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ABSTRACT

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Some Wind Characteristics
of Kahe Point, O'ahu and Vicinity

A THESIS SUBMITTED TO THE GRADUATE DIVISION OF THE
UNIVERSITY OF HAWAII IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE

IN METEOROLOGY

AUGUST 1988

By

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We certify that we have read this thesis and that, in our opinion, it is satisfactory in scope and quality as a thesis for the degree of Master of Science in Meteorology.

THESIS COMMITTEE

Chairman

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Local winds are observed in the form of sea-breeze and drainage-wind systems. Some aspects of these systems have been analyzed over a three-month period. Drainage is best developed during episodes of light ambient winds and clear skies and easily yields to synoptic winds. Sea-breeze circulation interaction with prevailing winds is found to be in good agreement with earlier numerical results of Estoque (1962). Hodographs display clockwise rotation about fifty-percent of the time while anti-clockwise rotation is observed one-tenth of the time.

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LIST OF ABBREVIATIONS

ACR	Anti-clockwise rotation
AGL	Above ground level
Bkn	Broken
CR	Clockwise rotation
Feb	February
Freq	Frequency
GLW	Gradient-level wind
HECO	Hawaiian Electric Company
HST	Hawaiian standard time
ISO	Isothermal
Jan	January
Mar	March
Mn Std Dev	*Mean Standard Deviation*
NWSFO	National Weather Service Forecast Office
Sct	Scattered

1. Introduction

As the population of O'ahu increased steadily during the 1970s, so did the demand for electrical power and the concern for a healthy environment. In an effort to meet these needs, the Hawaiian Electric Company (HECO) designed, implemented, and maintained an automated air-quality monitoring network consisting of 10 sites located in the vicinity of its generating plant near Kahe Point, O'ahu. The utility operated the network over a four-year period during which data were collected for an average of 16 months per site.

The data set made available by HECO included hourly values of wind, temperature, standard deviation of wind direction, and precipitation (not used in this study). Instrumentation satisfied Environmental Protection Agency requirements in effect at the time. Data were sampled every six minutes and averaged for each hour. Winds from one of the sites, 120, were sampled at 10 m and 45 m AGL while winds at remaining sites were sampled only at 10 m AGL. Figure 1 shows the locations of the sites - note that Kahe Point is the terminus of the ridge which extends southwestward approximately 1 km south of site 120. The data sampling density and the complex topography presented an opportunity to further understand the wind and forces affecting it over this part of the island.

This paper describes general wind characteristics over the southern flank of the Wai'anae mountain range from Makakilo to Nānākuli, and local wind circulations, such as the sea-breeze and drainage-wind systems.

2. Climatology

I define long-term as the length of record during which all available data were collected per site. Table 1 gives data periods and number of hourly wind observations at each site. Sampling periods varied considerably ranging from 9 months to 2 years. Only as many as seven sites overlapped during most of 1982 and early 1983. Although not exact, I did not consider this detrimental to computing and comparing general wind characteristics discussed in this section.

Windroses presented here were compiled in the following manner. Directions are given using the 16-point compass and speed in 1 ms^{-1} classes; e.g., 0.0 - 0.9 ms^{-1} are defined as calm, 1.0 - 1.9 ms^{-1} are defined as 1 ms^{-1}, et cetera, to 15.9 ms^{-1}. Speeds greater than 15.9 ms^{-1} were included in the 15 ms^{-1} class.

All values, except the total number of observations per direction class, are expressed in percent. Direction frequencies were computed by dividing the total number of observations per direction less the number of calms for the direction by the number of observations greater than or equal to 1 ms^{-1}; calm frequencies were computed by dividing the number of calms by the total number of observations. Speed frequencies for calm is the fraction of observations from the given direction with a speed of less than 1 ms^{-1}. Speed frequency classes 1 through 15

ms^{-1} were computed after removing all calms from the given direction. Therefore, summing columns 1-15 will total 100% plus or minus any rounding error.

Typical for Hawaii, tradewinds dominate at all sites with winds from the northeast through east prevailing 60-70% of the time. Winds from SW through NW account for approximately 10-20% of the total while winds from within a few degrees either side of northerly and southerly directions are typically less than 15% of the total. These frequencies compare well with long-term windroses of other O'ahu locations with good tradewind exposure, such as Barbers Point Naval Air Station and Honolulu International Airport.[1] The wind speed mode is near 3-4 ms^{-1} for all sites combined.

Further wind characteristics are revealed from an analysis of hourly resultant mean winds, mean wind speeds, and derived quantities of standard deviation of wind speed, referred to here as sigma, and steadiness, defined as the ratio of the resultant mean wind speed to the mean wind speed. These quantities are shown in Table 3. Resultant mean winds for several hours are depicted in Figure 2.

1) Data for Barbers Point Naval Air Station taken from Summary of Meteorological Observations, Surface, prepared by the Naval Weather Service Detachment, Federal Building, Asheville, North Carolina. Data for Honolulu International Airport taken from Revised Uniform Summary of Surface Weather Observations prepared by the Data Processing Branch, USAFETAC, Air Weather Service (MAC), Federal Building, Asheville, North Carolina.

Mean nighttime winds are unidirectional from the tradewind quadrant. Daytime winds tend toward a more easterly direction, though still trades. Sites 121 and 122 show the greatest departure from the "average" flow.

The response of the resultant mean wind at sites 121 and 122 is probably due to their proximity to the heated terrain slope and the ocean. Closer to the heated slope, site 122 is subject to a localized temperature gradient earlier in the day than site 121. As the day progresses maximum terrain heating changes from southwestward-facing slopes located to the east of site 122 to the westward-facing slopes east of site 120 and along the highway north of site 122, however, site 120 does not respond to this heating pattern. It may be that locally generated winds do not penetrate often enough across the highway to affect the mean wind at the site.

Steadiness for all sites is high, generally over 80%, and nearly constant during the night. It declines shortly after sunrise to a minimum near 1400 HST and then gradually increases to its nighttime maximum shortly after sunset. Since a mean sea-breeze circulation is not observed over the long-term, decreased daytime steadiness results from convective mixing and occasional onshore flow.

Sites 121 and 122 are most influenced by the heating cycle as their steadiness falls to near 10% between 1200-

1400 HST. Steadiness at sites 126 and 129 falls only to 60% between 1200-1600 HST suggesting that sites nearer to shore and closer to sea level experience disruptions of the trades more frequently than locations further from shore and higher in elevation. This occurs over about 2 km with respect to site 126.

Mean wind speeds at low elevation sites (120, 121, 122, 123, 128, and 129) have an early afternoon (near 1400 HST) maximum and a pre-dawn (near 0500 HST) minimum with a difference of 1-2 ms^{-1}. Speeds at higher elevation sites (124, 125, 126, and 127) have a maximum around 0900 HST and another maximum around 2100 HST; minima occur near 0500 and 1700 HST. Differences between maxima and minima here are less than 1 ms^{-1}.

Nighttime wind-speed minima at low elevation sites are the result of a stable layer due to surface cooling. As the day progresses mean wind speeds increase as convection transports low-momentum wind upward and high-momentum wind downward resulting in a singular peak by early afternoon. Mean wind-speeds at higher elevation sites display profiles similar to some identified by Ramage, et al., (1977). In that study, sites at about 600 m, in particular, Kolekole Pass (600 m) located on the Wai'anae range, were said to be located in a transition layer which separated low-elevation sites having an afternoon wind speed maximum from high-elevation sites having an afternoon wind speed minimum, such as Mauna Kapu (820 m) also located on the Wai'anae range. Apparently, sites 124 (230 m), 125 (310 m), 126 (510 m), and 127 (380 m) are located in a transition layer since they do not display a singular well-defined afternoon speed maximum or minimum. Thus, the base of the transition layer is near 200 m and the top is near 700 m.

Divergence calculated over the network from hourly resultant mean winds using the method of least squares (Table 4) shows that, on the average, divergence (convergence) is closely associated with the daily cooling (heating) cycle.

3. Drainage Flow

In his theoretical treatment of nocturnal drainage winds, Fleagle (1947) assumed a uniform slope of large extent. Some observational studies, such as Schroeder (1981), Bowen, et al., (1981), and Horst and Doran (1981), are of areas where the slope is "uniform" and have a sufficiently "large extent" to make such studies inherently more straightforward than the current study where the slope is neither uniform nor of large extent. The data network was not designed primarily to monitor drainage flow. Solar radiation, multilevel wind and temperature profiles, and dewpoint were unavailable.

The network was situated on the southern flank of the Wai'anae mountain range - a northwest-southeast ridge remnant of a heavily eroded shield volcano. The slope's shape is broadly convex to the south and east, while Nānākuli and Lualualei valleys cut deeply into its western flank. The summit, Pu'umanawahua, dominating the southward-facing incline, rises to approximately 730 m about 5 km from the ocean towards its southwest while the broad 'Ewa plain lies about 5 km south and southeast. The average slope between a NNE-SSW line including sites 123, 124, 125, and 126 and a line from the summit to site 129 is approximately 12 percent.

Table 5 lists elevations, directions of steepest incline, and slopes for seven sites. These sites were chosen because the period January-March 1983 provided maximum data overlap with site 120 providing wind and temperature profiles of the drainage flow at 45 m AGL. Climatologically, this period coincided with the peak intensity of the 1982-83 El Nino event determined from the southern oscillation index. Mean height anomalies at 700 mb for December 1982 - February 1983 show a well-developed subtropical high centered in the west Pacific at 20^{o} N but extending into the east Pacific with its associated ridge passing to the south of Hawai'i at about 18^{o} N (Quiroz, 1983). As a result, the three-month period is best described as synoptically stagnant.

The problem was to differentiate between drainage and tradewind regimes. As can be seen from Table 5, directions for drainage flow at sites 120, 126, and 127 coincide with tradewind directions. To a lesser degree, this is true also at sites 123, 124, and 125. Site 129 provided the optimum drainage flow direction in relation to the tradewinds.

Schroeder (1981) concludes that the degree to which drainage flow interacts with prevailing winds is determined by the orientation of the slope. On leeward slopes, drainage develops unaffected by prevailing winds while slopes aligned perpendicular to prevailing winds typically display weak to virtually non-existent drainage flow. Indeed, these observations are from well-developed drainage systems on the island of Hawai'i where thermal properties of lava soils along some transects used in the study are highly conducive to cooling of the adjacent layer of air. Typical transect lengths were on the order of 10 km.

By way of contrast, Horst and Doran (1981) describe drainage flow in the Geysers Geothermal Area of Northern California on the southeast slope of Cobb Mountain, an area where surrounding topography is described as a broad, bowl-shaped valley having vegetation of pine trees and brush. Slope length at Cobb Mountain is approximately 3 km. Although they could not determine a clear relationship between ambient wind direction and drainage flow development due to a paucity of data, they state two factors that can suppress drainage flow are insufficient cooling of the slope, and too strong ambient winds. They also found that during many hours with a large temperature gradient from 5 m AGL to the top of the inversion layer and no drainage, there were strong or increasing ambient winds.

Due to similarities of ground cover and slope length at Cobb Mountain and the Kahe vicinity, and a preliminary inspection of a number of nighttime wind plots, criteria were established similar to Horst and Doran's (1981) under which drainage may or may not occur in order to differentiate between drainage and tradewind flow. To meet the cooling condition stated above, scattered skies were assumed to be necessary for radiational cooling for drainage. To meet the ambient wind condition stated above, I assumed gradient level wind (GLW) speeds 2.5 ms^{-1} or less were necessary to not disturb the katabatic layer. Atkinson (1971) defines the gradient level as the lowest level at which predominantly friction-free flow occurs which is generally regarded to be approximately 1 km over most of the tropics.

Two sets of nighttime data were used: 1) nights with GLWs of 2.5 ms^{-1} or less, and 2) nights with a tradewind component (NNE through ENE) GLW of 5 ms^{-1} or greater. A cloudiness index was then assigned to each night by averaging three total sky coverage synoptic observations: 0600 GMT (2000 HST), 1200 GMT (0200 HST), and 1800 GMT (0800 HST). Clear to scattered skies were defined as having an index of 0.3 or less - broken skies for an index larger than 0.3. Both GLW and total sky coverage data were for Honolulu airport (approximately 18 km ESE of Kahe Point), and manually extracted from Honolulu NWSFO synoptic plotting charts - GLW vectors were plotted to the nearest 10 degrees and 5 knots and total sky cloudiness was used for the cloudiness index.

Results listed in Table 6 show that for GLWs $\leq$ 2.5 ms^{-1} and scattered skies (Table 6a), observed winds were more northerly at every site, except site 120, than observed winds on nights with trade-component GLWs $\geq$ 5.0 ms^{-1} and scattered skies (Table 6b). Since winds from a more northerly direction follow topography, I conclude that I have isolated drainage flow from tradewind flow.

Easterly flow at site 120 may be attributed to the fact that it is located not on a slope proper, but in a very small westward-facing valley with an amphitheater-like shape. On nights with light GLW speeds and scattered-sky conditions, speeds at site 120 are 1-3 ms^{-1}; currents light enough to be funneled into a valley-wind regime by the time they arrive at the site. I propose that easterly flow at the site is caused by funneling.

To better detect if observed winds were influenced by the gradient level flow, nights with trade-component GLWs $\leq$ 2.5 ms^{-1} were compared against nights with GLWs 2.5 ms^{-1} or less. Of 18 nights with GLWs $\leq$ 2.5 ms^{-1}, five had a trade direction. Of these, two had scattered sky conditions.

General observations pertaining to trade-component GLW 2.5 ms^{-1} or less include: 1) mean wind speeds were generally higher during cloudy nights than during clear nights, 2) wind speeds at higher elevations (sites 124, 125, 126, and 127) differed appreciably from speeds at lower elevations. For example, nearly 73% of the observations at site 124 on clear nights ranged from 1-3 ms^{-1} while on cloudy nights speeds in this range dropped to 28% while almost 73% ranged from 3-7 ms^{-1}. Also, wind directions were clustered slightly tighter together on cloudy nights - of course, this goes hand-in-hand with the observed higher wind speeds.

There is good agreement of observed winds with GLWs 2.5 ms^{-1} or less (Table 6a) and trade-component GLWs 2.5 ms^{-1} or less (Table 6c). Therefore, if GLW speeds are weak and skies clear, GLW direction does not influence the katabatic layer.

The question still remains of explaining observed winds during cloudy nights. Observed winds are in excellent agreement regardless of sky conditions during nights with GLWs 5 ms^{-1} or greater (Table 6b). However, Tables 6a and 6c show that with weak GLWs, surface winds tend to be stronger and from a more easterly direction when skies are cloudy. Table 7a lists maximum observed hourly temperature differences, T, between the 45 m and 10 m levels at site 120 for several nights. Positive values of T indicate a ground inversion due to radiational cooling. Using T as an index of atmospheric stability, cloudy nights with small T implies convective mixing is less inhibited. Table 7 shows this occurred more frequently than cloudy nights with large T. Because convection transports horizontal momentum from level to level, this explains higher surface wind speeds on cloudy nights. Winds from more easterly directions is probably the result of ambient wind parcels being mixed downward into the katabatic flow.

Attempts to identify drainage flow on nights with non-trade-direction GLWs $\geq$ 5 ms^{-1} failed. Therefore, it is unlikely that drainage occurs at all during episodes of strong GLWs from any direction.

4. Sea Breeze

Leopold (1948) discussed sea-breeze circulation along the western side of O'ahu. Paraphrasing - "under circumstances where day-to-day synoptic changes are subtle and difficult to follow, the study of diurnal fluctuations may contribute to a better understanding of how great differences of climate are observed over very short distances." Later in the paper he states that "it appears that sea-valley and land-mountain winds affect the wind direction over most of the western third of O'ahu. Complete reversal of wind direction occurs only on the protected lee coast which lies downwind of both the two (Ko'olau and Wai'anae) mountain ranges. A nocturnal land-mountain wind prevails both at Waipahu and Waialua."

In a wind study for the island of O'ahu, Ramage, et al., (1977) state "over most of the island the diurnal variation of turbulent mixing overpowers the land breeze-sea breeze cycle. Only leeward of the Wai'anaes is the cycle weakly manifested. Nevertheless, when the trades fail to exceed 5 mi hr^{-1} or when winds from other directions prevail, a well-defined land breeze-sea breeze cycle may develop with wind directions changing through 360^{o}".

This section describes the sea breeze over the southern flank of the Wai'anaes following the diurnal variation approach suggested by Leopold (1948). Long-term hourly resultant mean winds do not reveal the existence of a sea-breeze circulation (page 5). As a baseline, the period January-March 1983 was used for reasons stated earlier (pages 8-9). Hourly resultant mean winds and other related quantities were computed as before.

Results for the period are completely different from those of the long-term and show that a diurnal land breeze-sea breeze cycle was the controlling mechanism. Table 8 shows flow is westerly at all sites during the daytime turning north-northeasterly at night. Except for several hours at sites 125 and 129, steadiness at any site never exceeded 60% throughout the day. Minimum steadiness (near 10%) occurred earliest at site 120 (closest to the west shore) at 0900 HST, then at 1000-1100 HST at sites 123, 124, 125, and 127. Minimum steadiness occurred latest for the highest site (126) at 1100 HST and the furthest site from the west shore (129) at 1200 HST. Subsequent to the progression of the late-morning minimum, steadiness increased slightly in the early-afternoon then decreased to a second minimum in late-afternoon to early-evening as it "backed" its way out, first at site 129 at 1600 HST, followed an hour later at intermediate sites, and lastly at site 120 as late as 2000 HST. Steadiness at all sites then increased to a nocturnal maximum of 50-60% around 2200-2300 HST.

These results are interpreted as the advance of a mean sea-breeze front which shows up first near the shore, moves further inland and upslope, and eventually extends eastward of site 129. Using a two-dimensional numerical model, Estoque (1962) showed that strongest vertical motions associated with the sea-breeze front occur with no geostrophic wind (case 1), with offshore geostrophic wind (case 2), and with geostrophic wind parallel to the coastline with low pressure at sea (case 3). Weakest vertical motions occur with onshore geostrophic flow (case 4) and with geostrophic flow parallel to the coastline with low pressure over land (case 5). Over the Kahe network, minimum steadiness in the morning resulted as the mean position of the sea-breeze front advances eastward against the prevailing synoptic flow - the nighttime flow from the NNE. This is Estoque's case 2. Later in the day onshore, westerly flow is diverted clockwise by the Coriolis effect (Haurwitz, 1947) to more-or-less northerly flow, case 5. This is evident from the Figure 3 sequence of hourly resultant mean winds and from hodographs of the resultant mean wind (Figure 4). As a result, steadiness is not as adversely affected as it is earlier in the day because passage of the retreating "front" westward is not a prominent feature in the wind field.

Wind hodographs reflect local thermal forcing (Alpert, et al., 1984). Kusuda and Alpert (1983) showed that anti-clockwise rotation (ACR) results from thermal forcing in the x and y directions of a horizontal plane and that ACR is a balance between several forces: the mesoscale pressure gradient term, the horizontal and vertical advection terms, and the friction term. ACR also depends on the phase angle between the forces in the x-y plane and the rotation of the large-scale pressure gradient. In the absence of large-scale pressure gradient rotation, scale analysis shows that the important terms for ACR are the mesoscale pressure gradient term and the friction term. In the northern hemisphere, these forces counterbalance clockwise rotation (CR) due to the Coriolis force to produce a large range of hodograph traces.

Hodographs for several days during the period were analyzed to determine if local forcing was present. Days with GLWs of 2.5 ms^{-1} or less from midnight to midnight were used. Six days met this criterion: 16 Jan, 22-25 Feb, and 1 Mar. Overall, except for 22 Feb, evolution of the sea breeze on these days compared very well with that of the mean sea-breeze circulation.

Hodographs for 16 Jan (not shown) show light nocturnal winds characteristic of drainage flow described earlier (pages 11-12). From about 0800 HST to 1900 HST all sites show a westerly component with clockwise rotation (CR) of the wind vector end point. Hodographs for 22 Feb show drainage flow until about 0800. Again, westerly flow dominates after 0800, but with ACR of the end point until about 1900 HST (Figure 5). Hodographs for 23-25 Feb are similar to 16 Jan while hodographs for 1 Mar are slightly more complex but still exhibit clockwise rotation.

ACR on 22 Feb was the result of synoptic pressure gradient rotation. Analysis of NWSFO surface charts show a weak ridge over the islands oriented almost parallel with the island chain early in the day. As the day progressed, a weak high-pressure cell developed about 600 km NW of Kaua'i and eventually evolved into an ENE-WSW oriented ridge axis passing over Kaua'i. The reorientation of the ridge axis occurred in an anti-clockwise sense and, therefore, explains the observed ACR.

Since hodographs of hourly resultant mean winds for the period show CR, this is conclusive evidence that ACR produced by mesoscale thermal forcing, frictional effects, and synoptic pressure gradient rotation is overcome by the effect of the Coriolis force.

As a check, daily hodographs for each site were plotted over the period to determine if CR and ACR were peculiar to various synoptic wind directions (Tables 9 and 10). CR occurred half the time, ACR occurred 10% of the time, and random traces 40% of the time. This explains why CR shows up in the mean although it is nearly as likely to occur as not for any synoptic condition (Table 10).

It can be shown by assuming a balance of the inertial and Coriolis accelerations, the size of a circulation system at a given latitude may be estimated from observed wind speeds (Atkinson, 1981). For the Coriolis force to affect the wind field, the size of the disturbance must exceed a characteristic length scale determined by the observed wind speed. From Table 8, a representative wind speed during the early afternoon is 4 ms^{-1}, implying that the size of the disturbance at latitude 21.5^{o} N is on the order of 60 km, or roughly, about the size of O'ahu. CR hodographs of resultant mean winds for the period seem to imply that the Coriolis force may be an important consideration in the evolution of the mean wind field, however, through scaling and CR frequency of occurrence, the Coriolis effect on the sea breeze at Kahe Point is only of secondary importance.

5. Summary

Hourly wind data from a network of ten automated sites located on the southern flank of the Wai'anae mountain range, O'ahu, Hawai'i, were analyzed to describe wind characteristics, such as long-term windroses, diurnal variation of resultant mean winds, steadiness, and mean wind speeds. Over the long-term, winds were bimodal. Tradewinds dominate but occasionally yield during the day as evidenced by decreased steadiness. Long-term resultant mean winds did not reveal a mean sea-breeze circulation, therefore, decreased daytime steadiness is probably due to convective mixing interspersed with episodes of weak trades which would allow development of onshore flow for a few hours in the afternoon - a situation observed on several occasions. Diurnal variation of wind speeds at low-elevation sites show a singular pre-dawn minimum and an early-afternoon maximum due to momentum mixing. Wind speeds from higher-elevation sites indicate a transition layer where high-momentum wind from above about 700 m is mixed with low-momentum wind from below about 200 m. Divergence of long-term resultant mean winds occurs at night while convergence occurs during the day.

Drainage flow occurred during periods of very light synoptic winds and was easily overwhelmed by strengthening synoptic winds. Drainage was governed by topography only on clear nights with weak GLW speeds. With increased cloudiness, drainage was influenced by GLWs. With the slope at Kahe aligned nearly perpendicular to prevailing winds, interaction of synoptic winds with drainage flow seemed consistent with an earlier discussion by Schroeder (1981), however, further comparison is difficult as overall topography and vegetation is markedly different for the earlier study. Also consistent with a discussion by Horst and Doran (1981), a ground-based inversion did not ensure drainage if synoptic winds were above 5 ms^{-1}.

Over a three-month synoptically stagnant period, a diurnal sea breeze-land breeze cycle was shown to be the mean circulation. Comparison of several days with light synoptic winds verified that the evolution of the observed sea breeze on these days resembled that of the mean sea-breeze circulation. Interaction between the mean sea-breeze and prevailing flow was in good agreement with earlier numerical results of Estoque (1962). Clockwise rotation of the resultant mean wind vector's end point on hodographs suggests that the Coriolis force dominated over other forces which could work to counteract it, however, only about half the time. Clockwise rotation was observed for every synoptic wind direction.

APPENDIX I: TABLES 1-10

Table 1. Data availability for the sites

Site	Period	# Obs
120	Jan 83 - Mar 84	10765
121	Dec 80 - Nov 81, Sep 83 - Sep 84	18125
122	Dec 80 - Nov 81	8776
123	Jan 82 - Apr 83	17706
124	Mar 82 - Apr 83	8575
125	Jan 82 - Mar 84	18643
126	Mar 82 - Mar 84	16905
127	Mar 82 - Apr 83	8545
128	Mar 82 - Dec 82	5630
129	Mar 82 - Mar 84	17529

Table 2a. Long-term Windrose for Site 120

Dir	%	Speed: Calm	1	2	3	4	5	6	7
Calm	6.6	-	-	-	-	-	-	-	-
N	0.5	50.0	67.3	17.3	9.6	5.8	-	-	-
NNE	1.0	28.2	40.2	25.5	4.9	-	1.0	1.0	3.9
NE	8.0	5.0	13.4	21.8	19.3	14.3	12.9	8.8	6.5
ENE	45.4	1.9	5.8	18.4	20.6	23.1	17.2	8.8	3.7
E	14.4	7.6	45.6	29.8	12.4	8.6	3.4	0.2	-
ESE	3.3	23.3	71.8	25.2	2.7	0.3	-	-	-
SE	2.1	22.9	60.5	31.6	7.0	0.5	0.5	-	-
SSE	0.6	33.0	45.8	39.0	15.3	-	-	-	-
S	0.9	15.2	30.5	31.6	26.3	10.5	1.1	-	-
SSW	1.9	9.4	14.0	28.5	36.8	19.2	1.6	-	-
SW	1.4	7.1	22.9	62.5	12.5	2.1	-	-	-
WSW	2.5	8.8	25.7	47.8	14.9	6.4	3.2	2.0	-
W	6.2	3.3	14.4	44.7	21.0	11.9	4.4	2.7	0.8
WNW	6.1	4.5	14.6	36.3	28.5	11.7	5.7	2.4	0.6
NW	4.2	5.6	17.9	32.9	29.0	8.3	5.7	4.8	1.4
NNW	1.4	14.7	44.8	41.4	11.7	1.4	0.7	-	-

Dir	Speed: 8	9	10	11	12	13	14	15	#Obs
Calm	-	-	-	-	-	-	-	-	706
N	-	-	-	-	-	-	-	-	104
NNE	10.8	3.9	2.0	5.9	1.0	-	-	-	142
NE	2.4	0.8	0.1	-	-	-	-	-	842
ENE	1.6	0.5	0.2	-	-	-	-	-	4652
E	-	-	-	-	-	-	-	-	1569
ESE	-	-	-	-	-	-	-	-	434
SE	-	-	-	-	-	-	-	-	279
SSE	-	-	-	-	-	-	-	-	88
S	-	-	-	-	-	-	-	-	112
SSW	-	-	-	-	-	-	-	-	213
SW	-	-	-	-	-	-	-	-	155
WSW	-	-	-	-	-	-	-	-	273
W	0.2	-	-	-	-	-	-	-	641
WNW	0.2	-	-	-	-	-	-	-	646
NW	-	-	-	-	-	-	-	-	445
NNW	-	-	-	-	-	-	-	-	170

Number of obs $\geq$ 1 ms^{-1} = 10059. All values in percent, except total observations per direction, #Obs, dimensionless, and speed, meters per second.

Table 2b. Long-term Windrose for Site 121

		Speed							
Dir	%	Calm	1	2	3	4	5	6	7
Calm	9.6	-	-	-	-	-	-	-	-
N	3.7	20.6	63.1	25.9	9.7	1.2	-	0.2	-
NNE	6.8	15.6	42.6	41.0	10.5	2.9	2.1	0.8	0.1
NE	13.9	10.4	27.1	41.9	24.3	4.9	1.4	0.3	0.2
ENE	25.4	5.9	11.9	37.9	41.4	7.8	1.0	-	-
E	12.9	8.2	17.3	37.6	35.1	8.5	1.3	0.2	-
ESE	6.8	9.1	25.9	30.5	28.0	12.9	2.5	0.1	-
SE	3.1	11.0	27.6	31.7	18.4	15.9	5.7	0.6	0.2
SSE	1.5	13.7	23.2	20.3	24.8	22.0	8.5	1.2	-
S	1.9	9.4	12.6	17.7	30.0	30.6	8.2	0.9	-
SSW	2.3	5.6	12.7	30.5	29.4	14.3	8.4	3.8	0.8
SW	2.1	7.7	18.9	39.8	20.6	9.5	5.2	2.6	1.1
WSW	3.2	8.4	22.8	41.2	15.9	10.0	5.9	3.1	0.8
W	3.2	8.1	21.3	35.8	17.9	12.6	6.6	2.8	1.9
WNW	4.4	6.7	13.7	28.4	26.8	15.6	8.9	2.6	1.8
NW	5.5	10.5	16.3	20.4	15.9	20.1	13.0	5.2	3.8
NNW	3.2	19.1	45.7	26.1	14.1	8.0	3.8	0.8	0.8

	Speed								
Dir	8	9	10	11	12	13	14	15	#Obs
Calm	-	-	-	-	-	-	-	-	1749
N	-	-	-	-	-	-	-	-	754
NNE	-	-	-	-	-	-	-	-	1326
NE	-	-	-	-	-	-	-	-	2538
ENE	-	-	-	-	-	-	-	-	4420
E	-	-	-	-	-	-	-	-	2299
ESE	-	-	-	-	-	-	-	-	1225
SE	-	-	-	-	-	-	-	-	574
SSE	-	-	-	-	-	-	-	-	285
S	-	-	-	-	-	-	-	-	350
SSW	0.3	-	-	-	-	-	-	-	393
SW	2.0	0.3	-	-	-	-	-	-	378
WSW	0.4	-	-	-	-	-	-	-	570
W	0.8	0.2	-	-	-	-	-	-	577
WNW	1.4	0.7	0.1	-	-	-	-	-	775
NW	2.9	1.8	0.4	0.1	0.1	-	-	-	1012
NNW	-	0.6	0.2	-	-	-	-	-	649

Number of obs $\geq$ 1 ms^{-1} = 16376. All values in percent, except total observations per direction, #Obs, dimensionless, and speed, meters per second.

Table 2c. Long-term Windrose for Site 122

Dir	%	Speed Calm	1	2	3	4	5	6	7
Calm	7.1	-	-	-	-	-	-	-	-
N	2.8	28.6	51.7	39.1	7.0	0.4	1.7	-	-
NNE	5.0	18.8	39.2	34.3	15.3	4.1	3.2	3.4	0.2
NE	16.0	6.6	25.5	43.8	19.1	6.0	2.5	0.9	1.1
ENE	21.7	2.5	13.3	20.9	20.7	19.8	13.2	6.9	3.2
E	19.6	2.6	11.2	16.6	21.6	31.1	14.5	4.0	0.8
ESE	6.4	5.2	16.8	15.8	22.3	24.4	14.3	5.1	1.1
SE	1.8	10.0	25.7	11.8	16.0	33.3	13.2	-	-
SSE	1.6	10.1	15.8	12.0	15.0	30.8	21.1	4.5	0.8
S	2.4	2.5	8.8	15.0	19.7	22.3	15.5	9.8	7.3
SSW	2.2	6.2	11.6	40.9	26.5	11.6	5.0	0.6	2.8
SW	2.3	7.8	24.7	42.1	20.5	6.8	4.2	1.1	0.5
WSW	2.8	7.7	24.6	39.5	18.4	6.1	4.4	4.8	1.8
W	4.5	9.2	18.8	29.4	24.5	11.2	8.7	3.5	1.6
WNW	5.2	8.6	16.5	23.8	20.0	14.9	11.6	2.8	3.1
NW	3.3	10.3	22.3	28.3	20.8	12.6	6.3	4.1	3.3
NNW	2.3	16.7	39.7	37.6	18.5	4.2	-	-	-

Dir	Speed 8	9	10	11	12	13	14	15	#Obs
Calm	-	-	-	-	-	-	-	-	625
N	-	-	-	-	-	-	-	-	322
NNE	0.2	-	-	-	-	-	-	-	506
NE	0.8	0.3	-	-	-	-	-	-	1394
ENE	1.0	0.7	0.2	0.1	-	-	-	-	1814
E	0.2	0.2	-	-	-	-	-	-	1639
ESE	0.2	-	-	-	-	-	-	-	554
SE	-	-	-	-	-	-	-	-	160
SSE	-	-	-	-	-	-	-	-	148
S	1.0	0.5	-	-	-	-	-	-	198
SSW	1.1	-	-	-	-	-	-	-	193
SW	-	-	-	-	-	-	-	-	206
WSW	0.4	-	-	-	-	-	-	-	247
W	1.1	0.8	-	-	-	-	-	-	404
WNW	2.8	1.9	1.2	1.2	0.2	-	-	-	464
NW	2.2	-	-	-	-	-	-	-	300
NNW	-	-	-	-	-	-	-	-	227

Number of obs $\geq$ 1 ms^{-1} = 8151. All values in percent, except total observations per direction, #Obs, dimensionless, and speed, meters per second.

Table 2d. Long-term Windrose for Site 123

Dir	%	Speed Calm	1	2	3	4	5	6	7
Calm	6.2	-	-	-	-	-	-	-	-
N	1.2	30.4	79.9	16.7	2.9	0.5	-	-	-
NNE	3.5	19.2	54.3	34.2	9.4	1.9	0.2	-	-
NE	10.6	10.6	37.8	33.3	16.1	7.0	2.9	1.7	1.2
ENE	33.0	2.8	12.6	24.5	26.3	22.2	9.9	3.5	0.9
E	26.6	2.6	10.4	19.7	24.0	24.1	14.5	6.0	1.2
ESE	4.3	10.1	23.3	19.4	24.6	22.3	7.9	1.6	0.6
SE	2.3	9.3	19.8	17.8	24.0	20.4	11.6	3.4	1.8
SSE	1.1	15.2	24.7	15.7	26.4	23.6	6.2	1.1	1.1
S	0.9	12.0	21.8	33.3	23.1	17.0	3.4	-	0.7
SSW	1.4	7.5	16.7	39.5	33.5	9.9	0.4	-	-
SW	1.5	7.5	19.4	47.0	25.5	5.3	1.6	0.8	0.4
WSW	1.8	10.7	19.1	47.1	17.1	7.8	4.4	2.4	1.4
W	3.7	3.7	11.3	36.2	23.7	11.1	9.5	4.2	3.4
WNW	4.2	2.8	11.6	24.3	32.9	17.5	6.5	3.9	2.6
NW	3.0	6.9	16.1	26.0	23.8	15.5	7.5	3.8	5.6
NNW	1.0	26.2	46.8	35.8	9.5	5.1	1.9	-	1.3

Dir	Speed 8	9	10	11	12	13	14	15	#Obs
Calm	-	-	-	-	-	-	-	-	1095
N	-	-	-	-	-	-	-	-	293
NNE	-	-	-	-	-	-	-	-	713
NE	-	-	-	-	-	-	-	-	1975
ENE	0.1	-	-	-	-	-	-	-	5639
E	-	-	-	-	-	-	-	-	4540
ESE	0.3	-	-	-	-	-	-	-	786
SE	-	-	0.3	1.0	-	-	-	-	428
SSE	-	-	-	1.1	-	-	-	-	210
S	-	-	0.7	-	-	-	-	-	167
SSW	-	-	-	-	-	-	-	-	252
SW	-	-	-	-	-	-	-	-	267
WSW	-	0.3	-	0.3	-	-	-	-	328
W	0.5	0.2	-	-	-	-	-	-	645
WNW	0.3	0.3	0.1	-	-	-	-	-	716
NW	1.6	-	-	-	-	-	-	-	533
NNW	-	-	-	-	-	-	-	-	214

Number of obs $\geq$ 1 ms^{-1} = 16611. All values in percent, except total observations per direction, #Obs, dimensionless, and speed, meters per second.

Table 2e. Long-term Windrose for Site 124

		Speed							
Dir	%	Calm	1	2	3	4	5	6	7
Calm	2.6	-	-	-	-	-	-	-	-
N	2.1	8.7	40.4	38.2	13.5	6.7	0.6	0.6	-
NNE	3.1	8.5	14.7	26.4	27.9	20.9	6.6	1.9	0.8
NE	10.8	2.3	5.4	7.1	15.2	20.1	15.9	13.1	8.3
ENE	41.0	0.5	1.5	2.0	5.6	12.4	17.5	20.3	16.1
E	18.1	0.8	3.4	4.5	5.9	11.8	21.7	21.5	15.2
ESE	2.9	2.4	16.5	13.6	15.7	21.1	16.5	11.2	1.2
SE	1.6	6.3	11.2	6.0	15.7	26.1	19.4	13.4	3.7
SSE	0.7	12.7	25.5	21.8	18.2	23.6	3.6	1.8	3.6
S	0.5	24.5	27.5	35.0	10.0	15.0	12.5	-	-
SSW	0.7	10.9	31.6	40.4	22.8	5.3	-	-	-
SW	1.1	11.9	28.1	33.3	29.2	8.3	1.0	-	-
WSW	2.2	6.5	13.4	24.7	22.6	15.1	10.8	4.3	5.4
W	6.5	1.8	7.6	12.0	16.6	17.3	14.6	10.3	6.6
WNW	4.5	4.5	8.2	11.9	14.3	16.4	17.7	11.4	7.7
NW	2.1	10.1	20.7	15.1	19.0	21.2	11.2	7.8	2.2
NNW	2.0	8.6	41.8	38.2	13.5	3.5	2.4	-	0.6

	Speed								
Dir	8	9	10	11	12	13	14	15	#Obs
Calm	-	-	-	-	-	-	-	-	224
N	-	-	-	-	-	-	-	-	195
NNE	0.4	0.4	-	-	-	-	-	-	282
NE	7.1	4.4	1.3	0.7	0.2	0.6	0.2	0.2	921
ENE	12.0	7.8	3.3	0.8	0.5	0.1	-	-	3438
E	9.4	4.6	1.4	0.5	0.1	-	-	-	1527
ESE	0.8	0.8	0.4	0.8	0.4	0.4	0.4	-	248
SE	2.2	2.2	-	-	-	-	-	-	143
SSE	1.8	-	-	-	-	-	-	-	63
S	-	-	-	-	-	-	-	-	53
SSW	-	-	-	-	-	-	-	-	64
SW	-	-	-	-	-	-	-	-	109
WSW	3.2	-	0.5	-	-	-	-	-	199
W	2.4	4.1	3.3	2.0	1.1	1.1	0.9	-	552
WNW	4.0	5.0	1.9	1.6	-	-	-	-	396
NW	1.7	1.1	-	-	-	-	-	-	199
NNW	-	-	-	-	-	-	-	-	186

Number of obs $\geq$ 1 ms^{-1} = 8351. All values in percent, except total observations per direction, #Obs, dimensionless, and speed, meters per second.

Table 2f. Long-term Windrose for Site 125

		Speed							
Dir	%	Calm	1	2	3	4	5	6	7
Calm	1.8	-	-	-	-	-	-	-	-
N	2.7	4.3	44.9	34.8	13.0	5.9	1.4	-	-
NNE	6.2	2.6	14.2	15.6	15.5	19.6	13.3	9.3	6.1
NE	35.0	0.4	1.6	2.0	3.5	8.6	15.0	17.1	16.7
ENE	29.3	0.5	1.9	2.1	3.8	6.6	12.3	19.2	19.0
E	4.6	2.0	7.4	9.8	11.2	17.4	17.3	13.3	11.0
ESE	1.6	3.9	11.2	15.0	19.4	22.8	15.3	8.5	4.1
SE	1.3	7.4	9.7	21.1	13.5	22.4	18.6	9.3	3.0
SSE	1.1	9.8	16.1	14.0	21.2	22.3	14.5	7.3	2.6
S	0.9	6.5	18.2	22.0	17.0	22.6	11.3	5.0	3.1
SSW	1.6	6.6	21.4	22.1	18.9	15.1	10.5	6.7	3.2
SW	3.9	3.8	8.2	20.9	25.7	15.3	10.9	7.1	6.1
WSW	3.6	2.4	7.1	16.6	36.3	25.8	7.4	4.1	2.4
W	3.2	2.2	7.6	12.4	23.3	22.9	14.1	9.1	5.5
WNW	1.8	4.8	9.6	18.3	17.7	22.8	16.8	8.7	3.6
NW	1.9	8.2	13.8	16.4	21.6	21.3	14.1	6.1	4.6
NNW	1.5	9.2	27.3	28.4	31.3	8.3	2.9	0.7	1.1

	Speed								
Dir	8	9	10	11	12	13	14	15	#Obs
Calm	-	-	-	-	-	-	-	-	340
N	-	-	-	-	-	-	-	-	514
NNE	3.4	1.9	0.6	0.4	-	0.1	-	0.1	1169
NE	13.1	9.8	6.2	3.5	1.4	0.7	0.4	0.4	6433
ENE	15.2	10.2	5.8	2.8	0.8	0.2	0.1	0.1	5382
E	7.6	3.7	1.0	0.2	-	-	-	-	850
ESE	1.0	1.7	1.0	-	-	-	-	-	306
SE	0.8	-	0.4	0.4	0.4	0.4	-	-	256
SSE	0.5	0.5	-	-	-	-	-	-	214
S	0.6	-	-	-	-	-	-	-	170
SSW	1.1	1.1	-	-	-	-	-	-	305
SW	3.2	0.8	0.4	-	0.4	0.1	0.7	0.1	736
WSW	0.3	0.2	-	-	-	-	-	-	680
W	3.8	1.2	-	-	-	-	-	-	593
WNW	2.4	0.3	-	-	-	-	-	-	351
NW	1.4	0.6	-	-	-	-	-	-	378
NNW	-	-	-	-	-	-	-	-	306

Number of obs $\geq$ 1 ms^{-1} = 18303. All values in percent, except total observations per direction, #Obs, dimensionless, and speed, meters per second.

Table 2g. Long-term Windrose for Site 126

Dir	%	Speed Calm	1	2	3	4	5	6	7
Calm	2.4	-	-	-	-	-	-	-	-
N	1.6	14.0	61.3	31.0	6.6	1.1	-	-	-
NNE	2.8	6.0	32.6	34.5	20.0	7.2	3.2	0.6	1.3
NE	21.2	1.0	3.4	9.1	18.4	20.0	20.0	13.7	7.4
ENE	48.3	0.4	1.1	1.9	5.6	12.0	20.6	22.9	18.8
E	6.9	2.8	4.4	8.3	12.1	21.9	22.7	14.5	8.2
ESE	1.4	4.8	9.7	23.2	16.0	25.7	13.5	7.2	1.3
SE	1.1	7.9	13.8	19.0	20.1	17.8	19.5	5.7	1.7
SSE	0.8	11.6	22.3	14.6	22.3	23.1	12.3	3.8	-
S	1.1	9.8	20.7	27.6	16.7	13.2	11.5	4.0	3.4
SSW	1.4	8.9	26.0	35.7	18.7	11.5	4.3	3.0	0.4
SW	1.5	2.3	19.6	39.6	23.6	12.0	4.4	0.4	0.4
WSW	2.3	3.8	14.6	27.3	28.6	13.8	7.6	4.9	2.3
W	3.3	5.3	10.7	26.6	22.4	16.6	10.4	7.6	3.3
WNW	2.4	5.7	14.2	26.9	23.6	23.9	7.1	3.6	0.8
NW	2.2	8.2	25.8	36.8	24.4	8.7	3.4	0.6	0.3
NNW	1.7	13.8	41.2	40.5	16.8	1.5	-	-	-

Dir	Speed 8	9	10	11	12	13	14	15	#Obs
Calm	-	-	-	-	-	-	-	-	412
N	-	-	-	-	-	-	-	-	315
NNE	0.4	-	-	-	-	-	-	-	499
NE	3.7	2.4	1.2	0.5	0.1	-	-	-	3524
ENE	10.1	4.9	1.5	0.4	0.1	-	-	-	8005
E	5.8	1.5	0.4	0.2	-	-	-	-	1176
ESE	1.7	-	0.4	1.3	-	-	-	-	249
SE	-	0.6	0.6	-	0.6	0.6	-	-	189
SSE	1.5	-	-	-	-	-	-	-	147
S	2.9	-	-	-	-	-	-	-	193
SSW	0.4	-	-	-	-	-	-	-	258
SW	-	-	-	-	-	-	-	-	256
WSW	0.5	-	-	-	-	-	-	-	399
W	1.8	0.6	-	-	-	-	-	-	571
WNW	-	-	-	-	-	-	-	-	418
NW	-	-	-	-	-	-	-	-	388
NNW	-	-	-	-	-	-	-	-	318

Number of obs $\geq$ 1 ms^{-1} = 16493. All values in percent, except total observations per direction, #Obs, dimensionless, and speed, meters per second.

Table 2h. Long-term Windrose for Site 127

		Speed							
Dir	%	Calm	1	2	3	4	5	6	7
Calm	7.8	-	-	-	-	-	-	-	-
N	4.2	15.2	44.3	36.5	12.6	4.8	1.5	0.3	-
NNE	4.2	16.0	42.7	24.8	17.0	9.1	3.6	0.9	0.3
NE	7.2	8.5	25.4	30.3	18.7	9.8	5.6	4.7	2.5
ENE	25.9	2.2	5.6	9.9	13.9	12.7	13.2	11.7	11.1
E	27.9	1.8	2.9	5.2	9.7	13.7	15.2	15.8	13.8
ESE	4.5	7.6	18.6	17.7	15.2	17.7	12.4	8.2	3.9
SE	2.7	13.4	16.8	9.3	12.1	15.9	15.9	9.3	7.5
SSE	1.0	26.6	20.0	18.8	13.8	12.5	6.3	8.8	13.8
S	2.4	15.0	19.8	18.7	28.3	16.0	6.4	4.3	5.3
SSW	2.3	10.8	26.9	36.3	22.0	10.4	3.3	1.1	-
SW	3.2	12.7	21.7	23.6	27.2	13.0	3.5	6.7	2.8
WSW	1.9	18.9	28.8	41.8	19.2	7.5	2.1	0.7	-
W	2.7	14.7	23.4	26.2	25.7	10.7	5.1	5.6	2.8
WNW	3.7	10.2	16.6	20.4	28.0	18.0	10.0	1.7	3.1
NW	2.9	17.2	25.7	20.4	15.5	14.2	8.8	6.6	2.7
NNW	3.3	20.4	38.9	29.0	15.6	8.0	4.6	3.8	-

	Speed								
Dir	8	9	10	11	12	13	14	15	#Obs
Calm	-	-	-	-	-	-	-	-	664
N	-	-	-	-	-	-	-	-	394
NNE	1.2	-	0.3	-	-	-	-	-	393
NE	1.1	1.2	0.5	-	0.2	-	-	-	624
ENE	9.0	7.4	4.1	1.0	0.4	-	-	-	2084
E	11.0	7.1	3.7	1.3	0.5	-	-	-	2240
ESE	4.5	1.4	-	0.3	-	-	-	-	384
SE	2.3	4.2	1.4	0.9	1.4	-	0.5	2.3	247
SSE	-	3.8	1.3	1.3	-	-	-	-	109
S	1.1	-	-	-	-	-	-	-	220
SSW	-	-	-	-	-	-	-	-	204
SW	1.6	-	-	-	-	-	-	-	291
WSW	-	-	-	-	-	-	-	-	180
W	0.5	-	-	-	-	-	-	-	251
WNW	2.1	-	-	-	-	-	-	-	322
NW	5.3	0.9	-	-	-	-	-	-	273
NNW	-	-	-	-	-	-	-	-	329

Number of obs $\geq$ 1 ms^{-1} = 7881. All values in percent, except total observations per direction, #Obs, dimensionless, and speed, meters per second.

Table 2i. Long-term Windrose for Site 128

		Speed							
Dir	%	Calm	1	2	3	4	5	6	7
Calm	14.4	-	-	-	-	-	-	-	-
N	7.5	22.2	80.1	19.9	-	-	-	-	-
NNE	15.9	11.9	45.9	40.3	12.4	1.0	0.1	0.1	-
NE	29.3	7.7	23.8	32.9	30.4	9.9	2.2	0.6	-
ENE	20.9	9.8	32.7	21.2	19.5	18.2	6.9	1.5	-
E	3.8	23.9	27.6	30.8	20.5	14.1	4.9	2.2	-
ESE	0.9	39.1	57.1	33.3	9.5	-	-	-	-
SE	1.3	19.2	28.6	30.2	31.7	9.5	-	-	-
SSE	1.4	17.3	16.4	26.9	31.3	19.4	4.5	-	1.5
S	1.3	21.7	20.0	29.2	41.5	7.7	1.5	-	-
SSW	1.5	12.0	49.3	46.6	4.1	-	-	-	-
SW	1.7	20.0	88.1	11.9	-	-	-	-	-
WSW	1.8	16.8	88.8	11.2	-	-	-	-	-
W	4.2	14.8	52.5	46.0	1.5	-	-	-	-
WNW	3.1	18.9	30.7	56.0	13.3	-	-	-	-
NW	1.7	35.9	71.4	21.4	7.1	-	-	-	-
NNW	3.6	32.4	86.7	13.3	-	-	-	-	-

	Speed								
Dir	8	9	10	11	12	13	14	15	#Obs
Calm	-	-	-	-	-	-	-	-	813
N	-	-	-	-	-	-	-	-	465
NNE	-	-	-	-	-	-	-	-	867
NE	0.1	-	-	-	-	-	-	-	1526
ENE	-	-	-	-	-	-	-	-	1114
E	-	-	-	-	-	-	-	-	243
ESE	-	-	-	-	-	-	-	-	69
SE	-	-	-	-	-	-	-	-	78
SSE	-	-	-	-	-	-	-	-	81
S	-	-	-	-	-	-	-	-	83
SSW	-	-	-	-	-	-	-	-	83
SW	-	-	-	-	-	-	-	-	105
WSW	-	-	-	-	-	-	-	-	107
W	-	-	-	-	-	-	-	-	237
WNW	-	-	-	-	-	-	-	-	185
NW	-	-	-	-	-	-	-	-	131
NNW	-	-	-	-	-	-	-	-	256

Number of obs $\geq$ 1 ms^{-1} = 4817. All values in percent, except total observations per direction, #Obs, dimensionless, and speed, meters per second.

Table 2j. Long-term Windrose for Site 129

		Speed							
Dir	%	Calm	1	2	3	4	5	6	7
Calm	3.4	-	-	-	-	-	-	-	-
N	4.8	3.1	14.7	33.0	30.2	13.6	6.5	1.3	0.6
NNE	17.9	3.8	3.3	14.9	35.9	29.6	11.1	3.1	1.4
NE	36.3	3.2	1.3	3.4	17.5	33.8	29.2	10.3	3.3
ENE	18.2	1.2	1.4	3.5	7.5	19.9	33.2	24.7	8.3
E	4.9	2.1	3.1	9.5	17.8	32.3	26.2	9.0	1.9
ESE	1.1	7.7	15.0	32.2	27.8	20.0	2.8	2.2	-
SE	1.6	8.6	16.1	21.7	23.2	22.1	12.0	3.7	1.1
SSE	1.0	10.6	19.2	24.9	35.0	17.5	1.7	1.7	-
S	0.8	12.3	20.4	28.9	20.4	14.8	7.7	3.5	4.2
SSW	1.2	7.5	26.1	34.6	23.7	12.3	1.4	1.9	-
SW	2.7	3.4	13.6	30.9	35.1	13.1	4.2	2.7	0.4
WSW	3.0	2.5	9.4	24.0	29.8	24.8	7.4	3.9	0.8
W	2.3	2.7	15.0	15.7	27.2	23.4	10.9	5.8	1.3
WNW	1.4	5.8	32.0	40.2	13.1	7.0	4.1	3.3	-
NW	1.3	7.0	52.0	33.3	7.1	5.8	1.8	-	-
NNW	1.3	8.0	50.9	44.5	4.6	-	-	-	-

	Speed								
Dir	8	9	10	11	12	13	14	15	#Obs
Calm	-	-	-	-	-	-	-	-	592
N	-	-	-	-	-	-	-	-	847
NNE	0.6	-	-	-	-	-	-	-	3153
NE	1.0	0.2	0.1	-	-	-	-	-	6354
ENE	1.4	0.1	-	-	-	-	-	-	3115
E	0.1	-	-	-	-	-	-	-	850
ESE	-	-	-	-	-	-	-	-	195
SE	-	-	-	-	-	-	-	-	292
SSE	-	-	-	-	-	-	-	-	198
S	-	-	-	-	-	-	-	-	162
SSW	-	-	-	-	-	-	-	-	228
SW	-	-	-	-	-	-	-	-	466
WSW	-	-	-	-	-	-	-	-	526
W	0.8	-	-	-	-	-	-	-	405
WNW	0.4	-	-	-	-	-	-	-	259
NW	-	-	-	-	-	-	-	-	242
NNW	-	-	-	-	-	-	-	-	237

Number of obs $\geq$ 1 ms^{-1} = 16937. All values in percent, except total observations per direction, #Obs, dimensionless, and speed, meters per second.

Table 3a. Diurnal Variation of Some Long-term Wind Characteristics for Site 120

Hour	Resultant Mean Wind	Mean Speed	Sigma	Steadiness
0	64 at 2.4	3.0	1.86	0.80
1	63 at 2.4	3.0	1.83	0.80
2	62 at 2.2	2.8	1.82	0.79
3	64 at 2.1	2.7	1.78	0.78
4	63 at 2.2	2.8	1.82	0.80
5	64 at 2.2	2.7	1.79	0.81
6	65 at 2.3	2.9	1.81	0.80
7	64 at 2.3	2.9	1.86	0.80
8	63 at 2.2	3.1	1.81	0.70
9	63 at 2.2	3.5	1.63	0.61
10	64 at 1.9	3.7	1.52	0.52
11	60 at 1.5	3.8	1.44	0.40
12	54 at 1.3	3.9	1.39	0.33
13	48 at 1.2	3.9	1.46	0.30
14	42 at 1.2	3.9	1.53	0.30
15	42 at 1.3	3.9	1.57	0.34
16	48 at 1.6	3.9	1.64	0.42
17	53 at 2.0	3.8	1.72	0.53
18	56 at 2.2	3.4	1.85	0.64
19	60 at 2.4	3.3	2.03	0.74
20	61 at 2.6	3.3	2.05	0.77
21	61 at 2.6	3.3	1.99	0.79
22	62 at 2.5	3.2	1.91	0.80
23	63 at 2.5	3.1	1.88	0.81

Times are Hawaiian Standard Time (HST). Winds are given as degrees at ms^{-1}. Mean speed and sigma are ms^{-1}. Steadiness is dimensionless.

Table 3b. Diurnal Variation of Some Long-term Wind Characteristics for Site 121

Hour	Resultant Mean Wind	Mean Speed	Sigma	Steadiness
0	63 at 1.5	2.2	1.16	0.68
1	60 at 1.5	2.1	1.17	0.70
2	56 at 1.4	2.0	1.18	0.69
3	55 at 1.4	2.0	1.22	0.69
4	53 at 1.4	2.0	1.22	0.68
5	50 at 1.4	2.0	1.21	0.68
6	52 at 1.4	2.0	1.22	0.69
7	57 at 1.3	2.1	1.25	0.62
8	68 at 1.3	2.5	1.19	0.52
9	79 at 1.3	3.0	1.13	0.43
10	86 at 1.2	3.3	1.11	0.36
11	88 at 0.8	3.4	1.12	0.23
12	84 at 0.5	3.5	1.16	0.13
13	37 at 0.3	3.6	1.27	0.08
14	14 at 0.4	3.6	1.25	0.10
15	14 at 0.5	3.5	1.23	0.14
16	37 at 0.7	3.4	1.15	0.21
17	46 at 1.1	3.1	1.13	0.35
18	51 at 1.3	2.7	1.08	0.48
19	56 at 1.4	2.4	1.12	0.59
20	55 at 1.5	2.3	1.14	0.64
21	57 at 1.5	2.3	1.18	0.66
22	59 at 1.5	2.2	1.20	0.68
23	60 at 1.5	2.2	1.18	0.70

Times are Hawaiian Standard Time (HST). Winds are given as degrees at ms^{-1}. Mean speed and sigma are ms^{-1}. Steadiness is dimensionless.

Table 3c. Diurnal Variation of Some Long-term Wind Characteristics for Site 122

Hour	Resultant Mean Wind	Mean Speed	Sigma	Steadiness
0	63 at 2.2	2.8	1.69	0.80
1	60 at 2.2	2.8	1.67	0.79
2	59 at 2.1	2.7	1.58	0.79
3	57 at 2.1	2.6	1.56	0.79
4	55 at 2.0	2.6	1.59	0.77
5	55 at 2.1	2.7	1.63	0.77
6	56 at 2.1	2.7	1.73	0.77
7	63 at 1.6	2.5	1.68	0.67
8	77 at 1.4	2.9	1.72	0.48
9	97 at 1.5	3.6	1.58	0.42
10	100 at 1.6	3.9	1.50	0.40
11	108 at 1.3	3.9	1.46	0.32
12	118 at 1.0	4.0	1.51	0.24
13	119 at 0.6	4.1	1.47	0.15
14	105 at 0.4	4.2	1.57	0.11
15	96 at 0.6	4.0	1.54	0.14
16	88 at 1.0	3.8	1.53	0.26
17	75 at 1.5	3.5	1.50	0.42
18	68 at 1.8	3.1	1.60	0.57
19	66 at 2.0	2.9	1.77	0.68
20	63 at 2.1	2.9	1.84	0.72
21	63 at 2.2	2.9	1.86	0.76
22	62 at 2.3	2.9	1.79	0.78
23	62 at 2.3	2.9	1.73	0.80

Times are Hawaiian Standard Time (HST). Winds are given as degrees at ms^{-1}. Mean speed and sigma are ms^{-1}. Steadiness is dimensionless.

Table 3d. Diurnal Variation of Some Long-term Wind Characteristics for Site 123

Hour	Resultant Mean Wind	Mean Speed	Sigma	Steadiness
0	68 at 2.1	2.6	1.36	0.80
1	67 at 2.1	2.6	1.35	0.80
2	67 at 2.0	2.5	1.31	0.80
3	66 at 1.9	2.5	1.35	0.78
4	64 at 1.9	2.4	1.34	0.78
5	64 at 1.9	2.4	1.31	0.79
6	65 at 1.9	2.5	1.34	0.79
7	72 at 2.2	2.7	1.41	0.80
8	79 at 2.5	3.3	1.52	0.76
9	85 at 2.6	3.8	1.51	0.69
10	88 at 2.5	4.0	1.50	0.62
11	91 at 2.1	4.1	1.53	0.52
12	91 at 1.8	4.2	1.51	0.44
13	88 at 1.7	4.2	1.49	0.39
14	82 at 1.6	4.2	1.44	0.39
15	75 at 1.7	4.1	1.45	0.41
16	72 at 1.9	3.9	1.44	0.47
17	70 at 2.1	3.6	1.42	0.59
18	68 at 2.2	3.2	1.40	0.69
19	69 at 2.2	2.9	1.32	0.77
20	68 at 2.3	2.8	1.32	0.81
21	68 at 2.3	2.8	1.33	0.81
22	68 at 2.3	2.8	1.32	0.82
23	68 at 2.2	2.7	1.34	0.82

Times are Hawaiian Standard Time (HST). Winds are given as degrees at ms^{-1}. Mean speed and sigma are ms^{-1}. Steadiness is dimensionless.

Table 3e. Diurnal Variation of Some Long-term Wind Characteristics for Site 124

Hour	Resultant Mean Wind	Mean Speed	Sigma	Steadiness
0	61 at 4.7	5.7	2.41	0.82
1	61 at 4.6	5.6	2.61	0.81
2	60 at 4.3	5.4	2.58	0.80
3	59 at 4.3	5.3	2.59	0.80
4	58 at 4.2	5.2	2.57	0.80
5	59 at 4.3	5.3	2.55	0.81
6	61 at 4.4	5.3	2.59	0.83
7	65 at 4.2	5.2	2.69	0.81
8	73 at 4.0	5.2	2.68	0.77
9	79 at 3.8	5.3	2.53	0.72
10	83 at 3.4	5.4	2.45	0.63
11	85 at 2.8	5.5	2.37	0.51
12	84 at 2.4	5.5	2.31	0.45
13	81 at 2.1	5.4	2.25	0.39
14	76 at 2.0	5.4	2.21	0.37
15	72 at 2.2	5.4	2.23	0.40
16	67 at 2.4	5.4	2.19	0.46
17	65 at 3.0	5.2	2.30	0.57
18	62 at 3.7	5.3	2.46	0.70
19	59 at 4.4	5.5	2.54	0.79
20	58 at 4.7	5.8	2.56	0.81
21	60 at 4.9	5.9	2.54	0.83
22	61 at 4.8	5.8	2.55	0.83
23	62 at 4.8	5.7	2.52	0.83

Times are Hawaiian Standard Time (HST). Winds are given as degrees at ms^{-1}. Mean speed and sigma are ms^{-1}. Steadiness is dimensionless.

Table 3f. Diurnal Variation of Some Long-term Wind Characteristics for Site 125

Hour	Resultant Mean Wind	Mean Speed	Sigma	Steadiness
0	48 at 5.4	6.2	2.77	0.86
1	47 at 5.2	6.1	2.75	0.86
2	47 at 5.0	5.9	2.75	0.85
3	46 at 5.0	5.9	2.82	0.85
4	45 at 5.0	5.9	2.81	0.85
5	46 at 5.1	5.9	2.76	0.86
6	47 at 5.1	6.0	2.81	0.86
7	51 at 5.1	5.9	2.91	0.86
8	59 at 4.8	5.9	2.92	0.81
9	66 at 4.5	6.0	2.80	0.75
10	72 at 4.0	5.9	2.67	0.68
11	75 at 3.4	5.8	2.57	0.59
12	76 at 3.0	5.8	2.49	0.52
13	75 at 2.8	5.8	2.49	0.49
14	71 at 2.9	5.8	2.46	0.49
15	64 at 3.1	5.8	2.51	0.52
16	60 at 3.5	5.8	2.58	0.59
17	55 at 4.0	5.8	2.67	0.69
18	49 at 4.5	5.8	2.76	0.78
19	46 at 5.1	6.1	2.85	0.84
20	46 at 5.4	6.3	2.83	0.86
21	47 at 5.5	6.4	2.81	0.87
22	48 at 5.5	6.3	2.86	0.87
23	48 at 5.4	6.3	2.82	0.87

Times are Hawaiian Standard Time (HST). Winds are given as degrees at ms^{-1}. Mean speed and sigma are ms^{-1}. Steadiness is dimensionless.

Table 3g. Diurnal Variation of Some Long-term Wind Characteristics for Site 126

Hour	Resultant Mean Wind	Mean Speed	Sigma	Steadiness
0	57 at 4.7	5.3	2.29	0.88
1	57 at 4.6	5.2	2.23	0.88
2	56 at 4.4	5.1	2.24	0.87
3	56 at 4.4	5.0	2.29	0.87
4	55 at 4.3	5.0	2.20	0.87
5	55 at 4.4	5.1	2.20	0.88
6	57 at 4.5	5.1	2.20	0.88
7	60 at 4.5	5.1	2.31	0.88
8	66 at 4.4	5.1	2.36	0.86
9	72 at 4.3	5.2	2.33	0.83
10	76 at 4.0	5.2	2.23	0.78
11	79 at 3.6	5.1	2.23	0.70
12	80 at 3.2	5.1	2.11	0.63
13	78 at 3.0	5.0	2.10	0.60
14	76 at 3.0	5.0	2.12	0.60
15	71 at 3.1	4.9	2.16	0.63
16	67 at 3.3	4.9	2.21	0.68
17	63 at 3.6	4.9	2.26	0.74
18	58 at 4.0	4.8	2.30	0.82
19	55 at 4.4	5.1	2.33	0.86
20	55 at 4.7	5.4	2.33	0.87
21	56 at 4.8	5.4	2.33	0.88
22	56 at 4.8	5.4	2.33	0.88
23	57 at 4.7	5.3	2.32	0.89

Times are Hawaiian Standard Time (HST). Winds are given as degrees at ms^{-1}. Mean speed and sigma are ms^{-1}. Steadiness is dimensionless.

Table 3h. Diurnal Variation of Some Long-term Wind Characteristics for Site 127

Hour	Resultant Mean Wind	Mean Speed	Sigma	Steadiness
0	72 at 3.9	4.8	2.86	0.82
1	71 at 3.7	4.6	2.90	0.80
2	71 at 3.6	4.5	2.90	0.80
3	70 at 3.5	4.4	2.85	0.79
4	69 at 3.3	4.2	2.83	0.78
5	70 at 3.3	4.2	2.88	0.79
6	72 at 3.5	4.4	2.92	0.79
7	76 at 3.4	4.3	3.03	0.79
8	83 at 3.1	4.1	2.98	0.75
9	89 at 2.8	4.1	2.67	0.68
10	95 at 2.7	4.3	2.47	0.63
11	101 at 2.3	4.3	2.43	0.55
12	103 at 2.1	4.3	2.35	0.48
13	103 at 1.8	4.3	2.26	0.41
14	101 at 1.6	4.3	2.26	0.37
15	91 at 1.5	4.1	2.08	0.37
16	81 at 1.8	4.0	2.16	0.44
17	75 at 2.2	4.1	2.28	0.54
18	70 at 2.9	4.2	2.61	0.70
19	68 at 3.6	4.6	2.86	0.79
20	68 at 4.0	4.9	2.96	0.81
21	70 at 4.2	5.0	2.98	0.84
22	71 at 4.0	4.8	3.03	0.83
23	72 at 4.0	4.8	3.05	0.83

Times are Hawaiian Standard Time (HST). Winds are given as degrees at ms^{-1}. Mean speed and sigma are ms^{-1}. Steadiness is dimensionless.

Table 3i. Diurnal Variation of Some Long-term Wind Characteristics for Site 128

Hour	Resultant Mean Wind	Mean Speed	Sigma	Steadiness
0	43 at 1.6	1.9	1.21	0.84
1	44 at 1.6	1.9	1.23	0.85
2	42 at 1.5	1.8	1.09	0.83
3	39 at 1.4	1.7	1.02	0.82
4	38 at 1.4	1.7	0.98	0.82
5	40 at 1.4	1.7	0.99	0.81
6	40 at 1.4	1.7	1.05	0.81
7	44 at 1.4	1.8	1.19	0.80
8	50 at 1.4	2.1	1.34	0.67
9	50 at 1.3	2.3	1.28	0.56
10	53 at 1.3	2.5	1.19	0.54
11	52 at 1.2	2.6	1.19	0.45
12	48 at 1.1	2.7	1.14	0.40
13	43 at 1.1	2.8	1.13	0.41
14	47 at 1.1	2.7	1.21	0.41
15	48 at 1.2	2.7	1.15	0.46
16	46 at 1.4	2.6	1.13	0.54
17	45 at 1.7	2.5	1.08	0.69
18	43 at 1.8	2.3	1.10	0.79
19	45 at 1.9	2.2	1.13	0.89
20	44 at 1.9	2.2	1.19	0.89
21	47 at 2.0	2.2	1.24	0.89
22	45 at 1.8	2.1	1.19	0.87
23	45 at 1.7	2.0	1.24	0.84

Times are Hawaiian Standard Time (HST). Winds are given as degrees at ms^{-1}. Mean speed and sigma are ms^{-1}. Steadiness is dimensionless.

Table 3j. Diurnal Variation of Some Long-term Wind Characteristics for Site 129

Hour	Resultant Mean Wind	Mean Speed	Sigma	Steadiness
0	34 at 3.5	3.9	1.53	0.87
1	33 at 3.4	3.9	1.48	0.88
2	32 at 3.3	3.8	1.46	0.88
3	31 at 3.3	3.8	1.46	0.88
4	31 at 3.3	3.7	1.47	0.88
5	31 at 3.3	3.7	1.43	0.88
6	32 at 3.3	3.8	1.44	0.88
7	39 at 3.5	3.9	1.57	0.89
8	52 at 3.6	4.2	1.70	0.86
9	63 at 3.7	4.5	1.70	0.82
10	71 at 3.5	4.6	1.67	0.77
11	75 at 3.3	4.7	1.62	0.70
12	79 at 3.0	4.8	1.58	0.63
13	77 at 2.9	4.9	1.58	0.60
14	74 at 2.8	4.8	1.61	0.58
15	67 at 2.8	4.8	1.64	0.60
16	60 at 3.0	4.7	1.66	0.65
17	54 at 3.2	4.5	1.66	0.72
18	45 at 3.3	4.2	1.63	0.79
19	38 at 3.5	4.1	1.60	0.84
20	35 at 3.6	4.2	1.57	0.86
21	35 at 3.6	4.1	1.58	0.87
22	35 at 3.6	4.1	1.52	0.87
23	34 at 3.5	4.0	1.49	0.87

Times are Hawaiian Standard Time (HST). Winds are given as degrees at ms^{-1}. Mean speed and sigma are ms^{-1}. Steadiness is dimensionless.

Table 4. Divergence (x 10^{-4} s^{-1}) of the Long-term Resultant Mean Wind

Hour	Divergence	Hour	Divergence
0	2.6	12	-5.1
1	2.8	13	-5.6
2	2.5	14	-5.0
3	2.6	15	-4.2
4	2.5	16	-3.7
5	2.7	17	-2.7
6	2.8	18	-0.8
7	1.1	19	0.8
8	-1.1	20	2.0
9	-2.9	21	2.2
10	-3.7	22	2.3
11	-5.1	23	2.8

Table 5. Site Topographical Characteristics

Site	Elevation (m)	Direction	Slope (%)
120	10	60	23
123	10	20	12
124	230	20	14
125	310	20	14
126	510	40	9
127	380	60	13
129	170	350	8

Elevations are given to the nearest 10 m. Directions given to the nearest 10 degrees. Slope was calculated by dividing 180 m by the horizontal distance from the site to a point directly upslope of the site described by the intersection of the slope and a horizontal line through a point 180 m vertically above the site - an arbitrarily convenient distance which permitted such a calculation for each site.

Table 6a. Observed Wind Characteristics for Various Ambient Wind Conditions for the Period January-March 1983

Omnidirectional GLWs ≤ 2.5 ms^{-1}

Site	Clds	Freq	Direction	Speed Range	Mn Std Dev
120	Sct	89.9	80-110	1-3	11
	Bkn	91.3	50-120	1-5	12
		(56.5)	(80-110)	(1-3)	(10)
123	Sct	85.9	0-60	1-3	10
	Bkn	74.3	30-80	1-3	12
124	Sct	63.9	330-50	1-3	13
		(30.2)	(60-90)	(1-4)	(5)
	Bkn	61.4	10-90	1-7	11
125	Sct	66.2	330-30	1-3	8
	Bkn	81.6	0-60	1-7	8
126	Sct	47.5	330-10	1-3	8
		(47.5)	(20-90)		(9)
	Bkn	73.9	10-80	1-5	11
127	Sct	55.8	330-20	1-3	10
		(39.5)	(80-120)	(1-4)	(8)
	Bkn	48.4	60-120	1-6	10
		(36.3)	(340-40)	(1-4)	(14)
129	Sct	90.2	330-20	1-3	5
	Bkn	85.0	340-30	1-5	6

Freq is the frequency, percent, of observations within the specified range of directions. Directions are given in degrees. Speeds are given in ms^{-1}. Mn Std Dev is the mean wind-direction standard deviation.

Table 6b. Observed Wind Characteristics for Various Ambient Wind Conditions for the Period January-March 1983

Trade-direction GLWs ≥ 5.0 ms^{-1}

Site	Clds	Freq	Direction	Speed Range	Mn Std Dev
120	Sct	79.6	50-80	1-8	18
	Bkn	84.9	40-90	1-8	20
123	Sct	70.1	40-80	1-5	12
	Bkn	80.2	20-70	1-5	14
124	Sct	75.2	40-80	3-11	7
	Bkn	81.0	30-80	3-10	6
125	Sct	95.2	20-70	3-12	7
	Bkn	78.3	20-60	2-11	8
126	Sct	85.6	30-70	2-8	12
	Bkn	72.9	30-70	2-7	11
127	Sct	63.3	50-90	1-9	17
	Bkn	64.5	40-90	1-9	16
129	Sct	98.1	0-60	2-7	7
	Bkn	88.9	10-50	2-6	7

Freq is the frequency, percent, of observations within the specified range of directions. Directions are given in degrees. Speeds are given in ms^{-1}. Mn Std Dev is the mean wind-direction standard deviation.

Table 6c. Observed Wind Characteristics for Various Ambient Wind Conditions for the Period January-March 1983

Trade-direction GLWs ≤ 2.5 ms^{-1}

Site	Clds	Freq	Direction	Speed Range	Mn Std Dev
120	Sct	92.3	80-100	1-3	7
	Bkn	94.1	50-100	1-5	16
123	Sct	84.5	10-60	1-3	12
	Bkn	81.0	40-80	1-3	15
124	Sct	54.5	330-20	1-3	11
	Bkn	71.0	30-70	2-7	6
125	Sct	60.0	350-20	1-3	8
	Bkn	78.3	20-60	2-7	6
126	Sct	47.0	50-70	1-3	9
		(41.1)	(330-0)		(7)
	Bkn	79.4	30-70	1-5	8
127	Sct	48.0	330-10	1-2	9
		(44.0)	(80-120)		(6)
	Bkn	71.5	40-90	1-6	16
129	Sct	87.6	340-20	1-3	5
	Bkn	97.5	0-40	2-4	7

Freq is the frequency, percent, of observations within the specified range of directions. Directions are given in degrees. Speeds are given in ms^{-1}. Mn Std Dev is the mean wind-direction standard deviation.

Table 7. Cloudiness and Inversion Data for Various Ambient Wind Conditions for the Period January-March 1983

a. Nights with Omnidirectional GLW $\leq$ 2.5 ms^{-1}

	Sct			Bkn		
	Date	Index	T	Date	Index	T
Jan	2	0.3	N/A	8	0.5	1.0
	15	0.2	1.7	12	0.5	0.6
Feb	6	0.2	1.0	17	0.5	0.6
	24	0.3	0.6	18	0.7	0.2
	28	0.1	0.9	22	0.6	0.4
				23	0.5	0.5
				25	0.6	0.2
Mar	1	0.1	1.1	4	0.5	-
	5	0.2	0.1	6	0.5	-
				12	0.7	ISO
				24	0.5	0.1

b. Nights with Trade-direction GLW $\geq$ 5.0 ms^{-1}

	Sct			Bkn		
	Date	Index	T	Date	Index	T
Jan	4	0.3	N/A	1	0.6	N/A
	6	0.3	N/A	3	0.5	N/A
	10	0.2	N/A	11	0.7	0.1
				14	0.4	1.5
				30	0.6	0.7
				31	0.6	N/A
Feb	7	0.2	1.3	1	0.4	1.0
	27	0.3	0.3	3	0.5	N/A
				4	0.8	1.3
Mar	15	0.3	-	16	0.4	ISO
	19	0.3	-	17	0.9	ISO
	23	0.3	-	22	0.4	-
				26	0.4	0.2

Index = cloudiness index, T = index for atmospheric stability; see text for details.

Table 7. Cloudiness and Inversion Data for Various Ambient Wind Conditions for the Period January-March 1983

c. Nights with Trade-direction GLW $\leq 2.5\ ms^{-1}$

	Sct			Bkn		
	Date	Index	T	Date	Index	T
Jan	2	0.3	N/A	12	0.5	0.6
	15	0.2	1.7			
Mar				12	0.7	ISO
				24	0.5	0.1

d. Nights with Non-trade-direction GLW $\geq 5.0\ ms^{-1}$

	Sct			Bkn		
	Date	Index	T	Date	Index	T
Jan				18	0.7	0.3
				20	0.4	0.2
				23	0.7	-
				24	0.9	-
				26	0.6	0.6
Feb	19	0.2	-	8	0.4	N/A
	20	0.2	-	9	0.5	N/A
	26	0.3	0.4	12	0.6	N/A
				13	0.4	0.6
				15	0.5	N/A
Mar	3	0.3	-	7	0.4	0.3
	8	0.3	0.1	10	0.8	ISO
	9	0.3	-	11	0.7	-

Index = cloudiness index, T = index for atmospheric stability; see text for details.

Table 8a. Diurnal Variation of Some Wind Characteristics for Site 120 for the Period January-March 1983

Hour	Resultant Mean Wind	Mean Speed	Sigma	Steadiness
0	42 at 1.1	2.6	1.63	0.41
1	37 at 0.9	2.5	1.51	0.36
2	36 at 0.7	2.3	1.47	0.32
3	47 at 0.7	2.2	1.42	0.34
4	48 at 0.9	2.3	1.41	0.38
5	52 at 0.9	2.2	1.44	0.39
6	61 at 0.9	2.4	1.36	0.37
7	60 at 1.1	2.4	1.35	0.44
8	32 at 0.4	2.4	1.50	0.19
9	332 at 0.5	2.7	1.31	0.17
10	288 at 0.8	3.0	1.17	0.25
11	277 at 1.2	3.3	1.30	0.36
12	275 at 1.3	3.4	1.22	0.37
13	275 at 1.5	3.5	1.23	0.43
14	279 at 1.9	3.6	1.28	0.54
15	287 at 1.9	3.5	1.33	0.54
16	294 at 1.6	3.5	1.29	0.47
17	302 at 1.4	3.2	1.32	0.43
18	329 at 1.1	3.0	1.58	0.36
19	5 at 1.0	2.8	1.67	0.35
20	18 at 1.0	2.8	1.74	0.35
21	34 at 1.2	2.8	1.68	0.43
22	39 at 1.2	2.7	1.64	0.44
23	43 at 1.3	2.7	1.72	0.49

Times are Hawaiian Standard Time (HST). Winds are given as degrees at ms^{-1}. Mean speed and sigma are ms^{-1}. Steadiness is dimensionless.

Table 8b. Diurnal Variation of Some Wind Characteristics for Site 123 for the Period January-March 1983

Hour	Resultant Mean Wind	Mean Speed	Sigma	Steadiness
0	16 at 1.1	2.2	1.40	0.48
1	18 at 1.1	2.2	1.38	0.50
2	15 at 1.0	2.2	1.32	0.48
3	18 at 1.1	2.1	1.27	0.52
4	21 at 1.1	2.1	1.28	0.52
5	23 at 1.1	2.1	1.28	0.53
6	29 at 1.1	2.1	1.30	0.50
7	46 at 1.0	2.1	1.28	0.48
8	69 at 0.8	2.5	1.53	0.31
9	86 at 0.7	3.2	1.42	0.23
10	98 at 0.4	3.6	1.30	0.12
11	231 at 0.4	3.8	1.54	0.11
12	243 at 0.7	4.0	1.37	0.18
13	257 at 1.0	4.1	1.44	0.25
14	270 at 1.3	4.1	1.30	0.31
15	284 at 1.4	4.1	1.30	0.34
16	292 at 1.2	3.9	1.34	0.31
17	313 at 1.0	3.4	1.30	0.30
18	339 at 1.1	2.8	1.45	0.38
19	0 at 1.2	2.6	1.48	0.46
20	2 at 1.2	2.5	1.53	0.50
21	15 at 1.3	2.4	1.42	0.52
22	17 at 1.3	2.3	1.31	0.54
23	21 at 1.2	2.2	1.32	0.54

Times are Hawaiian Standard Time (HST). Winds are given as degrees at ms^{-1}. Mean speed and sigma are ms^{-1}. Steadiness is dimensionless.

Table 8c. Diurnal Variation of Some Wind Characteristics for Site 124 for the Period January-March 1983

Hour	Resultant Mean Wind	Mean Speed	Sigma	Steadiness
0	14 at 1.9	4.3	2.53	0.44
1	16 at 1.9	4.3	2.64	0.44
2	8 at 1.8	4.1	2.57	0.44
3	13 at 1.8	4.0	2.41	0.45
4	15 at 1.8	4.1	2.28	0.45
5	20 at 2.0	4.1	2.20	0.48
6	34 at 2.0	4.2	2.27	0.47
7	38 at 1.8	4.1	2.37	0.43
8	48 at 1.1	4.0	2.46	0.27
9	62 at 0.8	4.3	2.35	0.19
10	62 at 0.2	4.6	2.16	0.05
11	266 at 0.8	4.8	2.25	0.16
12	268 at 1.3	5.2	2.02	0.25
13	268 at 1.6	5.3	2.22	0.30
14	275 at 2.3	5.4	2.25	0.42
15	281 at 2.2	5.3	2.34	0.41
16	285 at 2.0	5.3	2.31	0.38
17	304 at 1.9	5.0	2.40	0.37
18	340 at 1.8	4.7	2.56	0.39
19	358 at 2.2	4.6	2.64	0.47
20	359 at 2.1	4.5	2.60	0.47
21	8 at 2.2	4.5	2.64	0.48
22	10 at 2.0	4.3	2.62	0.46
23	14 at 2.0	4.2	2.67	0.48

Times are Hawaiian Standard Time (HST). Winds are given as degrees at ms^{-1}. Mean speed and sigma are ms^{-1}. Steadiness is dimensionless.

Table 8d. Diurnal Variation of Some Wind Characteristics for Site 125 for the Period January-March 1983

Hour	Resultant Mean Wind	Mean Speed	Sigma	Steadiness
0	16 at 2.3	4.0	2.14	0.58
1	15 at 2.3	4.0	2.23	0.57
2	12 at 2.3	3.9	2.05	0.58
3	13 at 2.2	3.8	2.13	0.58
4	15 at 2.3	3.9	1.99	0.57
5	19 at 2.5	4.0	1.91	0.61
6	27 at 2.3	4.0	2.09	0.58
7	31 at 2.2	4.0	2.19	0.54
8	46 at 1.4	3.9	2.11	0.36
9	64 at 1.0	4.2	2.01	0.24
10	121 at 0.5	4.5	1.92	0.11
11	214 at 0.8	4.4	1.93	0.18
12	226 at 1.2	4.6	1.56	0.26
13	234 at 1.6	4.8	1.67	0.33
14	252 at 1.8	4.8	1.64	0.38
15	261 at 1.5	4.7	1.83	0.32
16	275 at 1.2	4.6	1.70	0.27
17	317 at 1.3	4.4	2.04	0.29
18	354 at 1.8	4.3	2.27	0.43
19	5 at 2.4	4.3	2.29	0.56
20	8 at 2.6	4.4	2.25	0.58
21	13 at 2.6	4.3	2.28	0.62
22	12 at 2.5	4.0	2.40	0.61
23	16 at 2.5	4.1	2.36	0.62

Times are Hawaiian Standard Time (HST). Winds are given as degrees at ms^{-1}. Mean speed and sigma are ms^{-1}. Steadiness is dimensionless.

Table 8e. Diurnal Variation of Some Wind Characteristics for Site 126 for the Period January-March 1983

Hour	Resultant Mean Wind	Mean Speed	Sigma	Steadiness
0	18 at 1.6	3.3	1.79	0.49
1	17 at 1.6	3.3	1.75	0.49
2	12 at 1.6	3.2	1.68	0.51
3	11 at 1.6	3.1	1.68	0.51
4	15 at 1.7	3.2	1.66	0.52
5	19 at 1.7	3.3	1.63	0.52
6	28 at 1.7	3.4	1.70	0.50
7	32 at 1.6	3.3	1.75	0.47
8	49 at 1.2	3.3	1.88	0.37
9	70 at 1.2	3.7	1.84	0.31
10	92 at 0.7	3.8	1.72	0.19
11	156 at 0.2	3.7	1.73	0.06
12	220 at 0.5	4.0	1.56	0.12
13	245 at 0.8	4.0	1.65	0.20
14	257 at 1.1	4.0	1.55	0.27
15	270 at 1.0	3.9	1.57	0.24
16	286 at 0.8	3.8	1.59	0.22
17	321 at 1.0	3.6	1.70	0.28
18	355 at 1.4	3.4	1.86	0.39
19	6 at 1.8	3.5	1.79	0.51
20	9 at 1.8	3.5	1.74	0.52
21	12 at 1.8	3.3	1.77	0.55
22	12 at 1.7	3.3	1.87	0.53
23	16 at 1.7	3.3	1.79	0.53

Times are Hawaiian Standard Time (HST). Winds are given as degrees at ms^{-1}. Mean speed and sigma are ms^{-1}. Steadiness is dimensionless.

Table 8f. Diurnal Variation of Some Wind Characteristics for Site 127 for the Period January-March 1983

Hour	Resultant Mean Wind	Mean Speed	Sigma	Steadiness
0	31 at 1.2	3.1	2.11	0.38
1	25 at 1.2	3.1	2.11	0.38
2	13 at 1.2	2.9	2.01	0.42
3	21 at 1.2	3.0	2.06	0.41
4	23 at 1.2	2.9	2.02	0.43
5	31 at 1.3	2.9	1.97	0.45
6	45 at 1.3	3.0	2.04	0.42
7	52 at 1.2	3.1	2.09	0.40
8	81 at 0.8	2.9	2.08	0.28
9	112 at 0.6	3.2	1.92	0.20
10	164 at 0.7	3.5	1.90	0.19
11	203 at 0.9	3.8	1.88	0.23
12	215 at 1.1	3.9	1.67	0.29
13	226 at 1.3	4.2	1.62	0.32
14	242 at 1.7	4.2	1.64	0.40
15	253 at 1.6	4.1	1.59	0.38
16	270 at 1.3	3.8	1.59	0.33
17	301 at 1.1	3.6	1.60	0.30
18	350 at 1.0	3.4	1.83	0.31
19	14 at 1.5	3.5	1.99	0.43
20	15 at 1.5	3.4	2.02	0.45
21	26 at 1.6	3.3	2.11	0.49
22	26 at 1.5	3.2	2.21	0.46
23	31 at 1.4	3.1	2.36	0.45

Times are Hawaiian Standard Time (HST). Winds are given as degrees at ms^{-1}. Mean speed and sigma are ms^{-1}. Steadiness is dimensionless.

Table 8g. Diurnal Variation of Some Wind Characteristics for Site 129 for the Period January-March 1983

Hour	Resultant Mean Wind	Mean Speed	Sigma	Steadiness
0	355 at 2.0	3.1	1.34	0.65
1	358 at 2.0	3.1	1.18	0.65
2	356 at 2.1	3.1	1.16	0.67
3	356 at 2.1	3.0	1.13	0.68
4	359 at 2.1	3.1	1.25	0.68
5	2 at 2.1	3.0	1.15	0.69
6	6 at 2.0	3.0	1.11	0.66
7	9 at 1.8	3.0	1.23	0.60
8	34 at 1.3	3.0	1.54	0.42
9	65 at 1.1	3.5	1.52	0.33
10	89 at 0.9	3.7	1.42	0.26
11	129 at 0.7	3.9	1.41	0.18
12	177 at 0.7	4.0	1.44	0.17
13	206 at 0.8	4.3	1.23	0.18
14	226 at 0.8	4.2	1.23	0.20
15	255 at 0.7	4.3	1.35	0.17
16	279 at 0.7	4.1	1.31	0.16
17	318 at 0.9	3.8	1.44	0.23
18	341 at 1.4	3.5	1.57	0.40
19	351 at 1.9	3.4	1.46	0.57
20	351 at 2.1	3.4	1.42	0.62
21	355 at 2.1	3.2	1.40	0.66
22	355 at 2.1	3.2	1.31	0.67
23	355 at 2.1	3.1	1.32	0.67

Times are Hawaiian Standard Time (HST). Winds are given as degrees at ms^{-1}. Mean speed and sigma are ms^{-1}. Steadiness is dimensionless.

Table 9a. Chronology of the Occurrence of Clockwise Rotation of Observed Winds for the period January-March 1983

Month/Year	Date	Yes	No	Remarks
Jan 83	1		X	Trades
	2	X		Weak synoptic pressure gradient
	3		X	ACR; trades
	4		X	Trades
	5	X		Very subtle turning; trades
	6		X	Trades
	7		X	Yes at 129; trades
	8	X		Trades
	9	X		Weak synoptic pressure gradient
	10		X	Variable winds
	11		X	Trades
	12		X	Weak trades; shift to westerlies
	13	X		N component; drainage, sea breeze
	14		X	ACR; trades
	15	X		E component
	16	X		NW component; drainage, sea breeze
	17	X		NW component; drainage, sea breeze
	18		X	ACR; trades
	19	X		Westerlies
	20	X		Westerlies
	21	X		NW component
	22		X	NW component
	23		X	Synoptic pressure gradient rotation; trades becoming SW
	24		X	Westerlies
	25		X	ACR; NW component
	26	X		NW component
	27		X	Yes at 129; trades
	28		X	N component
	29	X		NW component
	30	X		NW component
	31		X	NNE component

Table 9b. Chronology of the Occurrence of Clockwise Rotation of Observed Winds for the period January-March 1983

Month/Year	Date	Yes	No	Remarks
Feb 83	1		X	ACR; trades
	2	X		Trades
	3	X		Weak rotation; trades
	4		X	Trades
	5		X	ACR; trades
	6	X		Trades
	7		X	N component
	8	X		Trades
	9		X	Shearline passage
	10		X	NW component
	11	X		Weak synoptic pressure gradient
	12	X		W component
	13	X		NW component
	14		X	Weak N component
	15	X		W component
	16		X	NW component
	17	X		Trades
	18	X		Weak synoptic pressure gradient
	19	X		N component
	20		X	NW component
	21	X		W component
	22		X	ACR; SW component
	23	X		NW component
	24	X		Weak trade component
	25	X		Weak trade component
	26		X	Shearline passage
	27		X	NW becoming trades
	28	X		Trades

Table 9c. Chronology of the Occurrence of Clockwise Rotation of Observed Winds for the period January-March 1983

Month/Year	Date	Yes	No	Remarks
Mar 83	1	X		Weak trades
	2	X		Weak synoptic pressure gradient
	3		X	SW component
	4	X		S component
	5	X		NW component
	6	X		Weak NNW component; missing 123
	7	X		W component; missing 123
	8	X		NW component
	9		X	Yes at 125-126; NW component
	10		X	W component
	11	X		SW component
	12		X	NW becoming trades
	13	X		Trades becoming NW
	14		X	NW component
	15		X	Strengthening trades
	16	X		Strong trades > 6 ms^{-1}
	17		X	Trades
	18		X	Trades
	19		X	Yes at 129; trades
	20		X	Yes at 129; trades
	21	X		Trades
	22		X	Trades
	23		X	Trades
	24	X		Trades
	25		X	Trades
	26		X	Trades
	27	X		Trades
	28	X		Good rotation signal at 123, 125, and 129; trades
	29		X	ACR; trades
	30	X		Weakening trades
	31		X	ACR; trades

Table 10. Occurrences of Clockwise Rotation for Various Synoptic Wind Directions

Synoptic Wind Direction	Clockwise Rotation		
	Yes	No	Total
Northerly	2	3	5
Trades	17	25	42
Easterly	1	0	1
Southeasterly	0	0	0
Southerly	1	0	1
Southwesterly	1	2	3
Westerly	6	2	8
Northwesterly	11	7	18
Variable	6	6	12
Total	45	45	90

APPENDIX II: FIGURES 1-5

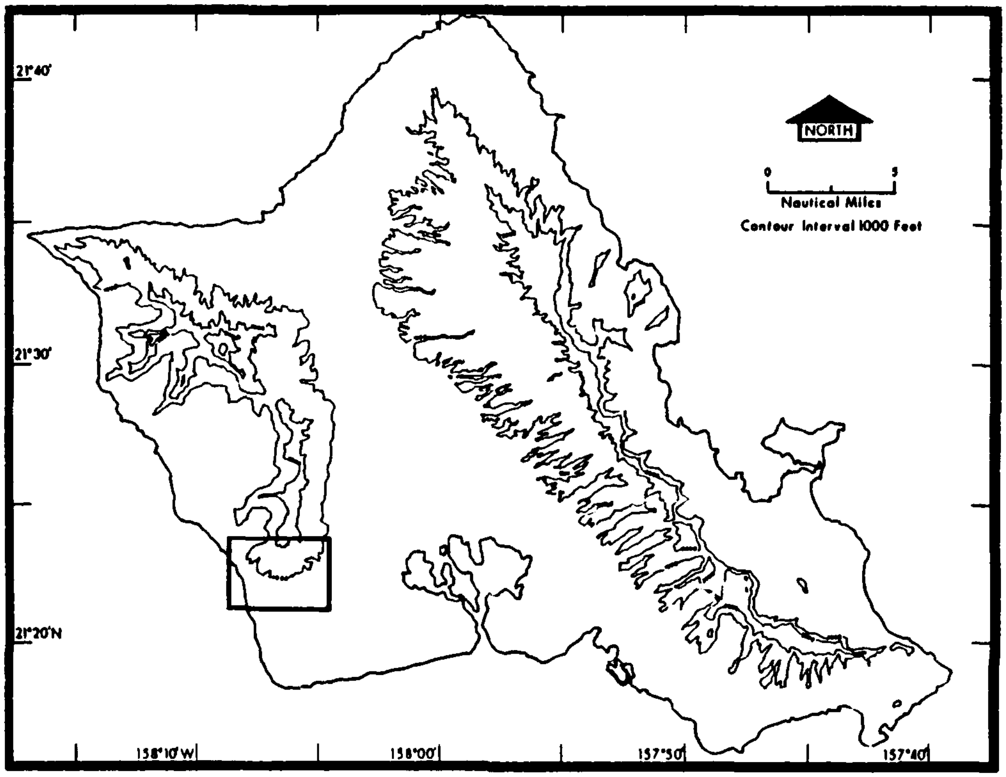

Figure 1a. Location of the monitoring network on the island of O'ahu, Hawai'i. Rectangle in lower left shows the area depicted in Figure 1b.

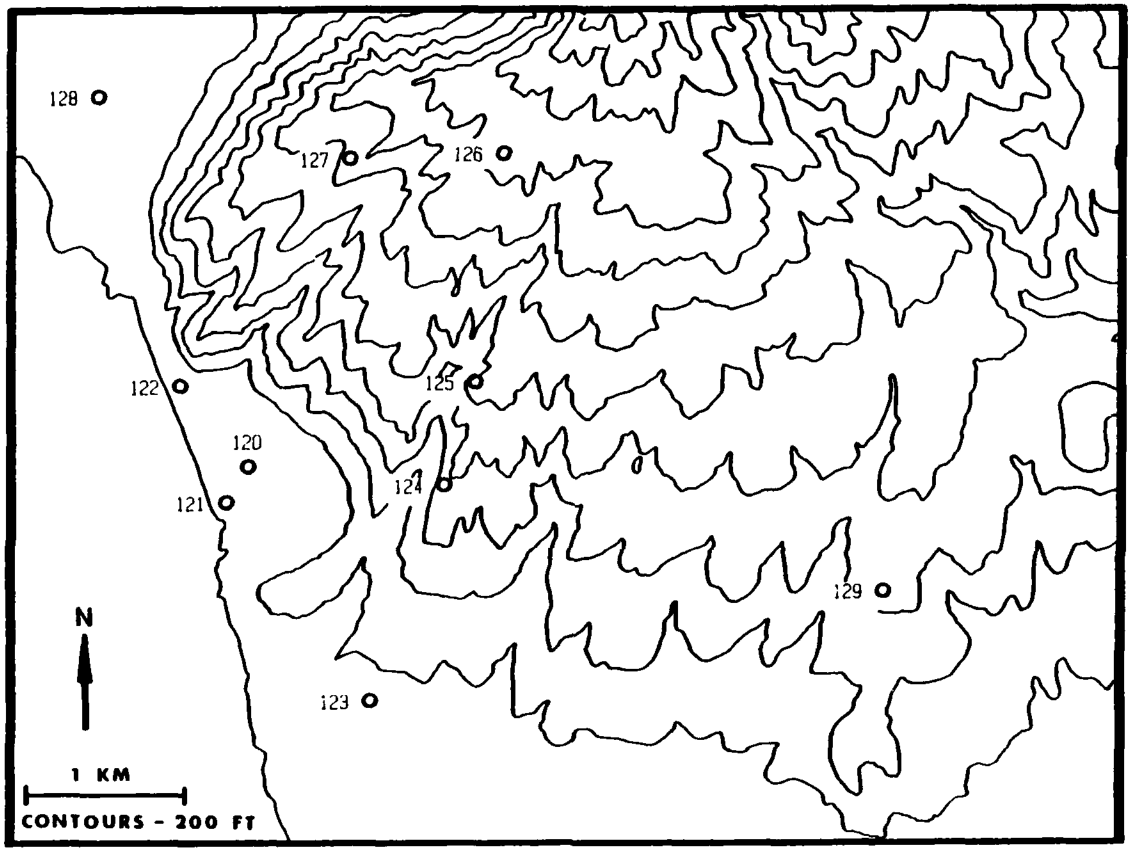

Figure 1b. Locations of the sites. Site 120 was collocated with the generating plant. Sites 121 and 122 were located between Farrington Highway (not shown) and the ocean. Site 123 was located in a canefield south of Farrington Highway. Sites 124 and 125 were located on the eastern ridge of Waimānalo Gulch. Site 126 was located at the United States Air Force Solar Observatory. Site 127 was located on the eastern ridge of Nānākuli Valley. Site 128 was located on the grounds of the Nānākuli fire station. Site 129 was located at a HECO substation in the Makakilo subdivision.

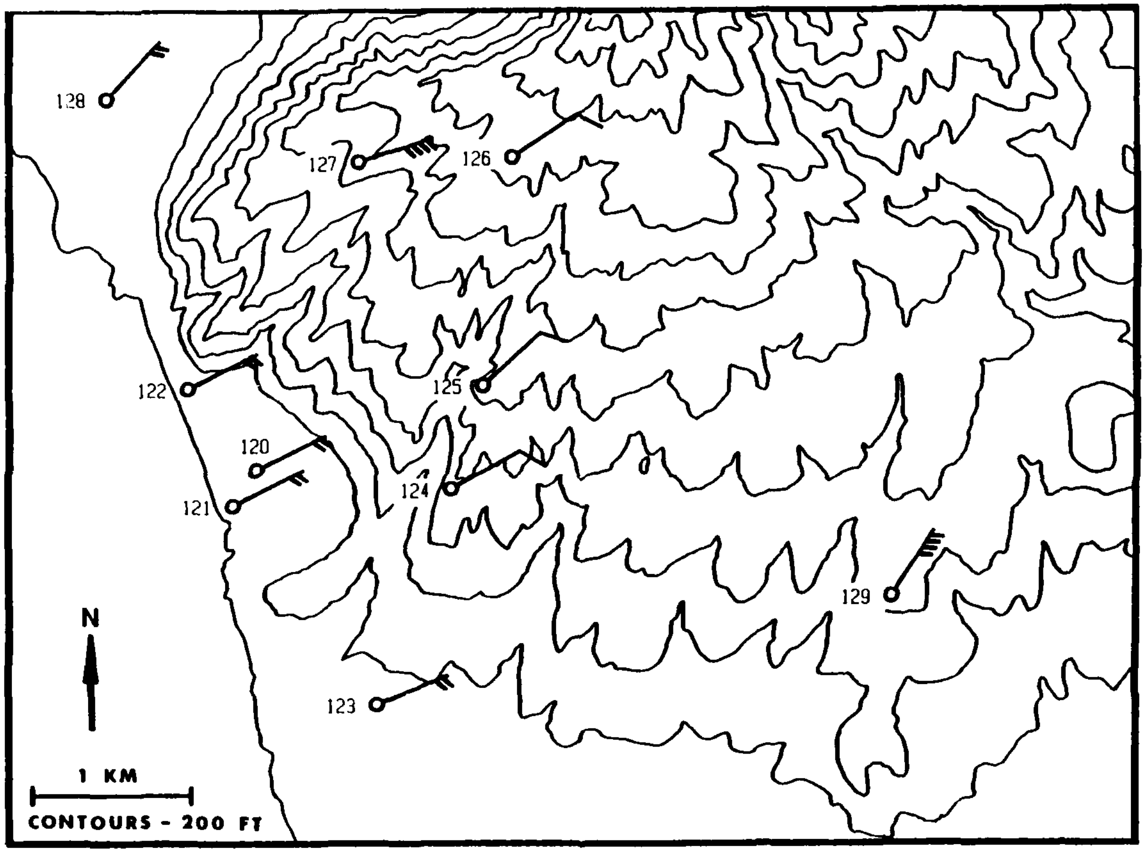

Figure 2a. Long-term resultant mean winds for 0000 HST. No barb is less than 1 ms^{-1}, half barb is 1 ms^{-1}, full barb is 5 ms^{-1}.

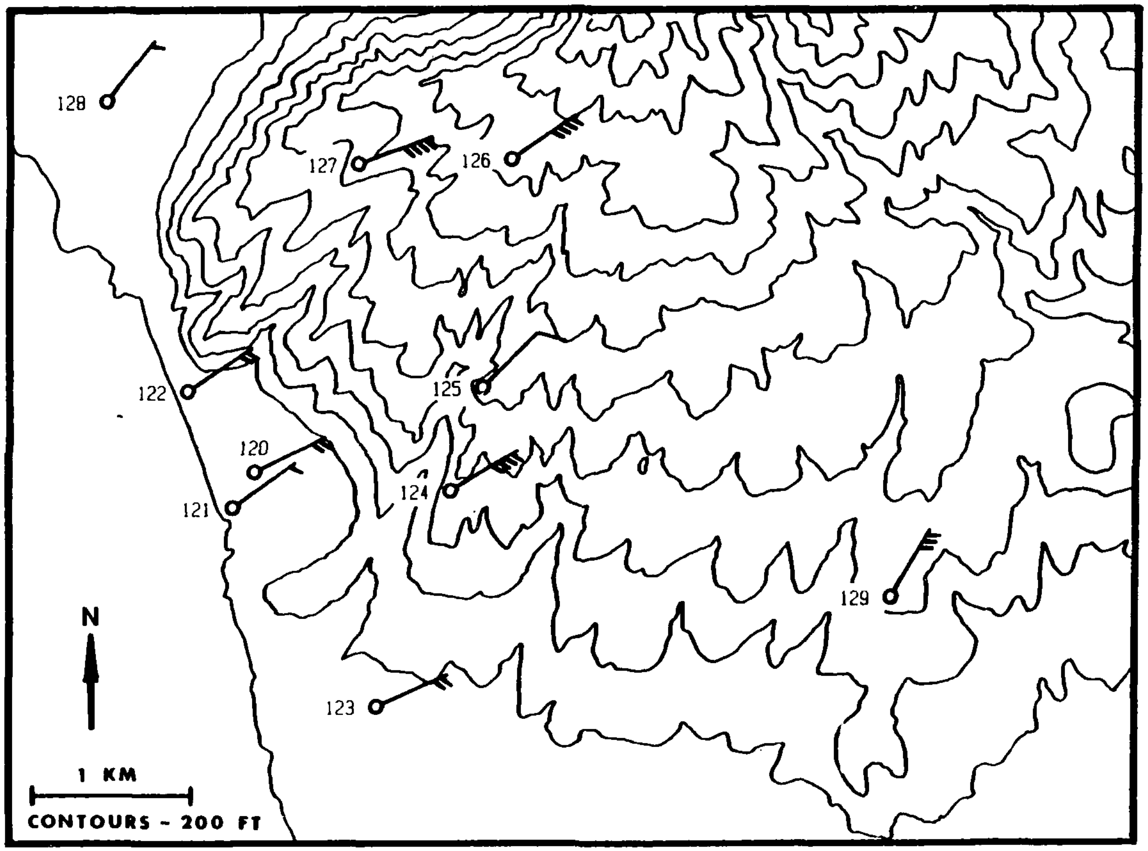

Figure 2b. Long-term resultant mean winds for 0300 HST. No barb is less than 1 ms^{-1}, half barb is 1 ms^{-1}, full barb is 5 ms^{-1}.

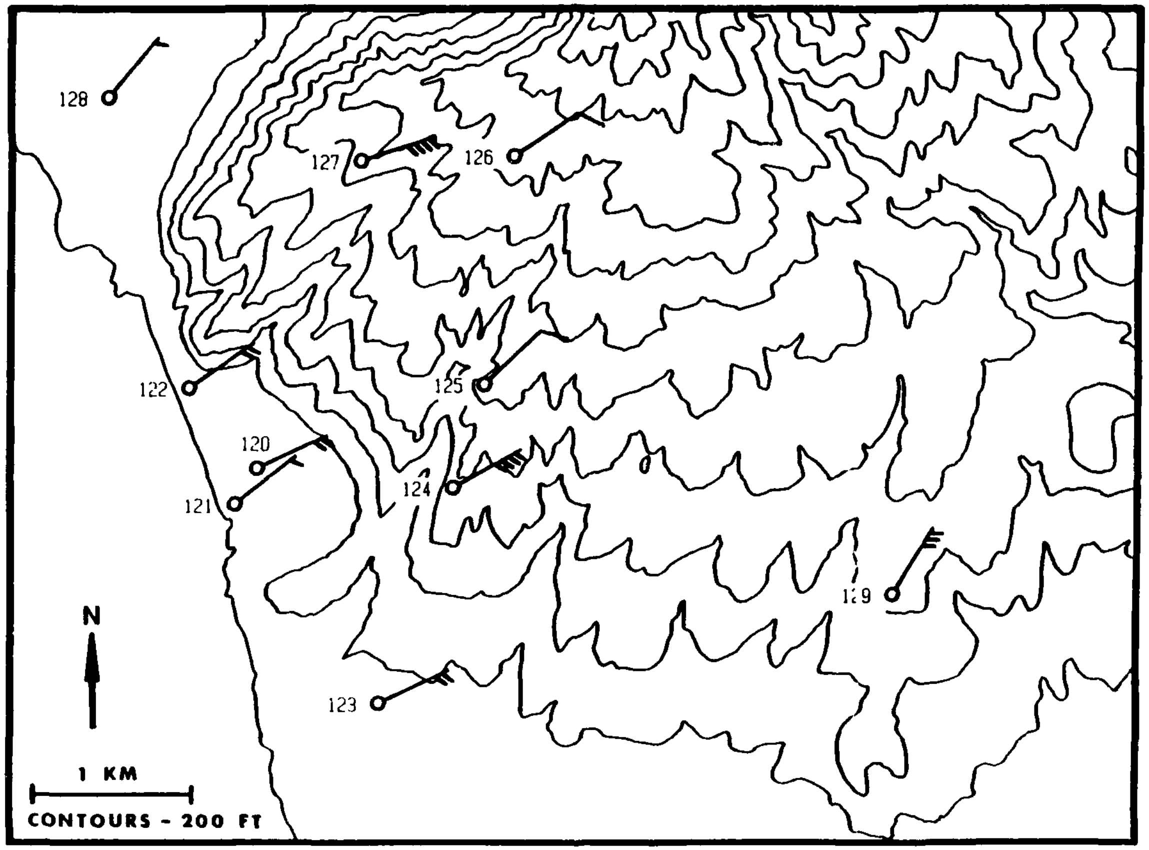

Figure 2c. Long-term resultant mean winds for 0600 HST. No barb is less than 1 ms^{-1}, half barb is 1 ms^{-1}, full barb is 5 ms^{-1}.

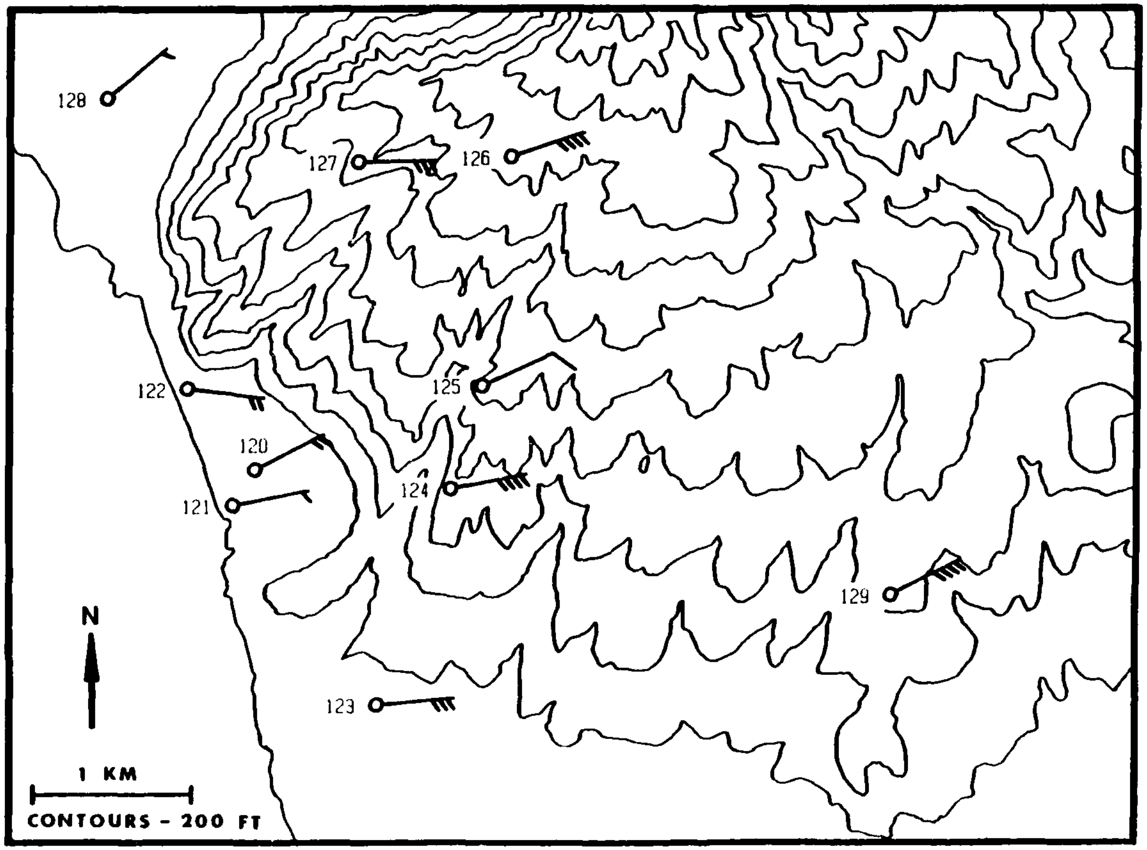

Figure 2d. Long-term resultant mean winds for 0900 HST. No barb is less than 1 ms^{-1}, half barb is 1 ms^{-1}, full barb is 5 ms^{-1}.

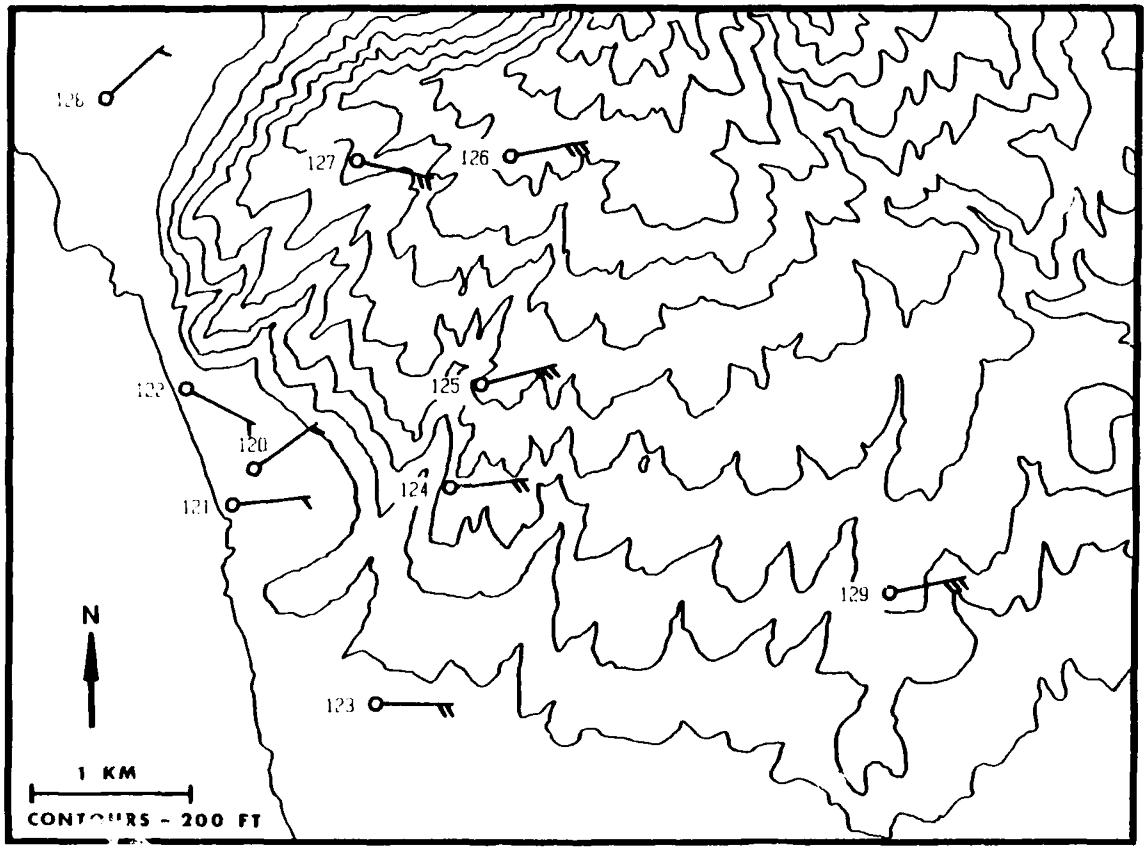

Figure 2e. Long-term resultant mean winds for 1200 HST. No barb is less than 1 ms^{-1}, half barb is 1 ms^{-1}, full barb is 5 ms^{-1}.

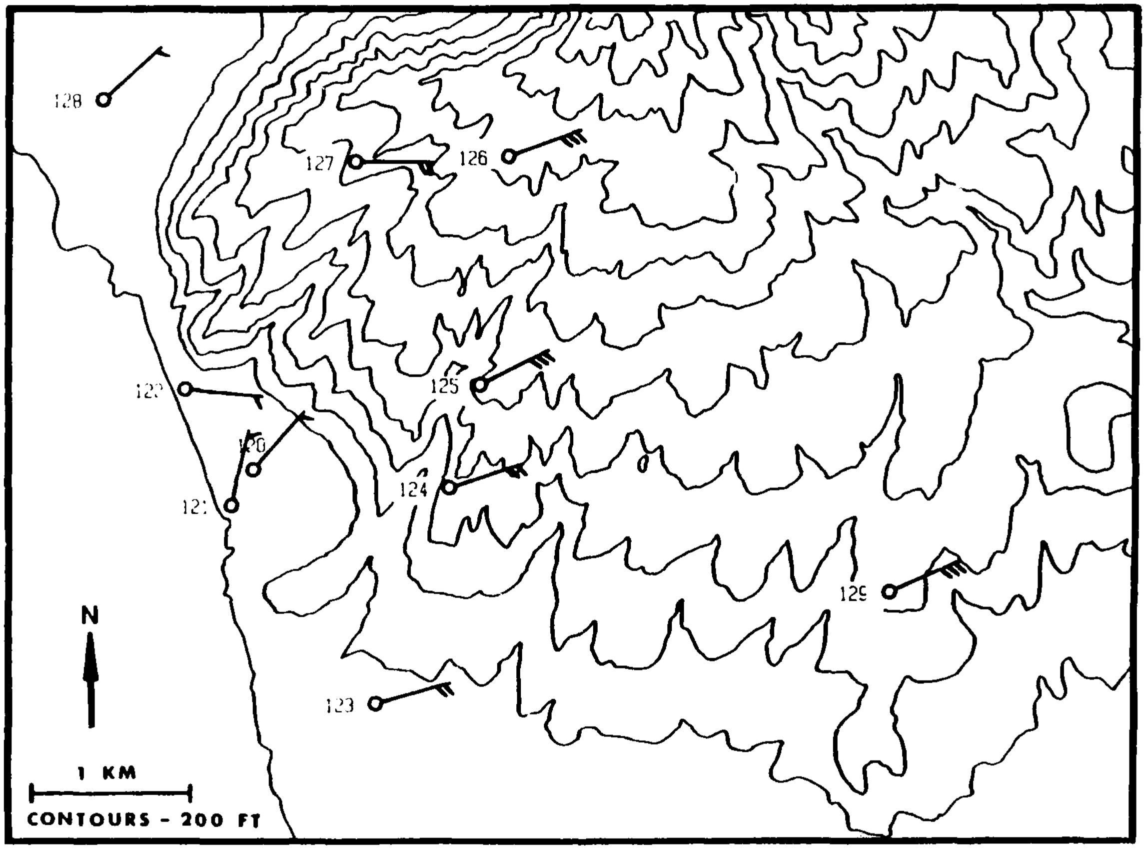

Figure 2f. Long-term resultant mean winds for 1500 HST. No barb is less than 1 ms^{-1}, half barb is 1 ms^{-1}, full barb is 5 ms^{-1}.

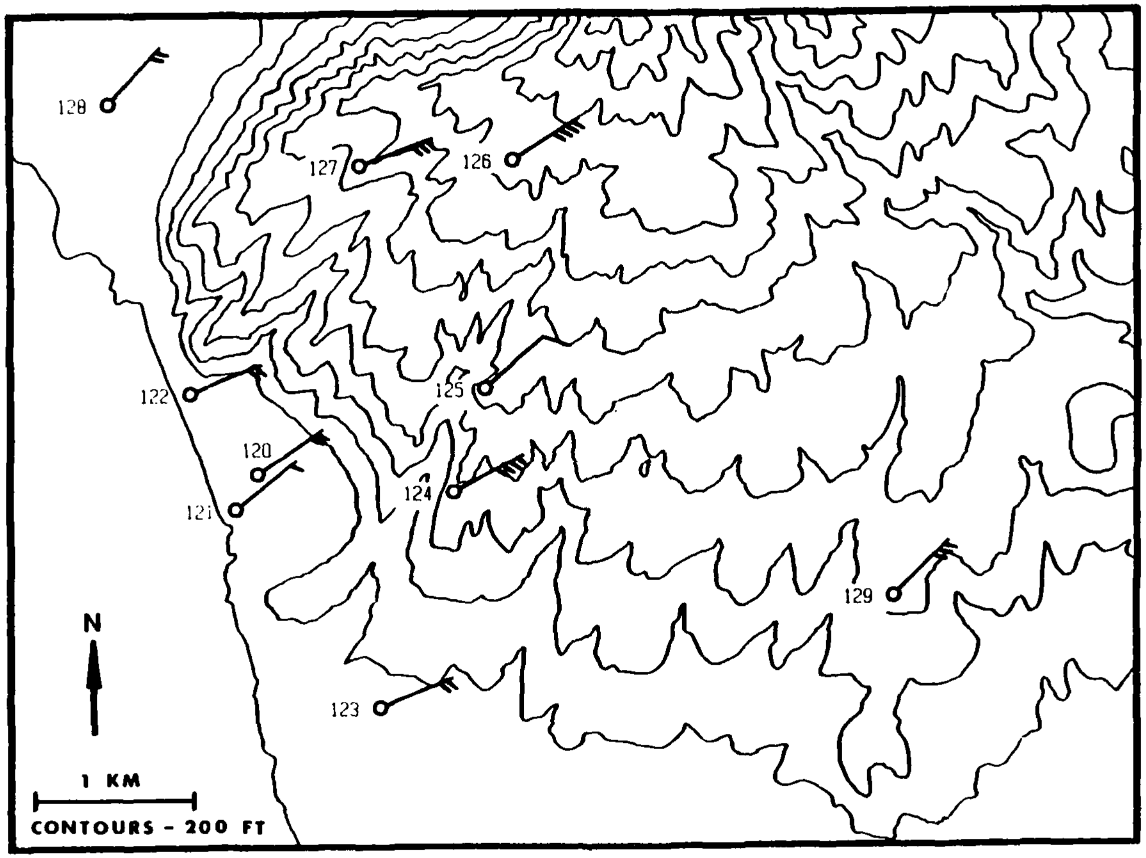

Figure 2g. Long-term resultant mean winds for 1800 HST. No barb is less than 1 ms^{-1}, half barb is 1 ms^{-1}, full barb is 5 ms^{-1}.

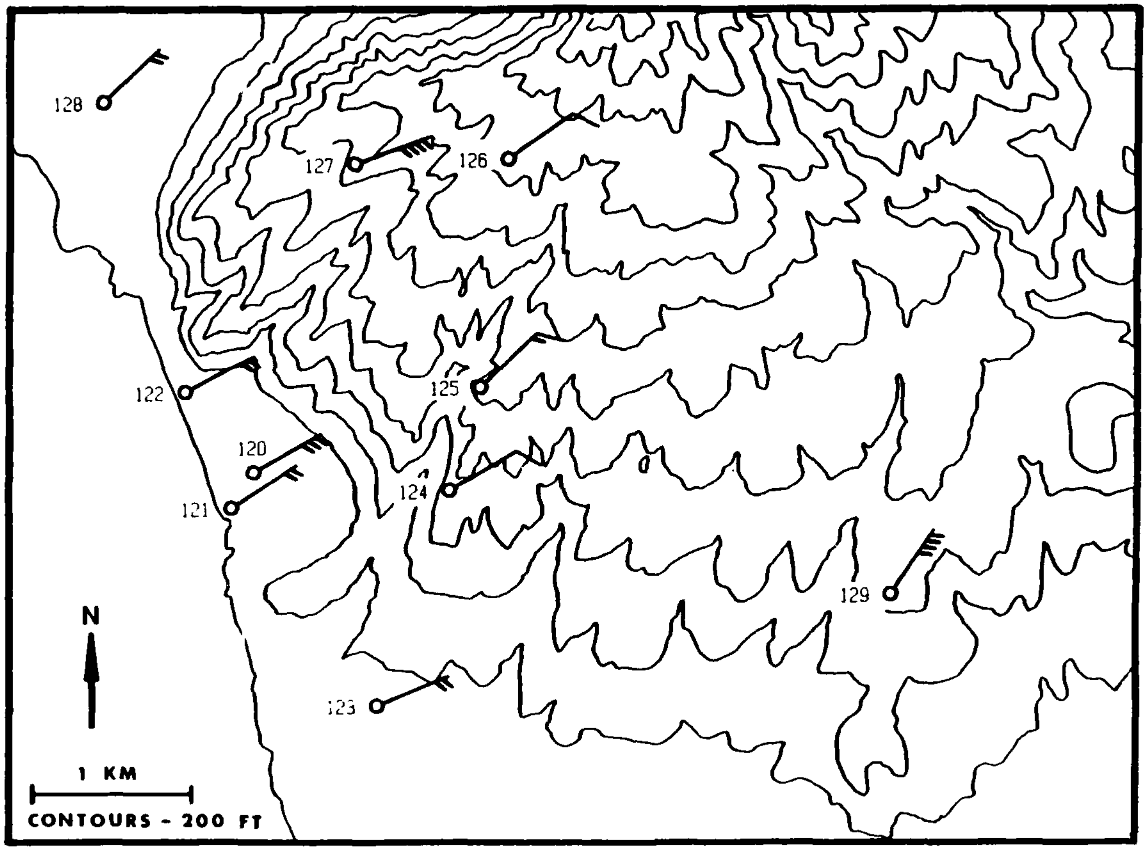

Figure 2h. Long-term resultant mean winds for 2100 HST. No barb is less than 1 ms^{-1}, half barb is 1 ms^{-1}, full barb is 5 ms^{-1}.

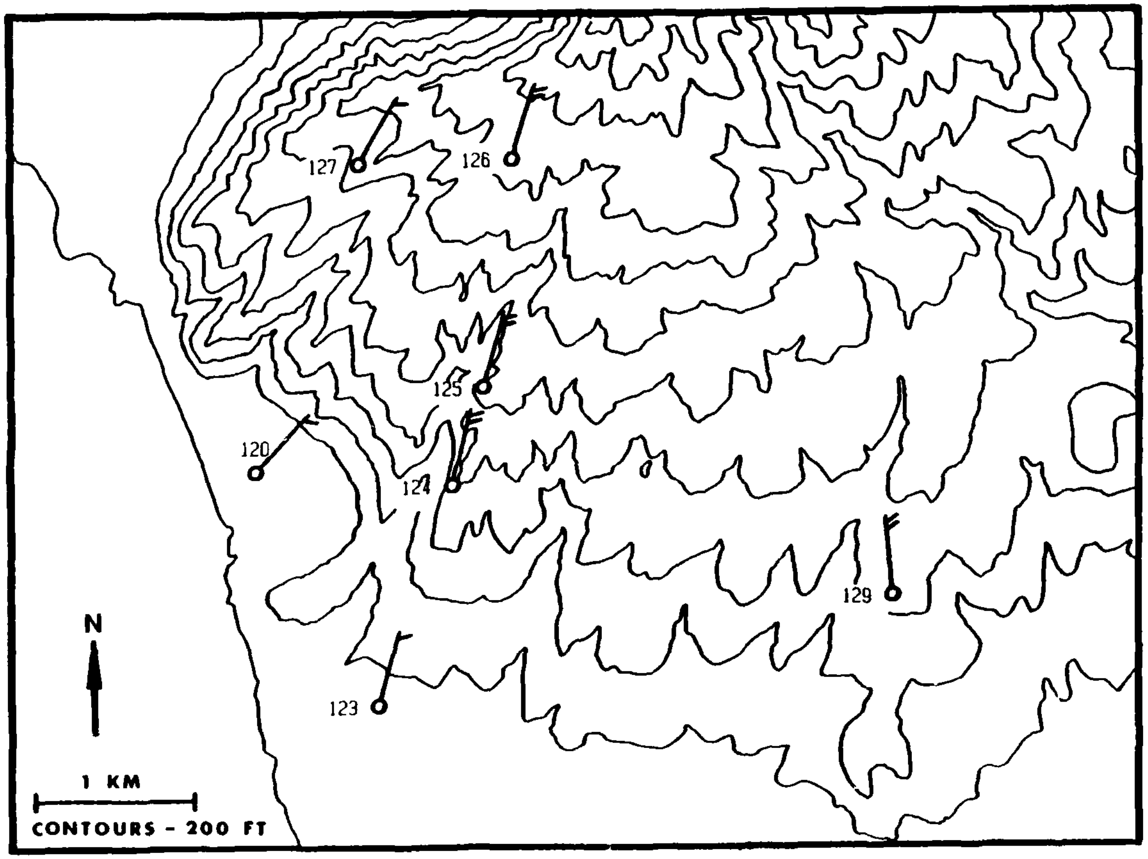

Figure 3a. January-March 1983 resultant mean winds for 0000 HST. No barb is less than 1 ms^{-1}, half barb is 1 ms^{-1}, full barb is 5 ms^{-1}.

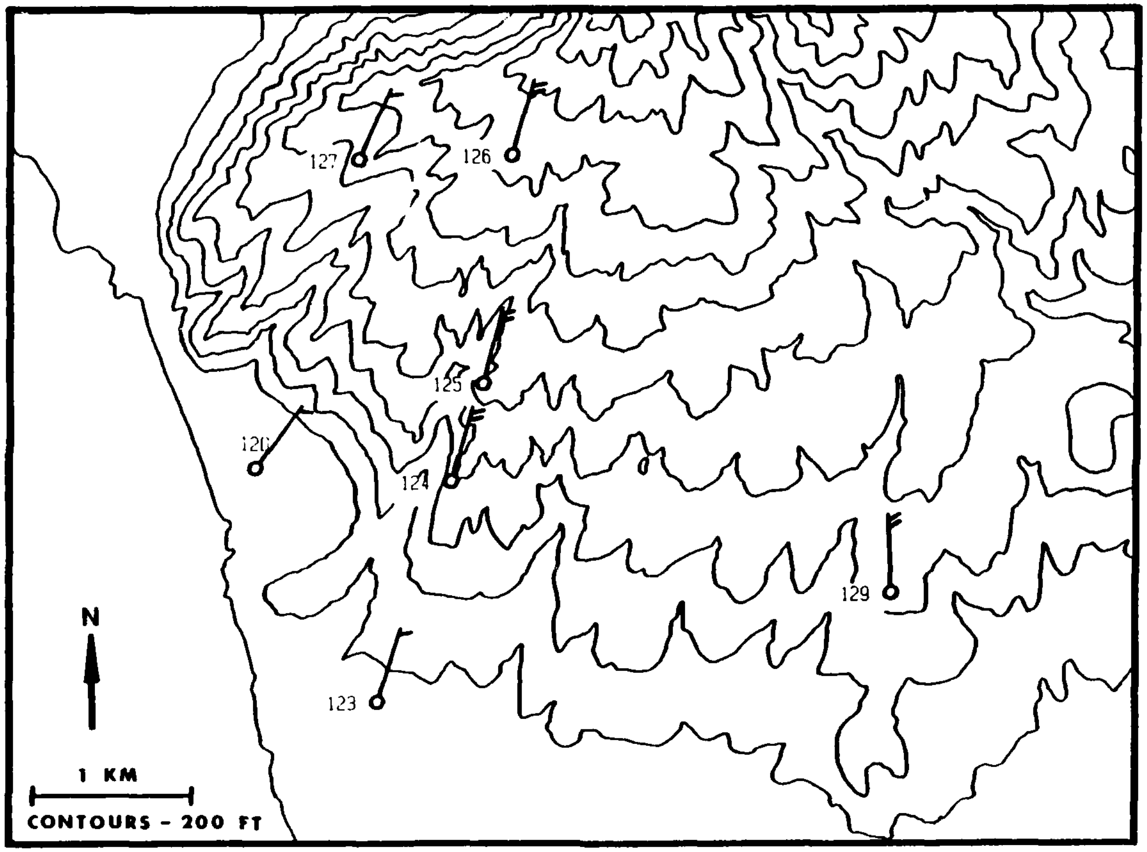

Figure 3b. January-March 1983 resultant mean winds for 0100 HST. No barb is less than 1 ms^{-1}, half barb is 1 ms^{-1}, full barb is 5 ms^{-1}.

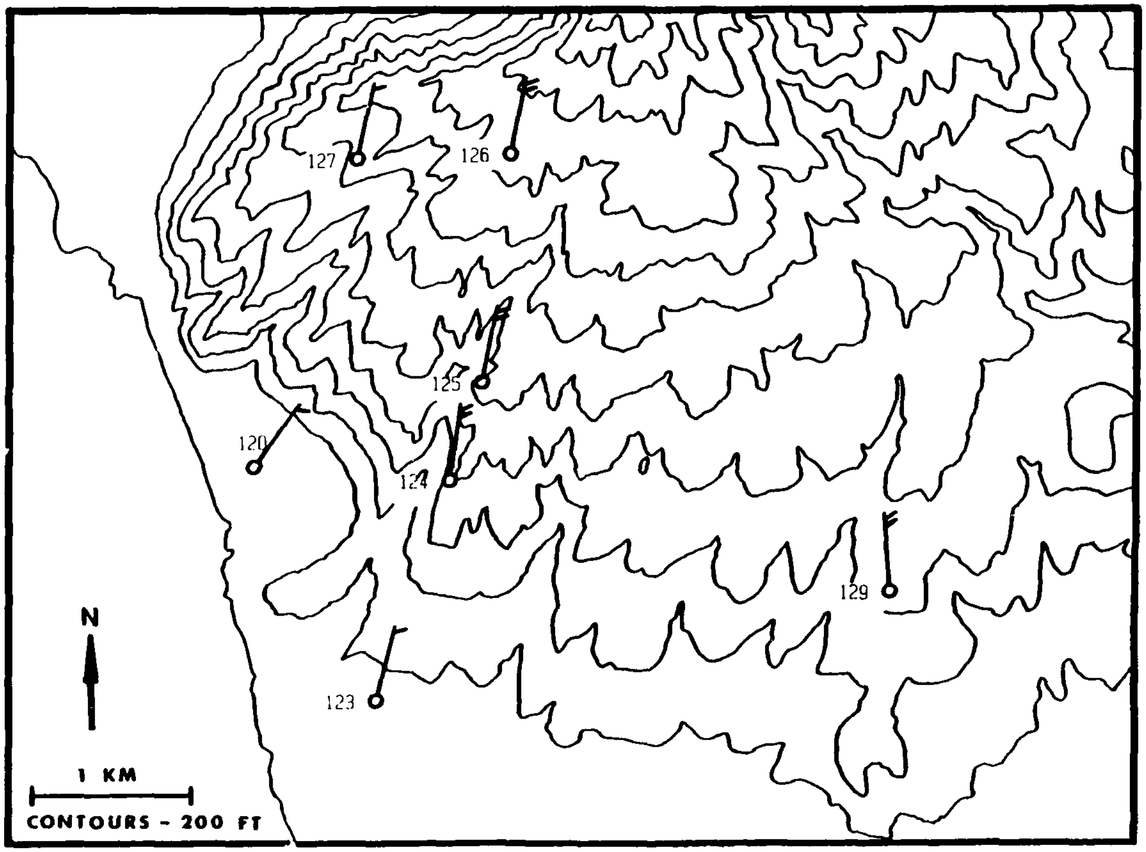

Figure 3c. January-March 1983 resultant mean winds for 0200 HST. No barb is less than 1 ms^{-1}, half barb is 1 ms^{-1}, full barb is 5 ms^{-1}.

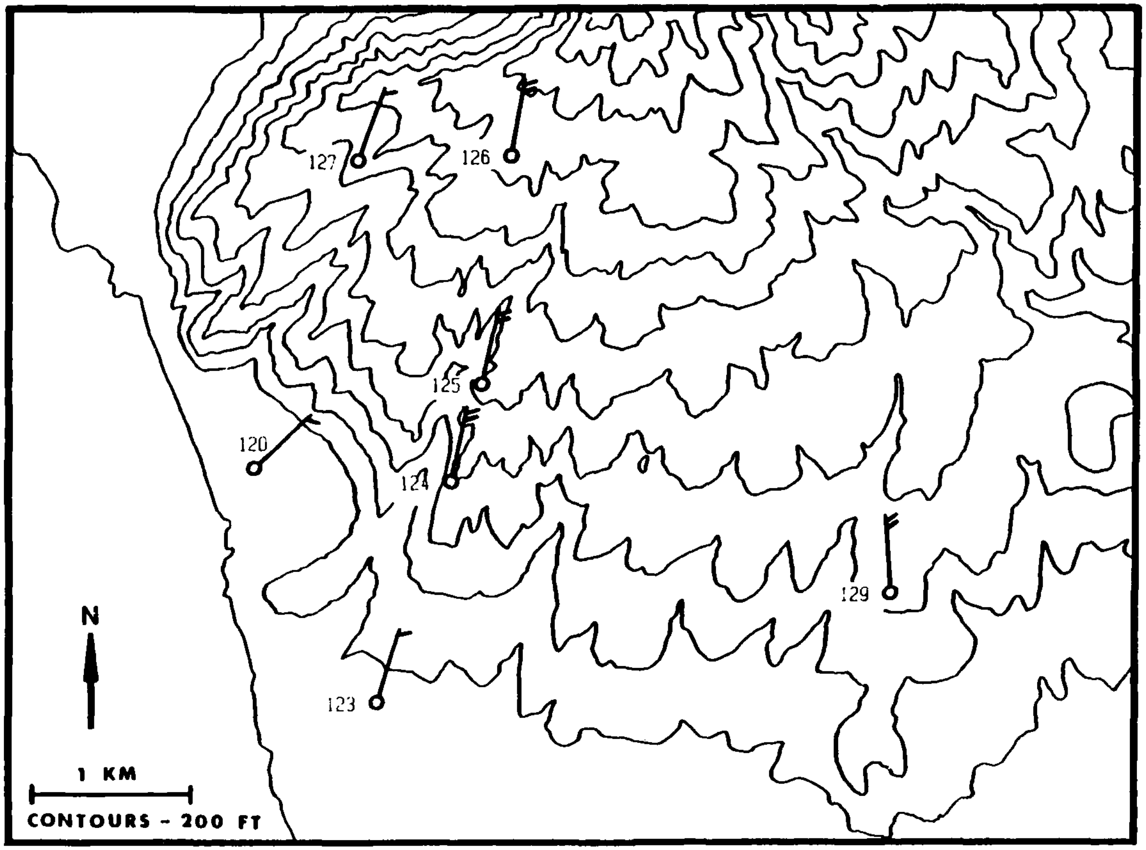

Figure 3d. January-March 1983 resultant mean winds for 0300 HST. No barb is less than 1 ms^{-1}, half barb is 1 ms^{-1}, full barb is 5 ms^{-1}.

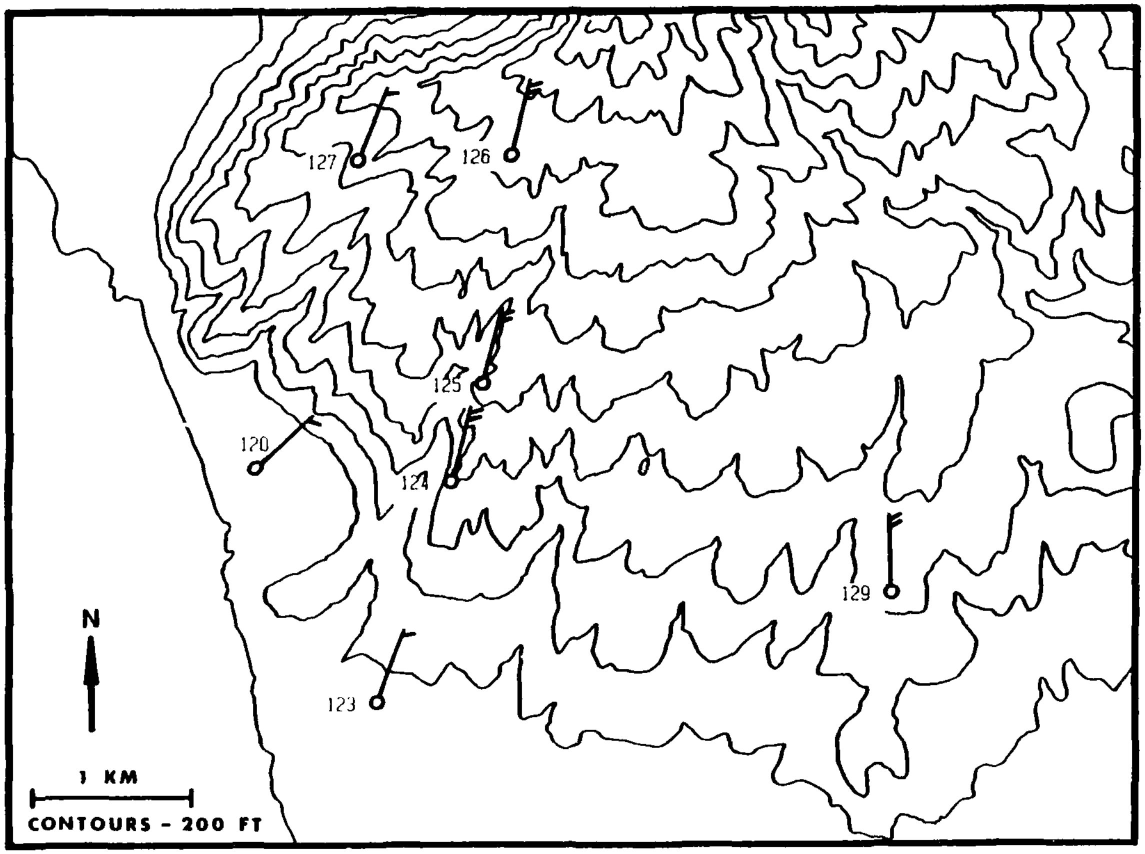

Figure 3e. January-March 1983 resultant mean winds for 0400 HST. No barb is less than 1 ms^{-1}, half barb is 1 ms^{-1}, full barb is 5 ms^{-1}.

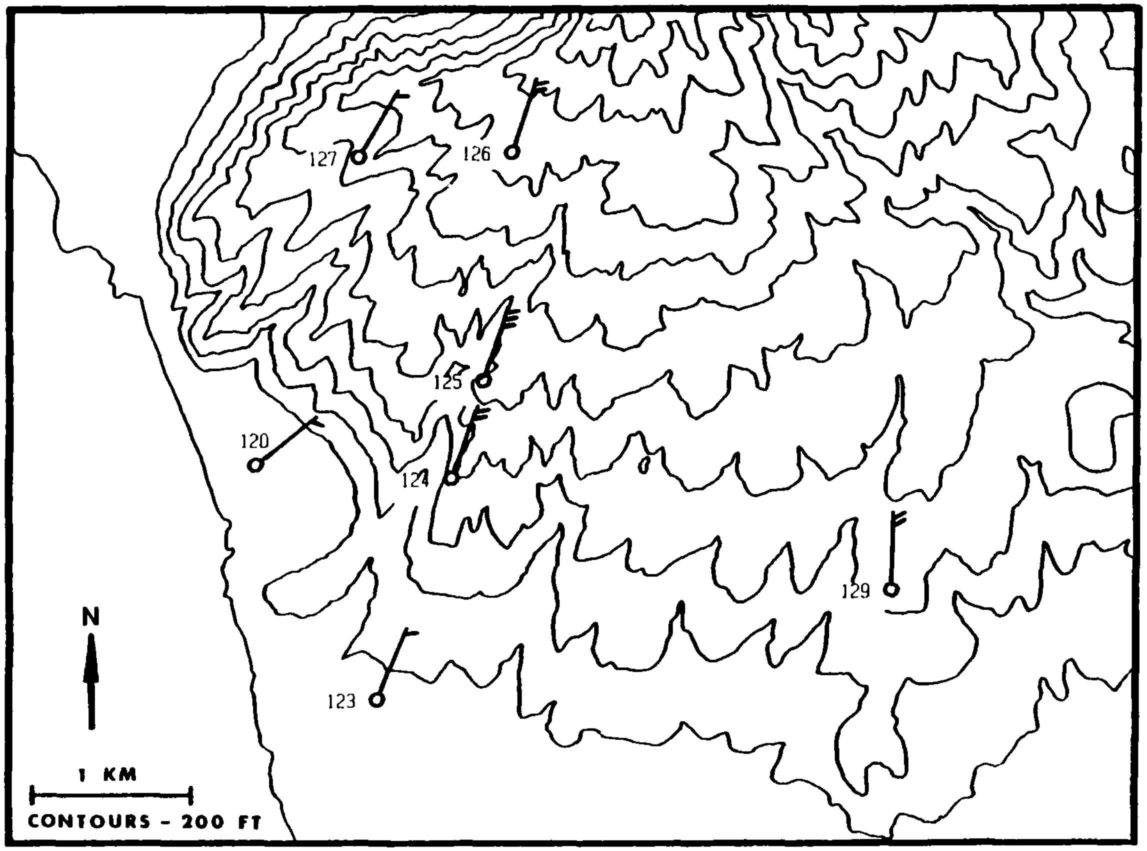

Figure 3f. January-March 1983 resultant mean winds for 0500 HST. No barb is less than 1 ms^{-1}, half barb is 1 ms^{-1}, full barb is 5 ms^{-1}.

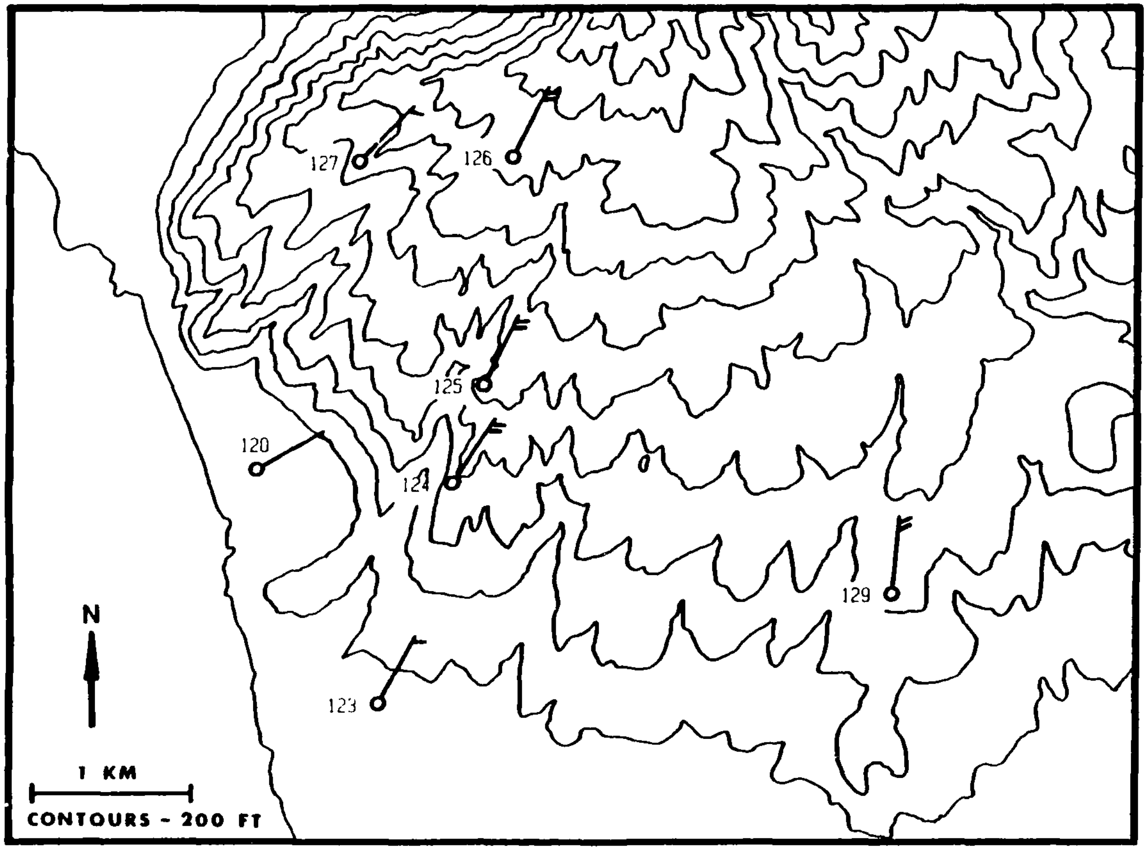

Figure 3g. January-March 1983 resultant mean winds for 0600 HST. No barb is less than 1 ms^{-1}, half barb is 1 ms^{-1}, full barb is 5 ms^{-1}.

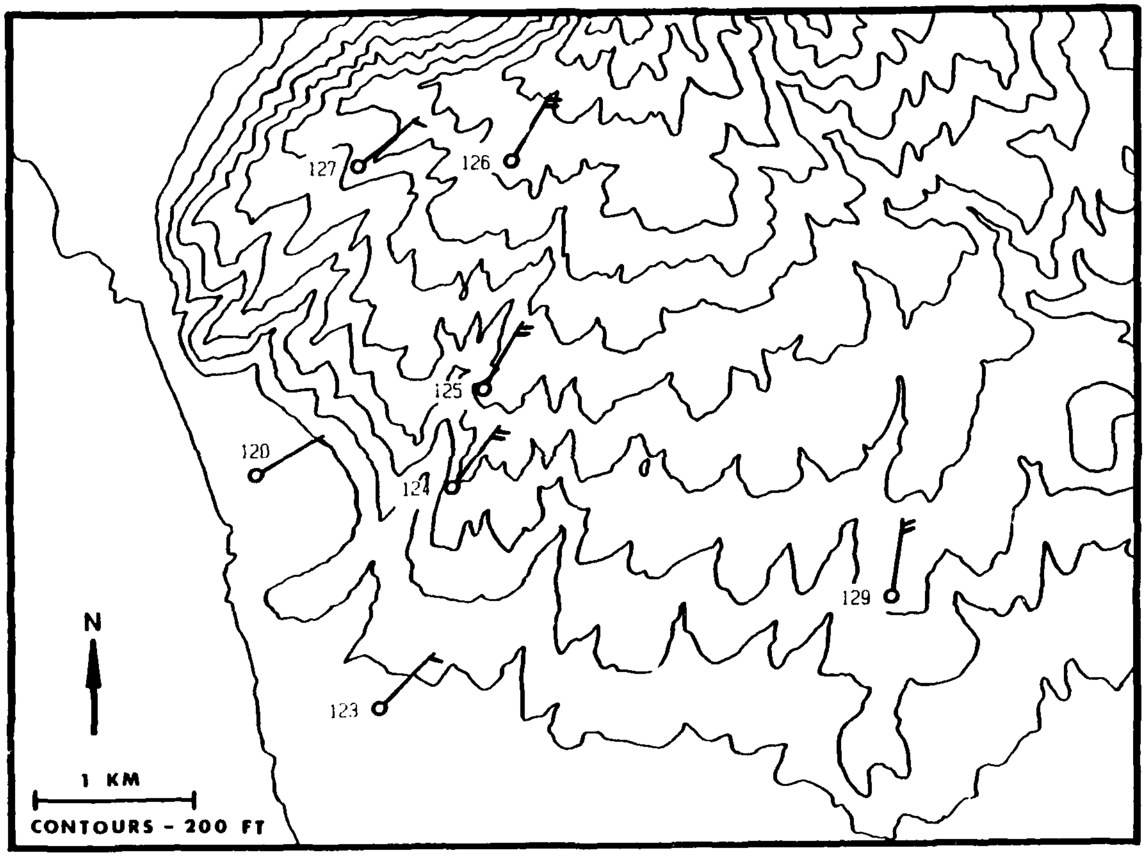

Figure 3h. January-March 1983 resultant mean winds for 0700 HST. No barb is less than 1 ms^{-1}, half barb is 1 ms^{-1}, full barb is 5 ms^{-1}.

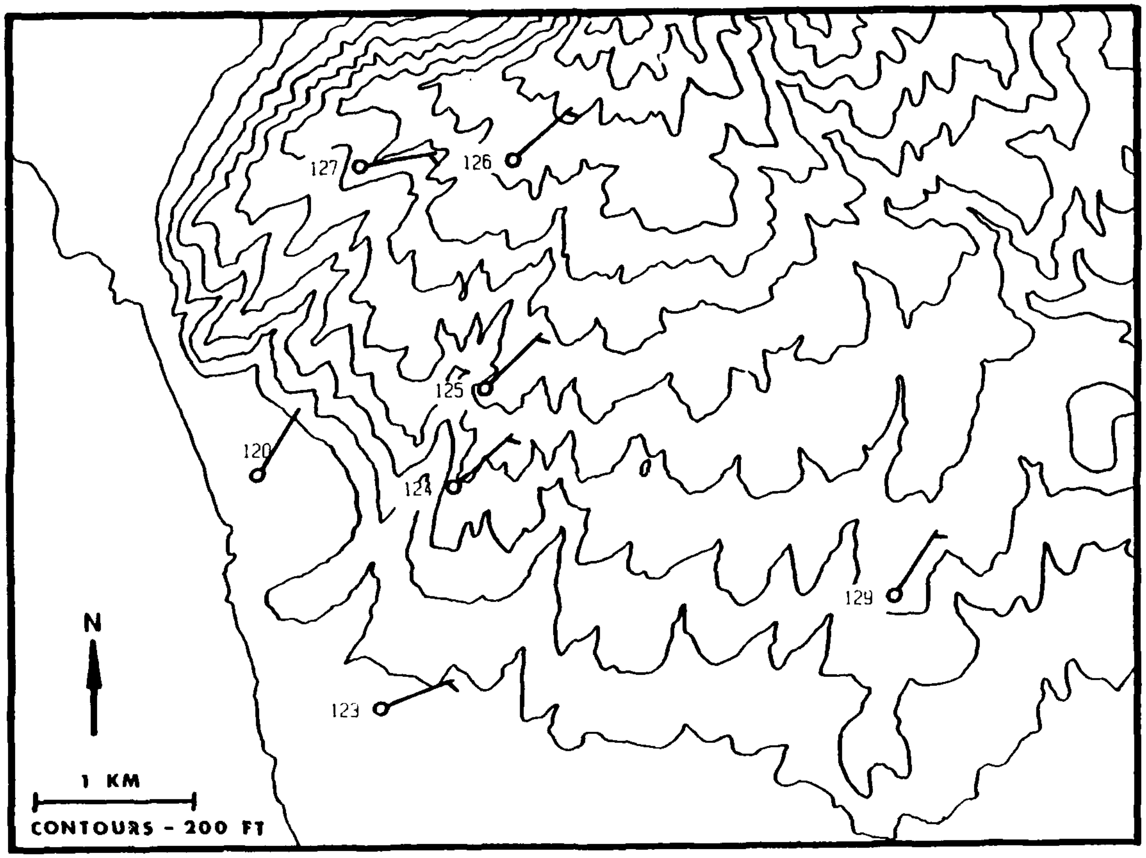

Figure 3i. January-March 1983 resultant mean winds for 0800 HST. No barb is less than 1 ms^{-1}, half barb is 1 ms^{-1}, full barb is 5 ms^{-1}.

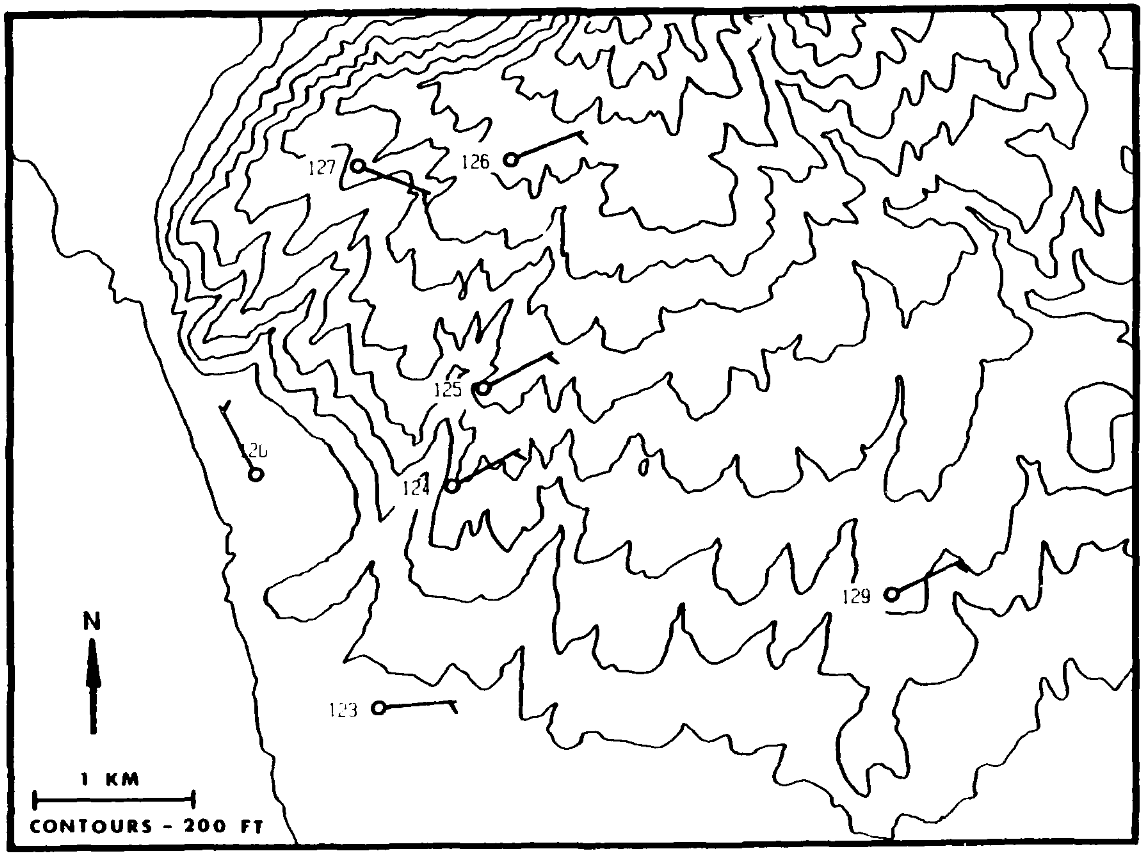

Figure 3j. January-March 1983 resultant mean winds for 0900 HST. No barb is less than 1 ms^{-1}, half barb is 1 ms^{-1}, full barb is 5 ms^{-1}.

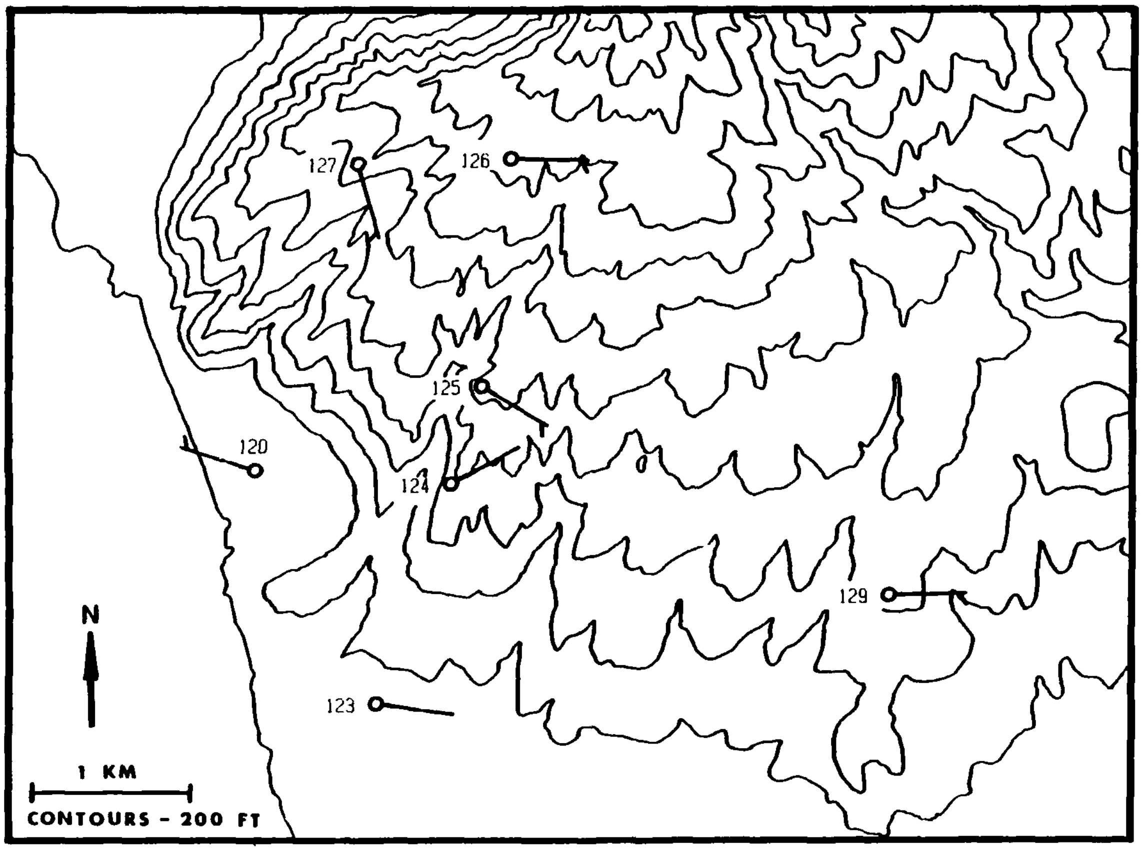

Figure 3k. January-March 1983 resultant mean winds for 1000 HST. No barb is less than 1 ms^{-1}, half barb is 1 ms^{-1}, full barb is 5 ms^{-1}.

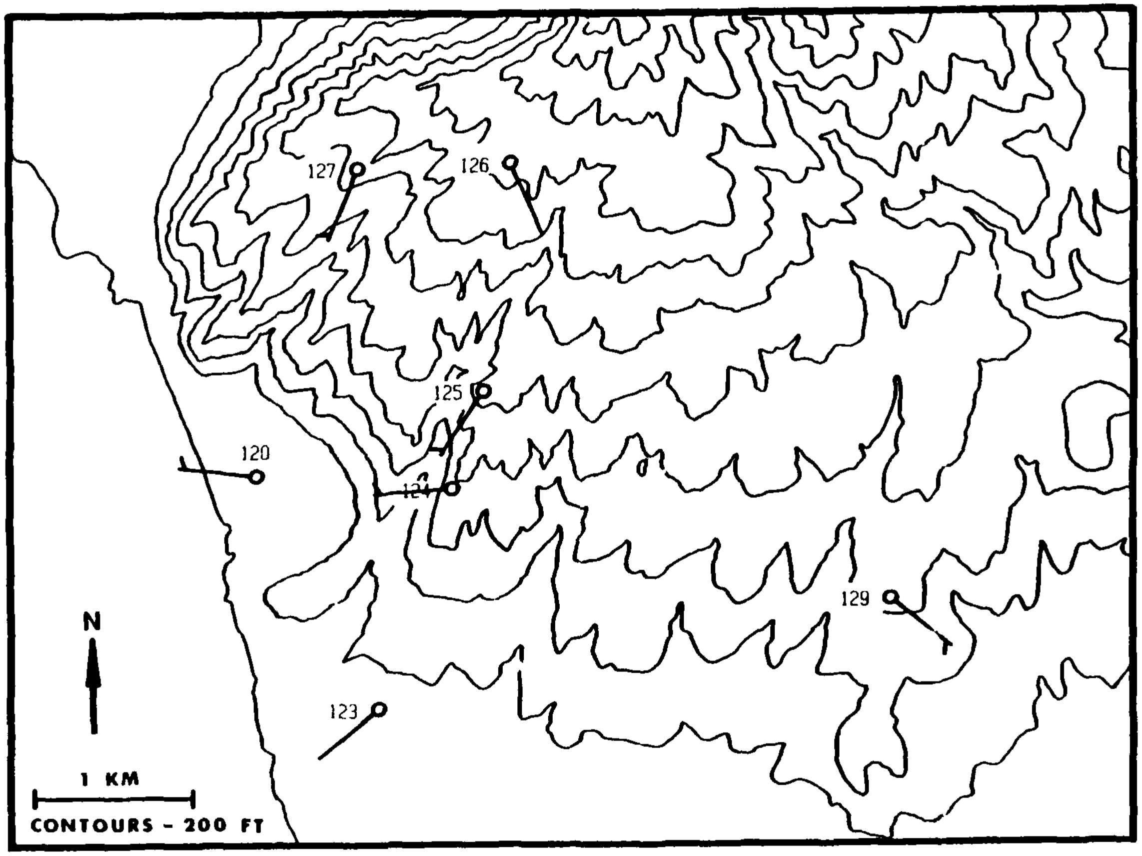

Figure 31. January-March 1983 resultant mean winds for 1100 HST. No barb is less than 1 ms^{-1}, half barb is 1 ms^{-1}, full barb is 5 ms^{-1}.

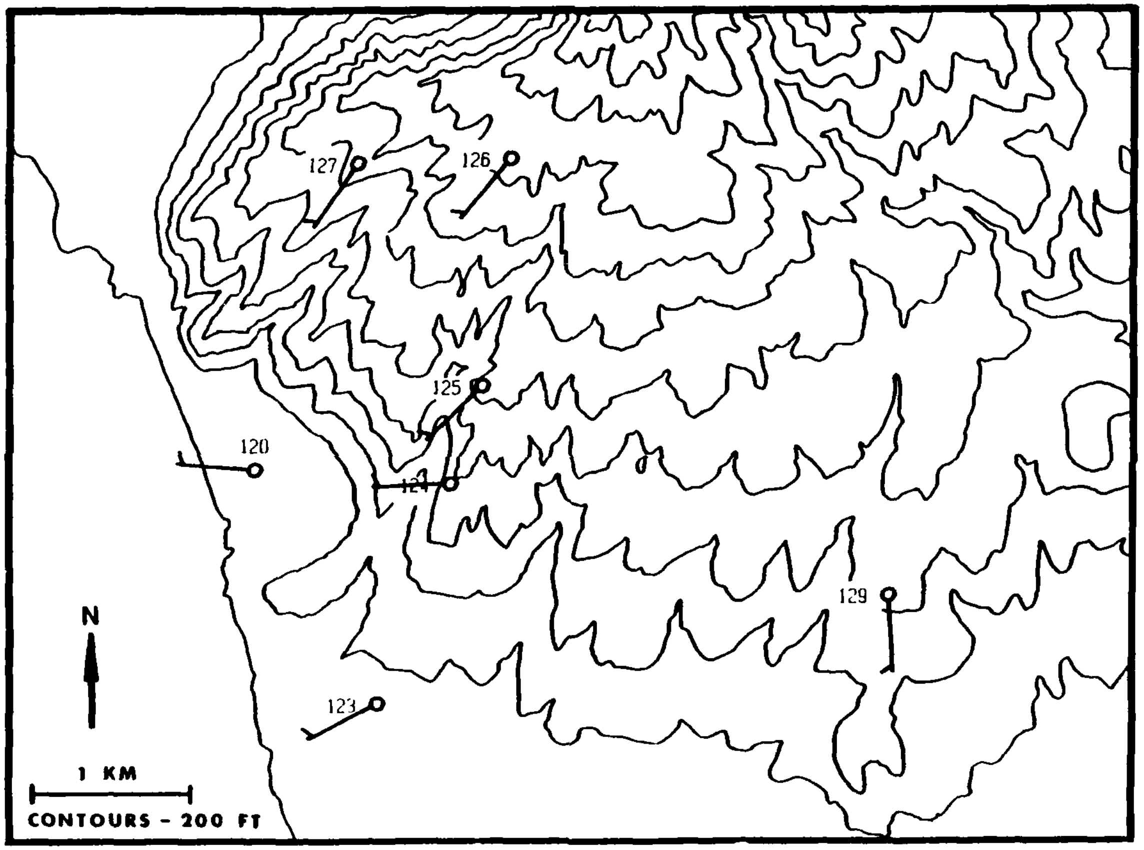

Figure 3m. January-March 1983 resultant mean winds for 1200 HST. No barb is less than 1 ms^{-1}, half barb is 1 ms^{-1}, full barb is 5 ms^{-1}.

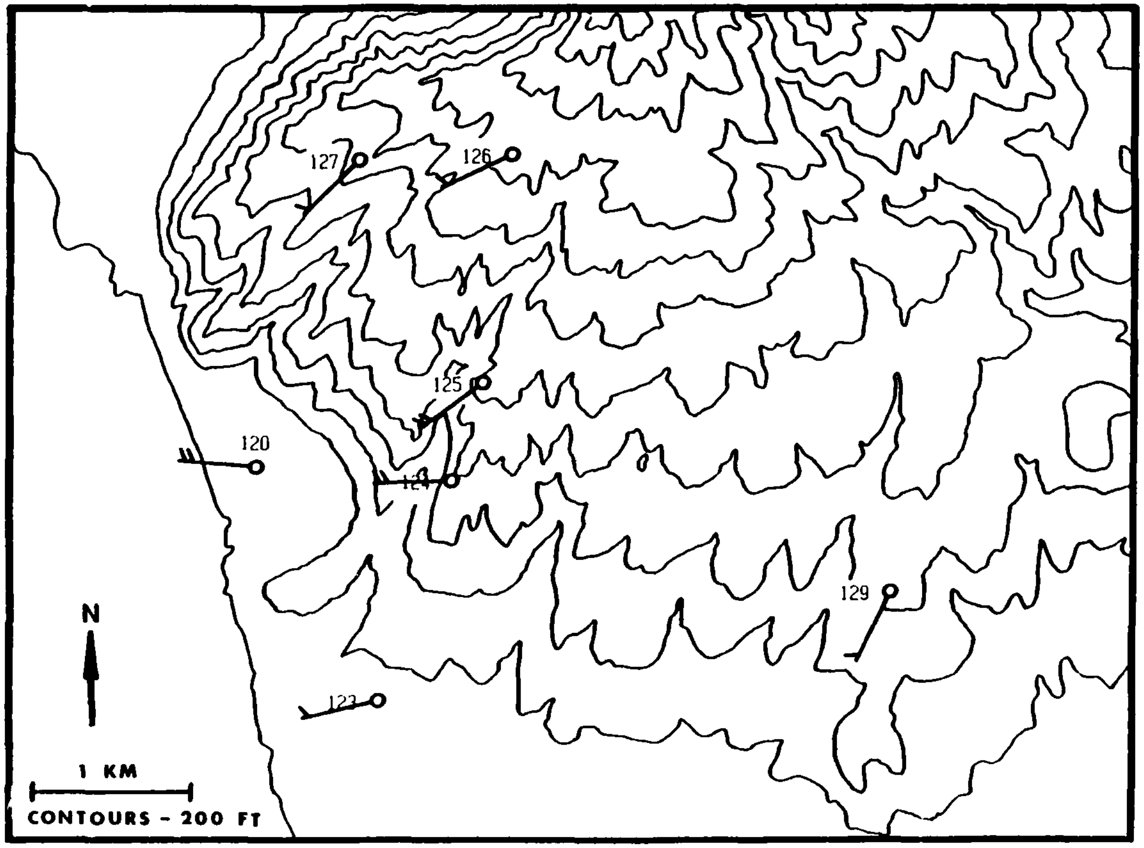

Figure 3n. January-March 1983 resultant mean winds for 1300 HST. No barb is less than 1 ms^{-1}, half barb is 1 ms^{-1}, full barb is 5 ms^{-1}.

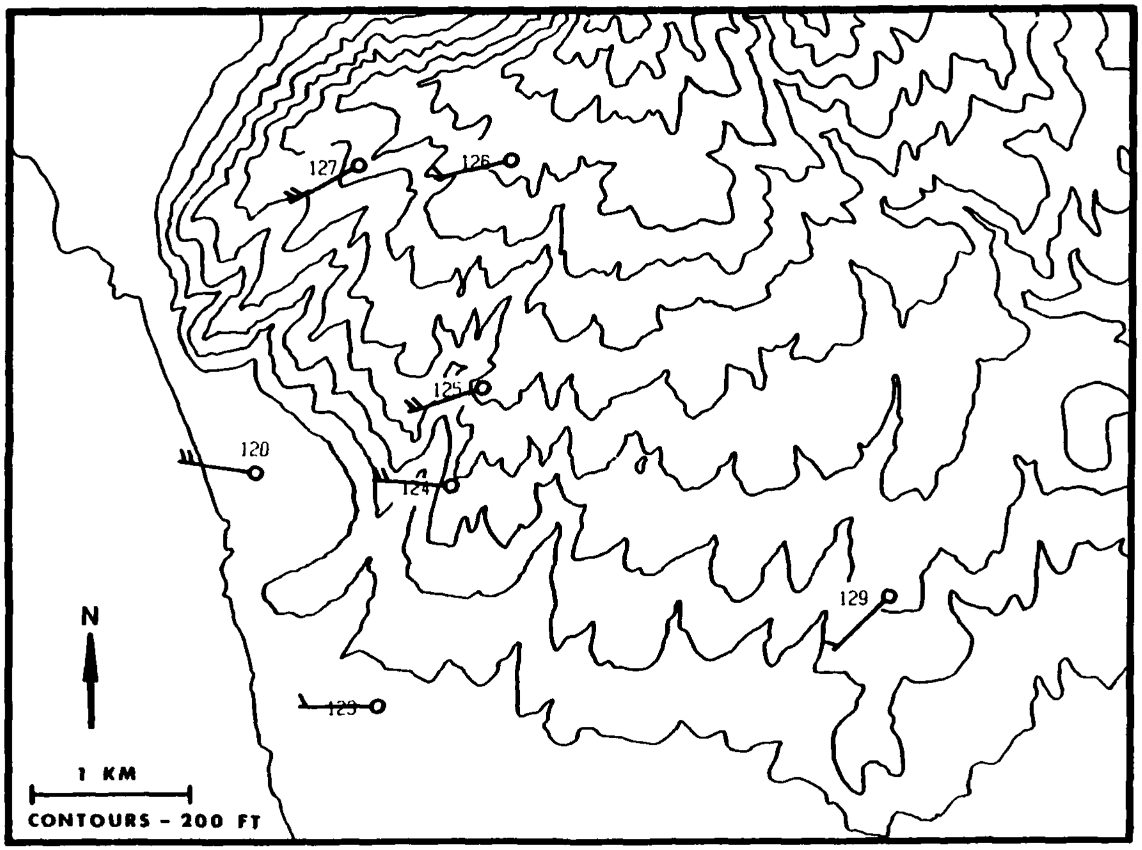

Figure 3o. January-March 1983 resultant mean winds for 1400 HST. No barb is less than 1 ms^{-1}, half barb is 1 ms^{-1}, full barb is 5 ms^{-1}.

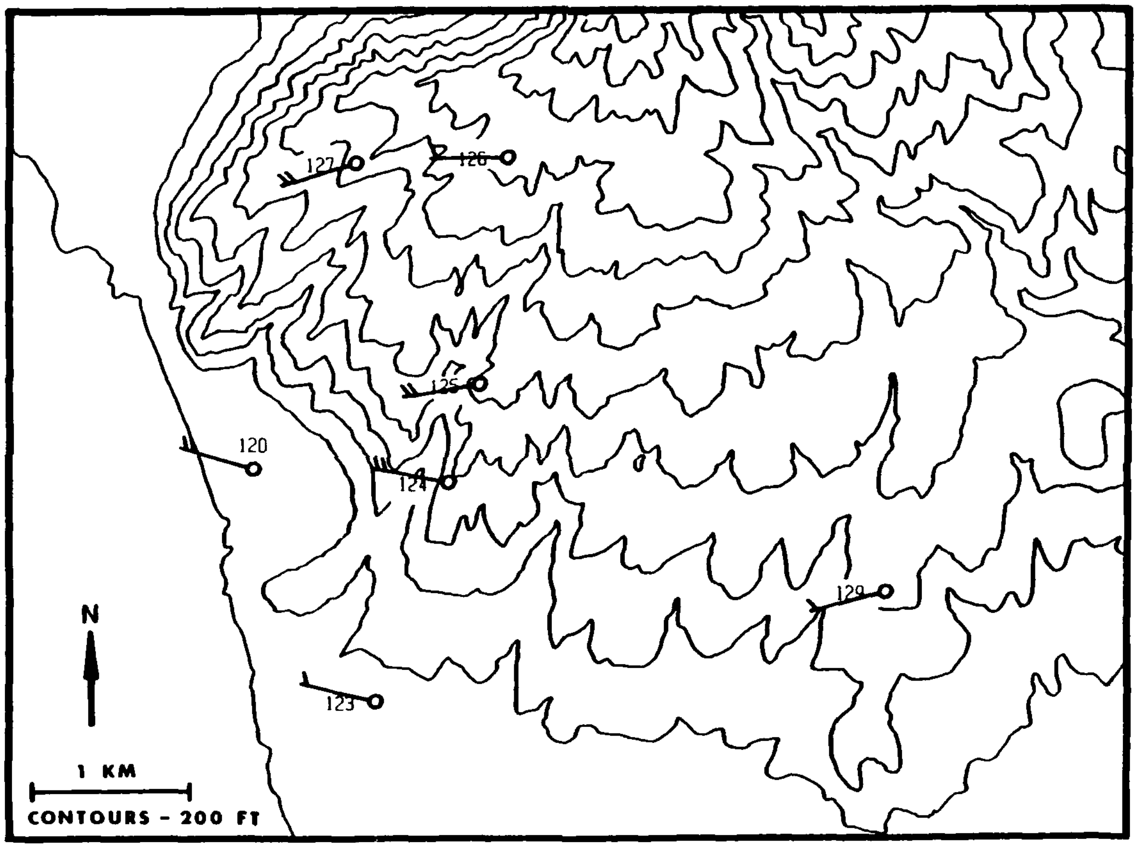

Figure 3p. January-March 1983 resultant mean winds for 1500 HST. No barb is less than 1 ms^{-1}, half barb is 1 ms^{-1}, full barb is 5 ms^{-1}.

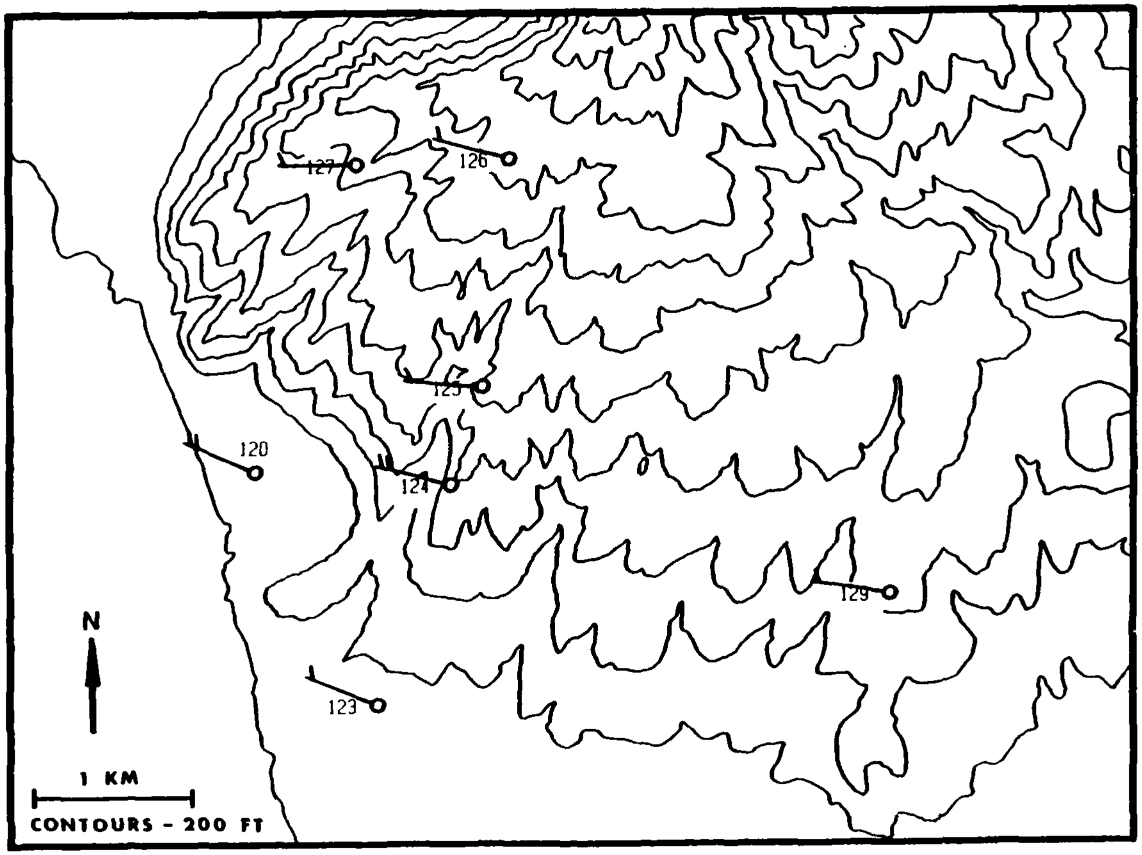

Figure 3q. January-March 1983 resultant mean winds for 1600 HST. No barb is less than 1 ms^{-1}, half barb is 1 ms^{-1}, full barb is 5 ms^{-1}.

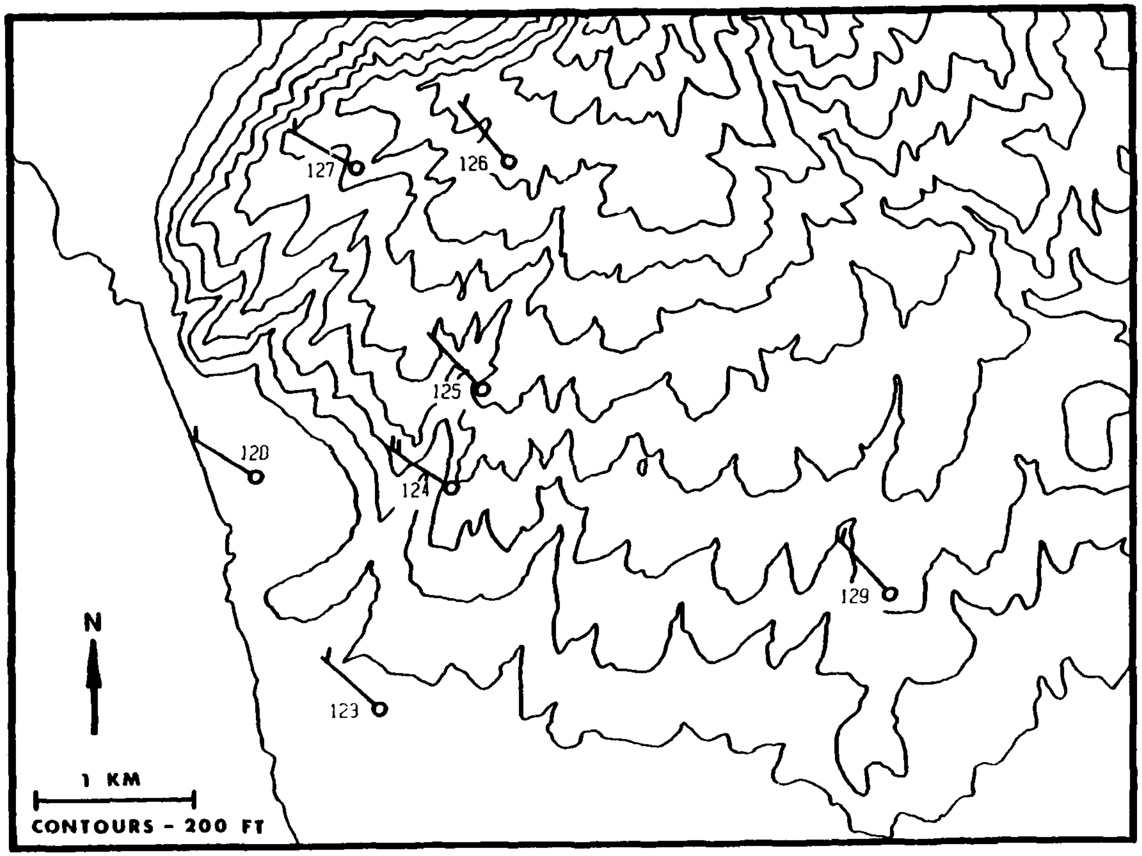

Figure 3r. January-March 1983 resultant mean winds for 1700 HST. No barb is less than 1 ms^{-1}, half barb is 1 ms^{-1}, full barb is 5 ms^{-1}.

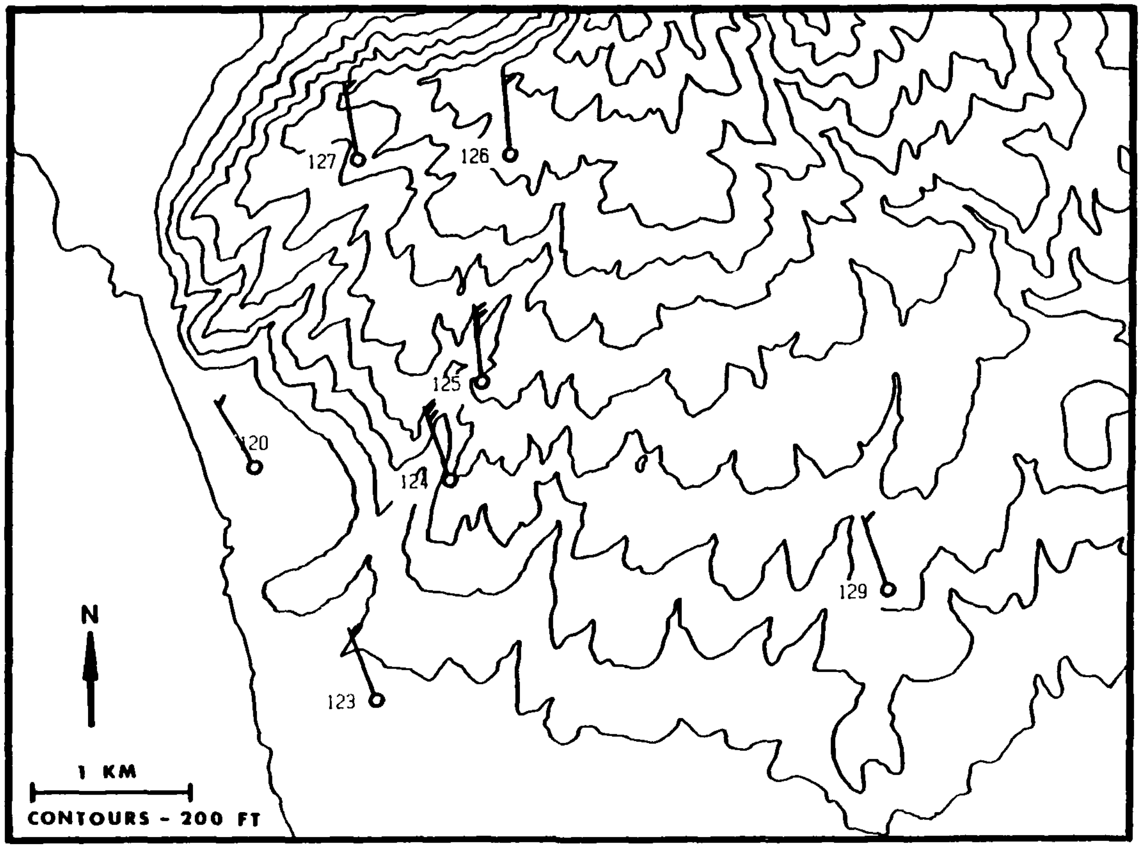

Figure 3s. January-March 1983 resultant mean winds for 1800 HST. No barb is less than 1 ms^{-1}, half barb is 1 ms^{-1}, full barb is 5 ms^{-1}.

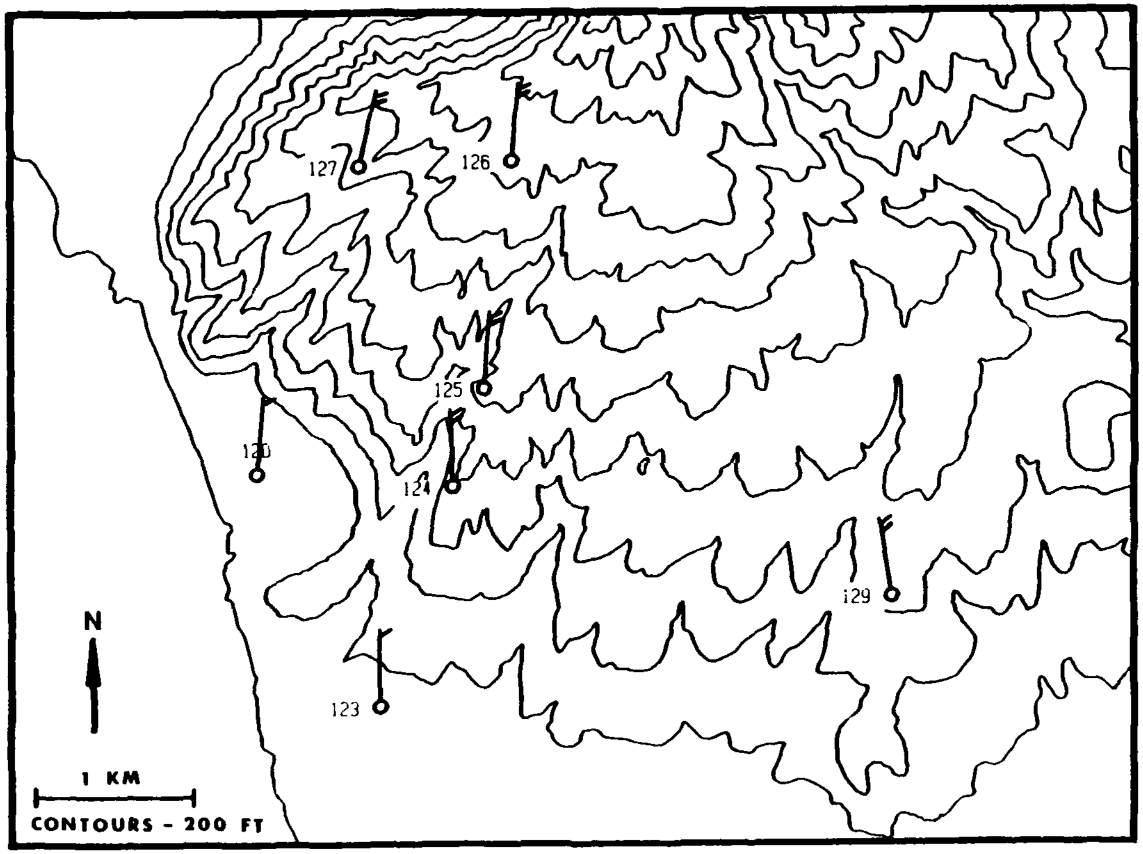

Figure 3t. January-March 1983 resultant mean winds for 1900 HST. No barb is less than 1 ms^{-1}, half barb is 1 ms^{-1}, full barb is 5 ms^{-1}.

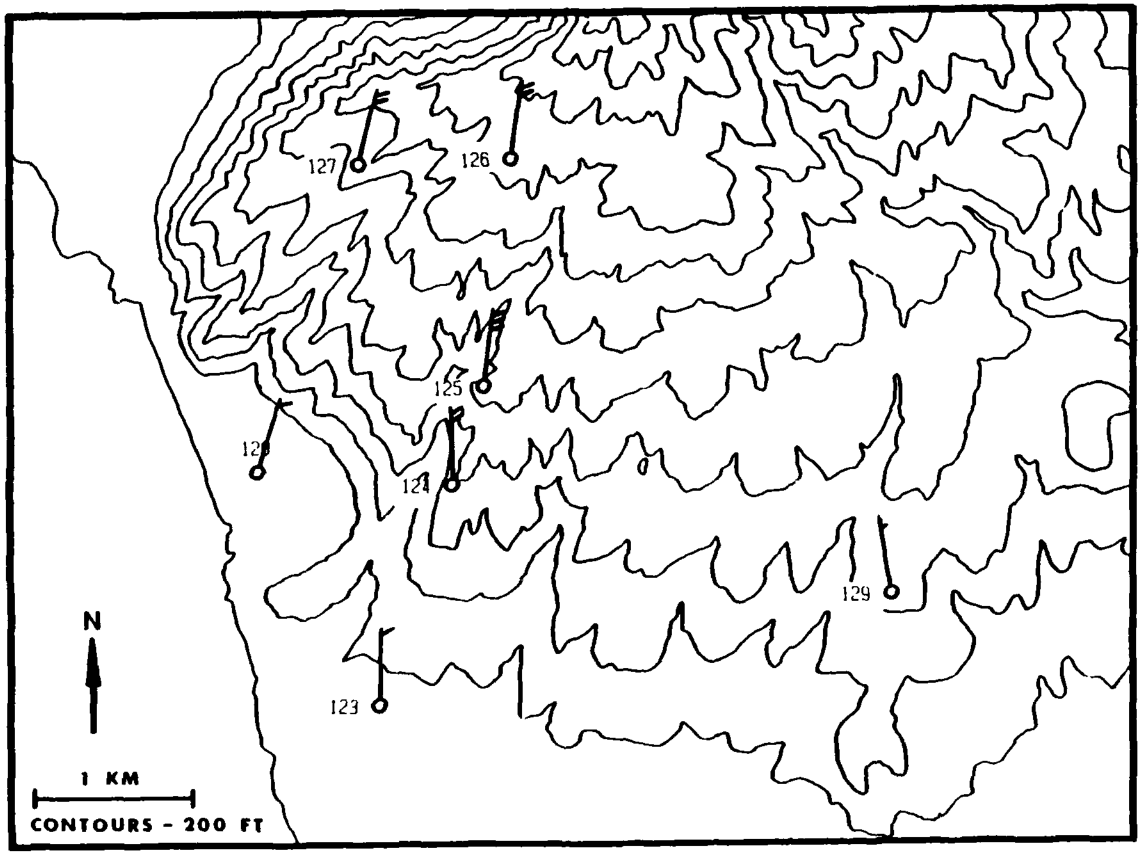

Figure 3u. January-March 1983 resultant mean winds for 2000 HST. No barb is less than 1 ms^{-1}, half barb is 1 ms^{-1}, full barb is 5 ms^{-1}.

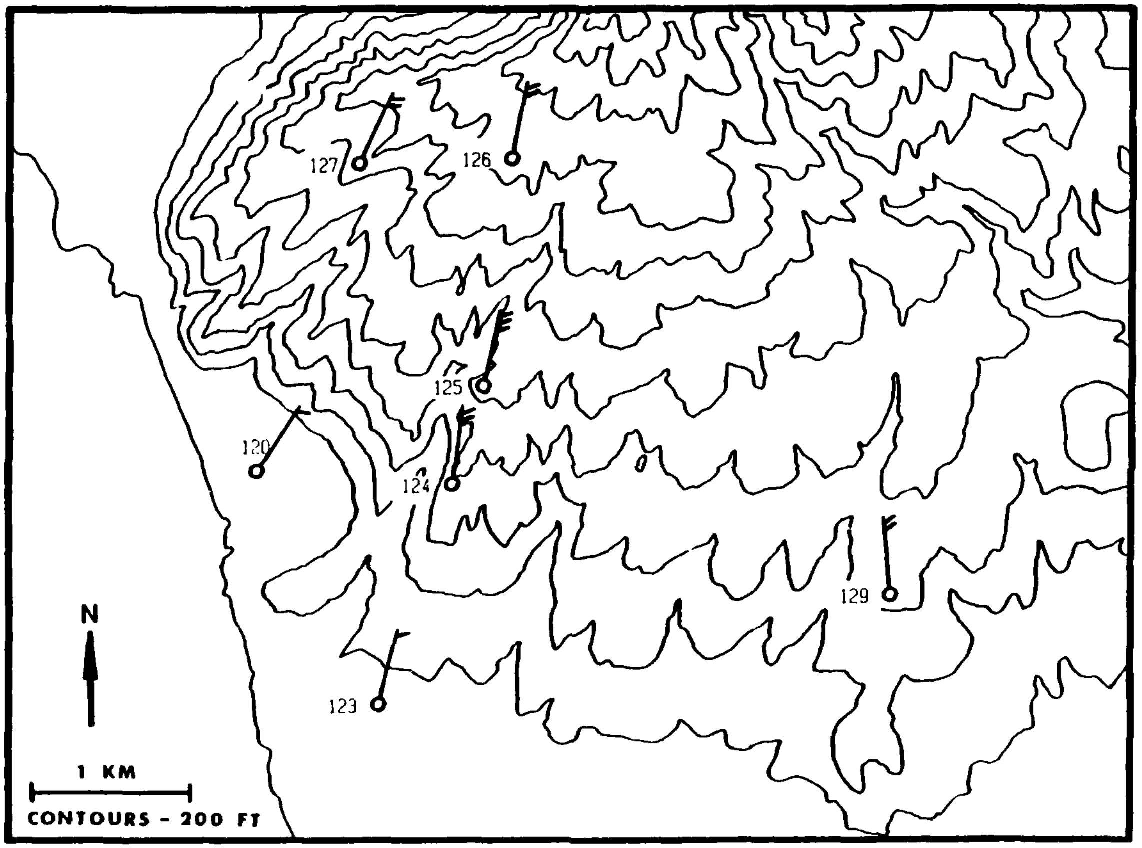

Figure 3v. January-March 1983 resultant mean winds for 2100 HST. No barb is less than 1 ms^{-1}, half barb is 1 ms^{-1}, full barb is 5 ms^{-1}.

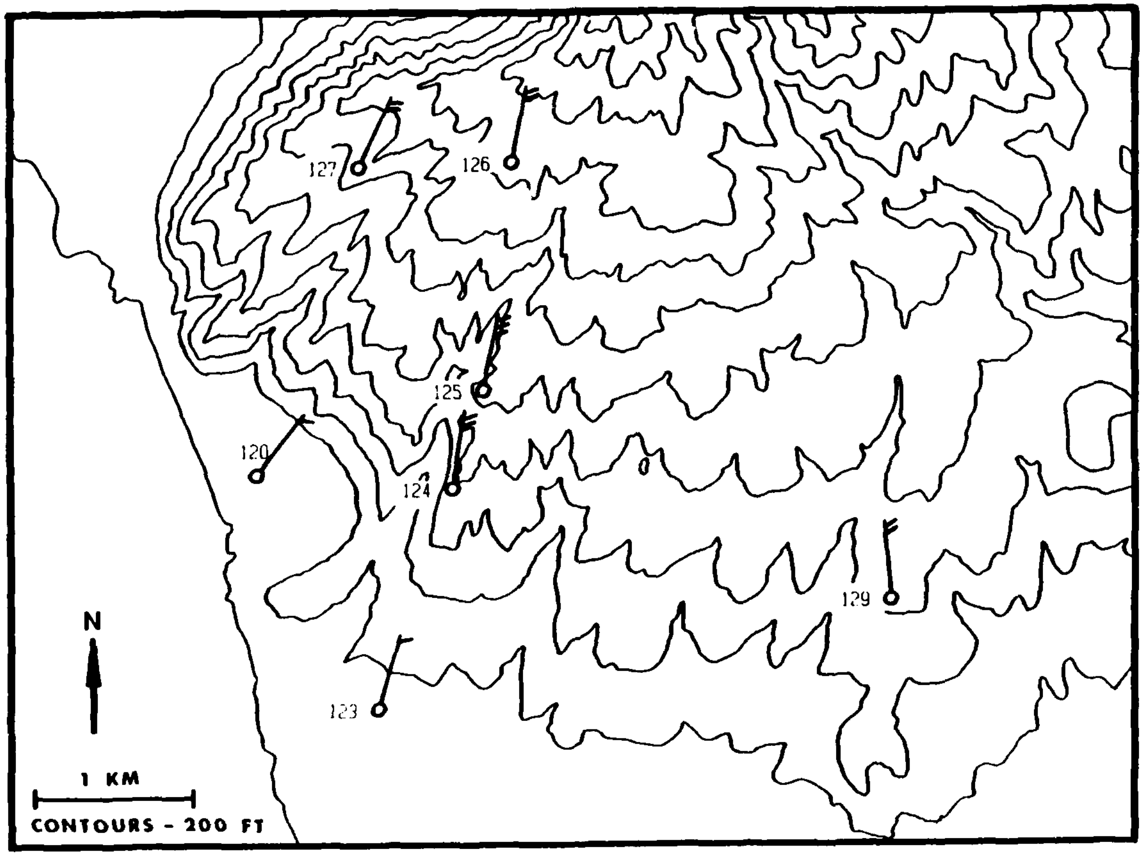

Figure 3w. January-March 1983 resultant mean winds for 2200 HST. No barb is less than 1 ms^{-1}, half barb is 1 ms^{-1}, full barb is 5 ms^{-1}.

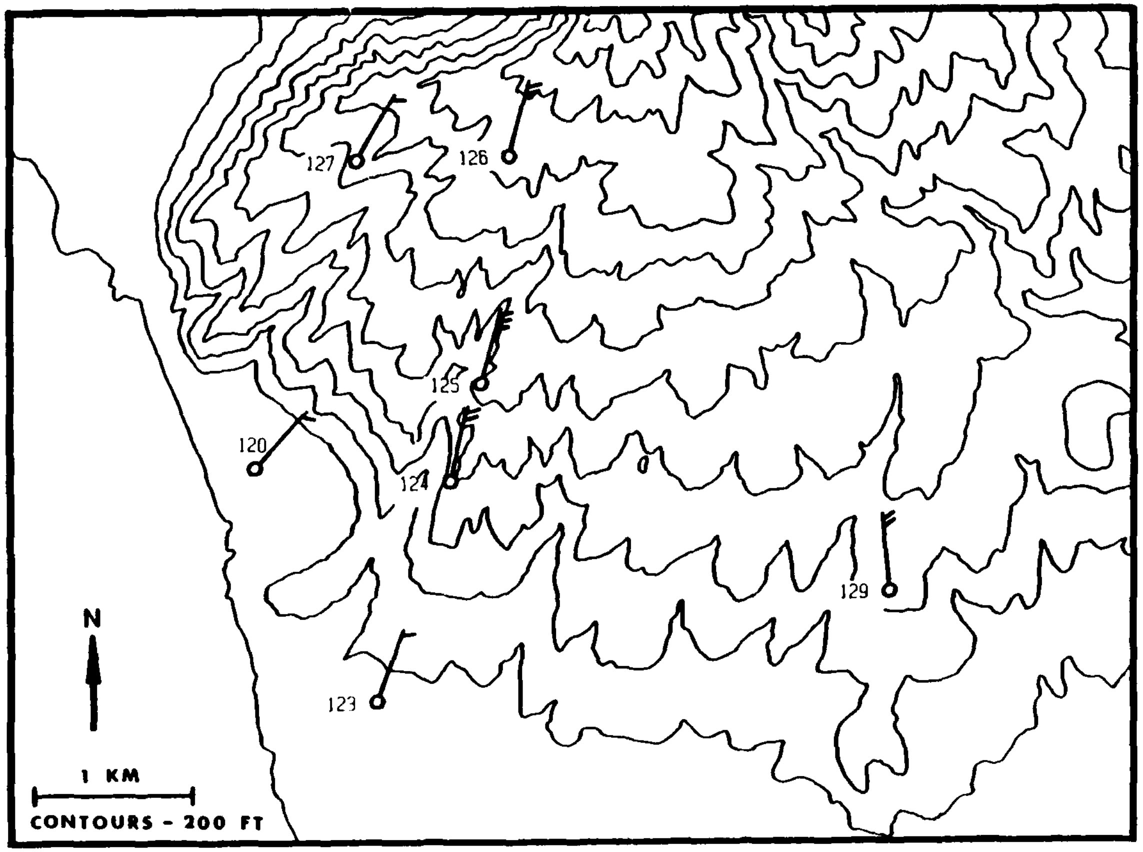

Figure 3x. January-March 1983 resultant mean winds for 2300 HST. No barb is less than 1 ms^{-1}, half barb is 1 ms^{-1}, full barb is 5 ms^{-1}.

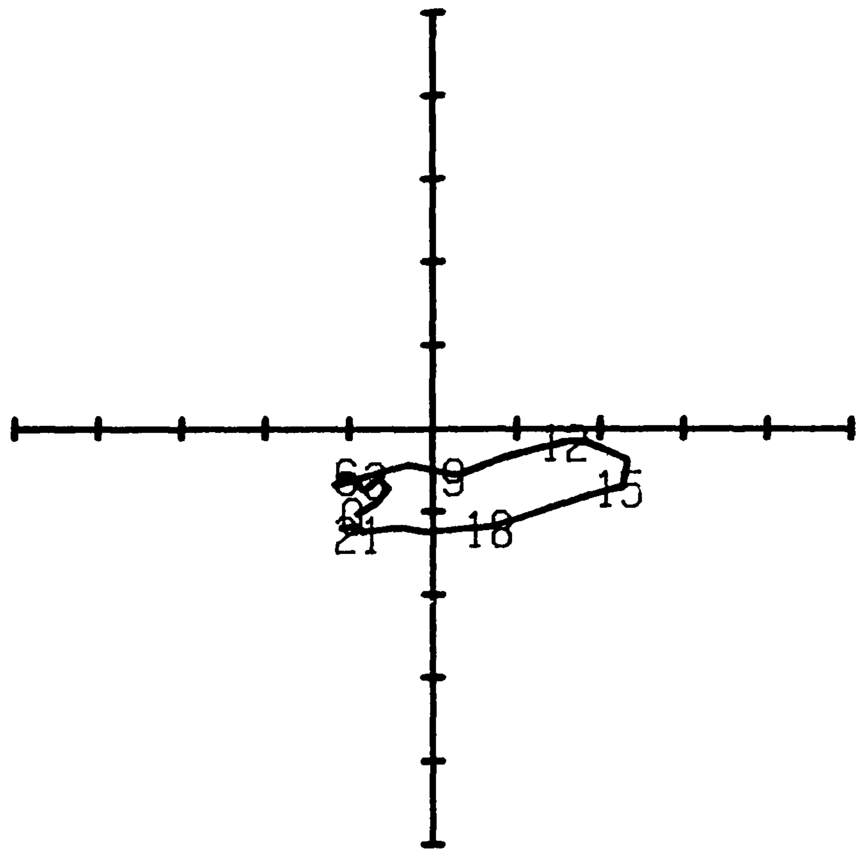

Figure 4a. Hodograph of January-March 1983 resultant mean wind for site 120. Increment along axes are 1 ms^{-1}. U (V) wind component positive towards the right (top) of diagram. Figures along the trace indicate time of day, i.e., 12 = 1200 HST.

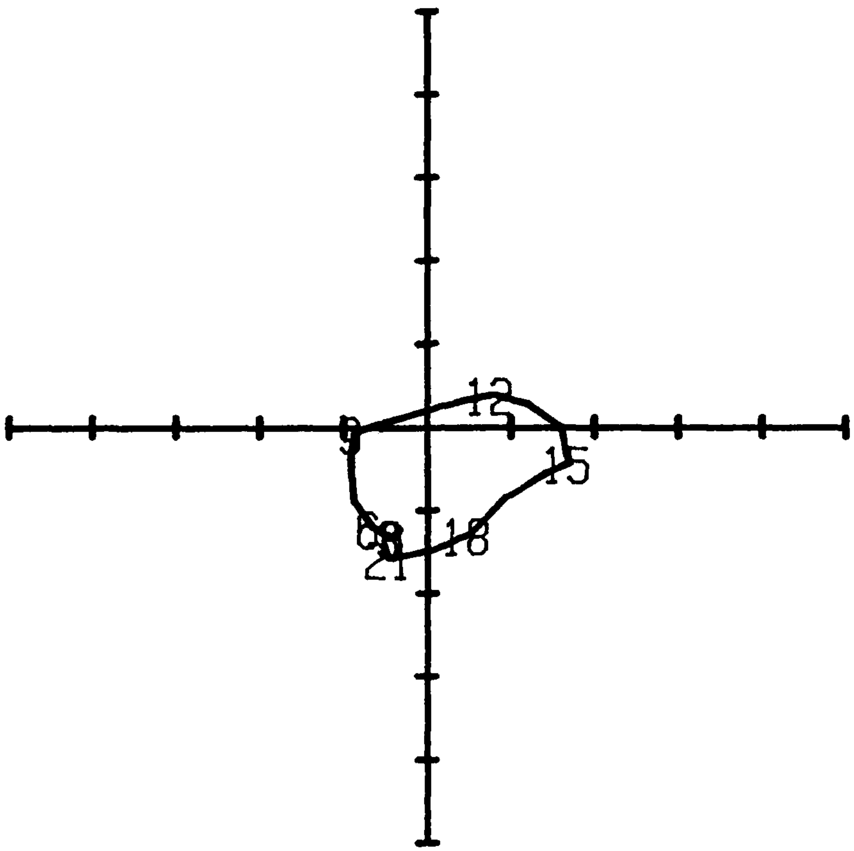

Figure 4b. Hodograph of January-March 1983 resultant mean wind for site 123. Increment along axes are 1 ms^{-1}. U (V) wind component positive towards the right (top) of diagram. Figures along the trace indicate time of day, i.e., 12 = 1200 HST.

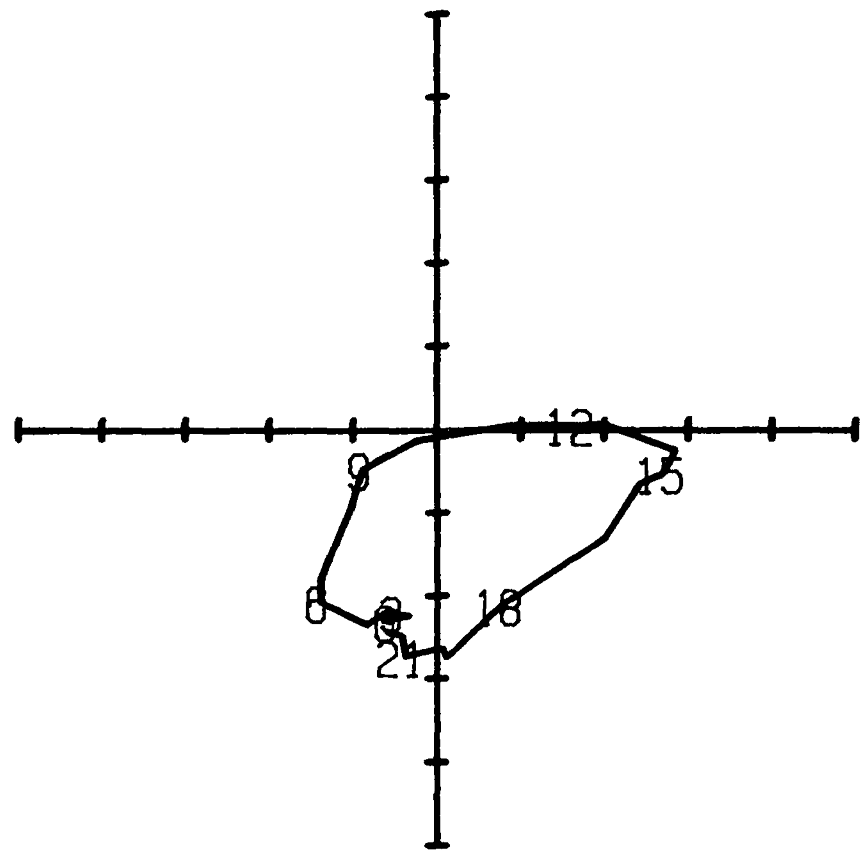

Figure 4c. Hodograph of January-March 1983 resultant mean wind for site 124. Increment along axes are 1 ms^{-1}. U (V) wind component positive towards the right (top) of diagram. Figures along the trace indicate time of day, i.e., 12 = 1200 HST.

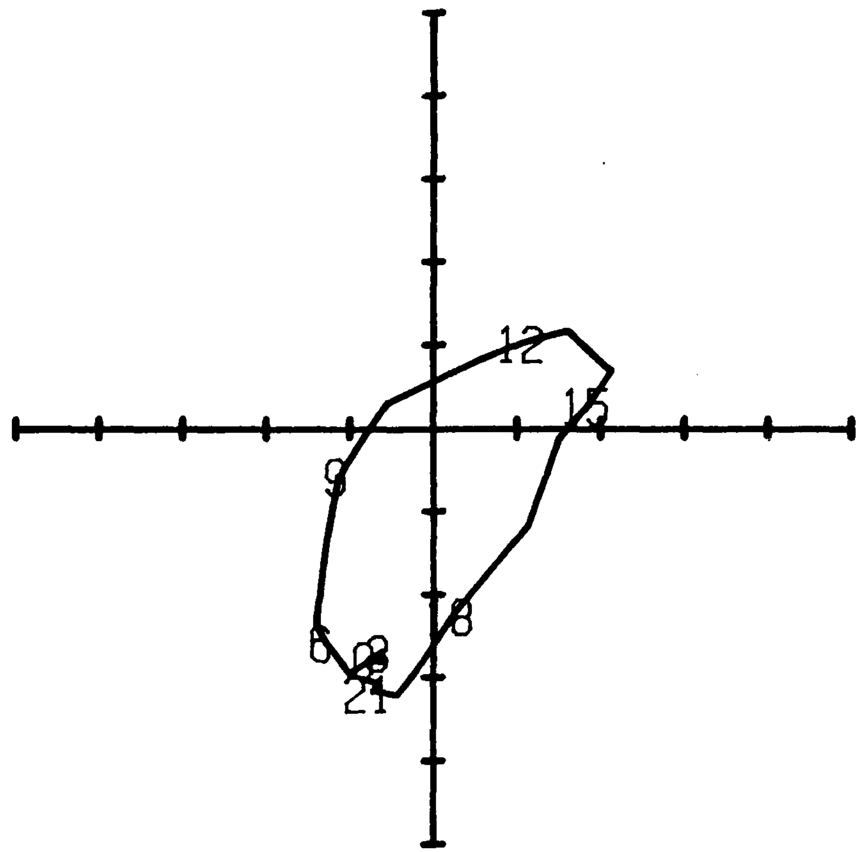

Figure 4d. Hodograph of January-March 1983 resultant mean wind for site 125. Increment along axes are 1 ms^{-1}. U (V) wind component positive towards the right (top) of diagram. Figures along the trace indicate time of day, i.e., 12 = 1200 HST.

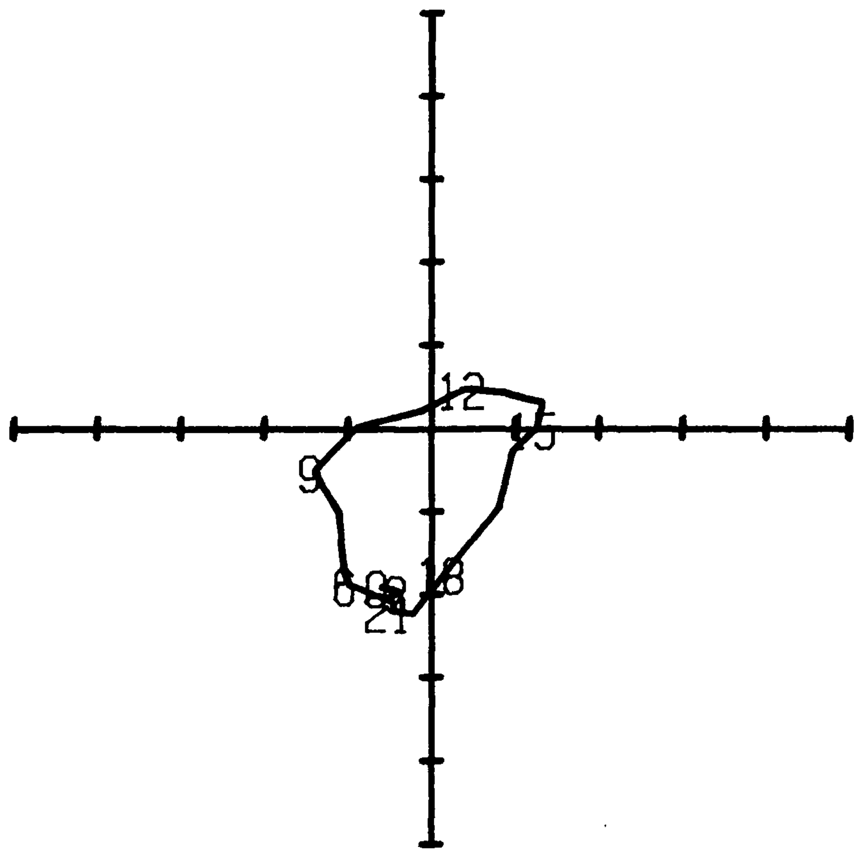

Figure 4e. Hodograph of January-March 1983 resultant mean wind for site 126. Increment along axes are 1 ms^{-1}. U (V) wind component positive towards the right (top) of diagram. Figures along the trace indicate time of day, i.e., 12 = 1200 HST.

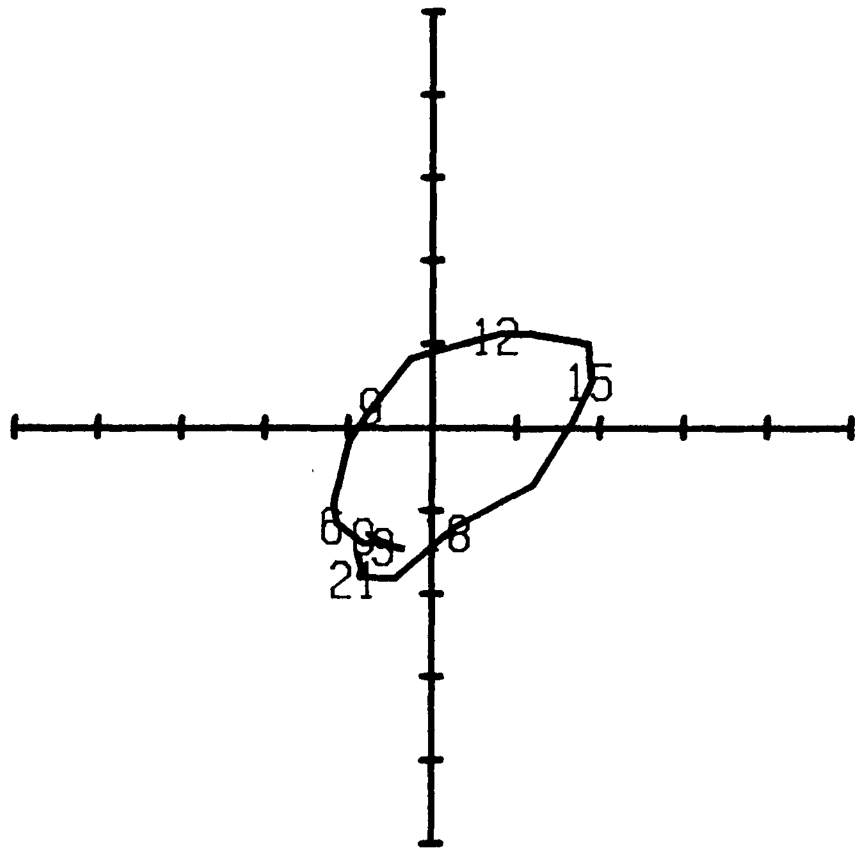

Figure 4f. Hodograph of January-March 1983 resultant mean wind for site 127. Increment along axes are 1 ms^{-1}. U (V) wind component positive towards the right (top) of diagram. Figures along the trace indicate time of day, i.e., 12 = 1200 HST.

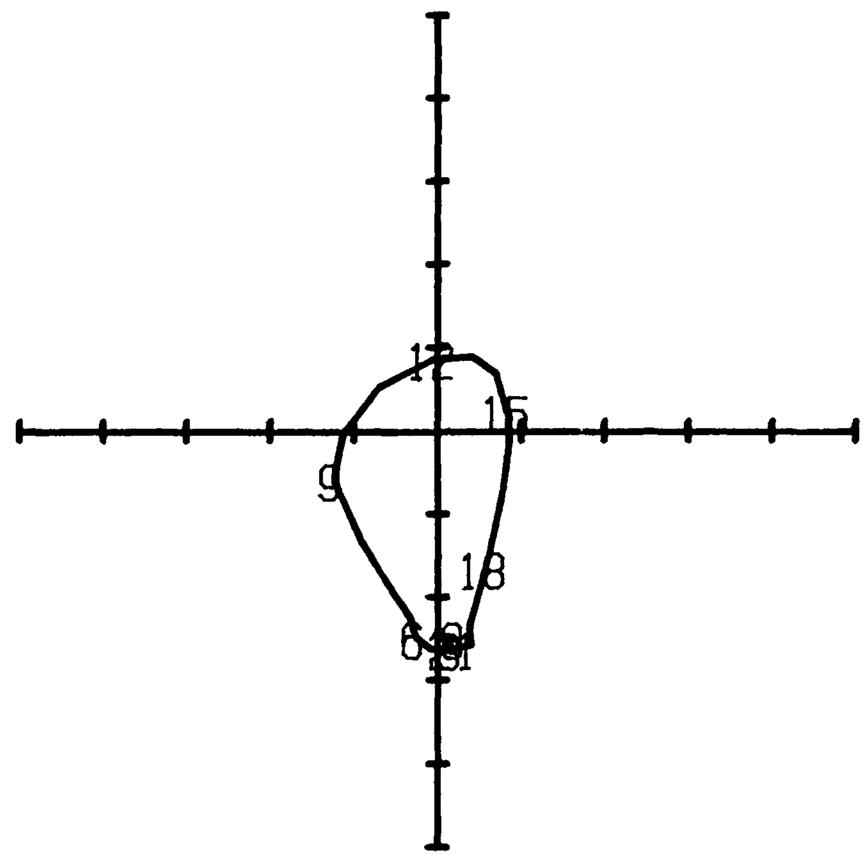

Figure 4g. Hodograph of January-March 1983 resultant mean wind for site 129. Increment along axes are 1 ms^{-1}. U (V) wind component positive towards the right (top) of diagram. Figures along the trace indicate time of day, i.e., 12 = 1200 HST.

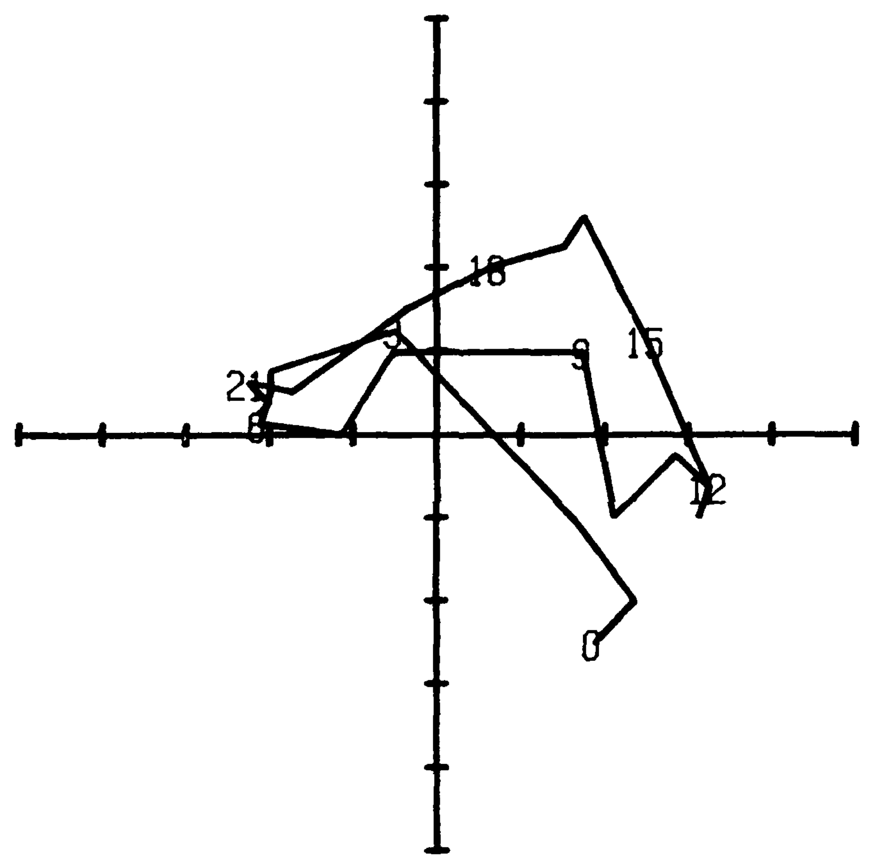

Figure 5a. Hodograph of 22 February 1983 for site 120. Increment along axes are 1 ms^{-1}. U (V) wind component positive towards the right (top) of diagram. Figures along the trace indicate time of day, i.e., 12 = 1200 HST.

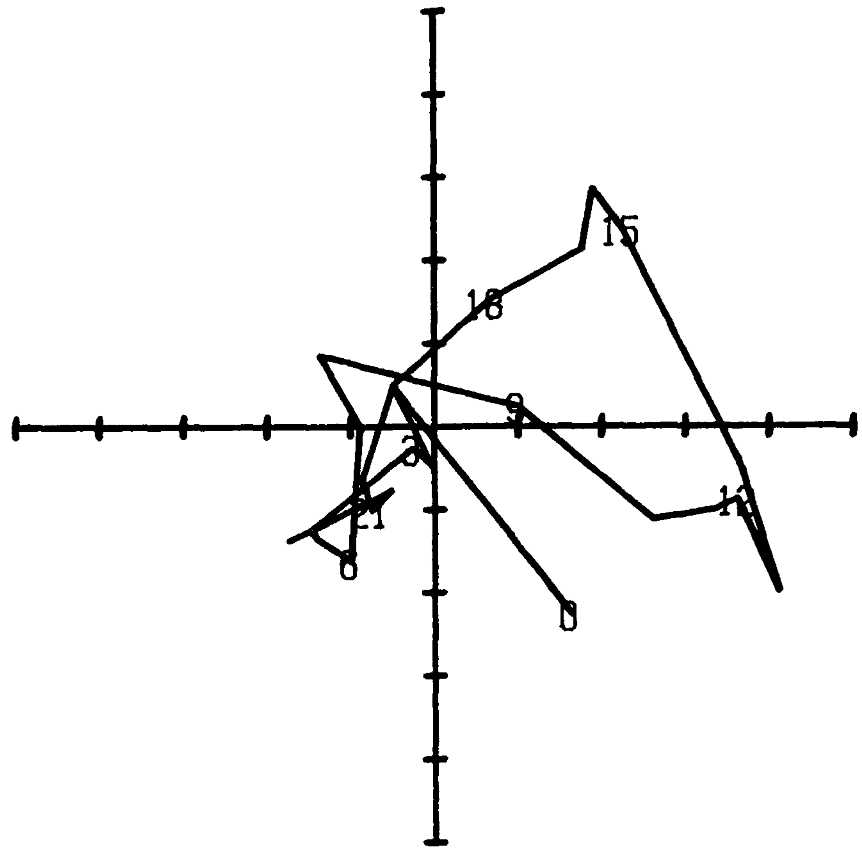

Figure 5b. Hodograph of 22 February 1983 for site 123. Increment along axes are 1 ms^{-1}. U (V) wind component positive towards the right (top) of diagram. Figures along the trace indicate time of day, i.e., 12 = 1200 HST.

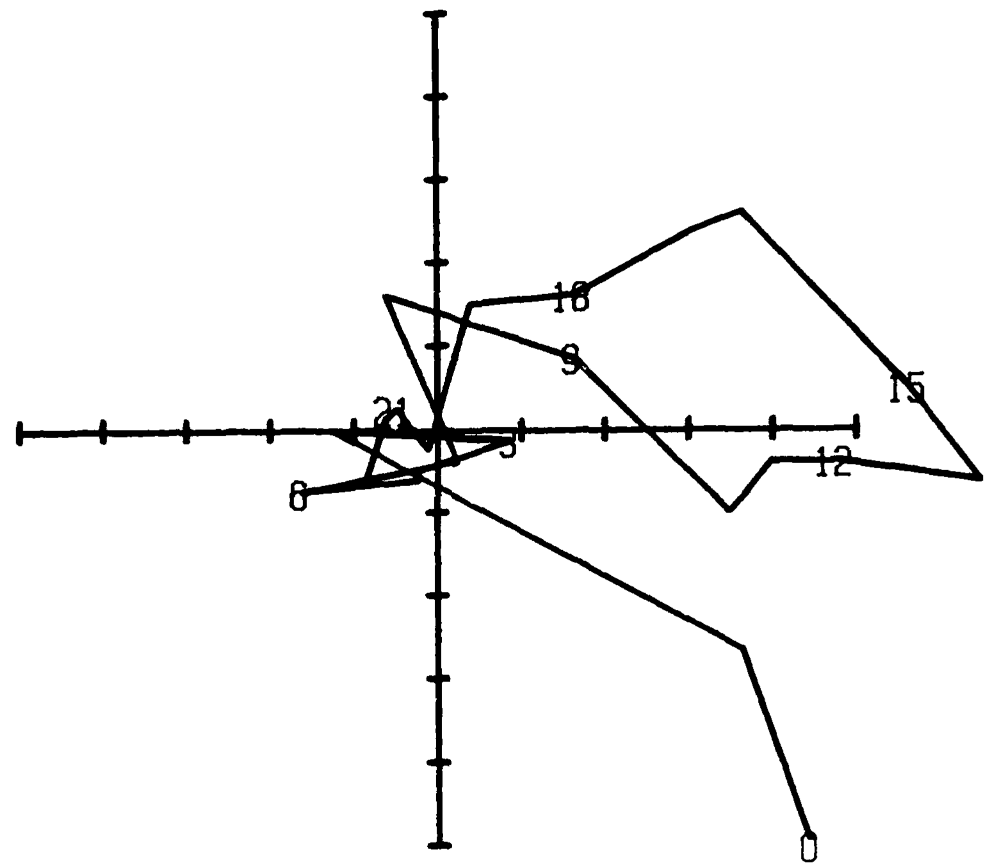

Figure 5c. Hodograph of 22 February 1983 for site 124. Increment along axes are 1 ms^{-1}. U (V) wind component positive towards the right (top) of diagram. Figures along the trace indicate time of day, i.e., 12 = 1200 HST.

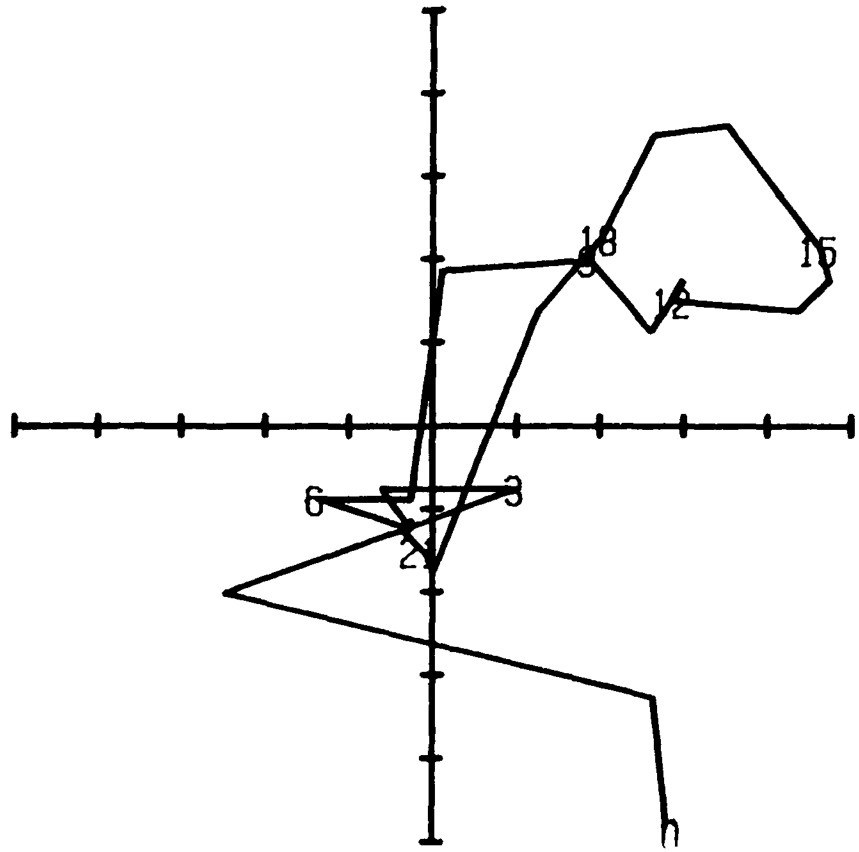

Figure 5d. Hodograph of 22 February 1983 for site 125. Increment along axes are 1 ms^{-1}. U (V) wind component positive towards the right (top) of diagram. Figures along the trace indicate time of day, i.e., 12 = 1200 HST.

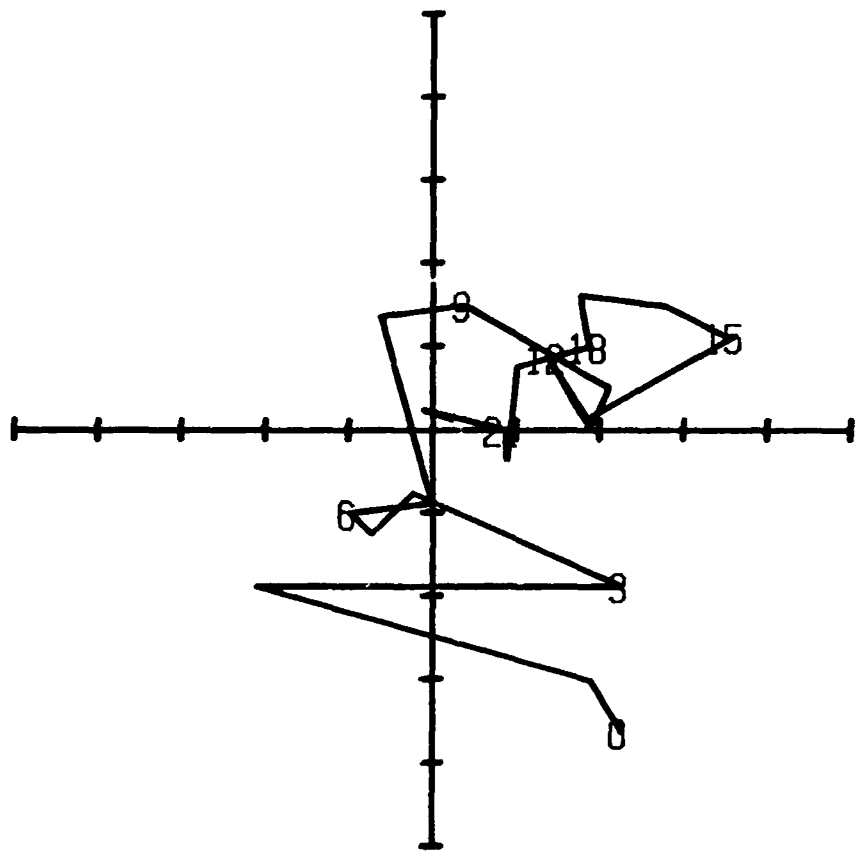

Figure 5e. Hodograph of 22 February 1983 for site 126. Increment along axes are 1 ms^{-1}. U (V) wind component positive towards the right (top) of diagram. Figures along the trace indicate time of day, i.e., 12 = 1200 HST.

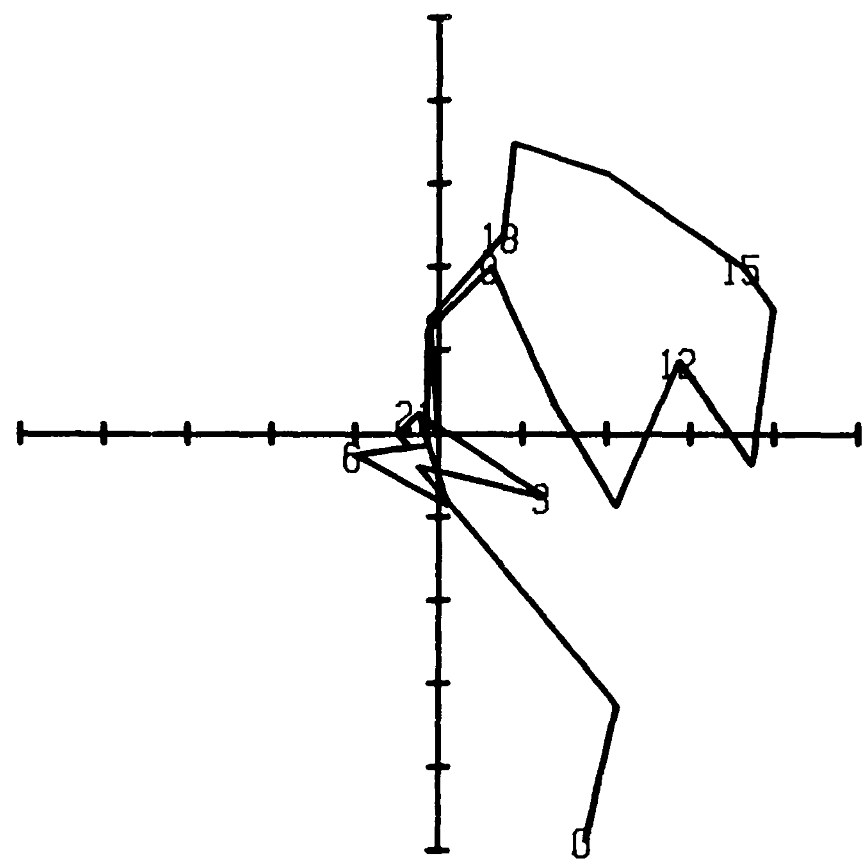

Figure 5f. Hodograph of 22 February 1983 for site 127. Increment along axes are 1 ms^{-1}. U (V) wind component positive towards the right (top) of diagram. Figures along the trace indicate time of day, i.e., 12 = 1200 HST.

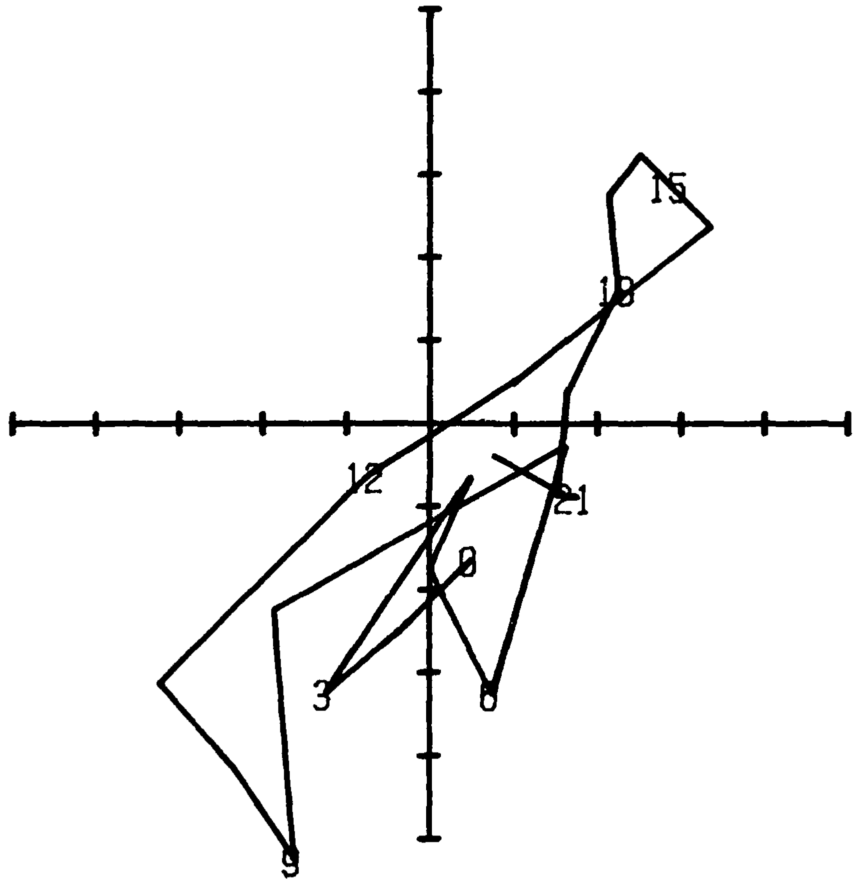

Figure 5g. Hodograph of 22 February 1983 for site 129. Increment along axes are 1 ms^{-1}. U (V) wind component positive towards the right (top) of diagram. Figures along the trace indicate time of day, i.e., 12 = 1200 HST.

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