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Title: Analysis of Meteorological Observations from an Array of Buoys during JASIN

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Observations of wind speed and direction, air and sea temperature, and solar radiation were obtained from an array of buoys in JASIN. The observations were analyzed to show spatial and temporal variability. Spectra of wind speed and air and sea temperature were computed to illustrate the distribution of variance over periods ranging from 3.5 minutes to 40 days. When plotted on log-log graphs the spectral estimates generally decrease with increasing frequency with slopes between -3/2 and -2. Spectra of air and sea temperature have a peak at the diurnal frequency. When plotted in variance-preserving form, the spectrum of wind speed is consistent with a spectral gap and is qualitatively similar to other observations of low frequency spectra. On the basis of a cross-correlation analysis, it appears that mesoscale eddies propagated with the mean wind speed except during frontal passages. Based on the cross-correlation between wind speed and air temperature, there is evidence of horizontal roll vortices or organized convection.

Analysis of Meteorological Observations from an Array of Buoys during JASIN

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Hiroshi Ishida

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in charge of major

Redacted for privacy

Dean of the School of Oceanography

Redacted for privacy

Dean of the Graduate School

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Typed by Gail Henwood for Hiroshi Ishida

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Preface

This thesis has been written in manuscript format rather than in the traditional format. The School of Oceanography encourages this approach to expedite the publication of the results of graduate research projects in scientific journals. For this reason, some deviations from the ordering of a traditional thesis are present: 1) Tables appear in order after the References; 2) Figures appear in order after the Tables; 3) Acknowledgments are placed after the text, rather than before. This manuscript will be submitted to the Journal of Geophysical Research with Hiroshi Ishida, Clayton A. Paulson and Wayne V. Burt as first, second and third authors, respectively.

ANALYSIS OF METEOROLOGICAL OBSERVATIONS FROM AN ARRAY OF BUOYS DURING JASIN

I. INTRODUCTION

In the past ten years, many observational and theoretical investigations have been directed toward understanding mesoscale processes in the atmospheric boundary layer over the sea. Internationally organized programs, all part of the Global Atmospheric Research Program (GARP), have included: 1) the Air-Mass Transformation Experiment (AMTEX); 2) the Barbados Oceanographic and Meteorological Experiment (BOMEX); 3) the GARP Atlantic Tropical Experiment (GATE); and 4) the Joint Air-Sea Interaction (JASIN) Experiments. The observations reported in this paper were made from an array of meteorological buoys about 400 km northwest of Scotland in the summer of 1978 as a part of JASIN.

The JASIN project was proposed in 1966 by the Royal Meteorological Society as an appropriate United Kingdom contribution to the GARP. A summary of the scientific and operational plans for the experiment is given by Pollard [1978]. The primary objectives of JASIN were: "(1) to observe and distinguish between physical processes causing mixing in the oceanic and atmospheric boundary layers and relate them to mean properties of the layers; (2) to examine and quantify aspects of the momentum and heat budgets in the ocean and atmospheric boundary layers and fluxes across and between them."

The objectives of this paper are to analyze the meteorological observations obtained from an array of buoys deployed during JASIN. We will describe temporal and spatial variability and examine the data for the existence of organized structures, such as horizontal roll vortices.

II. INSTRUMENTS

Moored, toroidal buoys provided the platform for the instruments. They were similar to those used in JASIN 70 and 72 [Burt et al., 1974]. Wind speed and direction were measured with a cup anemometer and a highly-damped wind vane and magnetic compass system manufactured by Ivar Aanderaa of Bergen, Norway. Dry and wet-bulb temperatures were measured with thermistors exposed to the air inside radiation shields ventilated by the wind. The measurements of wet-bulb temperature were not reliable because of the difficulty of keeping the thermistor entirely wetted by means of a wick and reservoir and were excluded from the analysis. The solar radiation sensor was manufactured by Lintronics. The instruments were mounted 2.5 m above mean sea level. Water temperatures were measured at 0.5 m and 2 m depth with rugged Aanderaa platinum resistance thermometers.

The data were recorded digitally on magnetic tape by an Aanderaa data logger attached to each buoy. Wind speed was averaged over sampling intervals while the other variables were sampled instantaneously. Variables were sampled at intervals of 3.5 or 1.75 minutes.

Data obtained by instantaneously sampling a fluctuating record are subject to aliasing errors. If fluctuations are present with frequencies greater than the Nyquist frequency (half the sampling frequency), spectral energy at frequencies greater than the Nyquist will be folded back to lower frequencies. Despite damping, the wind direction measurments were particularly susceptible to aliasing error. The error is magnified by erroneous fluctuations in wind direction induced by the motion of the buoy. R. Weller [personal communication, 1979] has compared rotary spectra measured by a vector-averaging meter with spectra from an Aanderaa cup and vane and found excess energy in the Aanderaa spectra in the highest decade of frequency. Measurements of temperature and solar radiation are not seriously affected by aliasing because the response time of the sensors is generally about one minute.

The measurements of wind speed are not expected to be seriously in error. Even though the buoy motion induces fictitious fluctuations of wind speed, averaging over the sampling interval practically eliminates aliasing. The effects of buoy motion on measurements of mean wind speed have been estimated by Pond [1968] and Badgley et al. [1972] and are expected to be small.

III. OBSERVATIONS

Observations were made from 28 July to 6 September 1978 about 400 km north-west of Scotland at the four locations shown in Figure 1 and Table 1. As shown in Table 1, the measurements were briefly interrupted on 12 and 30 August to change the data logger at each buoy. The sampling interval was 3.5 minutes during the first two periods and 1.75 minutes during the last period.

Meteorological observations were also taken from ships operating in the area. The most complete record was taken by the R/V METEOR. She was stationed near buoys B1, B2 and B3 during the experiment. Meteorological measurements were also made from other buoys.

The general weather in early August was influenced by high pressure in the Norwegian Sea resulting in north winds in the experimental area. In the middle of August, two low pressure systems passed the experimental site. In late August, there were westerly winds due to stationary high pressure west of England. The strongest winds during the experiment occurred over a period of several days beginning on 17 August, reaching a maximum of 15 m/s on 20 August. The near-surface sea temperature decreased by about 1°C during this event, presumably as the result of deepening of the well-mixed layer. Following the decrease of wind speed 24 August, the sea surface temperature rose about 1°C over a period of several days, very likely due to weak mixing and net heating of the upper layers.

A progressive vector diagram of the wind at B3 is shown in Figure 3. The first section of the wind direction record from B3 was corrected prior to plotting Figure 3. The correction was based on a linear regression to the data from B2 and B3. Three parts of the record, A, B and C, each 2.5 days long, were selected for the cross-correlation analysis discussed in subsequent sections. The criterion used in making the selections was to require that the wind be nearly constant in speed and direction. The times of beginning and ending of each part are tabulated in Table 2 together with average bulk Richardson numbers, wind direction and wind speed. The effect of the vertical humidity gradient on the bulk Richardson number was included by use of the hourly wet and dry bulb temperature observations from the R/V METEOR. The effect was equivalent to an air-sea potential temperature difference of -0.31, -0.08 and -0.16°C for parts A, B and C respectively. The stratification during part C was close to neutral. However, the estimates (B3, B3, METEOR) used to obtain the mean bulk Richardson number are all negative making it highly probable that the stratification was unstable during part C. No allowance was made for a cool skin temperature in the calculation of the bulk Richardson number. However, the error (~ 0.1°C) is probably compensated by errors caused by daytime radiational heating of the air temperature sensors.

The accuracy of the measurements can be estimated by comparing averages from the buoys and the R/V METEOR. Such a comparison for parts A, B and C shown in Table 3. The hourly observations of wind speed and direction from the METEOR were taken at a height of 23 m above mean sea level while observations of wet and dry bulb temperatures were taken at a height of 11 m. The wind speeds from the

METEOR were reduced to a height of 2.5 m based on the assumption of a log profile and a roughness length of 0.015 cm. Measured wind speeds from B1, B2 and B3 averaged over part A differ by no more than 0.24 m/s with each other and differ no more than 0.1 m/s with means over parts B and C. When B4 is included, the means differ by no more than 0.5 m/s. The difference between B4 and the other buoys may be accounted for by the distance between B4 and the other buoys (See Figure 1 and Table 4). The average over part A of hourly observations of wind speed from the METEOR (2.5 m) differs with means from B1, B2 and B3 by as much as 1.3 m/s. The difference is no more than 0.5 m/s in parts B and C. Part of the difference may be ascribed to an error in reduction of wind speed from the METEOR to a height of 2.5 m, i.e. the neglect of the effect of stability and uncertainty in the value of roughness length. In addition, the effect of interference of the ship's hull with the air flow could cause an error in measurements from the METEOR. In summary, agreement to within 0.5 m/s between the buoys and METEOR should be considered good.

There were systematic errors in the observation of wind direction from some of the buoys (See Table 3). Observations from B1, B3 and B4 averaged over part A were in error by about 40°. Observations from B4 averaged over parts B and C continued to systematically disagree with the other means by 24° and 40° respectively. The discrepancy is too large to be ascribed to the separation between B4 and the other buoys. A possible source of error is the disturbance of the magnetic field by ferromagnetic materials, although this possibility was minimized by the use of aluminum for the structure of the buoy. Means from the METEOR and those buoys considered reliable are in excellent agreement, within 4°, 2° and 9° in parts A, B and C respectively.

The comparison of mean air temperatures tabulated in Table 3 shows temperatures from B2 systematically in disagreement with the other observations. The cause of the error is undetermined. Fluctuations in temperature measured at B2 did not appear to be affected. Mean temperatures measured at B4 are on average a few tenths °C colder than temperatures from B1 and B3, possibly because of the northward displacement of B4 from the other buoys. Mean air temperatures from B1 and B3 are within 0.45°C of each other. Mean air temperature from METEOR is always at least 0.1°C and never more than 0.5°C cooler than temperature from B1 and B3. The disagreement among means from different buoys and METEOR may be partly caused by the natural variability of air temperature. There may also be errors, e.g. daytime heating of the sensors by solar radiation.

Sea temperature was measured at 0.5 and 2 m depth at most of the buoys. The agreement between means from both depths is excellent, the magnitude of the difference never exceeds 0.11°C and averages 0.04°C. In only one case is the mean from the upper sensors warmer than the lower mean, suggesting that the upper 2 m was unstably stratified during parts A, B and C. The wind speed was strong enough during all parts to cause vigorous mixing of the upper few meters. The sense of the temperature gradient suggests that there was, on average, net cooling of the surface. Mean sea temperatures from B1, B2 and B3 differ by no more than 0.13°C and differences are on average 0.03°C. Mean sea temperatures from B4 are systematically 0.1 to 0.4°C cooler than at the other buoys, which is similar to the behavior of air temperature. Mean bucket temperatures from METEOR differ by no more than 0.13°C with averages over B1, B2 and B3. Differences in mean sea temperatures among buoys may be partly ascribed to horizontal temperature gradients. The difference between mean temperature at 2 m depth from B2 and B3, the two buoys closest together (2.6 km), did not exceed 0.02°C in part A, B or C. We conclude that measurements of sea temperatures from buoys show excellent consistency and are likely to be accurate to within ± 0.03°C.

IV. SPECTRA

Spectra of wind speed, air temperature and sea temperature shown in Figures 4, 5 and 6 were estimated by averaging and patching spectra from different time series. The low-frequency estimates (X) in each of the plots were obtained from a spectral analysis of time series of hourly averages from two buoys, usually B1 and B3. The air temperature record from B2 was used in place of B3 because the record from B3 was incomplete. The time series of hourly averages extended over the entire 43 days of the experiment with the gaps filled by linear interpolation. Zeros were added to the series after subtracting the mean to increase their length to 1024 points permitting the use of the Fast Fourier Transform. The number of zeros added was less than 10% of the total length of the record in every case. Spectra were smoothed by averaging in non-overlapping frequency bands, equally spaced on a logarithmic scale. Finally, spectra from each of two buoys were averaged to obtain the low-frequency spectra shown in Figures 4, 5 and 6. The spectra at intermediate frequencies were estimated by analysis of the first 4096 points of each of the records obtained during periods one and two (See Table 1). The high-frequency spectra were obtained from analysis of the first 4096 points of records obtained during the third period (sampling interval, 1.75 min). For both intermediate and high-frequency spectra, the records used for analysis were more than two-thirds of the total available length. The smoothing and averaging used to obtain the intermediate and high-frequency spectra was similar to that used to obtain the low-frequency spectra. The validity of the procedure used to obtain the composite spectra can be judged from the agreement between spectra in the overlapping frequency ranges.

The spectrum of wind speed, shown in Figure 4, suggests a plateau at a period of about 20 days, falls off with a slope of about -2 for periods between 5 days and 2 hr, and falls off with a slope of -5/4 for periods between 2 hr and 3.5 min. There are no significant peaks in the spectrum. Unlike spectra from near-shore locations under the influence of a sea breeze [Halpern, 1974; O'Brien and Pillsbury, 1974] there is no significant peak or shoulder at diurnal frequences.

The spectrum of air temperature, shown in Figure 5, differs in some respects from the wind speed spectra. There is no suggestion of a peak or plateau at low frequencies. The spectra fall off with slope about -3/2 for periods between 10 days and 8 hr. For periods between 8 hr and 15 min, the slope is about -5/3. The increase in slope to greater than -1 at periods less than 15 min is very likely caused by aliasing associated with instantaneously sampling a thermistor having a time response less than 3.5 min. There is a significant peak in the spectrum at a period of one day associated with diurnal solar heating of the lower atmosphere.

The spectrum of sea temperature at 2 m depth is shown in Figure 6. The spectra fall off with a slope of about -2 for periods between 10 days and 3 hr. The slope increases to -3/2 for periods between 1 hr and 3.5 min. There is a large peak in the spectrum at the diurnal period which is larger in comparison to background energy than the similar peak in the spectrum of air temperature. There is no evidence that the high-frequency end of the spectrum is affected by aliasing.

The spectrum of wind speed was examined for consistency with the concept of a gap or region of low spectral energy, separating macro- and microscales. The spectrum in Figure 5 is plotted in variance-preserving form in Figure 7. This form is called variance-preserving because equal areas under the curve contribute equally to the variance. A region of low energy in spectra plotted in this form is often found between about 0.5 and 5 cph and is referred to as the spectral gap. Most observations of this gap have been over land (Van der Hoven, 1957; Vinnichenko, 1970; Fiedler and Panofsky, 1970]. Millard [1968] found a prominent gap between 0.1 and 10 cph in spectra taken over the sea. However, the observation may be suspect because of errors caused by buoy motions. Our spectra do not extend to sufficiently high frequencies to demonstrate by themselves the existence of a spectral gap. We have, therefore, plotted the similarity spectrum of Kaimal et al. [1972] to extend the spectrum to high frequencies. In so doing, we assumed neutral stability and a drag coefficient of 1.8×10^{-3}, a value equivalent to 1.3×10^{-3} for an observation height of 10 m. Kaimal et al's. spectrum matches ours at intermediate frequences and is consistent with a gap. The justification for using the Kaimal spectrum is strengthened by the observation that microscale spectra over the sea scale similarly to those over land [e.g. Leavitt, 1975].

For purposes of additional comparison, the spectrum of wind speed over land from Smedman-Högström and Högström [1974] is also shown in Figure 7. The microscale peak in Smedman-Högström and Högström's spectrum occurs at lower frequences than in Kaimal et al's. spectrum because conditions were unstably stratified for the spectrum reported by Smedman-Högström and Högström. The shift in the peak associated with stratification changing from neutral to unstable agrees qualitatively with Kaimal et al. [1972].

Rotary spectral analysis is a useful technique for analyzing time series of two-dimensional vectors [Gonella, 1972; Mooers, 1973]. The rotary spectrum is composed of two parts, clockwise and counter-closewise components which correspond to the distribution of variance with frequency of fluctuations associated with clockwise and counter-clockwise rotation respectively. For example, if there is a peak in the clockwise component larger than that in the counterclockwise at the same frequency, and the rotary coefficient is -1, that means the vector rotates clockwise at the prescribed frequency, its tip tracing a circle.

The rotary spectrum of hourly averages of horizontal wind velocity observed at B3 is shown in Figure 8. The spectrum was smoothed as previously described in non-overlapping frequency bands, 10 per decade. The clockwise spectral density exceeds the counterclockwise for frequencies above .015 cph. This result agrees with observations reported by Burt et al. [1974] who found clockwise spectral levels generally higher than counterclockwise. However, Burt et al. also found evidence of diurnal and inertial oscillations in the clockwise spectra, evidence of which is lacking in Figure 8. Inertial oscillations are expected to be small in the atmosphere [Holton, 1972], may depend on weather conditions and may not be sufficiently persistent or energetic to appear in the spectrum of a 43-day record. Diurnal variations in wind will likely be associated with diurnal fluctuations in stability which may have been small during JASIN.

V. TAYLOR'S HYPOTHESIS

It is a common and ordinarily well-justified practice to convert frequency spectra of microscale turbulence to wavenumber spectra by use of Taylor's hypothesis, the hypothesis that turbulence structure changes slowly while being advected past a point by the mean wind speed. It is tempting to also use Taylor's hypothesis to infer the statistics of mesoscale structure because time series at a single point are usually more easily obtained than spatial samples. However, the justification for using Taylor's hypothesis to infer mesoscale spatial structure is not well established.

An analysis was carried out to test the validity of Taylor's hypothesis for mesoscale structure. The three wind speed and air temperature records, parts A, B and C (Table 2) were used in the analysis. The autocorrelation function of wind speed averaged over all buoys is shown in Figure 9 for each part. If Taylor's hypothesis is strictly true, the cross-correlation coefficient computed between buoys lying along the path of the mean wind will be equal to the autocorrelation function at a lag, $\tau = x/u$ where x is the separation between the buoys and u is the mean wind speed. Values of the cross-correlation coefficient plotted in Figure 9 are qualitatively consistent with Taylor's hypothesis. The autocorrelation function of air temperature in parts A and B averaged over all buoys is shown in Figure 10 together with cross-correlation coefficients between buoys lying along the path of the mean wind. Part C was not included because the air temperature record from B1 was incomplete. The cross-correlation coefficients are qualitatively consistent with Taylor's hypothesis except that in part B the two cross-correlation coefficients involving the air temperature at B2 are in very poor agreement with Taylor's hypothesis. The reason may be the erroneous drift in the mean value of air temperature at B2 which was previously noted (Table 3).

A comparison between autocorrelation functions and cross-correlation coefficients was also carried out on time series which were filtered to remove the effect of long-period fluctuations. The wind speed and air temperature records from parts A, B and C were high-pass filtered by subtraction of a running two-hr mean. This filter passes 100% of the spectral energy at a period of two hr and 50% at five hr. Two hours is long compared to the distance between buoys divided by the mean wind speed. The filtered time series of wind speed and air temperature were analyzed identically to the unfiltered series as described above. The comparison between autocorrelation functions and cross-correlation coefficients is shown in Figures 11 and 12 for wind speed and air temperature respectively. The results are consistent with Taylor's hypothesis in parts A and C and inconsistent in part B. The results from part B suggest that mesoscale eddies propagate about twice as fast as the mean wind.

Propagation speeds of mesoscale structures were estimated by examining cross-correlation functions of high-pass filtered wind speed and air temperature from parts A, B and C. An estimate of the propagation time of an eddy between a pair of buoys lying along the path of the mean wind was taken as the lag at which the cross-correlation function is a maximum. An example of two cross-correlation functions, one of wind speed and the other air temperature, is shown in Figure 13. The estimates of propagation times are tabulated in Table 4 and are compared with propagation times computed by use of Taylor's hypothesis. The results from parts A and C are consistent with Taylor's hypothesis while the results from part B show eddy propagation times about half as large as those predicted by Taylor's hypothesis. The results in Table 4 are consistent with the comparison of autocorrelation functions and cross-correlation coefficients shown in Figures 11 and 12, i.e. mesoscale structures travel with the mean wind in parts A and C but travel twice as fast as the mean wind in part B.

The reason Taylor's hypothesis fails in part B is probably associated with frontal passages. Examination of the barometric pressure record and the synoptic analysis shows that there were frontal passages on 18 August about 12 hr into part B and on 20 August near the end of part B. These frontal passages are visible as shifts in wind direction in the progressive vector diagram shown in Figure 3. The propagation in a direction approximately normal to the mean wind of pressure disturbances and air masses associated with the fronts accounts for the failure of Taylor's hypothesis in part B.

IV. HORIZONTAL ROLL VORTICES

There is growing theoretical and observational evidence [Brown, 1970; Kuettner, 1972; Lemone, 1973; Agee et al., 1973; Burt et al., 1974; Agee and Dowel, 1974; Burt and Agee, 1977] that horizontal roll vortices are a common feature of the planetary boundary layer. A schematic diagram of the circulation associated with these vortices is shown in Figure 14.

An analysis was carried out to investigate whether there was evidence of roll vortices in the buoy measurements. It is possible, of course, that even though there might be vortices present in the planetary boundary layer, their influence on the variability of velocity, temperature and solar radiation 2.5 m above the sea surface might be undetectable. If they are felt at the surface, they might have important influences on the circulation of the upper ocean.

Evidence for the existence of roll vortices was sought by examining the cross-correlation functions of high-pass filtered data from parts A, B and C (Table 2). An example of the cross-correlation between wind speed and air temperature during Part C is shown in Figure 15. At zero lag there is a negative correlation between wind speed and air temperature associated with downward propagation of cool air having an excess of momentum. This result is consistent with the schematic of rolls shown in Figure 14. However, it is by no means conclusive verification of the presence of rolls. The result would also be consistent with cellular convection and perhaps other types of mesoscale structure. The case in favor of rolls is strengthened by the periodic nature of the cross-correlation function, consistent with the migration of rolls normal to the mean wind direction. Assuming the rolls have cross-wind dimensions of about 1 km, the period of 1 hr is consistent with a migration velocity of about 30 cm/s and an angle of 2° between the roll axis and the mean wind direction.

Cross-correlation functions from other buoys in part C and from buoys in parts A and B are qualitatively similar to Figure 15 except that the oscillation of the functions is usually not as periodic. The cross-correlation functions at zero lag in part B are positive as might be expected because the stratification was stable (Table 2).

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TABLE 1. Locations and periods of buoy observations, JASIN - 1978.

Buoy	Location		Period 1		Period 2		Period 3	
	Lat. (N)	Long. (W)	Begin (GMT)	End	Begin (GMT)	End	Begin (GMT)	End
B1	59° 00.4'	12°33.6'	8/1 1221	8/12 1538	8/12 1553	8/30 1302	8/30 1409	9/6 1100
B2	59° 00.2'	12°27.5'	7/29 1030	8/12 1847	8/12 1859	8/30 1235	8/30 1247	9/6 912
B3	59° 01.6'	12°27.4'	7/28 2206	8/12 1917	8/12 1938	8/30 1022	8/30 1040	9/6 750
B4	59° 10.7'	12°31.0'	7/28 1350	8/12 1253	8/12 1317	8/30 1545	8/30 1612	9/3 1328

TABLE 2. Parts of meteorological records having approximately constant wind speed and direction which were selected for cross-correlation analyses. The beginning and ending time for each part is 0000 and 1140 GMT respectively. Ri_B is the mean bulk Richardson number, averaged over reliable buoys and the R/V METEOR. Wind speed and direction are similarly averaged. Observations from the METEOR were reduced to a height of 2.5 m assuming a log profile and Z_0 = 0.015 cm.

Part	Time (GMT) Begin	Time (GMT) End	Ri_B (z = 2.5 m)	Wind Direction (degrees)	Wind Speed (m/s)
A	8/6	8/8	-0.0032	357	6.6
B	8/18	8/20	0.0004	172	11.1
C	8/22	8/24	-0.0001	266	8.8

TABLE 3. Comparison of means from the buoys and the R/V METEOR. The records, parts A, B and C, are each 59 hr long and are defined in Table 3. Means from the R/V METEOR are the averages of hourly ship observations. The symbols are defined as follows: u, wind speed; θ, wind direction; T_a, air temperature; T_{s1}, sea temperature at 0.5 m depth (buoy) or bucket temperature (METEOR); T_{s2}, sea temperature at 2 m depth. The temperature, T_{s1}, in part A from the R/V METEOR was corrected by subtracting 0.4°C from the observed mean following the suggestion of A. Macklin (personal communication).

Buoy or Ship	Part A					Part B					Part C				
	u (m/s)	θ (deg)	T_a (°C)	T_{s1} (°C)	T_{s2} (°C)	u (m/s)	θ (deg)	T_a (°C)	T_{s1} (°C)	T_{s2} (°C)	u (m/s)	θ (deg)	T_a (°C)	T_{s1} (°C)	T_{s2} (°C)
B1	6.82	42	11.53	12.97	13.00	11.1	172	13.70	12.85	12.87	8.98	270	-	12.13	12.13
B2	6.99	355	12.30	12.97	12.93	11.1	173	15.45	12.89	12.91	8.94	264	15.30	12.07	12.14
B3	7.06	42	11.98	12.84	12.95	11.1	170	13.50	12.85	12.91	8.90	269	12.21	12.12	12.13
B4	6.58	324	11.37	-	12.71	10.7	148	13.27	-	12.52	8.48	226	12.03	-	12.06
METEOR	7.08	359	11.45	13.05	-	13.95	171	13.43	12.83	-	10.39	261	12.07	12.24	-
METEOR @ 2.5 m	5.8					11.4					8.5				

TABLE 4. Comparison of along-wind eddy travel times estimated by use of Taylor's hypothesis (τ_f), from lags (τ_u) associated with peaks in the cross-correlation of wind speed measured at buoys lying on a line parallel to the mean wind direction and from similar lags (τ_t) associated with peaks in the cross-correlation of temperature.

BUOY PAIR	SEPARATION (km)	Part A (min)			Part B (min)			Part C (min)		
		τ_f	τ_u	τ_t	τ_f	τ_u	τ_t	τ_f	τ_u	τ_t
B1-B4	19.3	46	50	43	29	16	16	----	----	----
B2-B4	19.8	46	43	47	29	15	12	----	----	----
B3-B4	17.2	40	38	41	25	15	15	----	----	----
B2-B3	2.6	6	9	9	4	4		----	----	----
B1-B2	5.9	----	----	----	----	----	----	11	10	9

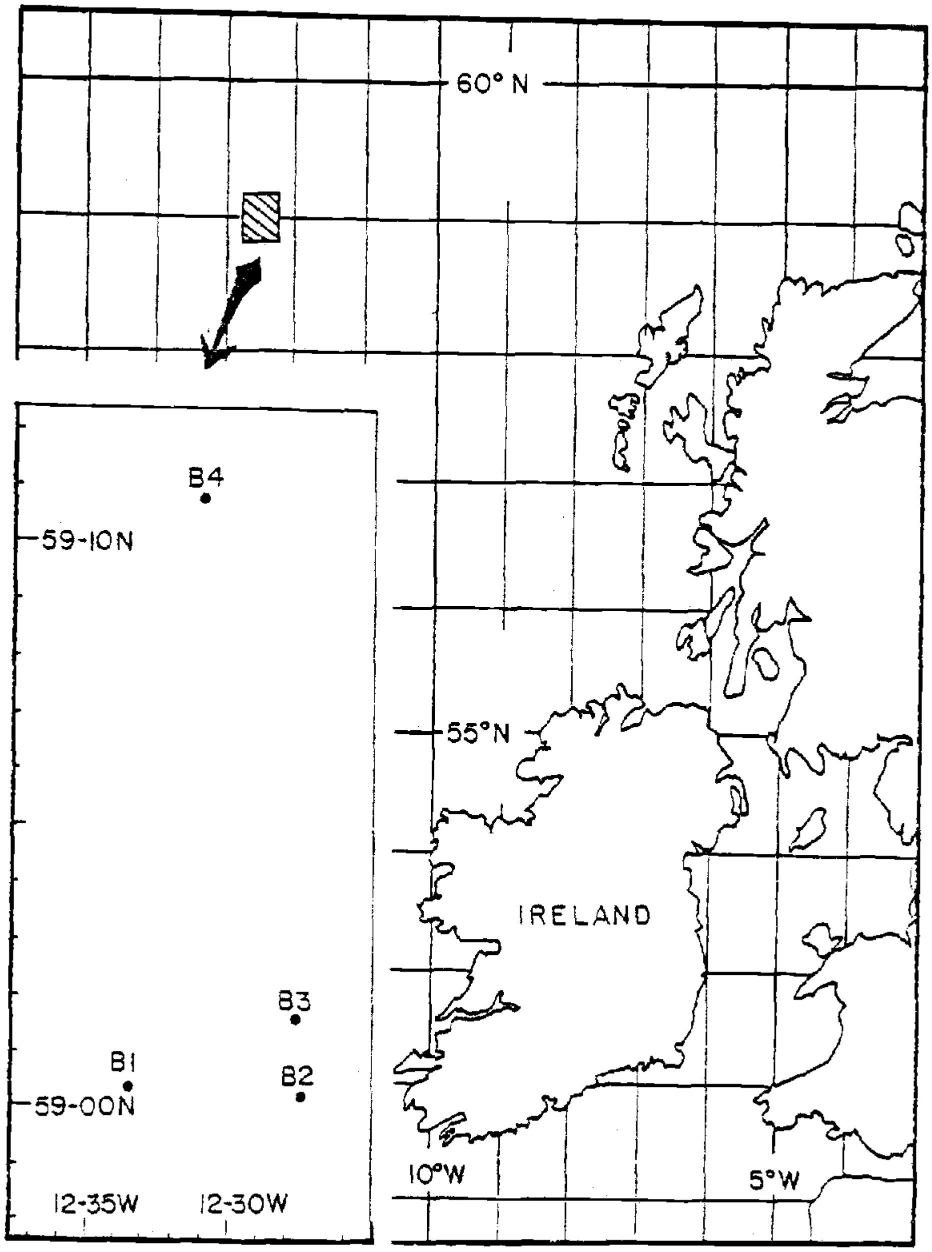

Figure 1. Locations of meteorological buoys, JASIN-1978.

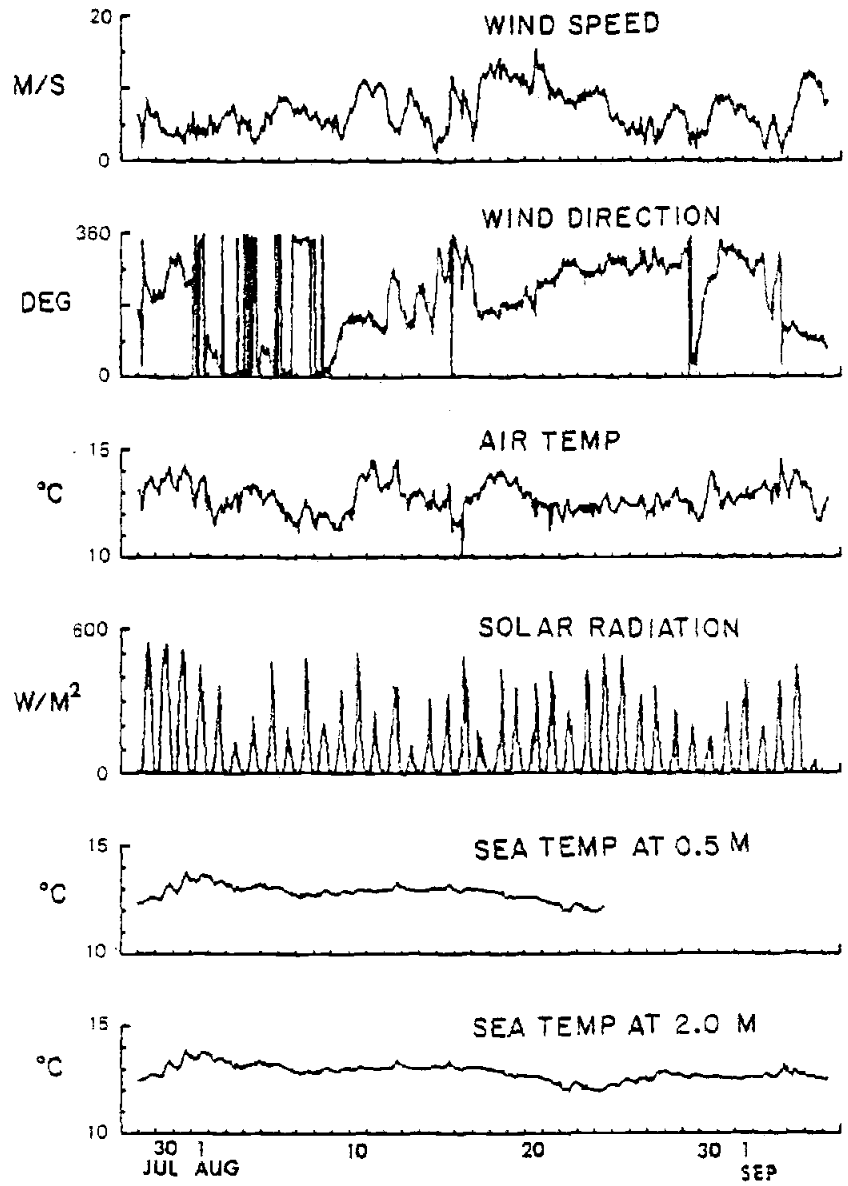

Figure 2. Time series of hourly averaged variables observed at B3 from 28 July to 6 September 1978.

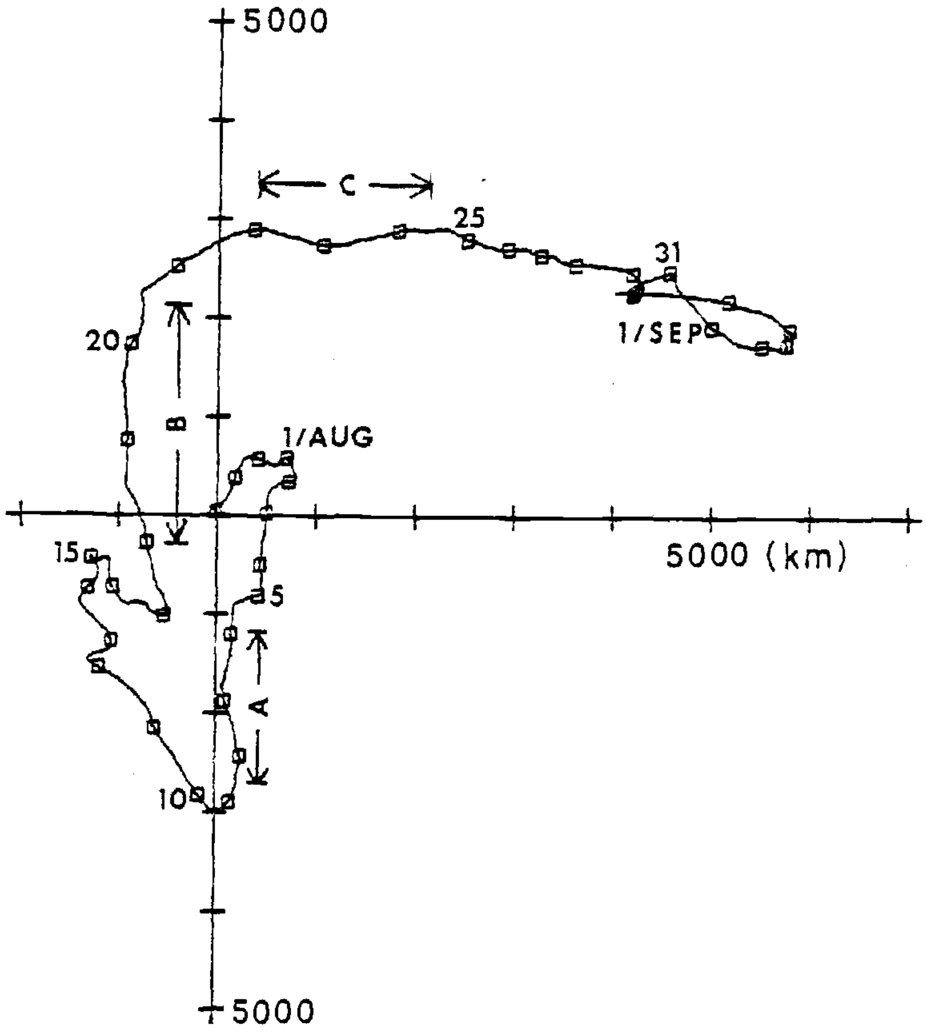

Figure 3. Progressive vector diagram of wind at B3 from 2300 GMT on 28 July to 6 September 1978. Each square is plotted at 0000 GMT.

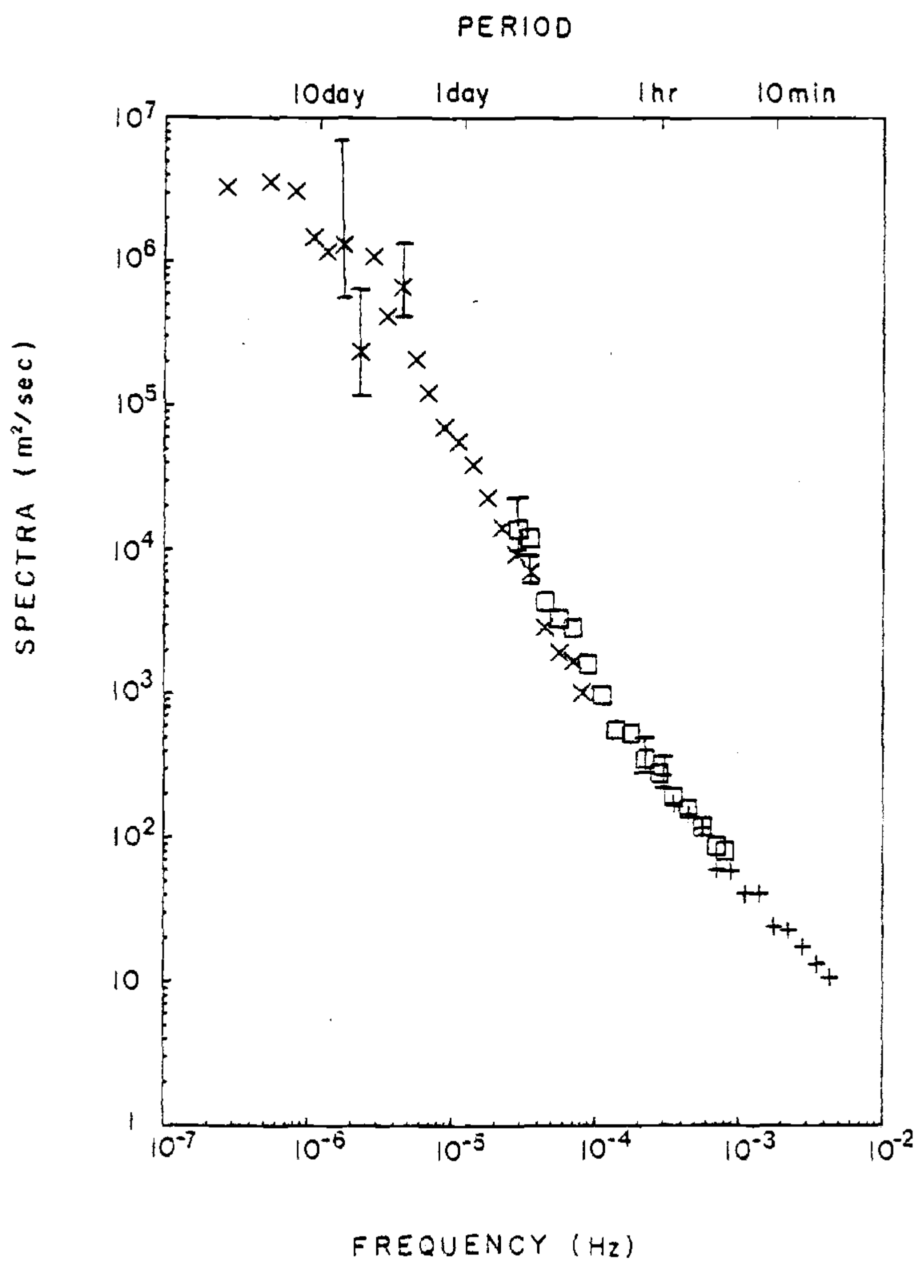

Figure 4. Composite spectrum of wind speed from B1 and B3. The symbols X are spectra from one-hourly averages, □ are spectra from 3.5-minute averages, and + are spectra from 1.75-minute averages. The vertical bars show the 90% confidence interval.

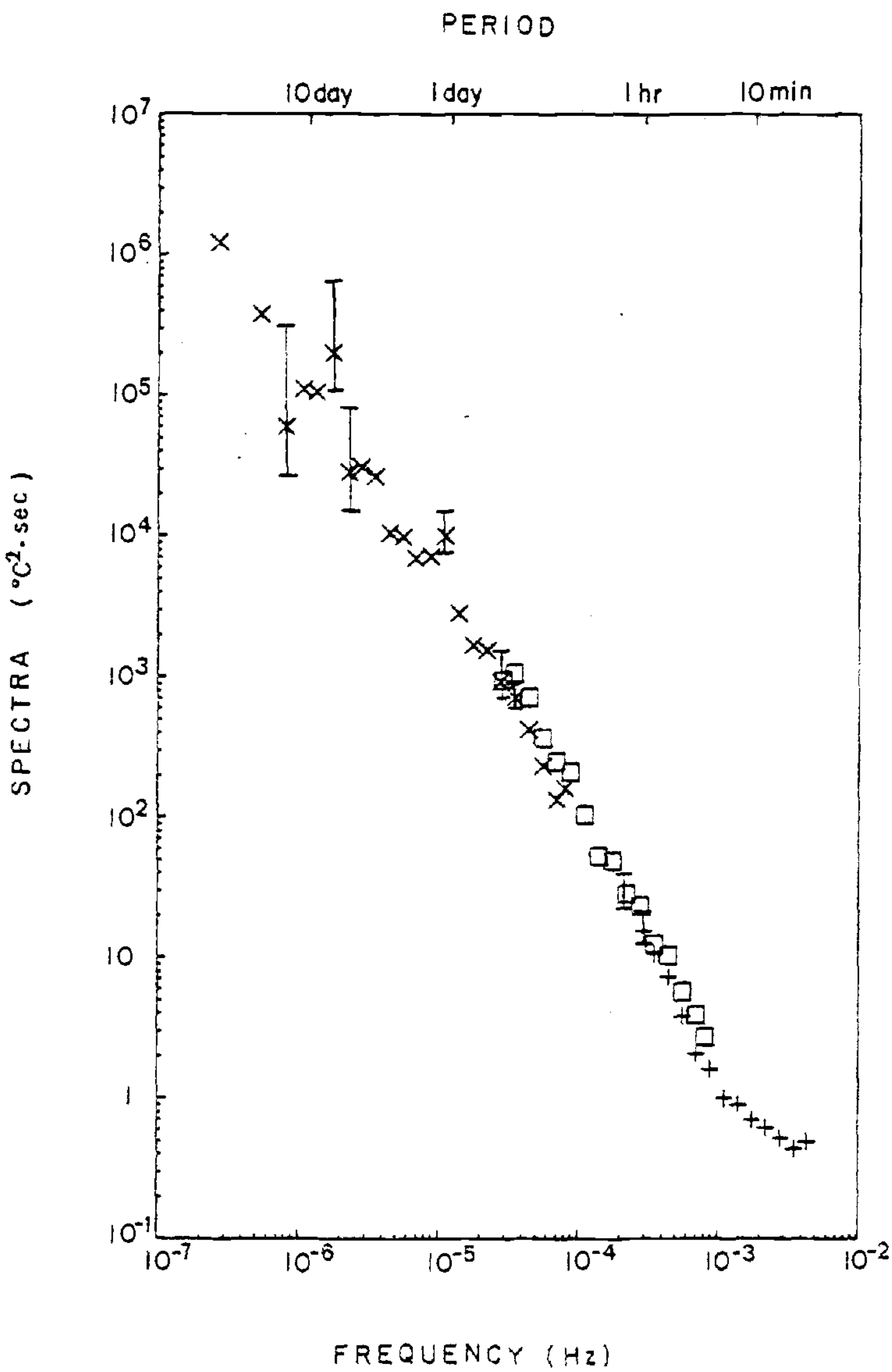

Figure 5. Composite spectrum of air temperature from B2 and B3. The symbols X, □, +, and I are defined in Figure 4.

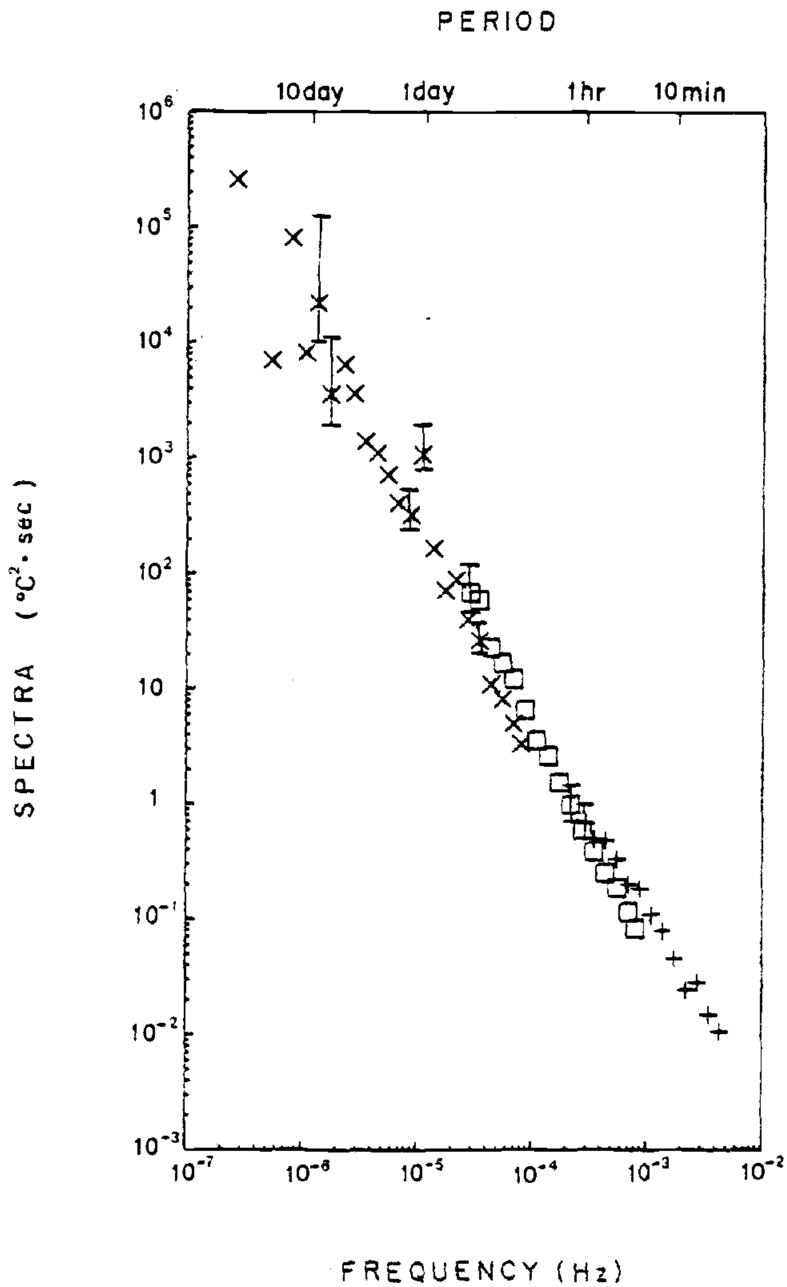

Figure 6. Composite spectrum of sea temperature from B1 and B3. The symbols X, □, +, and I are defined in Figure 4.

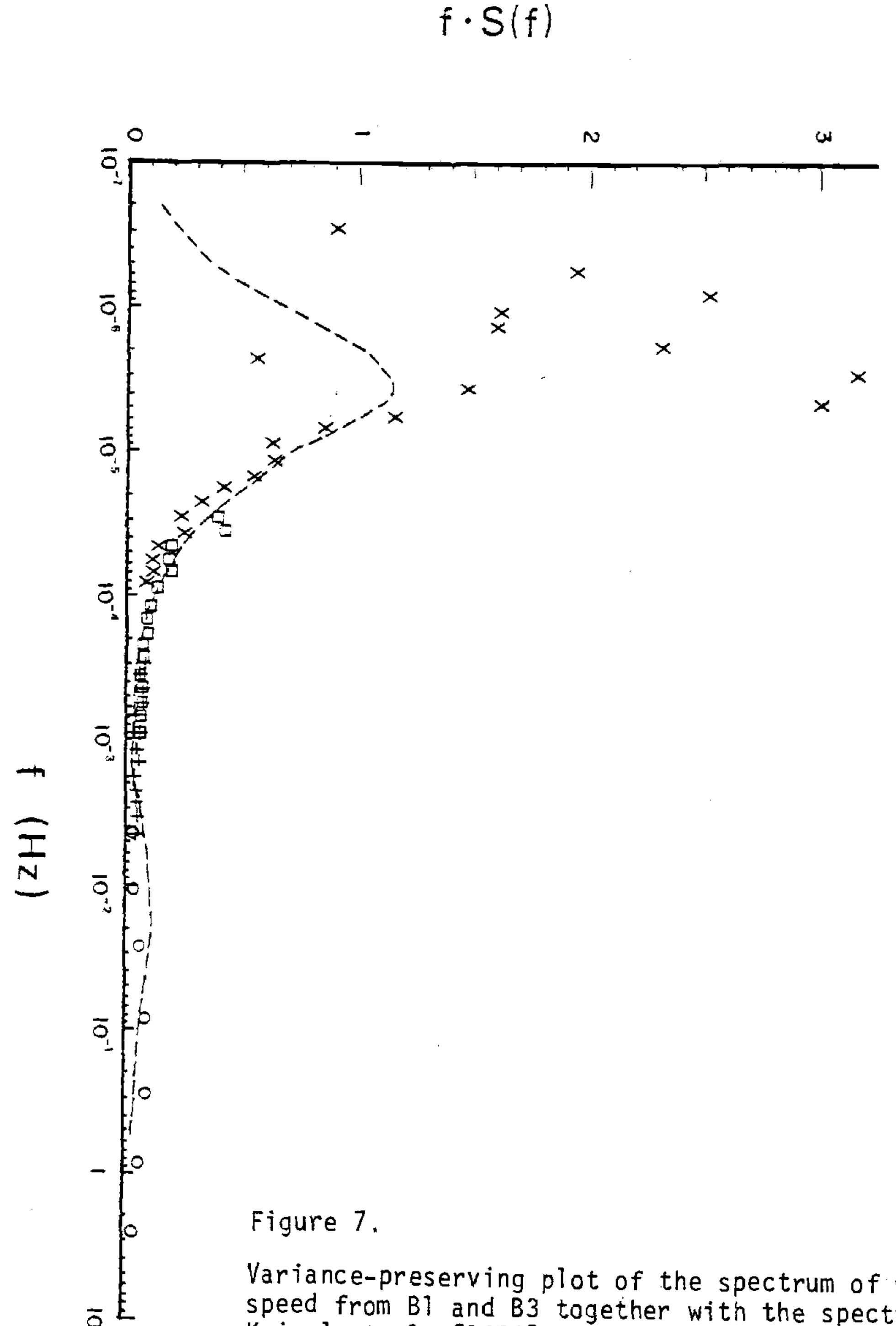

Figure 7.

Variance-preserving plot of the spectrum of wind speed from B1 and B3 together with the spectrum from Kaimal et al. [1972]. The symbols X, ☐, and + are defined in Figure 4, and o is Kaimal et al's [1972] spectrum. The broken line shows the spectrum measured by Smedman-Högström and Högström [1975] over land.

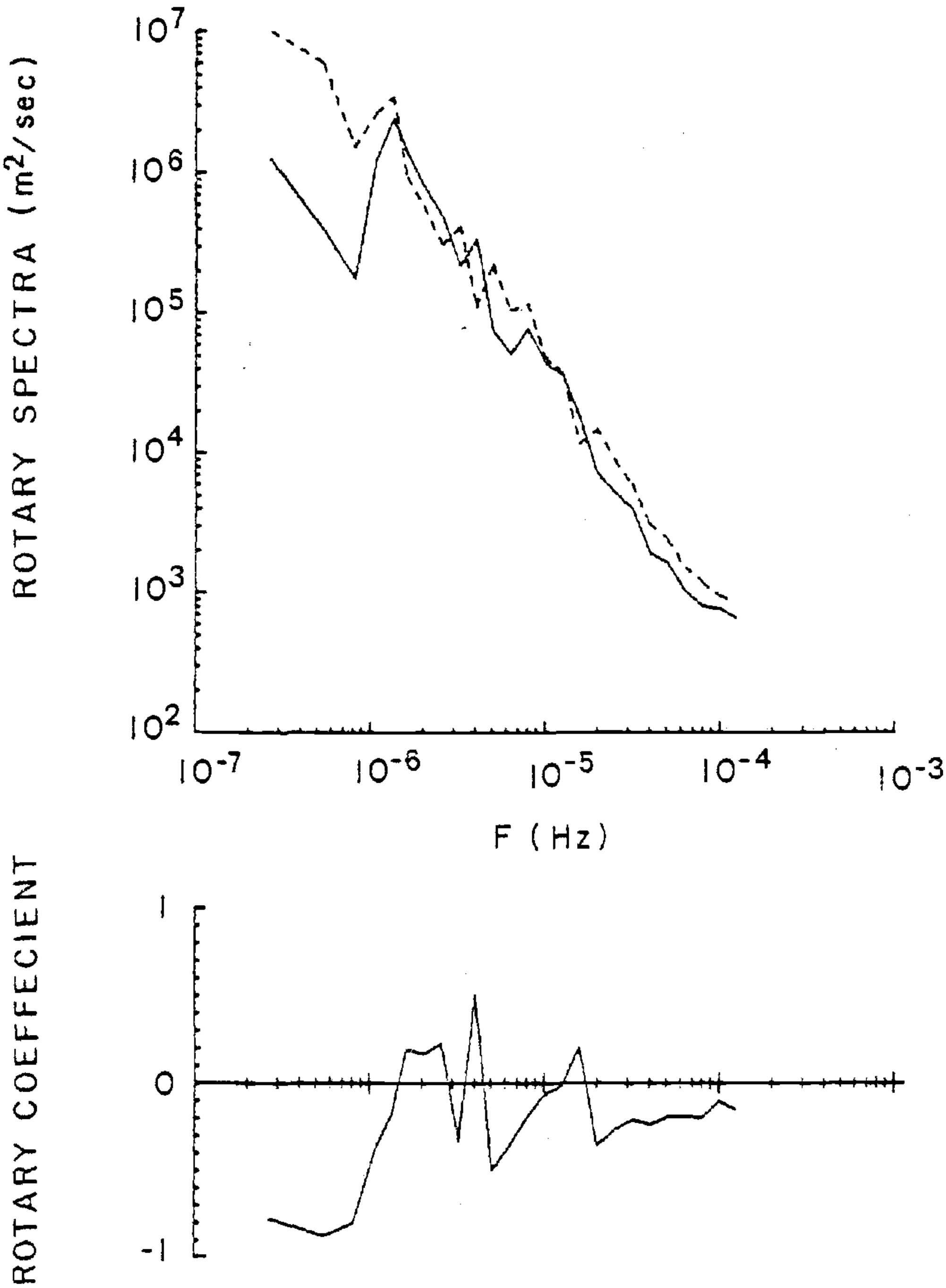

Figure 8. Rotary spectra (A) and rotary coefficient (B) of hourly averaged wind velocity from B3. The broken line represents clockwise rotation and the solid line represents counterclockwise rotation.

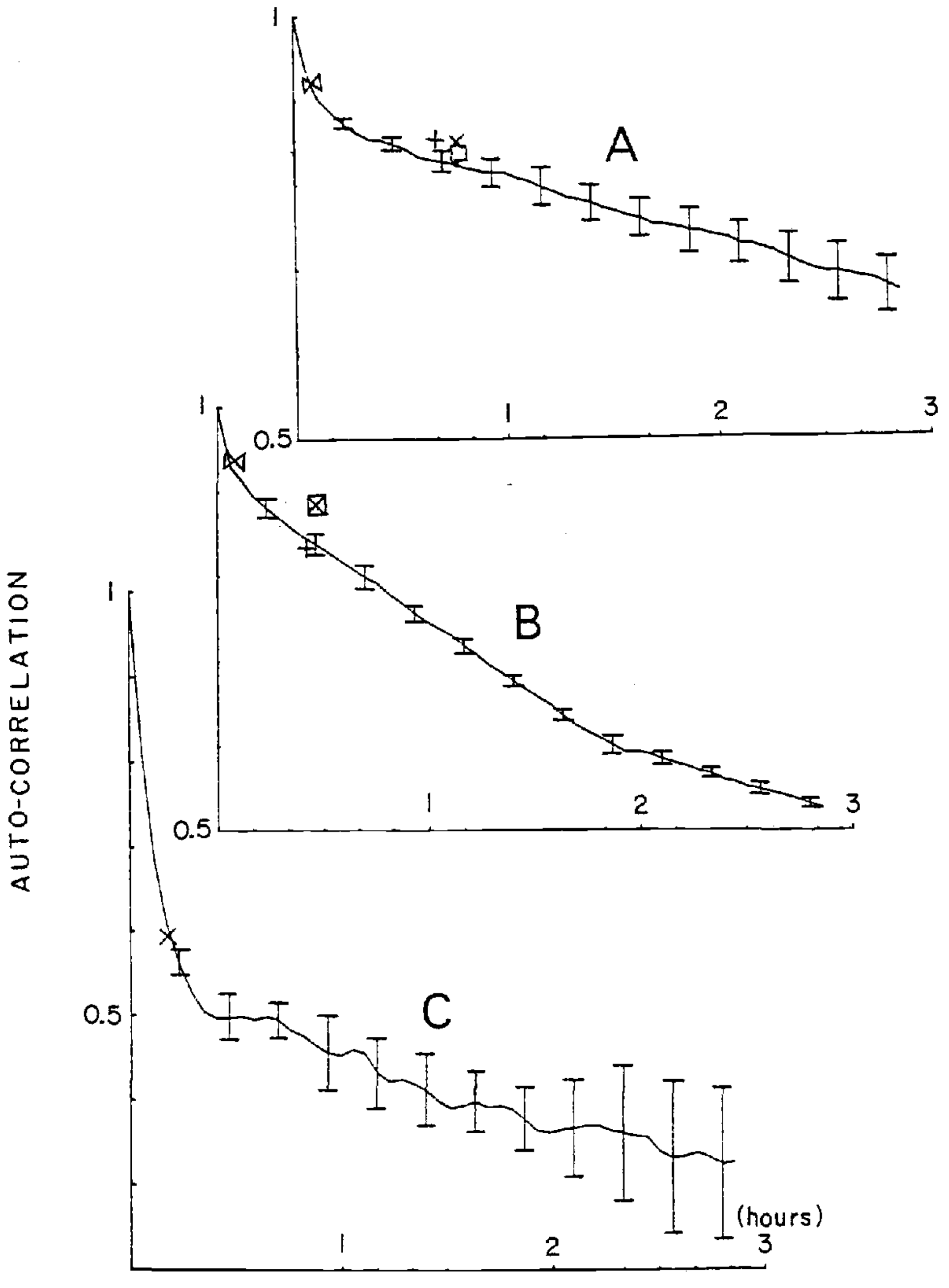

Figure 9. Mean auto-correlation functions of unfiltered wind speed from parts A, B and C. The auto-correlation functions are averages over buoys B1, B2, B3 and B4. The lengths of the vertical bars are twice the standard deviation. Cross-correlation coefficients from pairs of buoys lying along the mean wind direction are plotted. The symbols X, □, ⧗ and + represent the combinations B1-B4, B2-B4, B2-B3, and B3-B4 respectively in parts A and B. The symbol X represents the combination B1-B2 in part C.

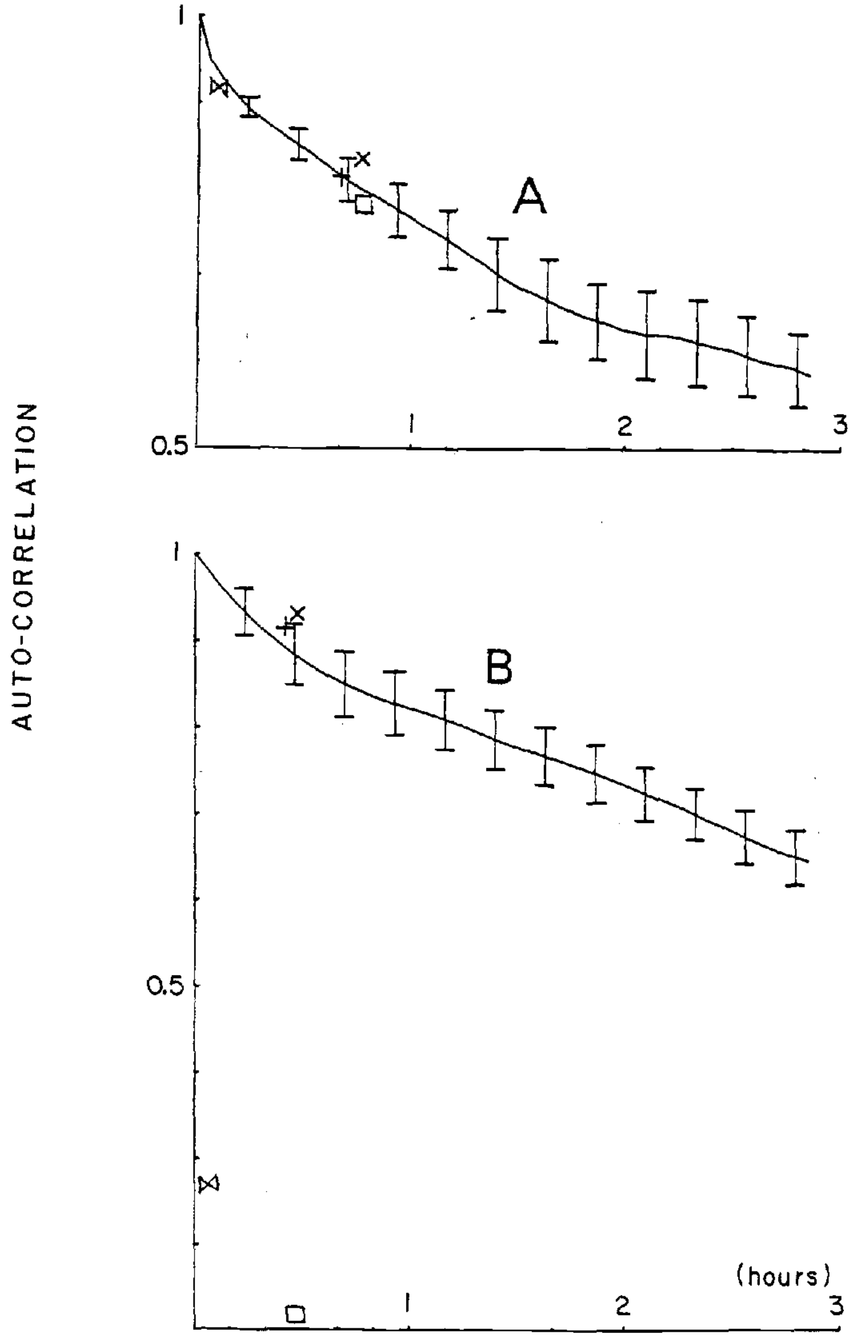

Figure 10. Mean auto-correlation functions of unfiltered air temperature from parts A and B. See Figure 9 for explanation. Part C is not included because the temperature record from B1 was incomplete.

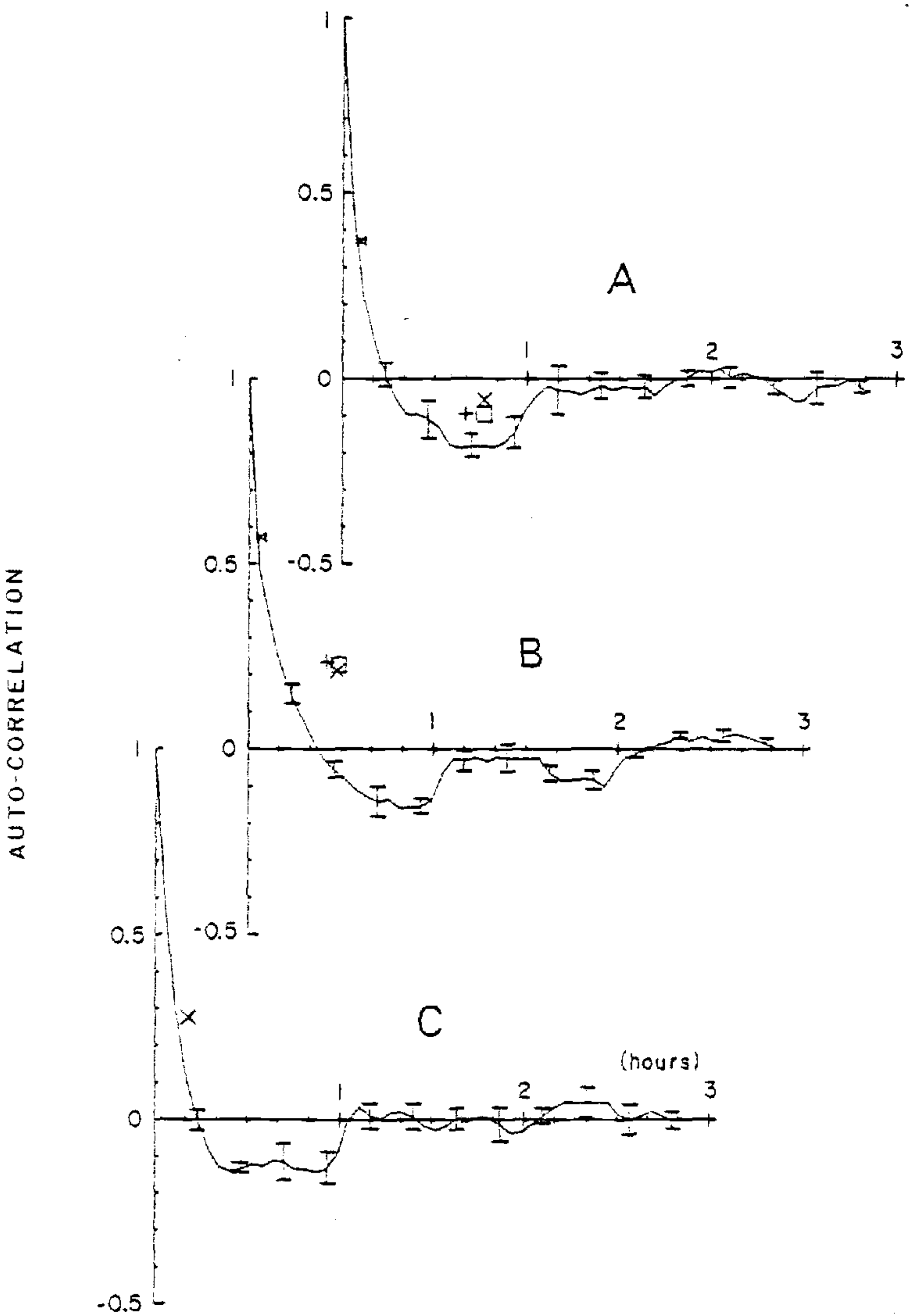

Figure 11. Mean auto-correlation functions of filtered wind speed from parts A, B and C. See Figure 9 for explanation.

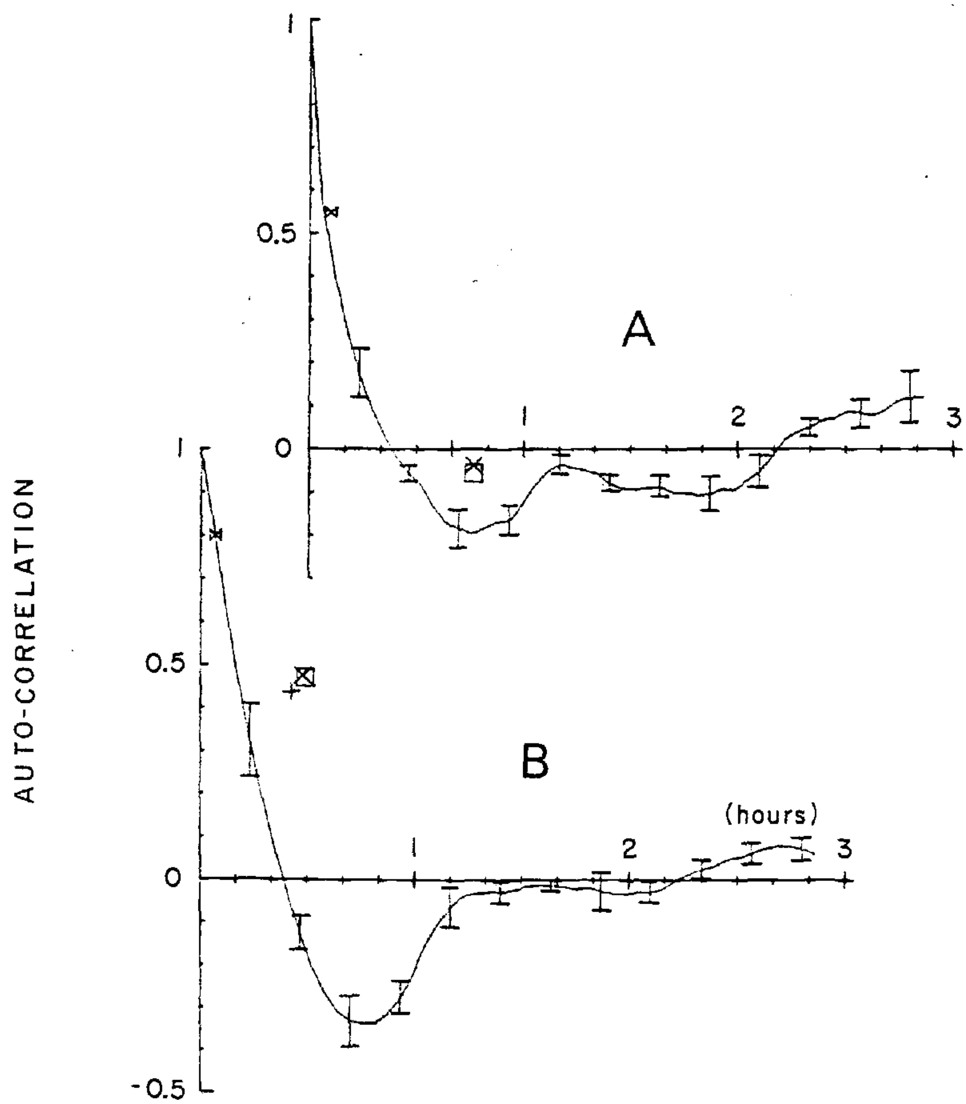

Figure 12. Mean auto-correlation functions of filtered air temperature from parts A and B. Part C is not included because the temperature record from B1 was incomplete.

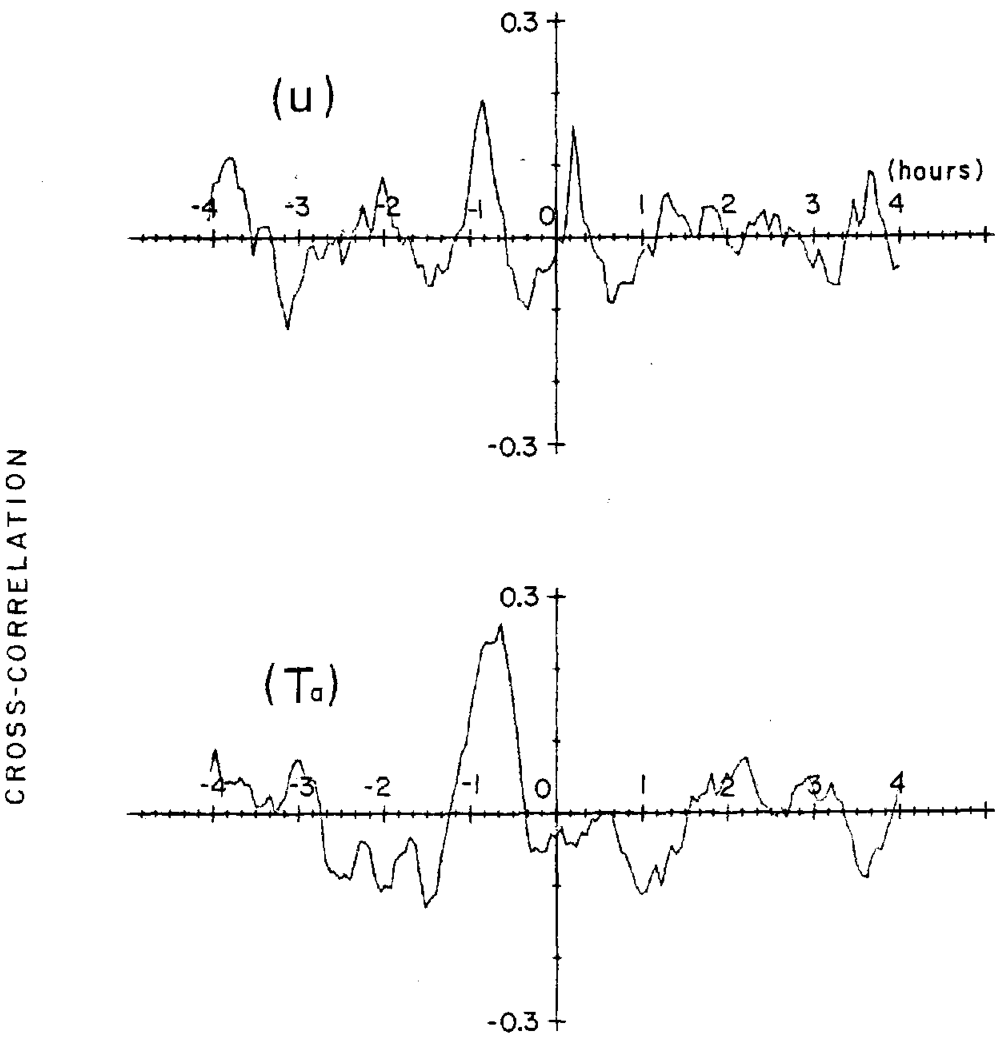

Figure 13. Example of cross-correlation functions of wind speed (u) from B1 and B4 and air temperature (T_a) from the same buoys used to determine the eddy travel time in the downwind direction. The records are high-pass filtered, part A.

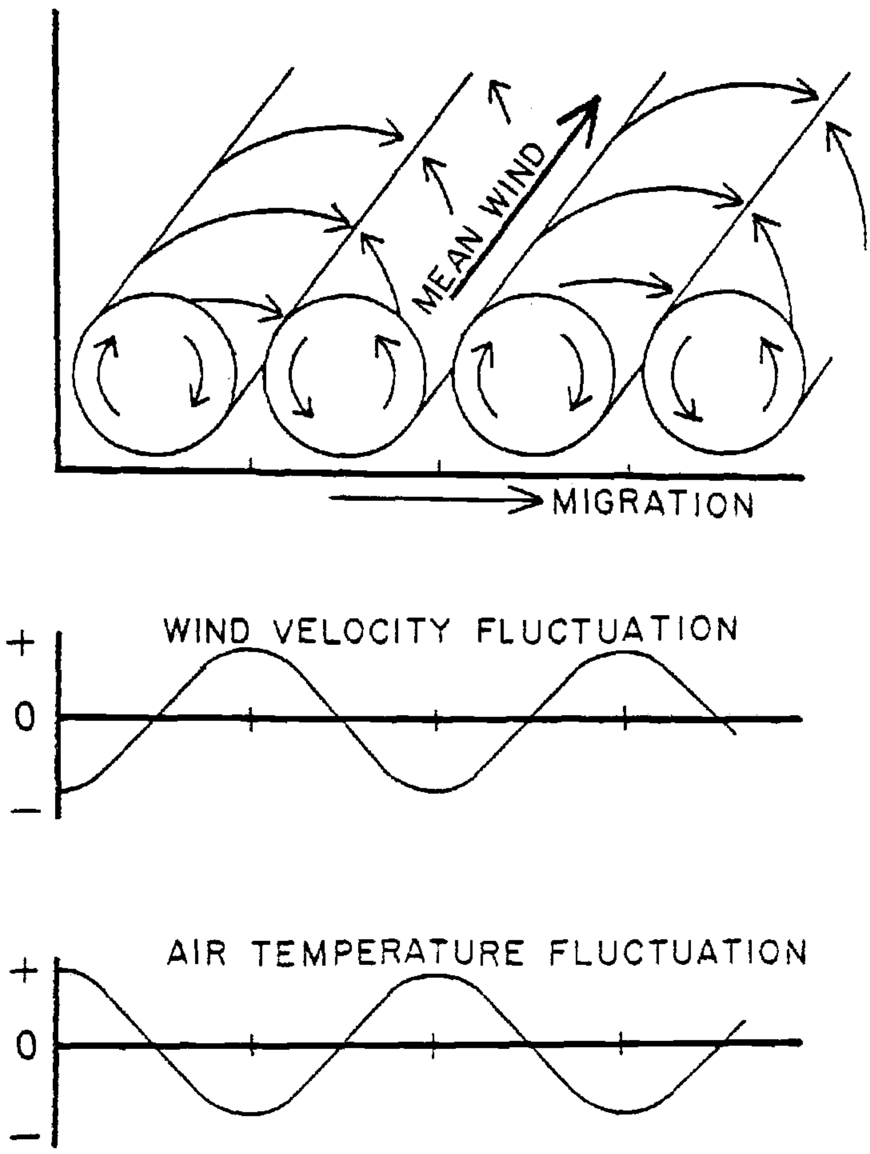

Figure 14. Schematic diagram of horizontal roll vortices and associated fluctuations of horizontal wind velocity and air temperature (assuming unstable stratification).

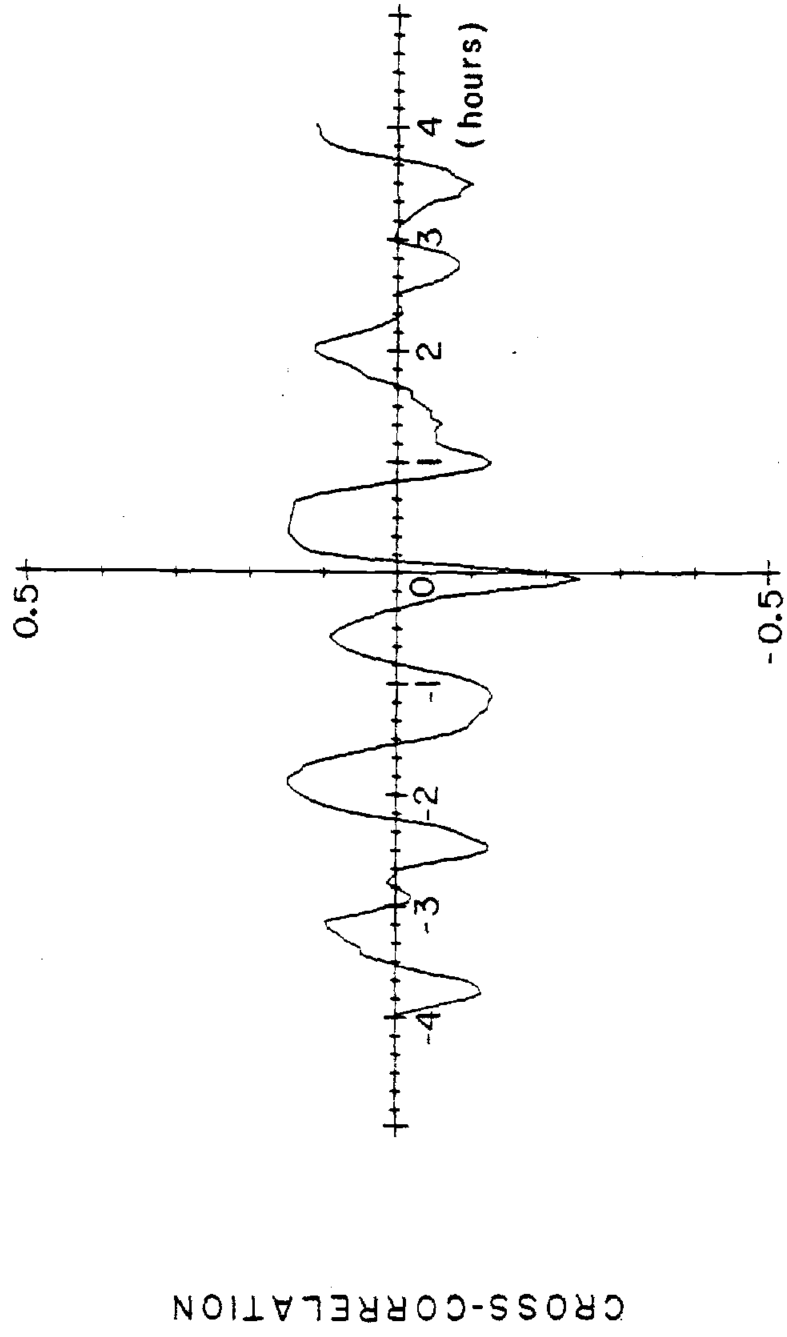

Figure 15. Cross-correlation function of high-passed wind speed and air temperature at B4, part C. Positive lags indicate that air temperature leads wind speed.

APPENDIX

APPENDIX

Hourly Averages From Buoy B3

There follows a listing of hourly averages from buoy B3. The averaging interval extends from a half hour before the hour to a half hour after the hour. The symbols are defined as follows: U, wind speed; DIR, wind direction; TA, air temperature; TS1, sea temperature at 0.5 m depth; TS2, sea temperature at 2 m depth; R, incoming solar radiation. Wind speed and direction and air temperature were measured 2.5 m above mean sea level. Wind speed direction has been corrected between the beginning of the observations and 1917 GMT on 12 August based on a linear regression between B2 and B3.

MN	DY	HR (GMT)	U (M/S)	DIR (DEG)	TA (C)	TS1 (C)	TS2 (C)	R (W/M**2)
7	28	23	6.36	168	13.08	12.41	12.53	0.82
7	29	0	6.15	167	13.12	12.39	12.52	1.23
7	29	1	5.97	143	13.12	12.38	12.50	1.94
7	29	2	5.62	147	13.08	12.37	12.49	6.15
7	29	3	5.01	136	12.73	12.36	12.48	6.15
7	29	4	2.58	114	12.28	12.36	12.49	1.64
7	29	5	1.88	27	12.17	12.37	12.50	6.15
7	29	6	2.61	343	12.27	12.36	12.50	40.57
7	29	7	3.56	289	12.73	12.38	12.51	131.96
7	29	8	4.71	249	13.07	12.41	12.53	154.05
7	29	9	6.41	251	13.38	12.44	12.56	357.37
7	29	10	6.62	230	13.47	12.48	12.60	484.41
7	29	11	7.51	237	13.36	12.53	12.65	509.82
7	29	12	8.76	237	13.29	12.55	12.67	352.86
7	29	13	8.05	229	13.45	12.52	12.63	548.75
7	29	14	7.49	217	13.51	12.54	12.66	534.00
7	29	15	7.07	217	13.58	12.57	12.69	505.11
7	29	16	6.49	215	13.69	12.63	12.75	450.81
7	29	17	6.63	205	13.74	12.66	12.78	399.99
7	29	18	6.25	195	13.80	12.67	12.80	323.76
7	29	19	6.19	199	13.68	12.66	12.79	204.09
7	29	20	6.21	184	13.58	12.65	12.78	132.37
7	29	21	6.42	182	13.36	12.61	12.73	21.31
7	29	22	6.36	221	13.23	12.61	12.73	0.39
7	29	23	5.94	204	13.23	12.61	12.73	0.00
7	30	0	6.48	189	13.18	12.61	12.73	0.41
7	30	1	6.80	201	13.15	12.61	12.74	0.00
7	30	2	6.89	202	13.20	12.63	12.75	0.82
7	30	3	6.12	205	13.15	12.58	12.70	0.00
7	30	4	6.16	195	13.17	12.54	12.66	0.41
7	30	5	5.09	218	12.92	12.54	12.66	9.68
7	30	6	4.69	220	13.19	12.52	12.65	87.70
7	30	7	4.68	211	13.58	12.52	12.64	224.58
7	30	8	4.33	197	13.61	12.53	12.65	310.65
7	30	9	4.00	202	13.68	12.61	12.72	420.07
7	30	10	3.91	197	13.61	12.71	12.82	465.56
7	30	11	4.32	204	13.59	12.80	12.90	516.79
7	30	12	4.63	210	13.56	12.87	12.98	460.98
7	30	13	4.49	218	13.58	12.97	13.07	503.26
7	30	14	3.73	264	13.84	13.09	13.19	540.15
7	30	15	3.94	249	13.89	13.18	13.29	494.25
7	30	16	3.66	262	14.03	13.21	13.32	428.68
7	30	17	3.56	267	14.07	13.18	13.30	354.91
7	30	18	3.67	277	14.08	13.22	13.34	279.50
7	30	19	3.62	290	14.21	13.30	13.42	239.59
7	30	20	3.71	303	13.98	13.26	13.38	120.90
7	30	21	3.66	302	13.59	13.14	13.27	30.33
7	30	22	3.51	293	13.35	13.14	13.27	0.00

MN	DY (GMT)	HR	U (M/S)	DIR (DEG)	TA (C)	TS1 (C)	TS2 (C)	R (W/M**2)
7	30	23	3.49	287	13.31	13.12	13.25	1.23
7	31	0	3.45	295	13.24	13.00	13.14	0.41
7	31	1	3.45	292	13.25	13.01	13.14	0.82
7	31	2	3.92	283	13.18	12.95	13.08	0.39
7	31	3	3.82	277	13.18	12.96	13.08	0.00
7	31	4	4.48	291	13.23	12.96	13.08	0.41
7	31	5	4.73	304	13.12	12.86	13.00	15.57
7	31	6	4.72	314	13.45	12.91	13.04	143.85
7	31	7	3.62	312	13.79	12.96	13.08	263.93
7	31	8	3.39	293	13.79	13.01	13.14	343.43
7	31	9	3.78	299	13.77	13.08	13.20	428.47
7	31	10	3.92	304	13.64	13.12	13.23	405.32
7	31	11	2.86	272	13.82	13.19	13.25	508.18
7	31	12	3.14	270	13.88	13.30	13.33	518.84
7	31	13	3.13	272	14.08	13.46	13.50	500.80
7	31	14	3.51	260	14.14	13.62	13.69	411.46
7	31	15	2.59	245	14.18	13.70	13.79	467.61
7	31	16	2.42	226	14.33	13.81	13.92	457.89
7	31	17	3.18	230	14.10	13.84	13.95	211.88
7	31	18	4.32	228	14.02	13.83	13.94	151.22
7	31	19	4.32	240	13.92	13.70	13.82	83.19
7	31	20	4.68	230	13.88	13.64	13.75	43.85
7	31	21	5.25	234	13.90	13.61	13.73	9.43
7	31	22	4.61	248	13.77	13.45	13.57	0.41
7	31	23	3.64	229	13.67	13.41	13.54	0.39
8	1	0	3.89	249	13.42	13.50	13.63	1.23
8	1	1	3.95	223	12.95	13.52	13.64	0.00
8	1	2	4.26	279	13.10	13.51	13.63	0.41
8	1	3	6.84	10	12.68	13.47	13.59	0.00
8	1	4	4.80	310	12.46	13.44	13.57	0.00
8	1	5	4.32	308	12.46	13.43	13.55	6.15
8	1	6	3.33	338	12.29	13.36	13.48	35.61
8	1	7	3.29	356	12.66	13.31	13.45	86.06
8	1	8	2.86	8	12.89	13.37	13.48	145.08
8	1	9	4.30	13	13.18	13.43	13.55	195.08
8	1	10	5.04	309	13.08	13.46	13.59	259.01
8	1	11	4.89	7	13.14	13.47	13.59	286.06
8	1	12	4.26	330	13.45	13.50	13.62	338.10
8	1	13	3.82	343	13.72	13.60	13.70	450.92
8	1	14	3.71	332	13.67	13.68	13.79	343.84
8	1	15	4.34	327	13.54	13.68	13.79	327.45
8	1	16	3.88	331	13.65	13.68	13.79	340.56
8	1	17	4.62	349	13.62	13.72	13.84	223.76
8	1	18	4.02	359	13.82	13.69	13.81	252.45
8	1	19	3.81	3	13.80	13.66	13.78	175.40
8	1	20	3.26	32	13.30	13.63	13.75	39.09
8	1	21	4.30	54	12.89	13.64	13.77	7.79
8	1	22	3.66	70	12.17	13.63	13.76	0.41

MN	DY (GMT)	HR	U (M/S)	DIR (DEG)	TA (C)	TS1 (C)	TS2 (C)	R (W/M**2)
8	1	23	4.34	104	12.47	13.61	13.73	0.00
8	2	0	4.53	105	12.81	13.58	13.72	0.00
8	2	1	5.22	79	12.83	13.58	13.70	0.00
8	2	2	5.94	84	12.60	13.58	13.71	0.00
8	2	3	6.47	79	12.37	13.58	13.71	0.00
8	2	4	5.74	66	12.08	13.50	13.62	1.23
8	2	5	5.24	63	11.75	13.40	13.53	9.43
8	2	6	3.79	48	11.60	13.33	13.45	22.95
8	2	7	4.83	57	11.54	13.28	13.41	43.85
8	2	8	5.35	61	11.68	13.23	13.36	54.51
8	2	9	4.82	51	11.50	13.24	13.37	85.24
8	2	10	4.34	71	11.74	13.28	13.41	158.69
8	2	11	4.11	65	11.97	13.33	13.45	231.55
8	2	12	3.89	38	11.96	13.37	13.49	236.47
8	2	13	4.43	26	12.12	13.38	13.50	336.87
8	2	14	4.68	21	12.28	13.38	13.50	284.42
8	2	15	5.29	20	12.41	13.38	13.50	366.38
8	2	16	5.36	22	12.39	13.40	13.51	209.83
8	2	17	5.12	7	12.47	13.41	13.53	120.37
8	2	18	5.66	7	12.50	13.41	13.54	65.98
8	2	19	5.90	357	12.36	13.39	13.51	28.69
8	2	20	5.99	0	12.07	13.38	13.51	11.48
8	2	21	6.19	3	12.08	13.34	13.46	1.64
8	2	22	6.38	11	12.19	13.25	13.37	2.87
8	2	23	6.65	2	12.44	13.20	13.32	0.00
8	3	0	6.68	4	12.78	13.18	13.30	1.16
8	3	1	7.11	3	12.84	13.24	13.36	0.00
8	3	2	6.90	10	12.72	13.27	13.40	0.00
8	3	3	6.55	7	12.46	13.26	13.39	0.41
8	3	4	6.24	5	12.38	13.23	13.36	0.41
8	3	5	6.50	5	12.45	13.24	13.36	2.05
8	3	6	6.82	3	12.38	13.23	13.35	9.02
8	3	7	7.19	5	12.29	13.18	13.30	21.68
8	3	8	7.69	7	12.40	13.10	13.23	63.52
8	3	9	7.75	13	12.56	13.04	13.16	81.15
8	3	10	8.09	15	12.63	13.01	13.14	82.78
8	3	11	7.60	8	12.82	12.93	13.05	105.32
8	3	12	7.04	7	12.95	12.88	13.01	109.83
8	3	13	6.18	15	12.95	12.99	13.11	132.78
8	3	14	5.71	5	12.96	13.11	13.23	106.44
8	3	15	5.18	350	13.06	13.16	13.28	71.31
8	3	16	5.34	346	12.71	13.14	13.26	60.24
8	3	17	4.41	20	12.20	13.05	13.18	59.42
8	3	18	3.67	15	12.12	13.03	13.15	31.97
8	3	19	3.95	4	12.21	13.03	13.15	21.31
8	3	20	5.38	1	12.71	13.01	13.13	16.39
8	3	21	6.47	2	12.99	12.92	13.04	2.32
8	3	22	6.03	2	13.12	12.97	13.09	0.82

MN	DY	HR (GMT)	U (M/S)	DIR (DEG)	TA (C)	TS1 (C)	TS2 (C)	R (W/M**2)
8	3	23	5.72	24	13.20	13.02	13.14	0.82
8	4	0	5.56	10	13.25	13.06	13.18	0.00
8	4	1	5.72	359	13.21	13.02	13.15	0.41
8	4	2	5.20	0	13.26	13.05	13.18	0.00
8	4	3	5.35	347	13.25	13.08	13.20	0.00
8	4	4	5.59	334	13.26	13.10	13.22	0.39
8	4	5	4.69	331	13.22	13.13	13.24	0.00
8	4	6	4.18	355	13.37	13.10	13.23	9.84
8	4	7	4.75	0	13.36	13.11	13.24	32.79
8	4	8	4.83	347	13.13	13.06	13.18	40.16
8	4	9	5.84	13	12.98	13.07	13.20	65.16
8	4	10	4.08	22	13.18	13.09	13.22	127.46
8	4	11	2.79	10	12.96	13.09	13.22	111.86
8	4	12	2.68	353	13.29	13.09	13.21	125.00
8	4	13	2.70	27	13.45	13.15	13.25	238.93
8	4	14	3.24	349	13.30	13.18	13.31	175.81
8	4	15	2.31	344	13.33	13.21	13.32	204.50
8	4	16	2.44	324	13.27	13.23	13.34	114.34
8	4	17	2.78	349	13.30	13.18	13.29	76.64
8	4	18	2.91	15	13.31	13.14	13.26	40.64
8	4	19	3.29	28	12.93	13.21	13.33	27.46
8	4	20	3.45	16	12.83	13.30	13.42	16.80
8	4	21	3.48	11	12.93	13.31	13.44	1.64
8	4	22	3.34	28	12.96	13.31	13.43	0.41
8	4	23	3.98	46	13.08	13.29	13.40	0.00
8	5	0	4.81	72	12.82	13.21	13.34	0.41
8	5	1	4.40	82	12.63	13.11	13.23	0.39
8	5	2	5.00	77	12.64	13.09	13.20	3.28
8	5	3	4.28	83	12.45	13.12	13.25	0.41
8	5	4	4.28	73	12.55	13.18	13.31	0.00
8	5	5	5.58	59	12.63	13.27	13.39	0.41
8	5	6	6.95	67	12.65	13.20	13.32	12.70
8	5	7	6.86	68	12.78	13.05	13.17	37.29
8	5	8	6.41	59	12.86	13.03	13.15	53.41
8	5	9	6.54	76	13.03	13.03	13.15	104.10
8	5	10	6.22	70	12.96	13.06	13.18	94.67
8	5	11	5.88	63	12.89	13.09	13.21	75.82
8	5	12	5.69	52	12.90	13.11	13.22	167.21
8	5	13	5.12	41	13.01	13.08	13.20	215.16
8	5	14	5.85	17	13.22	13.10	13.21	466.38
8	5	15	6.85	10	13.10	13.15	13.27	401.38
8	5	16	6.99	3	12.99	13.16	13.27	331.14
8	5	17	7.12	1	13.00	13.15	13.27	281.55
8	5	18	6.82	2	13.10	13.17	13.29	264.34
8	5	19	7.21	358	12.86	13.13	13.25	80.74
8	5	20	7.20	9	12.74	13.14	13.27	17.21
8	5	21	7.42	13	12.61	13.14	13.25	2.05
8	5	22	7.98	4	12.41	13.14	13.24	0.39

MN	DY (GMT)	HR	U (M/S)	DIR (DEG)	TA (C)	TS1 (C)	TS2 (C)	R (W/M**2)
8	5	23	8.68	10	12.69	13.12	13.24	1.64
8	6	0	8.66	358	12.62	13.11	13.22	0.00
8	6	1	8.86	347	12.51	13.11	13.22	0.00
8	6	2	9.11	357	12.17	13.09	13.21	0.41
8	6	3	8.63	352	12.12	13.06	13.19	0.00
8	6	4	8.34	4	12.40	13.04	13.17	0.82
8	6	5	8.49	7	12.50	13.04	13.15	0.39
8	6	6	8.62	9	12.40	13.04	13.15	11.88
8	6	7	8.68	16	12.28	13.02	13.13	20.49
8	6	8	8.58	23	12.12	12.98	13.09	36.88
8	6	9	8.68	16	11.92	12.95	13.07	40.57
8	6	10	8.82	9	11.74	12.95	13.06	101.23
8	6	11	8.96	8	11.67	12.94	13.06	141.80
8	6	12	8.46	11	11.99	12.92	13.03	129.28
8	6	13	8.47	13	12.18	12.90	13.03	197.13
8	6	14	8.32	14	11.90	12.89	13.00	93.85
8	6	15	8.15	20	12.06	12.85	12.97	115.16
8	6	16	8.02	14	12.08	12.86	12.99	99.18
8	6	17	7.79	5	12.01	12.86	12.98	76.64
8	6	18	7.60	3	11.81	12.81	12.93	72.95
8	6	19	7.27	358	11.49	12.89	13.01	37.54
8	6	20	6.60	357	11.52	12.80	12.92	11.88
8	6	21	7.12	356	11.59	12.77	12.89	0.82
8	6	22	6.18	350	11.56	12.79	12.90	0.41
8	6	23	6.78	341	11.65	12.77	12.89	0.41
8	7	0	6.69	351	11.64	12.81	12.93	0.00
8	7	1	7.04	338	11.65	12.81	12.93	0.00
8	7	2	7.49	339	11.33	12.76	12.88	0.39
8	7	3	7.08	339	11.16	12.72	12.85	0.41
8	7	4	6.82	337	11.52	12.71	12.82	0.00
8	7	5	6.89	344	11.78	12.67	12.79	4.51
8	7	6	6.56	332	11.82	12.72	12.84	13.11
8	7	7	6.83	343	11.95	12.77	12.89	39.34
8	7	8	7.39	344	12.17	12.70	12.81	80.74
8	7	9	7.28	346	12.24	12.74	12.85	101.41
8	7	10	7.92	349	12.41	12.73	12.85	193.85
8	7	11	7.19	350	12.57	12.74	12.85	268.43
8	7	12	7.36	344	12.56	12.77	12.88	427.45
8	7	13	7.26	346	12.73	12.81	12.92	480.72
8	7	14	6.70	345	12.40	12.85	12.95	446.71
8	7	15	6.15	352	12.30	12.87	12.98	333.60
8	7	16	6.39	346	12.32	12.82	12.94	195.85
8	7	17	5.89	350	12.34	12.80	12.91	152.45
8	7	18	5.75	1	12.30	12.78	12.90	99.18
8	7	19	5.78	1	12.30	12.75	12.87	68.44
8	7	20	5.66	338	12.26	12.75	12.87	27.87
8	7	21	5.98	341	11.98	12.73	12.85	2.46
8	7	22	6.31	341	11.60	12.76	12.87	0.00

MN	DY	HR (GMT)	U (M/S)	DIR (DEG)	TA (C)	TS1 (C)	TS2 (C)	R (W/M**2)
8	7	23	6.19	328	11.91	12.75	12.86	0.00
8	8	0	6.18	347	11.62	12.76	12.88	0.41
8	8	1	6.71	349	11.41	12.77	12.89	0.00
8	8	2	6.97	1	11.63	12.73	12.85	0.82
8	8	3	6.95	16	11.30	12.70	12.81	0.00
8	8	4	6.42	19	11.58	12.78	12.89	0.00
8	8	5	5.64	10	12.01	12.84	12.96	2.87
8	8	6	5.29	9	11.98	12.85	12.97	13.55
8	8	7	5.91	8	12.17	12.73	12.85	81.15
8	8	8	5.42	15	12.02	12.76	12.87	105.73
8	8	9	4.89	8	11.96	12.80	12.91	115.98
8	8	10	4.49	13	11.97	12.85	12.97	161.88
8	8	11	4.48	357	12.08	12.92	13.03	175.81
8	8	12	4.68	352	12.01	12.95	13.06	193.03
8	8	13	4.91	4	11.94	12.95	13.07	209.01
8	8	14	4.94	8	12.00	12.97	13.08	199.99
8	8	15	4.90	23	12.06	12.97	13.08	181.96
8	8	16	5.85	21	12.05	12.97	13.08	162.70
8	8	17	5.95	22	12.12	12.97	13.08	148.36
8	8	18	5.68	26	11.99	12.95	13.08	110.24
8	8	19	5.90	24	11.96	12.95	13.06	63.52
8	8	20	5.97	10	11.91	12.93	13.04	17.03
8	8	21	6.16	24	11.77	12.90	13.02	0.41
8	8	22	5.89	21	11.72	12.89	13.01	0.41
8	8	23	5.25	29	11.64	12.85	12.97	0.00
8	9	0	5.15	43	11.60	12.82	12.94	0.41
8	9	1	4.68	40	11.44	12.80	12.93	0.41
8	9	2	4.04	55	11.33	12.80	12.93	0.00
8	9	3	5.82	36	11.61	12.80	12.93	0.39
8	9	4	4.62	57	11.51	12.80	12.92	0.82
8	9	5	6.16	58	11.66	12.80	12.92	2.05
8	9	6	6.69	53	11.48	12.80	12.92	13.11
8	9	7	6.58	58	11.35	12.80	12.92	42.21
8	9	8	6.22	79	11.29	12.80	12.92	74.18
8	9	9	4.69	89	11.31	12.80	12.92	98.36
8	9	10	3.81	111	11.33	12.81	12.93	114.96
8	9	11	3.96	104	11.28	12.83	12.94	172.13
8	9	12	3.10	127	11.38	12.85	12.96	289.75
8	9	13	3.19	98	11.35	12.93	13.02	351.63
8	9	14	3.18	115	11.70	12.94	13.05	331.55
8	9	15	3.75	140	12.00	12.98	13.08	257.37
8	9	16	3.19	130	11.90	12.98	13.08	152.86
8	9	17	3.71	142	11.91	12.97	13.08	97.93
8	9	18	4.29	140	11.85	12.95	13.07	111.06
8	9	19	5.18	138	12.10	12.94	13.06	81.96
8	9	20	5.36	145	12.21	12.92	13.04	15.98
8	9	21	5.52	143	12.20	12.93	13.04	0.41
8	9	22	6.12	159	12.16	12.94	13.05	0.41

MN	DY	HR (GMT)	U (M/S)	DIR (DEG)	TA (C)	TS1 (C)	TS2 (C)	R (W/M**2)
8	9	23	6.20	151	12.06	12.91	13.02	0.41
8	10	0	6.54	142	12.09	12.90	13.01	0.00
8	10	1	7.30	134	11.95	12.90	13.01	0.82
8	10	2	7.16	148	12.35	12.90	13.01	0.00
8	10	3	6.76	146	11.96	12.90	13.01	0.00
8	10	4	7.08	166	11.70	12.90	13.01	0.82
8	10	5	7.53	138	12.30	12.90	13.01	2.05
8	10	6	7.67	135	12.40	12.90	13.01	53.69
8	10	7	7.64	146	12.83	12.90	13.01	99.09
8	10	8	8.04	146	12.66	12.90	13.01	49.18
8	10	9	8.72	158	13.14	12.92	13.03	152.04
8	10	10	9.04	143	13.30	12.95	13.06	274.99
8	10	11	9.24	139	13.61	12.98	13.08	502.44
8	10	12	9.77	160	13.59	13.02	13.13	451.22
8	10	13	10.25	149	13.65	13.02	13.13	400.81
8	10	14	10.14	141	13.79	13.03	13.13	357.25
8	10	15	10.54	158	13.86	13.02	13.13	274.99
8	10	16	10.29	147	13.87	13.02	13.13	167.21
8	10	17	10.98	127	13.89	13.02	13.13	110.24
8	10	18	10.96	151	13.90	13.00	13.09	91.80
8	10	19	10.98	138	13.92	12.97	13.08	39.34
8	10	20	11.30	145	13.82	12.96	13.06	5.33
8	10	21	11.36	145	13.53	12.93	13.02	0.77
8	10	22	11.02	139	13.55	12.91	13.01	0.82
8	10	23	10.83	147	13.55	12.90	13.00	0.41
8	11	0	10.94	159	13.68	12.94	13.05	0.41
8	11	1	10.88	168	13.75	12.98	13.08	0.00
8	11	2	10.49	158	13.76	12.99	13.08	0.41
8	11	3	10.55	174	13.91	12.97	13.08	0.41
8	11	4	10.08	159	14.14	12.97	13.08	0.39
8	11	5	9.85	161	14.29	12.97	13.07	5.74
8	11	6	9.71	143	14.50	12.95	13.06	51.23
8	11	7	9.01	157	14.54	12.95	13.04	88.11
8	11	8	8.88	126	14.26	12.92	13.02	84.42
8	11	9	8.86	132	14.12	12.92	13.02	170.49
8	11	10	9.45	139	14.35	12.92	13.02	235.65
8	11	11	9.41	143	14.52	12.93	13.02	261.65
8	11	12	9.70	139	14.37	12.93	13.03	188.52
8	11	13	10.23	142	14.24	12.92	13.01	132.37
8	11	14	10.13	129	13.99	12.93	13.03	102.87
8	11	15	10.30	123	13.55	12.96	13.06	95.08
8	11	16	10.50	136	13.39	12.98	13.08	79.92
8	11	17	10.47	121	13.15	12.99	13.08	48.77
8	11	18	10.77	130	13.07	12.99	13.08	31.35
8	11	19	10.71	118	13.01	12.99	13.09	14.75
8	11	20	10.95	124	13.05	12.99	13.08	6.15
8	11	21	10.69	116	13.20	12.99	13.08	0.41
8	11	22	10.41	120	13.26	12.99	13.08	0.00

MN	DY (GMT)	HR	U (M/S)	DIR (DEG)	TA (C)	TS1 (C)	TS2 (C)	R (W/M**2)
8	11	23	10.40	111	13.29	12.99	13.08	0.41
8	12	0	10.15	129	13.30	12.99	13.08	0.00
8	12	1	10.16	115	13.28	12.99	13.08	0.00
8	12	2	9.72	120	13.46	12.99	13.08	0.00
8	12	3	9.17	128	13.48	12.99	13.08	0.00
8	12	4	7.97	130	13.47	12.99	13.08	0.00
8	12	5	6.47	202	13.36	12.99	13.08	0.41
8	12	6	5.92	218	13.22	12.99	13.08	13.52
8	12	7	6.47	226	13.39	12.99	13.08	54.51
8	12	8	5.06	235	13.61	13.01	13.09	117.28
8	12	9	5.21	242	13.43	13.02	13.10	144.26
8	12	10	5.45	272	13.66	13.04	13.13	174.18
8	12	11	5.38	258	13.84	13.06	13.15	228.27
8	12	12	4.71	274	14.00	13.09	13.17	226.63
8	12	13	4.29	258	14.27	13.15	13.23	365.97
8	12	14	4.72	248	14.25	13.22	13.30	342.61
8	12	15	4.13	245	14.27	13.27	13.36	284.10
8	12	16	4.47	247	14.40	13.30	13.38	350.40
8	12	17	4.55	234	14.53	13.36	13.44	360.23
8	12	18	4.44	245	14.56	13.36	13.45	292.61
8	12	19	4.60	246	14.17	13.34	13.43	153.27
8	12	20	4.37	209	13.25	13.25	13.33	62.24
8	12	21	3.88	188	12.93	13.17	13.27	3.28
8	12	22	4.88	182	12.89	13.15	13.25	0.00
8	12	23	5.38	181	12.90	13.14	13.22	0.00
8	13	0	5.24	162	12.94	13.14	13.22	0.00
8	13	1	5.61	167	12.97	13.12	13.21	0.00
8	13	2	6.23	152	12.97	13.11	13.20	0.00
8	13	3	6.54	151	12.98	13.11	13.20	0.00
8	13	4	7.34	166	12.89	13.09	13.18	0.00
8	13	5	6.94	142	12.78	13.07	13.16	0.39
8	13	6	7.04	121	12.69	13.07	13.15	8.20
8	13	7	7.53	131	12.31	13.02	13.11	15.57
8	13	8	8.11	131	12.20	13.02	13.08	43.44
8	13	9	9.23	132	12.34	12.99	13.08	57.79
8	13	10	9.98	138	12.49	12.99	13.08	81.15
8	13	11	10.11	143	12.66	12.99	13.07	68.85
8	13	12	10.18	121	12.87	12.97	13.06	113.79
8	13	13	9.99	131	13.03	12.97	13.06	118.85
8	13	14	9.45	147	13.01	12.96	13.04	45.49
8	13	15	8.88	134	12.84	12.96	13.04	70.08
8	13	16	7.87	127	12.89	12.97	13.06	41.39
8	13	17	7.62	156	13.03	12.99	13.08	43.44
8	13	18	7.62	162	13.14	12.99	13.06	26.23
8	13	19	7.55	203	13.16	12.97	13.06	30.96
8	13	20	8.21	202	13.10	12.97	13.06	15.16
8	13	21	8.24	212	12.89	12.96	13.03	0.41
8	13	22	7.43	215	12.97	12.95	13.01	0.00

MN	DY (GMT)	HR	U (M/S)	DIR (DEG)	TA (C)	TS1 (C)	TS2 (C)	R (W/M**2)
8	13	23	7.06	232	13.13	12.95	13.01	0.00
8	14	0	6.29	216	13.25	12.95	13.02	0.00
8	14	1	6.16	222	13.11	12.95	13.03	0.00
8	14	2	5.73	229	13.09	12.95	13.03	0.00
8	14	3	6.40	210	13.06	12.96	13.03	0.00
8	14	4	6.73	239	13.02	12.97	13.06	0.00
8	14	5	5.94	233	12.90	12.97	13.06	0.00
8	14	6	5.28	217	12.77	12.97	13.06	13.93
8	14	7	4.74	220	12.79	12.97	13.06	33.61
8	14	8	4.69	179	12.68	12.96	13.03	60.65
8	14	9	5.07	190	12.47	12.95	13.01	74.70
8	14	10	6.02	177	12.20	12.95	13.03	104.51
8	14	11	5.94	180	12.21	12.97	13.04	118.44
8	14	12	6.19	169	12.20	12.97	13.06	111.88
8	14	13	6.16	163	12.54	12.99	13.07	270.89
8	14	14	5.79	147	12.69	13.03	13.09	312.70
8	14	15	5.48	143	12.71	13.06	13.14	282.78
8	14	16	4.56	146	12.47	13.09	13.16	202.04
8	14	17	4.27	126	12.25	13.09	13.17	81.15
8	14	18	3.46	108	12.50	13.09	13.17	77.46
8	14	19	1.91	146	12.94	13.09	13.17	53.69
8	14	20	1.70	160	13.16	13.09	13.17	21.31
8	14	21	2.46	175	12.70	13.09	13.16	0.82
8	14	22	1.48	173	12.46	13.08	13.15	0.00
8	14	23	1.19	225	12.34	13.06	13.15	0.00
8	15	0	1.93	290	12.50	13.06	13.15	0.00
8	15	1	3.12	325	12.26	13.04	13.13	0.00
8	15	2	3.18	321	12.24	13.04	13.13	0.00
8	15	3	3.34	322	12.29	13.04	13.13	0.00
8	15	4	3.48	321	12.21	13.04	13.12	0.00
8	15	5	2.82	305	12.26	13.04	13.12	1.23
8	15	6	2.70	290	12.41	13.04	13.11	28.26
8	15	7	2.78	262	12.47	13.04	13.11	45.08
8	15	8	3.01	246	12.64	13.04	13.12	86.88
8	15	9	3.37	249	12.72	13.06	13.13	130.32
8	15	10	3.39	249	12.55	13.07	13.15	123.77
8	15	11	3.98	237	12.61	13.09	13.17	138.93
8	15	12	4.95	240	12.36	13.10	13.17	160.24
8	15	13	4.47	242	12.95	13.14	13.21	311.19
8	15	14	4.55	266	12.71	13.18	13.25	188.52
8	15	15	3.82	283	13.50	13.25	13.32	332.78
8	15	16	4.59	305	13.32	13.30	13.37	192.21
8	15	17	4.74	336	13.36	13.29	13.36	136.06
8	15	18	7.76	346	12.77	13.24	13.32	59.01
8	15	19	11.78	5	11.30	13.17	13.26	22.95
8	15	20	11.36	1	11.14	13.09	13.17	10.84
8	15	21	11.42	359	11.36	13.09	13.17	0.82
8	15	22	11.61	355	11.80	13.07	13.16	0.41

MN	DY (GMT)	HR	U (M/S)	DIR (DEG)	TA (C)	TS1 (C)	TS2 (C)	R (W/M**2)
8	15	23	11.08	343	11.85	13.03	13.11	0.00
8	16	0	9.89	341	11.69	13.00	13.08	0.00
8	16	1	9.84	351	11.61	12.99	13.08	0.00
8	16	2	9.32	325	11.59	12.98	13.07	0.00
8	16	3	9.52	331	11.50	12.97	13.05	0.00
8	16	4	9.25	314	11.48	12.95	13.03	0.41
8	16	5	8.71	320	11.61	12.94	13.02	1.64
8	16	6	8.38	311	11.72	12.92	13.01	43.85
8	16	7	7.66	294	11.76	12.92	13.01	90.98
8	16	8	7.20	300	11.72	12.92	13.01	104.91
8	16	9	6.69	262	10.66	12.92	13.01	78.28
8	16	10	5.74	218	10.01	12.92	13.00	74.70
8	16	11	7.15	254	11.74	12.93	13.01	331.55
8	16	12	9.89	277	12.50	12.96	13.03	484.82
8	16	13	9.66	287	12.56	12.99	13.06	388.92
8	16	14	8.58	290	12.57	12.99	13.08	207.78
8	16	15	8.40	299	12.85	13.02	13.09	388.51
8	16	16	8.51	312	12.77	13.04	13.12	393.02
8	16	17	7.66	329	12.68	13.05	13.13	338.67
8	16	18	7.19	318	12.84	13.04	13.13	300.40
8	16	19	6.88	296	12.66	13.04	13.13	136.88
8	16	20	6.55	290	12.50	13.03	13.11	34.43
8	16	21	6.86	287	12.54	13.02	13.10	0.00
8	16	22	5.93	279	12.60	13.01	13.08	0.00
8	16	23	5.18	274	12.53	12.99	13.08	0.00
8	17	0	5.49	280	12.64	12.99	13.08	0.00
8	17	1	3.97	277	12.87	12.99	13.08	0.00
8	17	2	2.49	246	12.94	12.99	13.08	0.00
8	17	3	2.97	194	12.88	12.99	13.08	0.00
8	17	4	4.38	179	12.89	12.98	13.06	0.00
8	17	5	5.14	205	12.91	12.98	13.06	1.23
8	17	6	4.74	209	12.95	12.99	13.06	24.18
8	17	7	6.01	170	13.00	12.99	13.06	77.41
8	17	8	8.22	150	12.98	12.98	13.06	182.37
8	17	9	9.08	166	12.69	12.97	13.06	154.09
8	17	10	9.55	151	12.67	12.97	13.04	73.77
8	17	11	10.47	168	12.96	12.97	13.04	136.06
8	17	12	11.09	144	13.22	12.97	13.05	148.36
8	17	13	11.71	149	13.34	12.97	13.04	65.98
8	17	14	12.24	156	13.38	12.95	13.03	45.29
8	17	15	12.18	157	13.17	12.94	13.01	69.67
8	17	16	12.16	167	13.34	12.94	13.01	54.10
8	17	17	11.81	166	13.43	12.93	13.01	35.24
8	17	18	11.31	167	13.54	12.92	13.00	34.02
8	17	19	11.45	172	13.70	12.92	12.99	22.13
8	17	20	12.19	171	13.79	12.91	12.99	6.56
8	17	21	12.09	161	13.76	12.92	12.99	0.77
8	17	22	12.31	169	13.79	12.92	12.99	0.00

MN	DY (GMT)	HR	U (M/S)	DIR (DEG)	TA (C)	TS1 (C)	TS2 (C)	R (W/M**2)
8	17	23	12.70	159	13.93	12.92	12.99	0.00
8	18	0	13.58	168	13.95	12.90	12.98	0.00
8	18	1	13.52	171	13.87	12.90	12.98	0.00
8	18	2	13.06	166	13.86	12.89	12.96	0.00
8	18	3	12.59	178	13.86	12.89	12.96	0.00
8	18	4	12.48	169	13.59	12.87	12.95	0.00
8	18	5	12.06	162	13.45	12.87	12.94	0.00
8	18	6	11.89	163	13.41	12.87	12.93	12.70
8	18	7	11.35	168	13.44	12.87	12.91	15.98
8	18	8	12.04	159	13.78	12.85	12.89	38.93
8	18	9	12.93	156	13.77	12.85	12.89	56.56
8	18	10	13.16	153	13.87	12.85	12.89	81.55
8	18	11	13.68	150	13.97	12.85	12.89	122.70
8	18	12	13.67	146	13.94	12.85	12.89	119.26
8	18	13	14.05	151	13.79	12.85	12.89	105.73
8	18	14	14.20	161	14.01	12.85	12.89	109.01
8	18	15	11.36	180	13.81	12.83	12.87	156.96
8	18	16	11.61	177	14.02	12.83	12.87	434.41
8	18	17	12.84	188	14.08	12.86	12.90	343.43
8	18	18	13.37	182	13.96	12.91	12.95	191.59
8	18	19	13.47	181	13.91	12.84	12.88	140.98
8	18	20	13.03	182	13.73	12.76	12.80	20.90
8	18	21	12.78	179	13.74	12.72	12.78	0.00
8	18	22	12.86	190	13.72	12.68	12.74	0.00
8	18	23	12.52	172	13.66	12.66	12.73	0.00
8	19	0	11.89	189	13.28	12.66	12.72	0.41
8	19	1	11.77	173	13.53	12.66	12.73	0.00
8	19	2	11.76	169	13.52	12.69	12.74	0.00
8	19	3	11.08	181	13.44	12.71	12.77	0.00
8	19	4	11.35	179	13.37	12.73	12.78	0.00
8	19	5	10.81	177	13.34	12.71	12.78	0.41
8	19	6	11.06	175	13.39	12.70	12.73	43.44
8	19	7	11.35	173	13.47	12.65	12.70	129.91
8	19	8	11.63	173	13.50	12.64	12.68	157.14
8	19	9	11.69	181	13.50	12.64	12.68	158.60
8	19	10	11.82	174	13.54	12.64	12.68	199.58
8	19	11	11.93	172	13.65	12.64	12.69	289.34
8	19	12	12.00	187	13.72	12.66	12.71	354.91
8	19	13	11.77	172	13.48	12.66	12.71	203.27
8	19	14	11.58	166	13.58	12.66	12.71	160.65
8	19	15	11.92	188	13.31	12.65	12.70	165.66
8	19	16	11.52	186	12.97	12.64	12.68	97.54
8	19	17	10.99	189	13.09	12.64	12.68	104.91
8	19	18	10.82	196	13.19	12.65	12.70	99.59
8	19	19	10.18	187	13.27	12.66	12.71	54.92
8	19	20	10.22	182	13.28	12.66	12.70	18.44
8	19	21	11.48	174	12.71	12.65	12.68	0.00
8	19	22	12.02	191	12.73	12.64	12.68	0.00

MN	DY (GMT)	HR	U (M/S)	DIR (DEG)	TA (C)	TS1 (C)	TS2 (C)	R (W/M**2)
8	19	23	11.41	206	12.86	12.62	12.67	0.00
8	20	0	10.51	211	12.91	12.61	12.66	0.00
8	20	1	10.95	218	12.76	12.62	12.66	0.00
8	20	2	11.16	229	13.08	12.64	12.68	0.00
8	20	3	10.25	204	13.02	12.64	12.67	0.00
8	20	4	10.23	199	13.01	12.64	12.66	0.00
8	20	5	9.91	200	12.96	12.64	12.66	1.16
8	20	6	9.18	195	12.90	12.64	12.66	40.16
8	20	7	9.41	195	12.90	12.64	12.66	51.23
8	20	8	9.89	171	13.04	12.64	12.66	140.57
8	20	9	10.46	205	12.38	12.64	12.66	47.95
8	20	10	9.56	185	12.20	12.64	12.66	145.49
8	20	11	10.39	186	12.64	12.64	12.66	172.54
8	20	12	11.28	174	12.23	12.64	12.66	169.14
8	20	13	12.53	168	11.93	12.64	12.66	152.04
8	20	14	14.80	154	12.48	12.64	12.66	130.73
8	20	15	15.41	207	12.77	12.64	12.67	373.35
8	20	16	14.38	244	11.95	12.62	12.66	257.37
8	20	17	13.36	233	12.05	12.60	12.64	311.06
8	20	18	13.06	244	12.58	12.59	12.62	248.76
8	20	19	12.69	224	12.58	12.56	12.61	106.05
8	20	20	13.29	233	12.54	12.55	12.59	18.85
8	20	21	13.06	239	12.54	12.54	12.59	0.00
8	20	22	12.95	222	12.53	12.54	12.58	0.00
8	20	23	12.84	233	12.56	12.52	12.57	0.00
8	21	0	12.45	237	12.43	12.52	12.56	0.00
8	21	1	13.43	234	12.32	12.50	12.54	0.00
8	21	2	12.72	228	12.34	12.47	12.51	0.00
8	21	3	12.26	245	12.39	12.45	12.50	0.00
8	21	4	11.56	241	12.51	12.44	12.47	0.00
8	21	5	11.31	249	12.40	12.44	12.47	0.41
8	21	6	10.63	245	12.21	12.43	12.47	20.08
8	21	7	10.03	234	12.37	12.42	12.47	49.18
8	21	8	11.09	240	12.26	12.43	12.47	169.26
8	21	9	10.74	241	12.17	12.44	12.47	238.81
8	21	10	8.46	237	11.21	12.42	12.47	118.44
8	21	11	10.46	234	12.18	12.42	12.47	239.34
8	21	12	10.05	235	12.52	12.42	12.46	428.69
8	21	13	9.78	244	11.56	12.40	12.43	204.91
8	21	14	9.91	250	12.39	12.36	12.40	317.61
8	21	15	9.35	236	12.50	12.31	12.34	386.05
8	21	16	9.73	253	12.34	12.30	12.33	263.97
8	21	17	8.93	227	12.44	12.33	12.33	168.03
8	21	18	8.78	253	12.56	12.34	12.33	106.14
8	21	19	9.24	260	12.55	12.32	12.33	42.21
8	21	20	9.38	261	12.51	12.32	12.33	11.48
8	21	21	9.45	251	12.50	12.35	12.35	0.00
8	21	22	9.30	250	12.40	12.37	12.38	0.00

MN	DY (GMT)	HR	U (M/S)	DIR (DEG)	TA (C)	TS1 (C)	TS2 (C)	R (W/M**2)
8	21	23	10.03	272	12.11	12.36	12.38	0.00
8	22	0	9.77	261	12.13	12.33	12.33	0.00
8	22	1	9.21	261	11.98	12.30	12.33	0.00
8	22	2	9.81	268	11.92	12.23	12.24	0.00
8	22	3	9.55	283	11.74	12.05	12.08	0.00
8	22	4	8.96	294	11.71	12.03	12.06	0.00
8	22	5	8.45	297	11.61	12.01	12.04	0.41
8	22	6	8.67	283	11.89	12.02	12.05	22.84
8	22	7	8.06	287	11.96	12.05	12.07	24.18
8	22	8	7.89	282	12.31	12.06	12.09	77.46
8	22	9	8.19	279	12.55	12.06	12.09	119.67
8	22	10	8.08	277	12.68	12.07	12.09	200.40
8	22	11	8.29	291	12.64	12.06	12.09	198.76
8	22	12	8.36	292	12.62	12.05	12.07	250.81
8	22	13	7.96	283	12.57	11.97	12.00	258.55
8	22	14	8.48	276	12.32	11.95	11.97	193.44
8	22	15	8.23	281	12.04	12.09	12.11	166.80
8	22	16	8.07	279	12.04	12.20	12.22	195.08
8	22	17	7.69	289	11.95	12.27	12.30	160.24
8	22	18	8.26	292	11.86	12.30	12.33	67.62
8	22	19	7.99	294	11.98	12.32	12.35	30.74
8	22	20	7.69	281	12.01	12.35	12.38	7.35
8	22	21	7.15	286	12.16	12.35	12.38	0.00
8	22	22	8.07	279	12.08	12.35	12.38	0.00
8	22	23	8.28	276	12.21	12.32	12.35	0.00
8	23	0	8.76	277	12.15	12.31	12.33	0.00
8	23	1	9.22	272	12.32	12.30	12.33	0.00
8	23	2	9.19	269	12.40	12.29	12.32	0.00
8	23	3	8.88	273	12.29	12.27	12.30	0.00
8	23	4	8.08	257	12.28	12.25	12.28	0.00
8	23	5	8.78	265	12.36	12.21	12.23	0.41
8	23	6	9.02	265	12.35	12.18	12.21	7.38
8	23	7	9.49	262	12.16	12.09	12.11	33.61
8	23	8	8.98	257	12.08	12.00	12.03	50.41
8	23	9	8.37	241	12.05	12.06	12.09	100.00
8	23	10	8.27	232	12.41	12.06	12.09	104.12
8	23	11	9.99	266	12.17	12.12	12.14	158.60
8	23	12	9.34	258	12.23	12.17	12.19	405.73
8	23	13	9.12	253	12.08	12.17	12.19	269.25
8	23	14	9.13	266	12.40	12.16	12.18	427.04
8	23	15	8.98	255	12.17	12.08	12.09	345.07
8	23	16	9.10	248	12.59	12.04	12.06	369.25
8	23	17	9.36	255	12.25	12.00	12.02	109.54
8	23	18	9.78	257	12.05	11.98	12.00	89.75
8	23	19	9.19	267	11.91	11.98	12.00	38.11
8	23	20	8.94	252	12.45	11.98	12.00	7.79
8	23	21	9.44	256	12.51	11.98	12.00	0.00
8	23	22	9.32	255	11.90	11.98	12.00	0.00

MN	DY (GMT)	HR	U (M/S)	DIR (DEG)	TA (C)	TS1 (C)	TS2 (C)	R (W/M**2)
8	23	23	9.42	256	12.30	11.98	12.00	0.00
8	24	0	9.70	262	12.40	11.98	12.00	0.00
8	24	1	9.43	263	12.52	11.98	12.00	0.00
8	24	2	9.80	269	12.42	11.98	12.00	0.00
8	24	3	10.24	269	12.37	12.01	12.00	0.00
8	24	4	10.02	265	12.27	12.03	12.01	0.00
8	24	5	10.35	270	12.10	12.04	12.00	0.00
8	24	6	9.99	285	12.00	12.06	12.00	8.61
8	24	7	9.29	276	12.08	12.08	12.02	29.80
8	24	8	9.24	267	12.20	12.11	12.02	68.85
8	24	9	9.02	252	12.45	12.13	12.03	213.93
8	24	10	9.06	263	12.43	12.19	12.04	181.55
8	24	11	8.96	265	12.58	12.21	12.05	305.32
8	24	12	9.61	265	12.73	12.25	12.07	495.89
8	24	13	9.81	265	12.79	0.00	12.09	473.76
8	24	14	9.51	270	12.82	0.00	12.12	410.28
8	24	15	8.75	290	12.83	0.00	12.15	368.84
8	24	16	8.06	290	12.95	0.00	12.19	406.95
8	24	17	8.12	293	13.00	0.00	12.23	334.42
8	24	18	8.14	302	12.79	0.00	12.28	177.45
8	24	19	6.91	311	12.61	0.00	12.26	98.36
8	24	20	6.52	295	12.37	0.00	12.29	14.34
8	24	21	6.26	307	12.28	0.00	12.31	0.00
8	24	22	5.75	308	12.23	0.00	12.31	0.00
8	24	23	5.64	282	12.18	0.00	12.31	0.00
8	25	0	5.40	279	12.12	0.00	12.31	0.00
8	25	1	5.56	284	12.13	0.00	12.28	0.00
8	25	2	5.68	300	12.07	0.00	12.28	0.00
8	25	3	5.91	288	12.09	0.00	12.28	0.00
8	25	4	6.19	285	12.12	0.00	12.28	0.00
8	25	5	6.68	288	12.13	0.00	12.27	0.00
8	25	6	6.31	293	12.12	0.00	12.25	21.72
8	25	7	5.94	288	12.31	0.00	12.22	119.67
8	25	8	5.88	303	12.41	0.00	12.23	222.12
8	25	9	5.15	288	12.49	0.00	12.25	281.14
8	25	10	4.96	279	12.45	0.00	12.28	250.81
8	25	11	4.83	274	12.63	0.00	12.32	356.48
8	25	12	4.84	286	12.83	0.00	12.39	472.12
8	25	13	5.48	282	12.76	0.00	12.43	487.69
8	25	14	5.45	301	12.69	0.00	12.48	388.10
8	25	15	5.26	282	12.72	0.00	12.48	371.30
8	25	16	5.05	294	12.67	0.00	12.51	279.09
8	25	17	4.16	300	12.61	0.00	12.54	161.88
8	25	18	3.96	277	12.51	0.00	12.55	90.96
8	25	19	3.76	270	12.51	0.00	12.45	38.11
8	25	20	3.39	266	12.49	0.00	12.48	5.33
8	25	21	3.68	259	12.48	0.00	12.51	0.00
8	25	22	4.35	253	12.43	0.00	12.50	0.00

MN	DY (GMT)	HR	U (M/S)	DIR (DEG)	TA (C)	TS1 (C)	TS2 (C)	R (W/M**2)
8	25	23	3.66	268	12.40	0.00	12.49	0.00
8	26	0	4.37	255	12.39	0.00	12.47	0.00
8	26	1	4.69	266	12.37	0.00	12.46	0.00
8	26	2	4.44	259	12.39	0.00	12.45	0.00
8	26	3	5.05	257	12.43	0.00	12.45	0.00
8	26	4	5.53	259	12.44	0.00	12.43	0.00
8	26	5	5.15	275	12.42	0.00	12.37	0.00
8	26	6	4.52	275	12.43	0.00	12.33	6.56
8	26	7	3.91	278	12.43	0.00	12.35	36.06
8	26	8	3.77	280	12.40	0.00	12.29	61.93
8	26	9	3.58	270	12.40	0.00	12.39	101.23
8	26	10	3.79	277	12.37	0.00	12.36	125.41
8	26	11	4.46	282	12.35	0.00	12.41	153.27
8	26	12	3.99	287	12.64	0.00	12.49	282.37
8	26	13	3.74	281	12.83	0.00	12.58	269.66
8	26	14	4.98	296	12.77	0.00	12.51	278.27
8	26	15	6.03	324	12.54	0.00	12.58	325.90
8	26	16	3.98	303	12.80	0.00	12.55	225.81
8	26	17	3.89	282	12.83	0.00	12.58	159.01
8	26	18	3.82	290	12.69	0.00	12.61	80.33
8	26	19	2.78	312	12.70	0.00	12.60	42.21
8	26	20	3.01	316	12.25	0.00	12.58	5.33
8	26	21	2.28	308	12.10	0.00	12.63	0.41
8	26	22	2.82	293	12.14	0.00	12.67	0.00
8	26	23	3.78	268	11.74	0.00	12.62	0.00
8	27	0	4.88	256	12.02	0.00	12.52	0.00
8	27	1	4.99	267	12.10	0.00	12.45	0.00
8	27	2	5.76	272	12.07	0.00	12.47	0.00
8	27	3	6.25	265	12.11	0.00	12.50	0.00
8	27	4	6.12	273	12.12	0.00	12.48	0.00
8	27	5	5.55	283	12.23	0.00	12.51	0.77
8	27	6	5.72	278	12.23	0.00	12.61	7.38
8	27	7	5.44	291	12.35	0.00	12.58	41.80
8	27	8	5.20	322	12.19	0.00	12.49	88.52
8	27	9	4.15	321	11.90	0.00	12.51	131.14
8	27	10	2.70	324	12.07	0.00	12.62	236.88
8	27	11	2.28	326	12.84	0.00	12.66	368.43
8	27	12	3.14	297	12.91	0.00	12.78	230.69
8	27	13	3.28	288	12.86	0.00	12.87	237.70
8	27	14	2.66	293	12.99	0.00	12.90	194.26
8	27	15	4.44	281	12.94	0.00	12.88	214.34
8	27	16	4.47	276	12.81	0.00	12.86	142.21
8	27	17	3.11	280	12.82	0.00	12.80	124.18
8	27	18	3.17	288	12.58	0.00	12.81	74.18
8	27	19	3.84	300	12.33	0.00	12.88	22.84
8	27	20	3.90	298	12.26	0.00	12.94	4.10
8	27	21	4.19	280	12.16	0.00	12.91	0.41
8	27	22	4.74	270	12.21	0.00	12.92	0.00

MN	DY (GMT)	HR	U (M/S)	DIR (DEG)	TA (C)	TS1 (C)	TS2 (C)	R (W/M**2)
8	27	23	5.45	267	12.49	0.00	12.91	0.00
8	28	0	5.26	254	12.50	0.00	12.90	0.00
8	28	1	5.97	268	12.51	0.00	12.90	0.00
8	28	2	5.87	262	12.57	0.00	12.88	0.00
8	28	3	6.00	259	12.53	0.00	12.85	0.00
8	28	4	6.49	265	12.46	0.00	12.82	0.00
8	28	5	6.37	281	12.37	0.00	12.80	0.00
8	28	6	6.02	286	12.71	0.00	12.80	5.33
8	28	7	6.18	277	12.83	0.00	12.79	34.43
8	28	8	6.82	285	12.89	0.00	12.76	63.93
8	28	9	7.02	274	12.88	0.00	12.74	93.28
8	28	10	7.68	278	12.98	0.00	12.74	137.70
8	28	11	7.98	271	12.91	0.00	12.71	90.98
8	28	12	7.65	283	12.79	0.00	12.71	68.44
8	28	13	7.01	278	13.16	0.00	12.77	262.29
8	28	14	7.39	276	13.14	0.00	12.78	167.62
8	28	15	7.58	275	13.22	0.00	12.80	248.76
8	28	16	7.45	284	13.19	0.00	12.81	154.82
8	28	17	7.51	284	13.14	0.00	12.80	74.59
8	28	18	7.34	267	12.98	0.00	12.78	22.95
8	28	19	6.78	281	12.56	0.00	12.75	7.79
8	28	20	6.51	284	12.65	0.00	12.74	1.23
8	28	21	6.66	273	12.67	0.00	12.70	0.41
8	28	22	6.87	294	12.65	0.00	12.68	0.00
8	28	23	6.64	302	12.56	0.00	12.66	0.00
8	29	0	6.34	308	12.57	0.00	12.66	0.00
8	29	1	6.51	308	12.56	0.00	12.66	0.00
8	29	2	6.88	308	12.51	0.00	12.63	0.00
8	29	3	6.17	312	12.62	0.00	12.60	0.00
8	29	4	6.18	321	12.67	0.00	12.60	0.00
8	29	5	5.42	321	12.64	0.00	12.60	0.00
8	29	6	5.07	319	12.64	0.00	12.61	3.87
8	29	7	5.12	312	12.57	0.00	12.59	7.79
8	29	8	2.66	339	12.17	0.00	12.58	15.16
8	29	9	3.21	6	11.94	0.00	12.56	35.65
8	29	10	2.54	347	11.98	0.00	12.54	100.82
8	29	11	2.22	344	12.25	0.00	12.60	95.49
8	29	12	2.01	352	12.59	0.00	12.68	147.95
8	29	13	3.71	37	12.52	0.00	12.72	199.72
8	29	14	4.05	36	12.29	0.00	12.69	201.63
8	29	15	4.16	31	12.21	0.00	12.69	177.86
8	29	16	3.44	45	12.00	0.00	12.72	133.19
8	29	17	2.85	59	12.03	0.00	12.73	102.05
8	29	18	2.67	54	11.99	0.00	12.71	59.01
8	29	19	1.59	27	12.03	0.00	12.70	18.03
8	29	20	2.36	49	12.03	0.00	12.70	2.32
8	29	21	4.57	84	11.74	0.00	12.71	0.41
8	29	22	3.58	93	11.64	0.00	12.69	0.00

MN	DY (GMT)	HR	U (M/S)	DIR (DEG)	TA (C)	TS1 (C)	TS2 (C)	R (W/M**2)
8	29	23	3.25	90	11.63	0.00	12.68	0.00
8	30	0	3.14	101	11.63	0.00	12.67	0.00
8	30	1	3.25	116	11.67	0.00	12.65	0.00
8	30	2	3.78	127	11.80	0.00	12.64	0.00
8	30	3	3.98	152	11.87	0.00	12.62	0.00
8	30	4	4.33	168	11.85	0.00	12.61	0.00
8	30	5	3.86	185	12.01	0.00	12.63	0.00
8	30	6	3.79	192	12.16	0.00	12.64	0.82
8	30	7	3.96	220	12.44	0.00	12.65	36.47
8	30	8	3.49	210	12.63	0.00	12.64	69.26
8	30	9	3.65	227	12.88	0.00	12.63	82.37
8	30	10	4.30	232	13.00	0.00	12.62	139.34
8	30	11	5.56	250	13.57	0.00	12.66	103.58
8	30	12	6.21	250	13.70	0.00	12.66	105.56
8	30	13	5.52	247	13.66	0.00	12.66	98.73
8	30	14	6.10	237	13.82	0.00	12.68	145.49
8	30	15	6.54	253	13.96	0.00	12.68	154.50
8	30	16	7.63	256	14.02	0.00	12.70	70.90
8	30	17	7.76	257	14.00	0.00	12.70	49.17
8	30	18	7.98	246	13.92	0.00	12.68	28.28
8	30	19	8.24	247	13.76	0.00	12.68	11.88
8	30	20	8.69	251	13.11	0.00	12.70	0.00
8	30	21	8.95	251	13.11	0.00	12.66	0.41
8	30	22	9.11	255	13.10	0.00	12.64	0.41
8	30	23	8.95	254	13.17	0.00	12.61	0.41
8	31	0	8.59	268	13.25	0.00	12.63	0.40
8	31	1	7.74	302	13.21	0.00	12.65	0.20
8	31	2	7.90	330	12.90	0.00	12.63	0.41
8	31	3	9.12	331	12.24	0.00	12.63	0.40
8	31	4	9.06	342	12.37	0.00	12.63	0.61
8	31	5	9.16	344	12.61	0.00	12.61	1.43
8	31	6	9.07	337	12.39	0.00	12.61	5.33
8	31	7	8.29	337	12.17	0.00	12.59	21.70
8	31	8	8.66	313	12.35	0.00	12.59	45.49
8	31	9	8.35	317	12.49	0.00	12.59	105.73
8	31	10	8.32	322	12.80	0.00	12.59	175.17
8	31	11	8.69	318	12.67	0.00	12.59	171.10
8	31	12	8.52	315	12.73	0.00	12.59	220.49
8	31	13	8.68	299	12.98	0.00	12.61	298.97
8	31	14	8.76	313	12.93	0.00	12.61	211.60
8	31	15	8.66	323	12.89	0.00	12.61	200.81
8	31	16	9.03	325	12.96	0.00	12.59	153.89
8	31	17	7.94	317	12.87	0.00	12.58	88.38
8	31	18	8.18	326	12.77	0.00	12.57	78.48
8	31	19	8.03	321	12.64	0.00	12.57	18.65
8	31	20	7.72	315	12.51	0.00	12.56	2.25
8	31	21	8.07	330	12.43	0.00	12.54	1.00
8	31	22	7.35	317	12.45	0.00	12.53	0.20

MN	DY (GMT)	HR	U (M/S)	DIR (DEG)	TA (C)	TS1 (C)	TS2 (C)	R (W/M**2)
8	31	23	6.71	315	12.41	0.00	12.52	0.41
9	1	0	6.40	310	12.34	0.00	12.54	0.20
9	1	1	6.17	318	12.46	0.00	12.54	0.41
9	1	2	6.45	299	12.59	0.00	12.56	0.20
9	1	3	7.75	300	12.61	0.00	12.57	0.20
9	1	4	7.33	291	12.77	0.00	12.56	0.80
9	1	5	7.09	292	12.75	0.00	12.54	0.20
9	1	6	7.40	309	12.86	0.00	12.54	6.15
9	1	7	7.79	317	12.81	0.00	12.53	41.01
9	1	8	7.56	309	12.88	0.00	12.50	105.12
9	1	9	7.33	296	12.90	0.00	12.50	180.12
9	1	10	7.63	305	12.79	0.00	12.51	188.31
9	1	11	7.68	304	12.78	0.00	12.55	306.35
9	1	12	7.13	295	12.79	0.00	12.57	299.79
9	1	13	7.20	280	12.78	0.00	12.57	276.43
9	1	14	7.46	291	12.87	0.00	12.58	324.07
9	1	15	6.75	293	13.01	0.00	12.61	389.74
9	1	16	6.19	271	13.22	0.00	12.63	347.74
9	1	17	6.09	296	13.19	0.00	12.66	258.60
9	1	18	5.31	283	12.79	0.00	12.64	71.86
9	1	19	5.48	277	12.65	0.00	12.64	25.61
9	1	20	5.62	260	12.61	0.00	12.63	0.61
9	1	21	5.38	267	12.73	0.00	12.61	0.60
9	1	22	5.64	258	12.91	0.00	12.61	0.41
9	1	23	5.60	256	12.88	0.00	12.61	0.20
9	2	0	6.09	262	13.01	0.00	12.63	0.41
9	2	1	6.13	251	12.69	0.00	12.64	0.20
9	2	2	6.07	276	12.90	0.00	12.64	0.41
9	2	3	5.09	284	13.06	0.00	12.61	0.41
9	2	4	5.17	294	13.09	0.00	12.61	0.20
9	2	5	4.72	285	13.14	0.00	12.61	0.20
9	2	6	5.05	280	13.11	0.00	12.61	0.20
9	2	7	5.02	288	13.12	0.00	12.61	19.47
9	2	8	5.39	288	13.14	0.00	12.61	75.64
9	2	9	5.05	292	13.16	0.00	12.59	87.29
9	2	10	4.68	300	13.18	0.00	12.59	117.82
9	2	11	4.11	289	13.22	0.00	12.60	145.71
9	2	12	3.97	291	13.20	0.00	12.61	137.09
9	2	13	3.34	295	13.30	0.00	12.63	151.02
9	2	14	2.34	311	13.41	0.00	12.67	180.73
9	2	15	2.28	267	13.49	0.00	12.72	197.66
9	2	16	2.21	269	13.56	0.00	12.78	176.43
9	2	17	1.40	236	13.55	0.00	12.80	106.76
9	2	18	2.16	218	13.22	0.00	12.83	54.54
9	2	19	1.81	185	13.18	0.00	12.85	20.29
9	2	20	2.84	186	13.12	0.00	12.79	1.02
9	2	21	3.38	178	13.18	0.00	12.74	0.41
9	2	22	4.01	181	13.06	0.00	12.74	0.40

MN	DY (GMT)	HR	U (M/S)	DIR (DEG)	TA (C)	TS1 (C)	TS2 (C)	R (W/M**2)
9	2	23	4.41	170	13.06	0.00	12.70	0.61
9	3	0	4.92	162	13.02	0.00	12.65	0.41
9	3	1	5.27	165	12.60	0.00	12.65	0.20
9	3	2	5.96	148	12.44	0.00	12.66	0.41
9	3	3	6.40	142	12.67	0.00	12.65	0.20
9	3	4	5.05	193	13.28	0.00	12.64	0.41
9	3	5	6.04	223	13.45	0.00	12.64	0.60
9	3	6	6.21	233	13.46	0.00	12.64	2.66
9	3	7	5.59	239	13.40	0.00	12.64	27.66
9	3	8	4.69	241	13.35	0.00	12.64	90.37
9	3	9	4.19	264	13.27	0.00	12.66	91.19
9	3	10	3.62	274	12.94	0.00	12.70	214.95
9	3	11	3.47	291	12.75	0.00	12.75	249.17
9	3	12	3.45	295	13.04	0.00	12.79	254.79
9	3	13	2.26	311	13.80	0.00	12.84	375.60
9	3	14	2.19	279	14.13	0.00	12.87	388.51
9	3	15	1.09	235	14.55	0.00	12.95	233.30
9	3	16	0.85	30	14.47	0.00	12.87	160.86
9	3	17	1.86	136	13.96	0.00	12.98	102.46
9	3	18	1.85	117	13.74	0.00	13.11	54.51
9	3	19	2.01	128	13.58	0.00	13.24	18.91
9	3	20	2.84	118	13.42	0.00	13.17	1.23
9	3	21	2.98	124	13.36	0.00	13.02	0.20
9	3	22	3.31	127	13.36	0.00	12.97	0.00
9	3	23	3.79	118	13.04	0.00	12.90	0.61
9	4	0	3.51	107	12.97	0.00	13.01	1.02
9	4	1	4.60	112	12.88	0.00	12.84	0.41
9	4	2	4.67	120	12.65	0.00	12.81	0.40
9	4	3	4.55	117	13.04	0.00	12.78	0.00
9	4	4	4.45	120	13.25	0.00	12.74	0.20
9	4	5	4.01	130	13.41	0.00	12.71	0.40
9	4	6	4.81	136	13.53	0.00	12.77	4.51
9	4	7	5.53	139	13.55	0.00	12.69	30.94
9	4	8	6.35	137	13.63	0.00	12.79	79.71
9	4	9	6.82	134	14.00	0.00	12.92	295.00
9	4	10	7.60	129	13.95	0.00	12.91	271.71
9	4	11	7.61	119	14.02	0.00	12.91	435.85
9	4	12	7.81	125	14.06	0.00	12.91	450.07
9	4	13	8.13	118	14.04	0.00	12.87	367.41
9	4	14	8.43	114	13.95	0.00	12.81	367.61
9	4	15	8.87	110	13.83	0.00	12.72	376.83
9	4	16	9.61	111	13.61	0.00	12.77	273.31
9	4	17	10.17	103	13.39	0.00	12.77	188.31
9	4	18	10.31	101	13.22	0.00	12.75	128.68
9	4	19	10.84	103	13.13	0.00	12.74	34.04
9	4	20	11.30	108	13.17	0.00	12.75	0.82
9	4	21	11.71	100	13.45	0.00	12.83	0.00
9	4	22	12.17	111	13.50	0.00	12.83	0.20

MN	DY (GMT)	HR	U (M/S)	DIR (DEG)	TA (C)	TS1 (C)	TS2 (C)	R (W/M**2)
9	4	23	11.95	111	13.40	0.00	12.77	0.20
9	5	0	11.33	113	13.46	0.00	12.72	0.00
9	5	1	11.30	93	13.45	0.00	12.70	0.00
9	5	2	11.42	112	13.32	0.00	12.65	0.40
9	5	3	11.38	92	13.19	0.00	12.64	0.41
9	5	4	12.13	99	13.14	0.00	12.61	0.41
9	5	5	12.41	94	13.09	0.00	12.61	0.20
9	5	6	12.11	96	13.11	0.00	12.61	0.20
9	5	7	12.14	99	13.14	0.00	12.64	5.94
9	5	8	12.19	106	13.00	0.00	12.67	12.29
9	5	9	11.54	95	12.72	0.00	12.66	17.32
9	5	10	11.72	92	12.48	0.00	12.66	32.79
9	5	11	12.03	93	12.28	0.00	12.64	41.80
9	5	12	11.76	89	12.06	0.00	12.61	54.51
9	5	13	11.28	102	12.23	0.00	12.58	46.38
9	5	14	10.89	106	12.17	0.00	12.53	51.43
9	5	15	10.51	96	11.95	0.00	12.53	22.95
9	5	16	10.22	95	11.87	0.00	12.54	13.73
9	5	17	10.05	92	11.65	0.00	12.57	6.76
9	5	18	10.03	86	11.70	0.00	12.57	0.82
9	5	19	11.01	87	11.72	0.00	12.58	0.41
9	5	20	10.85	91	11.70	0.00	12.60	0.00
9	5	21	11.00	90	11.81	0.00	12.59	0.20
9	5	22	10.52	96	11.69	0.00	12.58	0.41
9	5	23	9.90	101	11.63	0.00	12.56	0.40
9	6	0	8.78	97	12.06	0.00	12.53	0.41
9	6	1	8.06	99	12.22	0.00	12.52	0.00
9	6	2	8.17	89	12.48	0.00	12.52	0.41
9	6	3	7.56	84	12.33	0.00	12.52	0.40
9	6	4	7.60	85	12.24	0.00	12.52	0.00
9	6	5	8.36	80	12.53	0.00	12.54	0.20
9	6	6	8.29	69	12.63	0.00	12.54	0.20
9	6	7	8.26	78	12.76	0.00	12.54	6.15