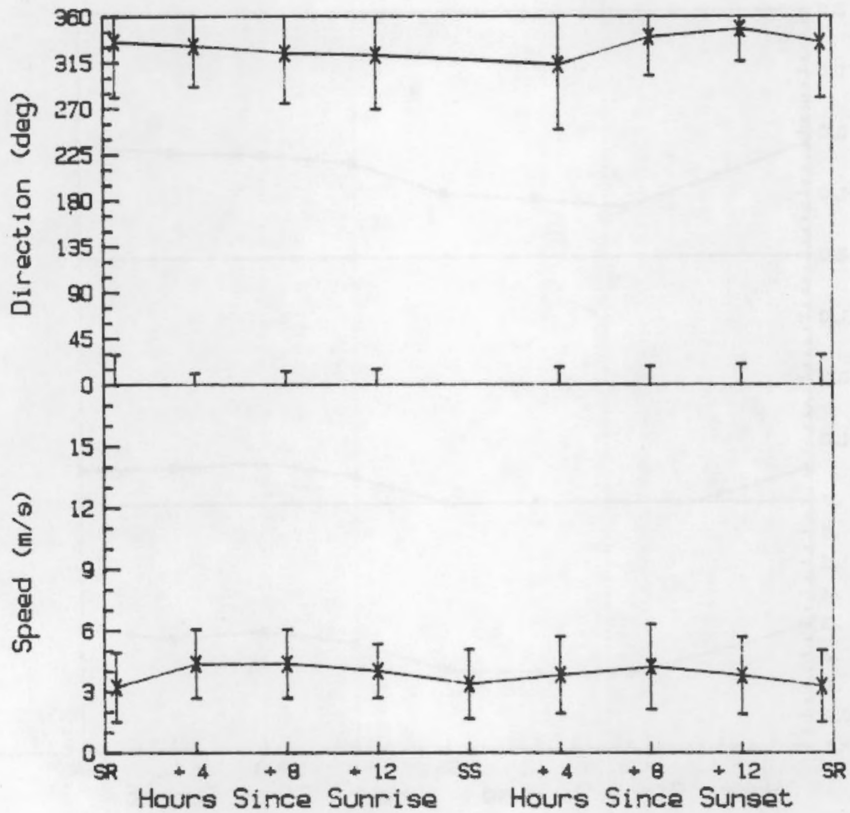
% Occurrence = 2.17

SECTION: W-III- 2 - 0

SEASON: Winter

CATEGORY: Cold Front

Vg (dir/mag): NE / All

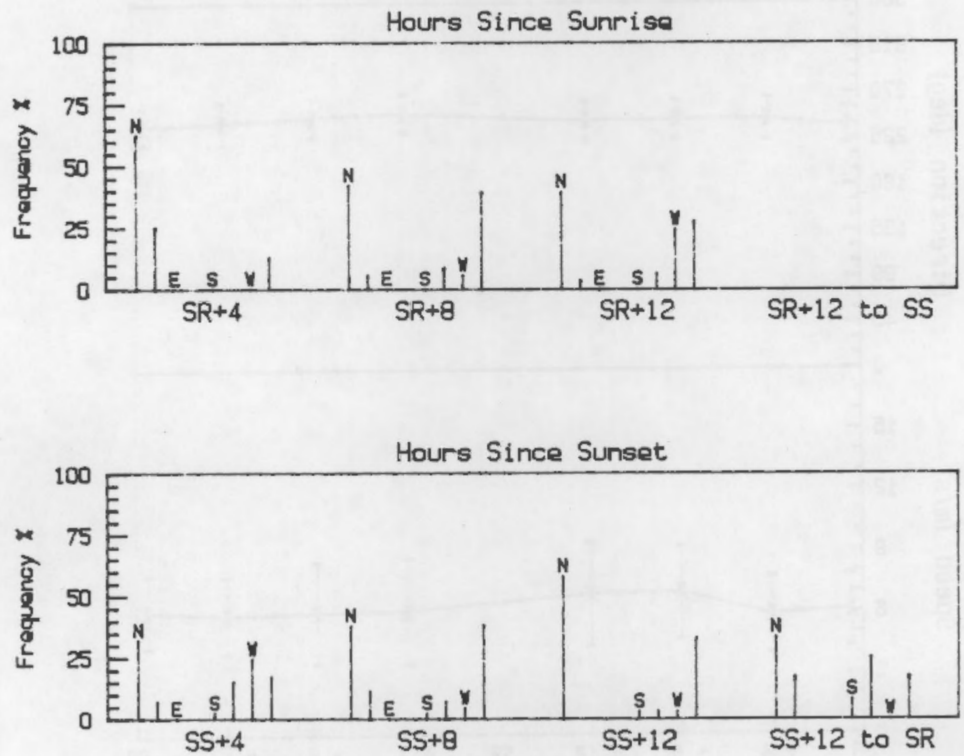


Mean Wind Statistics as a Function of Time of Day

SITE: Susquehanna PA.

% Occurrence = 2.17

SECTION: W-III- 2 - 0
SEASON: Winter
CATEGORY: Cold Front
Vg (dir/mag): NE / All

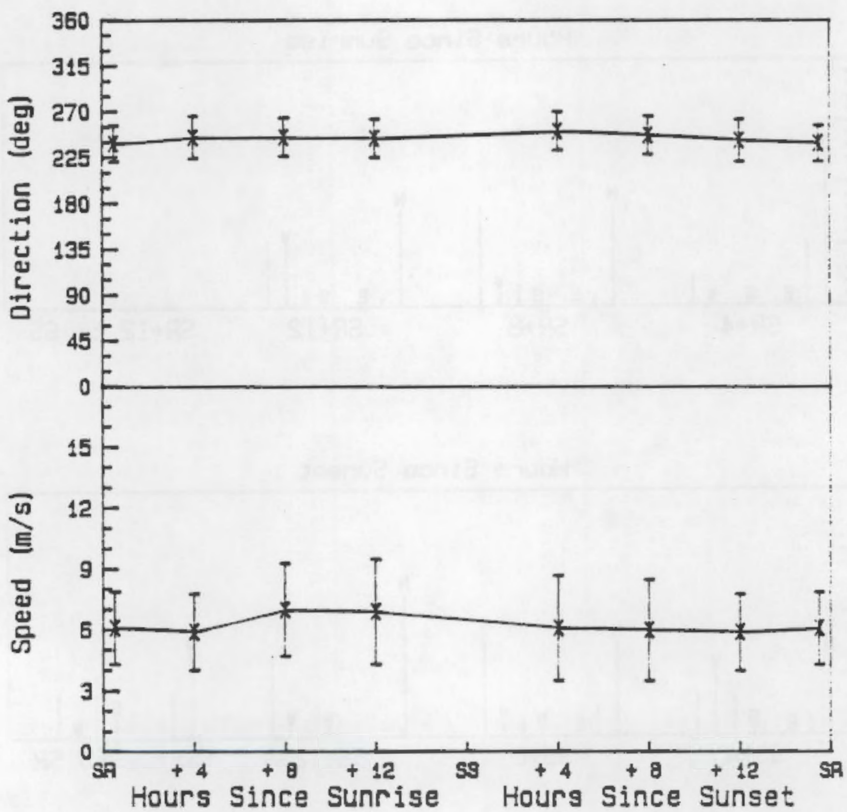


Site Wind Direction Frequencies as a Function of Time of Day

SITE: Susquehanna PA.

% Occurrence = 5.45

SECTION: W-III- 8 - 0
SEASON: Winter
CATEGORY: Cold Front
Vg (dir/mag): NW / All



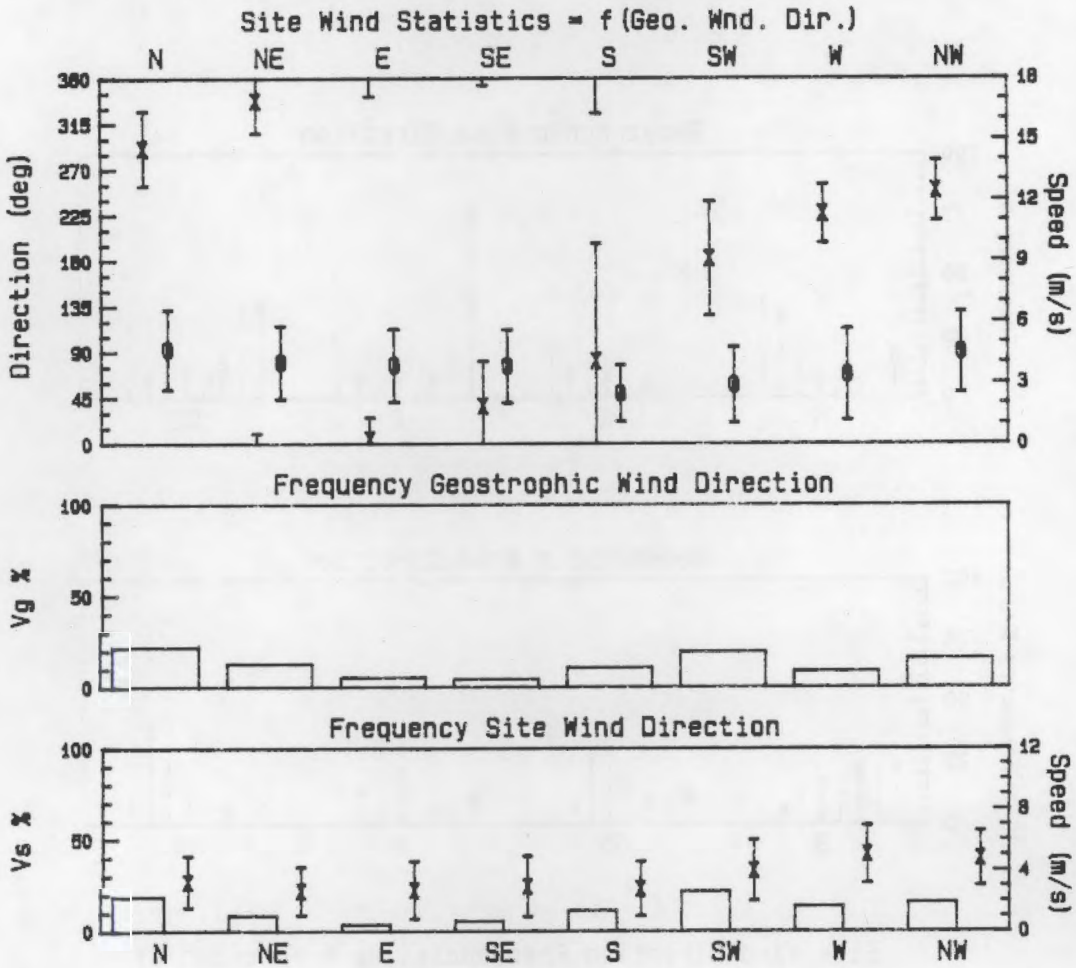
Mean Wind Statistics as a Function of Time of Day

SECTION: W-IV

SITE: Susquehanna PA. SEASON: Winter

% Occurrence = 25.57 CATEGORY: cP/cA Ridge

Vg (dir/mag): All / All



Diurnal Cross Reference Index

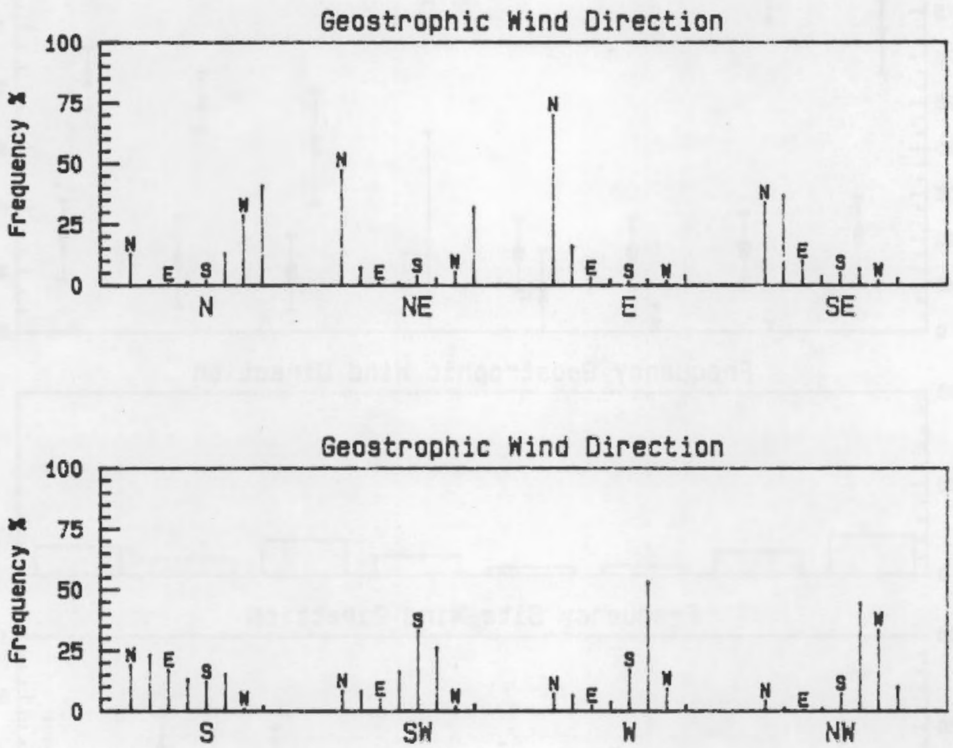
Pressure Gradient Orientation X Magnitude

	N	NE	E	SE	S	SW	W	NW
All		-2-0		-4-0	-5-0	-6-0	-7-0	
Strong								
Weak								

SITE: Susquehanna PA.

% Occurrence = 25.57

SECTION: W-IV
SEASON: Winter
CATEGORY: cP/cA Ridge
Vg (dir/mag): All / All



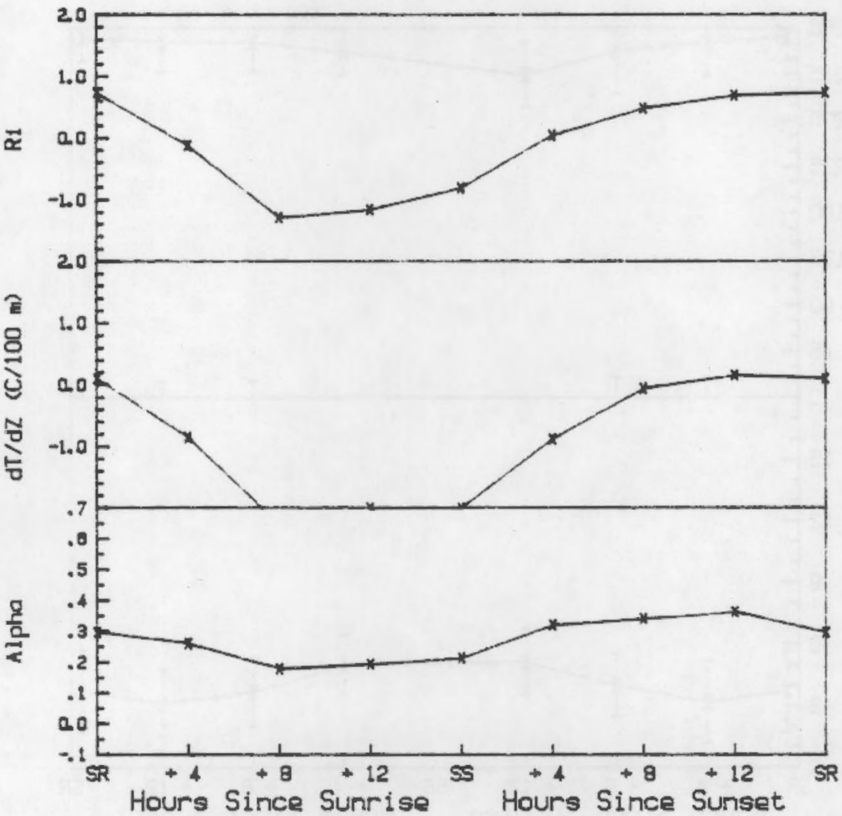
Site Wind Direction Frequencies as a Function of

Geostrophic Wind Direction

SITE: Susquehanna PA.

% Occurrence = 25.57

SECTION: W-IV
SEASON: Winter
CATEGORY: cP/cA Ridge
Vg (dir/mag): All / All

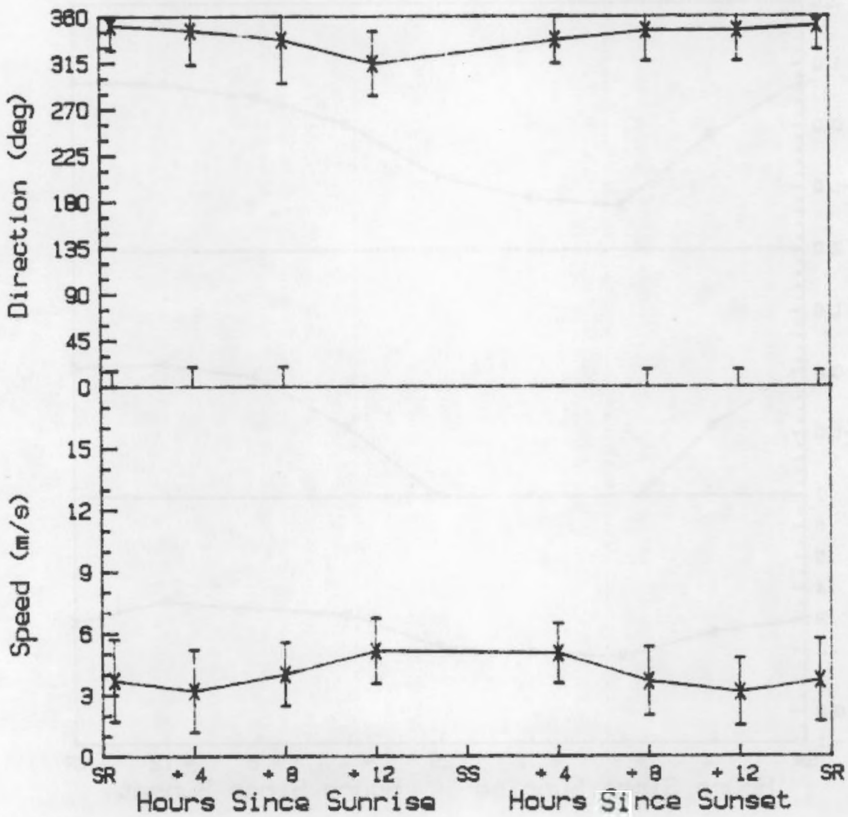


Mean Stability Parameters as a Function of Time of Day

SITE: Susquehanna PA.

% Occurrence = 3.35

SECTION: W-IV- 2 - 0
SEASON: Winter
CATEGORY: cP/cA Ridge
Vg (dir/mag): NE / All



Mean Wind Statistics as a Function of Time of Day

SITE: Susquehanna PA.

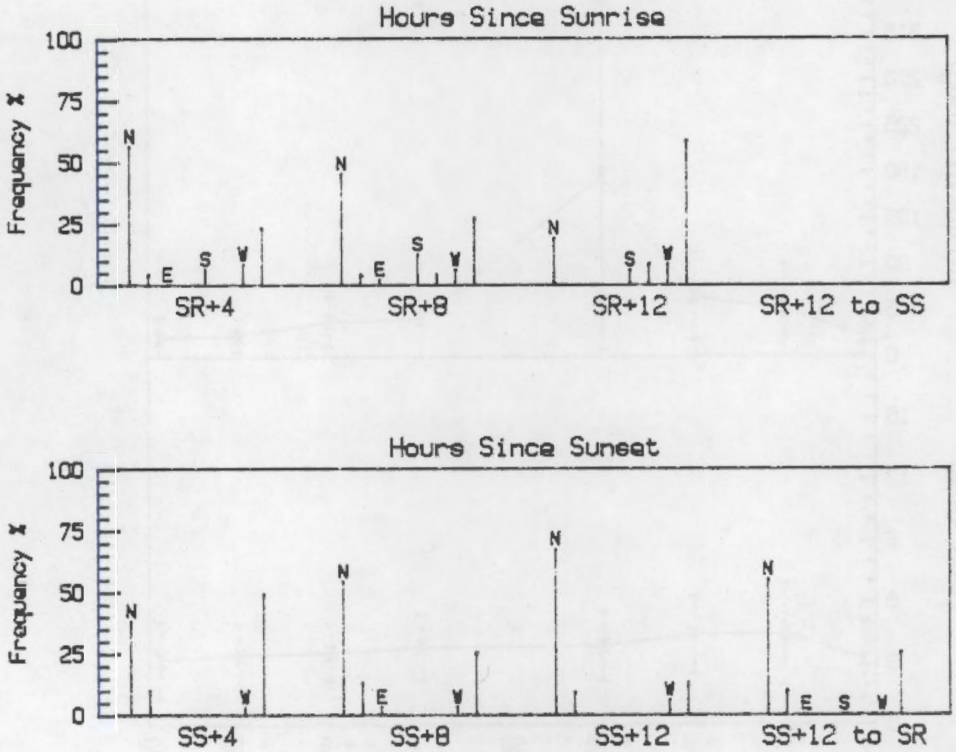
% Occurrence = 3.35

SECTION: W-IV- 2 - 0

SEASON: Winter

CATEGORY: cP/cA Ridge

Vg (dir/mag): NE / All



Site Wind Direction Frequencies as a Function of

Time of Day

SITE: Susquehanna PA.

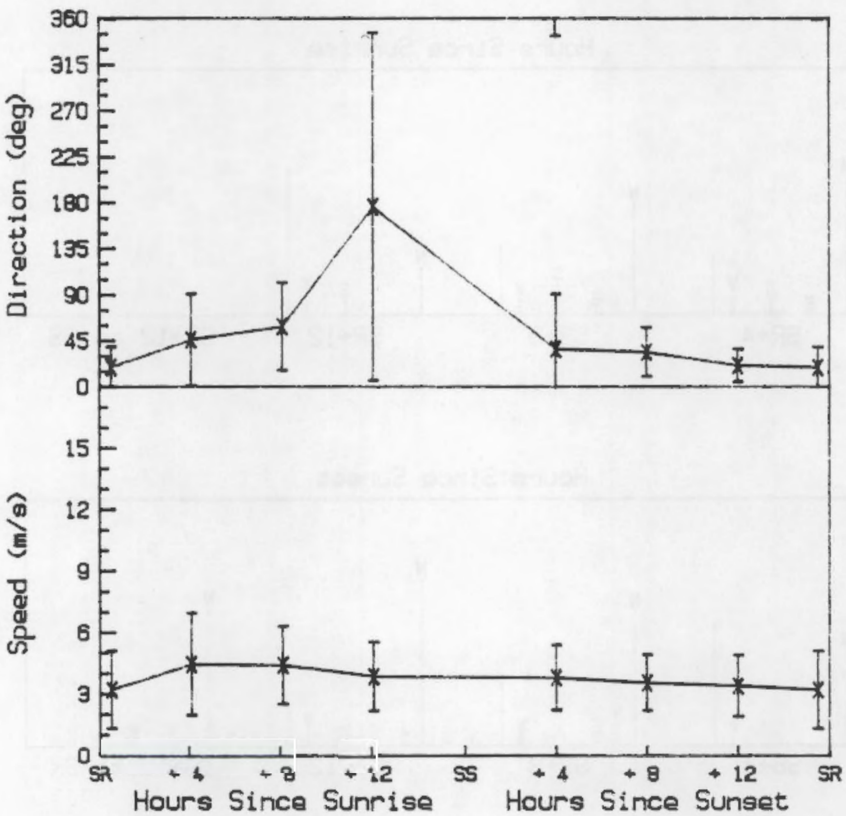
% Occurrence = 1.13

SECTION: W-IV- 4 - 0

SEASON: Winter

CATEGORY: cP/cA Ridge

Vg (dir/mag): SE / All

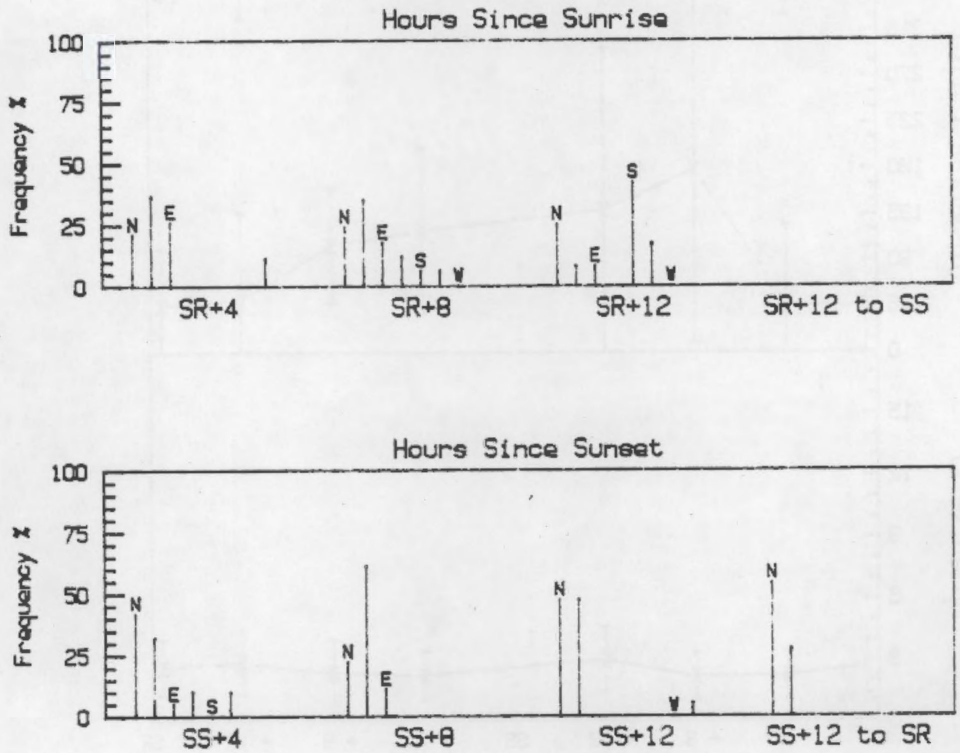


Mean Wind Statistics as a Function of Time of Day

SITE: Susquehanna PA.

% Occurrence = 1.13

SECTION: W-IV- 4 - 0
SEASON: Winter
CATEGORY: cP/cA Ridge
Vg (dir/mag): SE / All



Site Wind Direction Frequencies as a Function of Time of Day

SITE: Susquehanna PA.

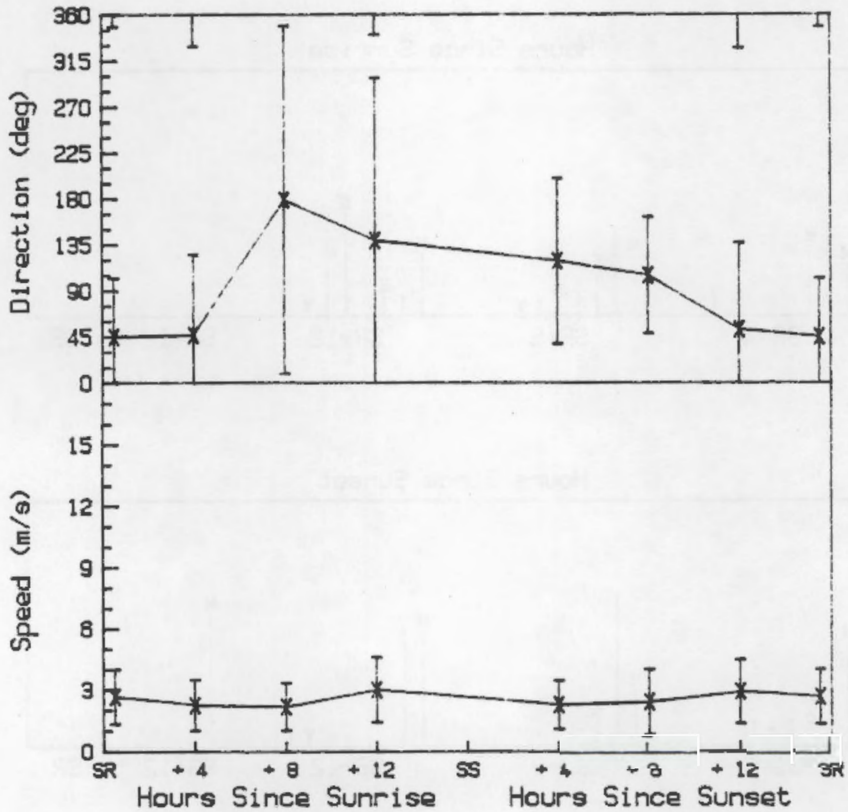
% Occurrence = 2.77

SECTION: W-IV- 5 - 0

SEASON: Winter

CATEGORY: cP/cA Ridge

Vg (dir/mag): S / All



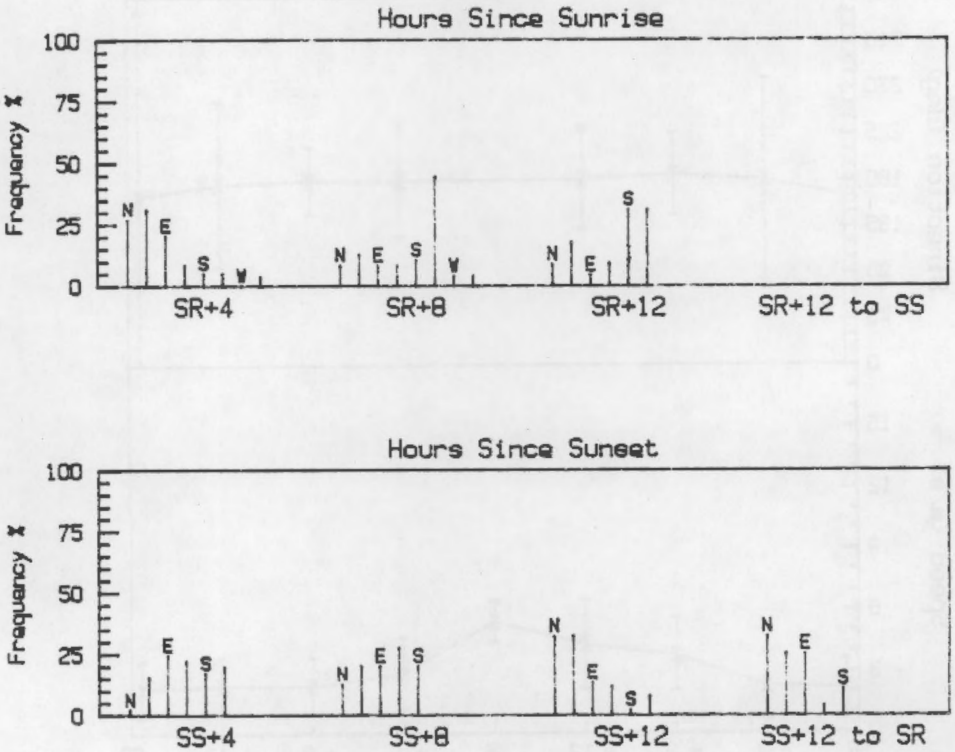
Mean Wind Statistics as a Function of Time of Day

SECTION: W-IV- 5 - 0

SITE: Susquehanna PA. SEASON: Winter

% Occurrence = 2.77 CATEGORY: cP/cA Ridge

Vg (dir/mag): S / All



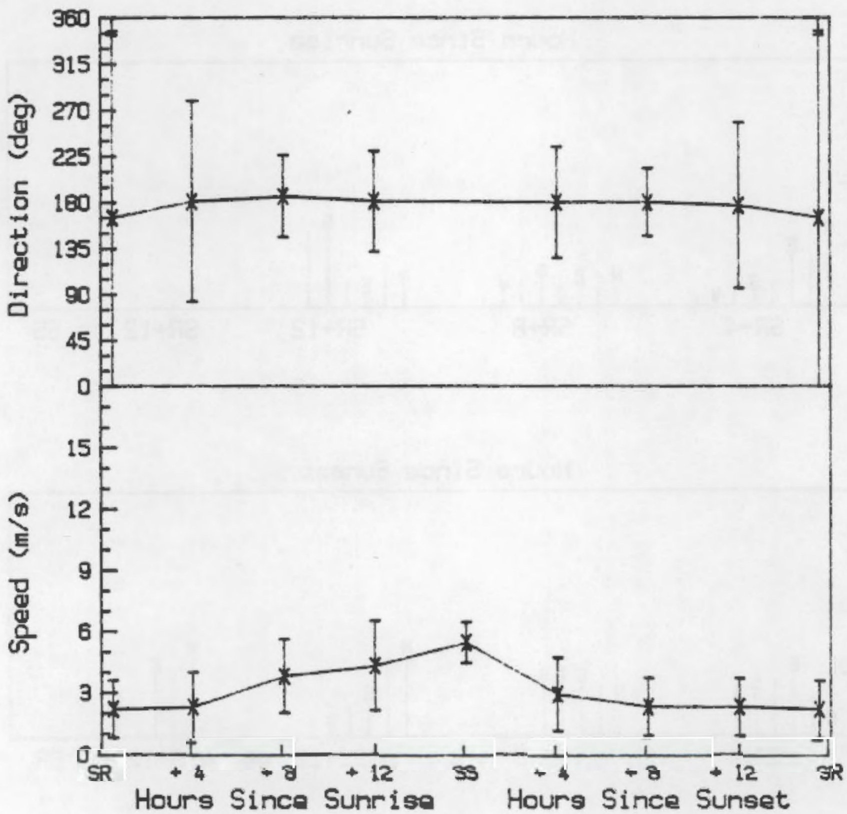
Site Wind Direction Frequencies as a Function of

Time of Day

SITE: Susquehanna PA.

% Occurrence = 4.99

SECTION: W-IV- 6 - 0
SEASON: Winter
CATEGORY: cP/cA Ridge
Vg (dir/mag): SW / All



Mean Wind Statistics as a Function of Time of Day

SITE: Susquehanna PA.

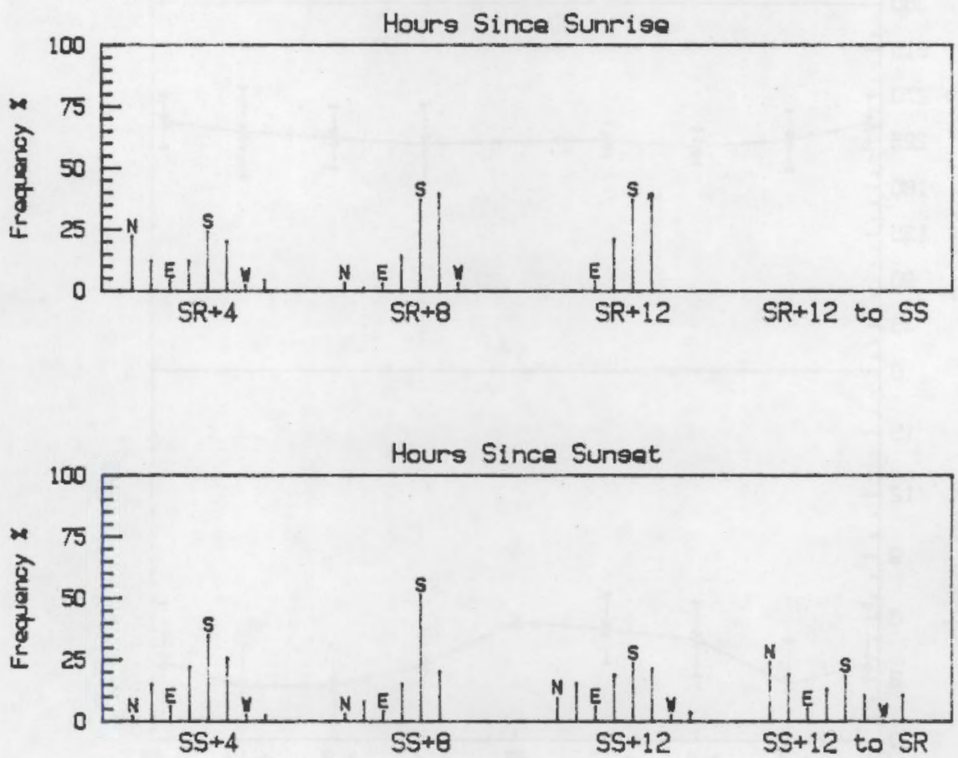
% Occurrence = 4.99

SECTION: W-IV- 6 - 0

SEASON: Winter

CATEGORY: cP/cA Ridge

Vg (dir/mag): SW / All

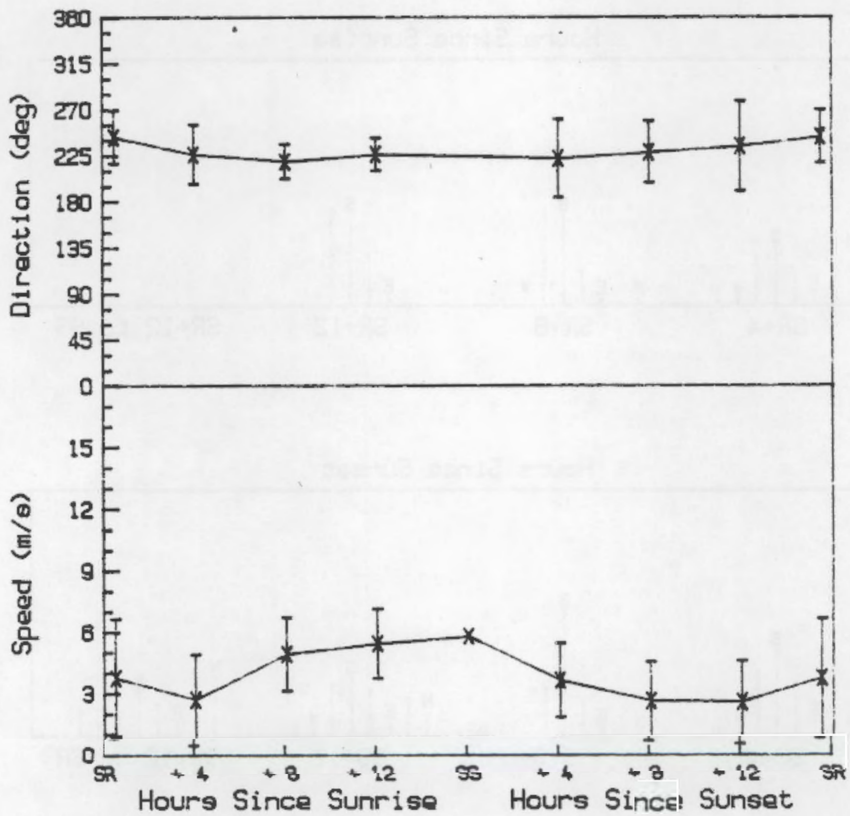


Site Wind Direction Frequencies as a Function of Time of Day

SITE: Susquehanna PA.

% Occurrence = 2.26

SECTION: W-IV- 7 - 0
SEASON: Winter
CATEGORY: cP/cA Ridge
Vg (dir/mag): W / All

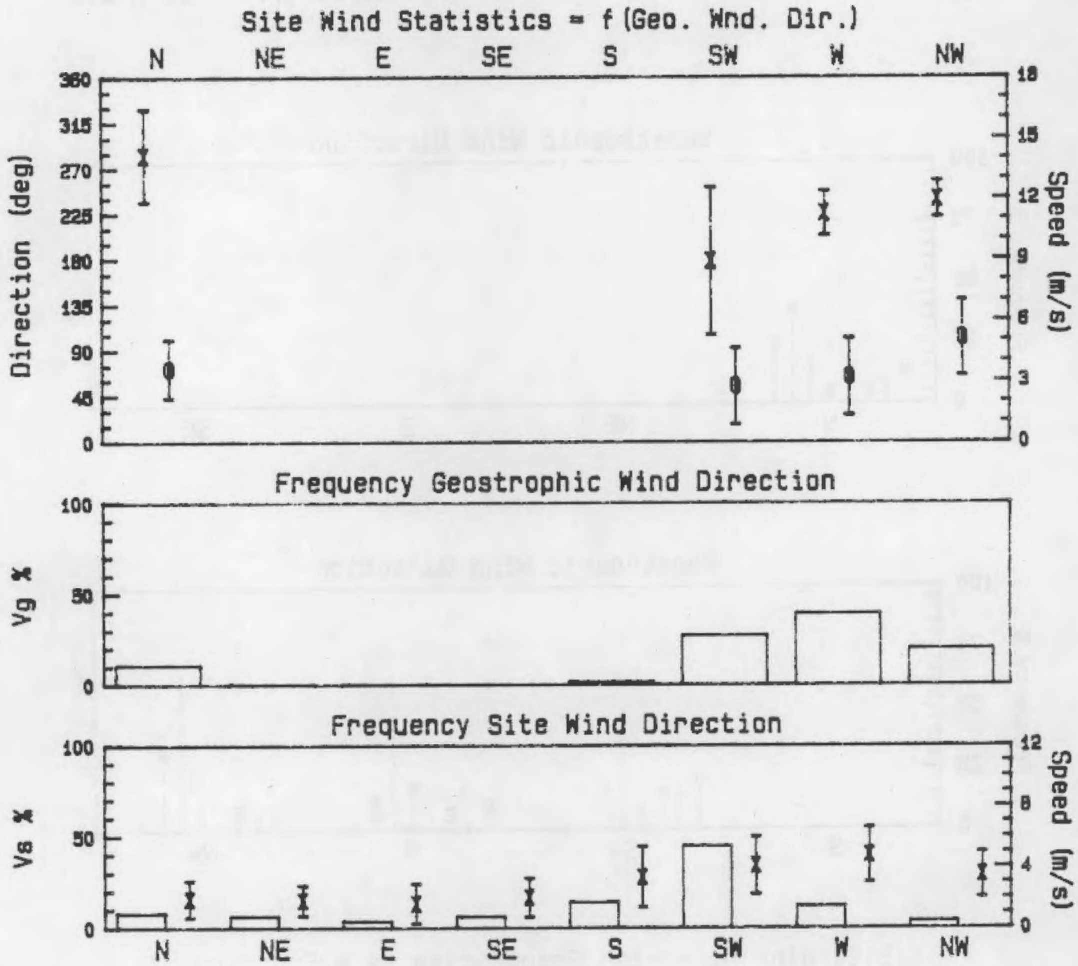


Mean Wind Statistics as a Function of Time of Day

SITE: Susquehanna PA.

% Occurrence = 3.00

SECTION: W-V
SEASON: Winter
CATEGORY: mT Ridge
Vg (dir/mag): All / All



Diurnal Cross Reference Index

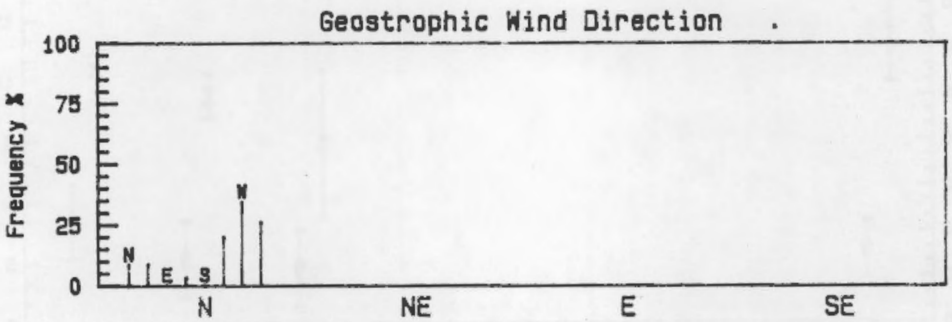
Pressure Gradient Orientation X Magnitude

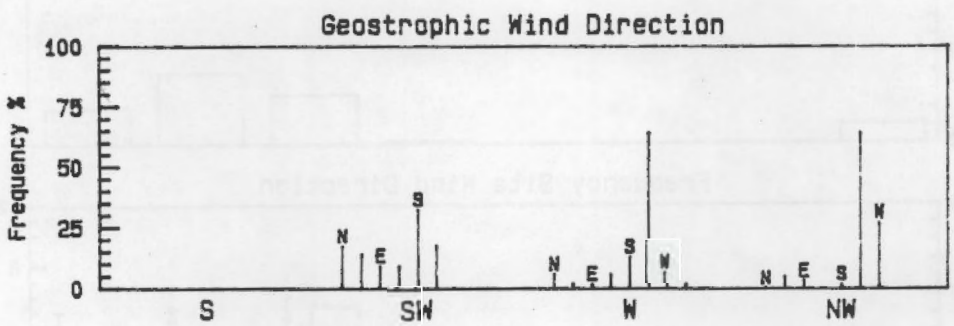
	N	NE	E	SE	S	SW	W	NW
All						-6-0		
Strong								
Weak								

SITE: Susquehanna PA.

% Occurrence = 3.00

SECTION: W-V
SEASON: Winter
CATEGORY: mT Ridge
Vg (dir/mag): All / All





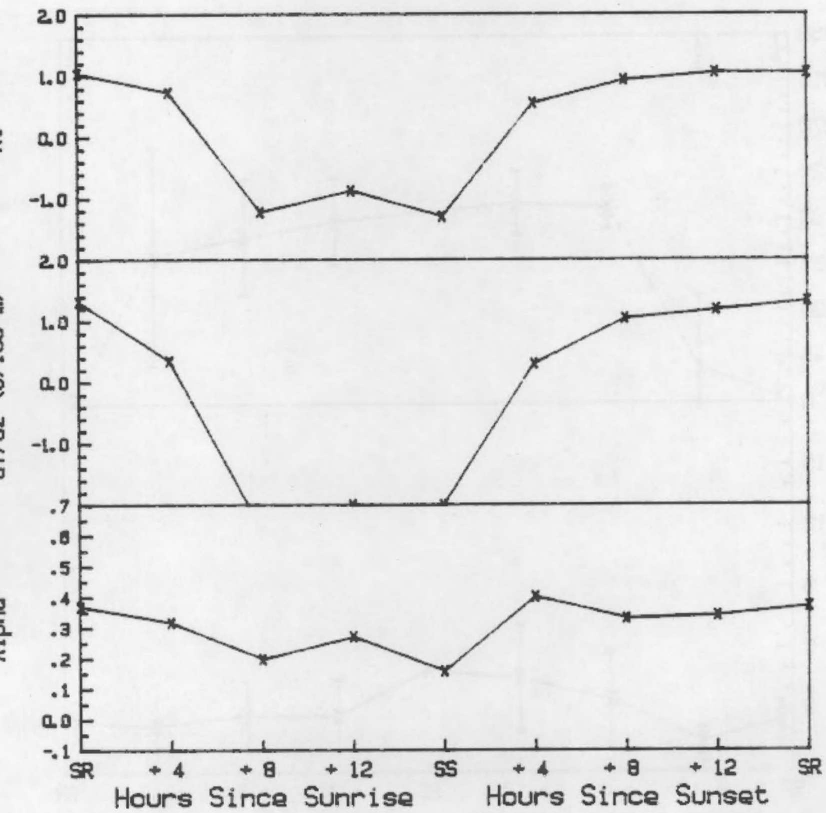
Site Wind Direction Frequencies as a Function of

Geostrophic Wind Direction

SITE: Susquehanna PA.

% Occurrence = 3.00

SECTION: W-V
SEASON: Winter
CATEGORY: mT Ridge
Vg (dir/mag): All / All

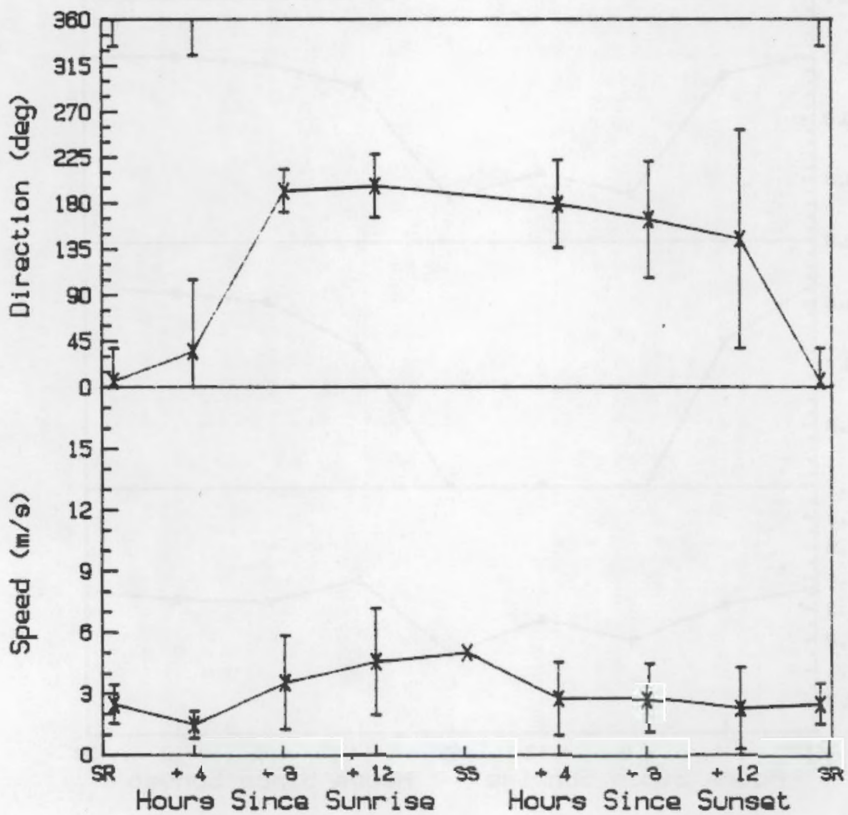


Mean Stability Parameters as a Function of Time of Day

SITE: Susquehanna PA.

% Occurrence = .82

SECTION: W-V- 6 - 0
SEASON: Winter
CATEGORY: mT Ridge
Vg (dir/mag): SW / All

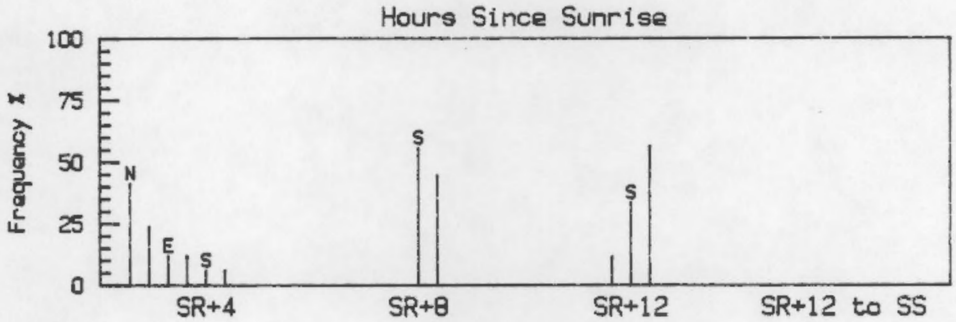


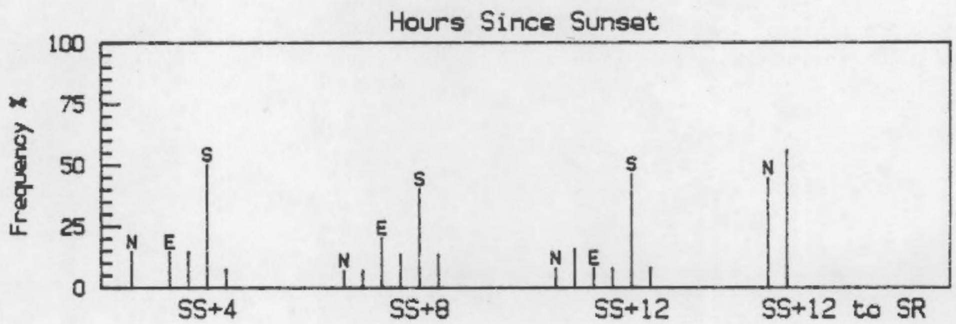
Mean Wind Statistics as a Function of Time of Day

SITE: Susquehanna PA.

% Occurrence = .82

SECTION: W-V- 6 - 0
SEASON: Winter
CATEGORY: mT Ridge
Vg (dir/mag): SW / All





Site Wind Direction Frequencies as a Function of

Time of Day

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