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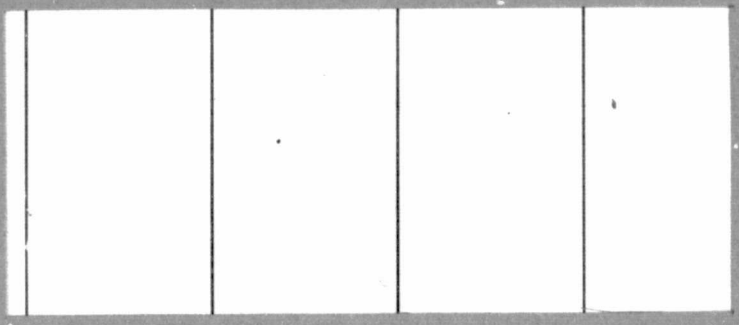

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DIURNAL STRATOSPHERIC TIDE IN MERIDIONAL WIND, 30 TO 60 KM, BY SEASON AND MONTHLY MEAN TEMPERATURES, 20 TO 60 KM, AT 80°N TO 0°N

By

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Moffet Field, CA 94035

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Diurnal Stratospheric Tide in Meridional Wind, 30 to 60 km, by Season

Abstract

The diurnal component in meridional wind is estimated for each season at twelve rocket stations. Amplitudes and phases are presented as a function of height-latitude or as vertical profiles. Many of the gross features of the tide persist throughout the year, but as they migrate in height and latitude the amplitude or phase at a given location may undergo large changes with season. Longitudinal variations in the diurnal tide are found in the mid-stratosphere, and it is suggested they are coupled with longitudinal variations in the tropospheric temperature structure.

1. Introduction

Large seasonal changes in the diurnal tide of wind in the lower stratosphere have been reported by several writers, most recently by Wallace and Tadd (1974). The latter suggest that large seasonal changes may occur in the upper stratosphere also, but a paucity of rocket data has discouraged attempts to identify them. Sufficient data are now available, however, to resolve the diurnal tide on a seasonal basis from 30 to 60 km at several stations and this paper presents these results for the meridional wind.

2. Basic Data and Analysis Technique

Rocket stations used in this study are listed in Table 1. The period of record for each (basically 1960-71) is as given by Belmont, et al. (1974), and extended to include 1972 data. In order to eliminate doubtful winds, only those meridional wind values within three standard deviations of the seasonal mean at each station and level were used in this analysis. The number of observations used at 50 km for each station and season is given in Table 1 where the seasons are also defined; as discussed below, statistical error estimates for some stations and seasons were not acceptable in which case a dash is entered in the table.

Seasonal mean values of the hourly meridional wind at 2 km intervals at each station were determined by averaging all observations taken between 30 minutes before to 29 minutes after the hour. Due to the irregular distribution of observation times (taken as the time of rocket launch), some

hours contained no data. The resulting sets of hourly mean values were analyzed by the periodic regression technique described in Belmont, et al. (1974). The periodic regression technique can be used to analyze time series of irregularly spaced data points, permitting some hours to contain no data, and simultaneously to determine an estimate of the statistical error of amplitude and phase for each component wave.

Initially, vertical profiles of the amplitude and phase (with errors) at 16 stations were plotted for each season. Also, the amplitude and phase values were plotted on height versus latitude diagrams. Inasmuch as very little smoothing was required (or information lost) on the height-latitude diagrams, the results are presented in that format below. Complete tabulations of the present results are given in Appendix A.

It was determined by inspection of the vertical profiles that values associated with amplitude errors greater than 3.9 m/s are unreliable, and those with amplitude errors greater than 2.5 m/s are questionable. Typical estimates of amplitude errors will be given in Table 3. All results at four stations were therefore discarded, and results for some seasons at three other stations. The magnitude of the statistical errors depends largely on the noise (mainly synoptic variations), sample size, and hourly distribution of the data. For illustration, the distribution of observations at 50 km at the two most complete stations and at Barking Sands, where the distribution is relatively poor, is given in Table 2. The phase

error also depends on amplitude, because as amplitude approaches zero phase can take on any value. The statistical error estimates were used to identify suspicious values when drawing contours of amplitude and phase, which will be presented in Figs. 1-8. For example, the decreasing number of observations with altitude resulted in relatively large error estimates above 48 km at Antigua (17°N) during winter through summer. In spring, when the contours of amplitude are nearly vertical above 55 km at 17°N, they have been drawn with broken lines to indicate uncertainty of the analysis since Antigua is not a useful station there. Other cases of uncertainty, resulting from large statistical errors or a lack of stations, are also drawn with broken lines.

At Churchill (59°N) the amount of data and its time distribution were adequate to provide acceptable error estimates during all seasons, but at Fort Greely (64°N) and Thule (77°N) the large synoptic noise during autumn through spring resulted in excessive error estimates. Thus, only during summer are the height-latitude sections extended beyond Churchill. At Fort Sherman (9°N) the distribution of observation times is so biased toward one hour in most seasons that the resulting error estimates were acceptable only during spring. The analysis at 8°N in spring is therefore based on an average of the results at Fort Sherman and Kwajalein, while in the other seasons the analysis at 8°N is based on Kwajalein only. Latitudinal gradients of the diurnal tide in meridional wind may become larger near the equator than at other latitudes, so interpolation between 8°N and 8°S was not felt justified and results for Ascension Island (8°S) will be presented separately.

If higher harmonics of the daily variation are important, then resolving only the first harmonic could result in misleading estimates because of aliasing effects caused by the non-uniform distribution of observations. To test this possibility, the diurnal and semidiurnal tides were simultaneously resolved at the three stations listed in Table 2. Not surprisingly, due to its poor time distribution of observations, statistical errors at Barking Sands were excessive in this test (Table 3). Therefore, with the presently limited data, it was necessary to assume that aliasing by the semidiurnal tide was unimportant and all of the results given below were determined without consideration of the semidiurnal tide. This assumption is supported by the fact that at White Sands and Churchill the error estimates and the corresponding values of amplitude (Table 3) generally changed little when the semidiurnal wave was included.

3. Results

a. Height-latitude sections of amplitude and phase. The largest amplitudes of the diurnal tide are found in spring (Fig. 1) above 50 km near 10°N (10 m/s). Values in excess of 9 m/s are also found near 38°N in spring, 60°N in summer (Fig. 2), and near 15°N and 38°N in winter (Fig. 4). Amplitudes less than 1 m/s are found only in summer and autumn below 40 km.

A relative minimum amplitude of the diurnal tide in meridional wind is found consistently above 50 km at low latitudes. During spring (Fig. 1) the minimum extends nearly vertically at 25°N with its largest value of the year, over 6 m/s. In summer (Fig. 2) it is above 55 km near 30°N and has

values slightly less than 5 m/s. It is smallest in autumn (Fig. 3), barely over 2 m/s, along an arc from 48 km at 10°N to 56 km at 20°N. During winter (Fig. 4) the minimum is closed off between 50 and 55 km near 30°N.

In general, the phase (Figs. 5-8) progresses downward from highest levels to near 40 km below which the phase reverses once or twice between 40 and 30 km. In winter there is continuous downward progression at all latitudes shown. Note that the regions of rapid phase change during spring through autumn are where the amplitudes are very small and hence the phase pattern has little significance. The results in Figs. 2 and 6 agree in general with the corresponding results for summer given by Reed, et al. (1969), except for the phase at 20°N near 40 km, where the phase is least reliable because of small amplitude.

b. Vertical profiles at Ascension Island. Results for Ascension Island are presented separately because of possible problems in interpolating across the equator. Also, this station has more data than any other within 20° of the equator. Vertical profiles of amplitude at Ascension Island (Fig. 9), where summer is defined as December through February, show maxima near 35 and 50 km, with minima near 30, 40 and 55-60 km. Near the maxima at 35 and 50 km, amplitudes are largest in summer and smallest in winter.

On the average, the wave progresses downward about 30 km in 36 hours (Fig. 10) with some large changes and even reversals in rate and direction between 30 and 40 km. Note that phase here is the time of maximum southward wind, unlike Figs. 5-8.

Reed, et al.(1969), estimated the mean yearly diurnal tide in meridional wind at Ascension Island by consolidating data for all months. Thus, direct comparison of their results with those in Figs. 9 and 10 is not possible although it should be noted that their amplitude profile is generally within the envelope of amplitudes given in Fig. 9. Their phase profile shows the phase at 42 km lags that at 36 km by 14 hours while the phase values in Fig. 10 at 42 km lead those at 36 km by 6 to 9 hours. This difference illustrates the sensitivity of phase of differing data samples, especially when the amplitude is small.

4. Discussion

Many of the changes with season found in Figs. 1-8 at a given location are larger than predicted by theory (Lindzen, 1967). However, the theoretical calculations are for an atmosphere at rest on a uniform sphere, and are based on highly idealized models of the distribution of water vapor and ozone. McKenzie (1968) has found that changes as large as 100% in amplitude and several hours in phase can result when a different distribution of water vapor is assumed. As both water vapor (Mastenbrook, 1974) and ozone (Heath, 1974) are now known to have large seasonal variations, quantitative comparison of the present results with those of theory does not seem warranted. Further, seasonal changes in the influence of topography, e.g. land-sea heating differences, tropospheric temperature structure (Lindzen, 1968), tropospheric wind structure (Wallace and Tadd, 1974), and perhaps other factors may account for some of the present seasonal variations in the

diurnal tide. Some qualitative features predicted by theory are discussed below.

Lindzen (1968) found that changes in the tropospheric temperature structure can cause large changes in the diurnal tide at stratospheric levels. His calculations for 25 degrees latitude show that the propagating mode with 12 km vertical wavelength is dominant when there is a low, cold tropopause. In winter (Fig. 8) at 30 to 38°N the phase lag between 30 and 36 km is about 12 hours which, when extrapolated, corresponds to 12 km vertical wavelength. It is not clear, however, why a propagating mode is dominant at the relatively high latitude 38°N, as classical theory predicts that trapped modes dominate poleward of about 30 degrees latitude.

Longitudinal variations probably account for some of the detailed features found in Figs. 1-8, but in most cases the stations are too widely separated in latitude to detect longitudinal variations. Between 28°N and 38°N, however, the station coverage is adequate to suggest that the relatively early phases near 33°N at 36 km in summer (Fig. 6) and autumn (Fig. 7) are due to longitudinal variations. For direct comparison, the summer phase profiles at Wallops, Mugu, White Sands and Kennedy are shown in Fig. 11. Barking Sands is included in the figure to illustrate the phase at even lower latitude. Note that in the range 30 to 40 km the profiles at Wallops, Kennedy, and Barking sands indicate increasing phase variability as latitude decreases, but that White Sands and Mugu both have more variability than Kennedy despite their higher latitudes. Since the topography and mean state of the lower atmosphere in summer differ significantly between the

southwestern United States and the east coast, the anomalous (with respect to Kennedy and Wallops, i.e., 80°W) summer phases at White Sands and Mugu are probably due to longitudinal differences.

There is also theoretical reason for expecting longitudinal variations such as the above. Lindzen (1968) has shown that the tropospheric temperature structure, especially near the tropopause, can significantly affect the stratospheric diurnal tide. Data given by Crutcher and Meserve (1970) indicate that in July the change of lapse rate at the tropopause is less, and the mean lapse rate from 700 to 200 mb is greater, over New Mexico than at 80°W at 33°N. Thus, this longitudinal difference in tropospheric temperature structure between 80°W and the southwestern United States could give rise to the different summer phase profiles at White Sands and Mugu. This hypothesis is supported by the similarity of the phase profiles from 28°N to 38°N during winter (Fig. 8; although those at White Sands and Mugu are shifted a few kilometers higher) for in January there is little difference in the tropospheric temperature structures over New Mexico and at 80°W at 33°N.

In this one case longitudinal differences in the stratospheric diurnal tide are apparently coupled with the tropospheric temperature structure. Other mechanisms which have been suggested to explain longitudinal differences in the diurnal tide, such as longitudinal differences in tropospheric winds or the non-uniform heating cycle due to land and sea differences, may be important at other times or in other places, but the present data are too limited to discuss them.

5. Conclusions

(1) Largest amplitudes of the diurnal tide in meridional wind, 30-60 km, are found near the stratopause during all seasons. In the Northern Hemisphere tropics and subtropics, largest amplitudes of the year near the stratopause occur in spring and the smallest in autumn.

(2) Equatorward of 40°N the latest phase is near 40 km except during winter when the latest phases are below 30 km.

(3) Because the above features of the diurnal tide vary with season, the tidal wind at a given location and time of day will vary in magnitude, and may change sign, from season to season.

(4) Further observations and analysis are needed to determine the significance of, and factors which influence, longitudinal variations in the diurnal tide in the mid and upper stratosphere.

6. Grid Point Values of Mean Tidal Winds

The diurnal tide may be an important mixing mechanism in the upper atmosphere. In the case of height or latitude dependent photochemical processes it may be especially important as reactions will proceed when the tidal flow is in one direction, but do not proceed (or a different reaction occurs) when the tidal flow is in the opposite direction. This process can result in a net flux of a photochemical specie.

To facilitate use of the results in Figs. 1-8 in photochemical models which include both day and night circulation, estimates at grid points of the

mean speed (in tenths of meters per second) of the diurnal component in meridional wind during the hours of daylight and of darkness for each month are given in Appendix B. The sunrise/sunset times at 40 km, which represent the time periods over which these mean winds were calculated at all levels, are also given.

The grid point values are based on the amplitudes and phases in Figs. 1-8, read off at 5 km, 5 degree intervals of height and latitude, respectively, linearly interpolated to 2.5 km height intervals. The mean speed was calculated at each level by numerically integrating the diurnal wave in four minute time steps from sunrise to sunset, and sunset to sunrise. Inasmuch as Thule and Greely provided trustworthly results only during the summer, grid point values do not extend beyond 60 degrees latitude during other seasons. In Appendix B, negative winds are from the north.

References

Belmont, A. D., D. G. Dartt, and G. D. Nastrom; 1974: Periodic variations in stratospheric zonal wind from 20 to 65 km, at 80°N to 70°S. Quart. J. Roy. Meteor. Soc., 100, 203-211.

Crutcher, H. L. and J. M. Meserve; 1970: Selected level heights, temperatures and dew points for the Northern Hemisphere, NAVAIR 50-1C-52. Naval Weather Service Command, Washington, 220 pp.

Heath, D. F.; 1974: Recent advances in satellite observations of solar variability and global atmospheric ozone. Proceedings of the International Conference on Structure, Composition and General Circulation of the Upper and Lower Atmospheres and Possible Anthropogenic Perturbations, Vol. 2, Melbourne, 1294 pp.

Lindzen, R. S.; 1967: Thermally driven diurnal tide in the atmosphere. Quart. J. Roy. Meteor. Soc., 93, 18-42.

_____1968: The application of classical atmospheric tidal theory. Proc. Roy. Soc. A303, 299-316.

Mastenbrook, H. J., 1974: Stratospheric water vapor distribution and variability. Proceedings of the International Conference on Structure, Composition and General Circulation of the Upper and Lower Atmospheres and Possible Anthropogenic Perturbations, Vol. 2, Melbourne, 1294 pp.

McKenzie, D. J.; 1968: The diurnal atmospheric tide with Newtonian cooling and longitudinally dependent drives. Ph.D. Thesis, University of Washington, 139 pp.

References (Cont'd)

Reed, R. J., M. J. Oord, and M. Siemenski; 1969: A comparison of observed and theoretical diurnal tidal motion between 30 and 60 kilometers. Mon. Wea. Rev., 97, 456-459.

Wallace, J. M. and R. F. Tadd; 1974: Some further results concerning the vertical structure of atmospheric tidal motions within the lowest 30 kilometers. Mon. Wea. Rev., 102, 795-803.

Figure Legends

Figure 1. Amplitude (m/s) of the diurnal wave in meridional wind in spring. Letters at top of the figure refer to rocket stations used. A dash-dot line is used to indicate uncertainty of the analysis due to large statistical errors or a lack of stations. Intermediate isolines are dotted.

Figure 2. As in Figure 1 except for summer.

Figure 3. As in Figure 1 except for autumn.

Figure 4. As in Figure 1 except for winter.

Figure 5. Phase (hour of maximum northward speed) of the diurnal tide in meridional wind in spring. Letters at top of the figure refer to rocket stations used.

Figure 6. As in Figure 5 except for summer.

Figure 7. As in Figure 5 except for autumn.

Figure 8. As in Figure 5 except for winter.

Figure 9. Amplitude of the diurnal tide in meridional wind at Ascension Island for each Southern Hemisphere season.

Figure 10. Phase (hour of maximum southward speed) of the diurnal tide in meridional wind at Ascension Island for each Southern Hemisphere season.

Figure 11. Phase of the diurnal tide in meridional wind in summer at selected rocket stations.

NAME	LAT. *	LONG. *	SPRING (MAR,APR,MAY)	SUMMER (JUN,JUL,AUG)	AUTUMN (SEP,OCT,NOV)	WINTER (DEC,JAN,FEB)
ASCENSION	-7°59'	14°25'	306	272	327	289
KWAJALEIN	8°42'	-167°42'	68	85	87	78
FT. SHERMAN	9°20'	79°59'	150	-	-	-
ANTIGUA (48 KM)	17°09'	61°47'	138	101	133	137
BARKING SANDS	21°54'	159°35'	325	390	370	277
CAPE KENNEDY	28°27'	80°32'	471	473	431	516
WHITE SANDS	32°23'	106°29'	601	663	647	503
PT. MUGU	34°07'	119°07'	497	564	477	393
WALLOPS IS.	37°50'	75°29'	363	355	343	249
FT. CHURCHILL	58°44'	93°49'	205	186	251	277
FT. GREELY	64°00'	145°44'	-	265	-	-
THULE	76°33'	68°49'	-	122	-	-

Table 1. Rocketsonde observations used at 50 km by season. Dash indicates inadequate distribution of observations by hour.

*North or west, minus is south or east

		HOUR (LOCAL TIME)						
STATION	SEASON	0-4	4-8	8-12	12-16	16-20	20-24	TOTAL
WHITE SANDS	SPRING	16	38	8	35	376	128	601
	SUMMER	27	26	21	84	380	125	663
	AUTUMN	23	25	16	59	387	137	647
	WINTER	30	31	8	20	281	133	503
BARKING SANDS	SPRING	46	1	1	0	7	270	325
	SUMMER	78	0	4	9	2	297	390
	AUTUMN	73	1	1	2	11	282	370
	WINTER	43	4	2	0	1	227	277
FT. CHURCHILL	SPRING	61	14	8	18	80	24	205
	SUMMER	20	9	3	34	107	13	186
	AUTUMN	38	16	8	48	121	20	251
	WINTER	52	25	6	10	142	42	277

Table 2. Examples of the time distribution of meridional wind observations available at 50 km.

Table 3. Estimates of the amplitude (m/s) and error (in parentheses) of the diurnal tide in meridional wind at 50 km for the stations in Table 2. The upper rows of results were determined fitting the data with only the diurnal (D) wave while the bottom rows were determined fitting the data with both the diurnal and semidiurnal (SD) waves.

STATION	WAVES	SPRING	SUMMER	AUTUMN	WINTER
CHURCHILL	D	6.5(0.6)	7.7(0.7)	6.4(0.7)	1.0(0.4)
	D+SD	6.0(0.7)	5.9(0.8)	5.9(0.8)	4.1(0.7)
WHITE SANDS	D	8.0(0.6)	7.5(0.5)	6.6(0.7)	5.7(0.8)
	D+SD	7.4(0.7)	7.4(0.6)	5.9(0.8)	6.0(0.9)
BARKING SANDS	D	7.4(1.9)	6.6(0.8)	2.7(1.1)	7.9(1.9)
	D+SD	11.3(4.4)	9.0(2.4)	3.6(2.6)	29.3(8.5)

Monthly Mean Temperatures, 20 to 60 km, at 80°N to 0°N

Grid point values of the monthly mean temperature, 20 to 60 km, from the equator to 80°N are given in Appendix C. Data and analysis technique used to derive the values are as follows:

In addition to the rocket stations listed in Table 1, Section A of this report, each temperature observed at Grand Turk (20°N) and Primrose Lake (55°N) was adjusted for solar radiation errors and biasing by the yearly mean diurnal temperature tide. This procedure has been described in Nastrom and Belmont (1975), where a list of the number of observations at each station is also given.

Monthly means of the adjusted temperatures were plotted at each station's latitude at 2 km intervals. Monthly means at Volgograd (49°N) and Heiss Island (81°N) were also plotted, but only to 48 km as they are not compatible with North American data above that level (Finger, et al., 1975). At 80°N the analyses are therefore based on interpolation between Heiss Island and Thule (77°N) below 50 km, and are extrapolations from Thule at 50 km and higher. Grid point values were read off the analyzed monthly height-latitude sections at 5° latitude by 5 km intervals, and were then linearly interpolated with height to 2.5 km intervals.

Finger, F. G., M. E. Gelman, F. J. Schmidlin, R. Leviton, and B. Kennedy; 1975: Compatibility of meteorological rocketsonde data as indicated by international comparison tests. J. Atmos. Sci., 32, in press.

Nastrom, G. D., and A. D. Belmont; 1974: Periodic variations in stratospheric-mesospheric temperature from 20-65 km at 80°N to 30°S. J. Atmos. Sci., 32, in press.

APPENDIX A

Amplitudes and phases (with errors) of the diurnal tide in meridional wind by season. Error values marked by an asterisk are 10.0 units or greater. Values associated with amplitude errors greater than 3.9 m/s are considered unreliable, and those with amplitude errors greater than about 2.5 m/s are considered questionable.

STATION KWAJALEIN

ANALYSIS OF SEASONAL DIURNAL TIDES IN MERIDIONAL WIND, 30 TO 60 KM
AMPLITUDES ARE IN M/S AND PHASES ARE IN LOCAL TIME.
NUMBERS IN PARENTHESES ARE THE ERRORS (M/S OR HOURS)

SEASON	SPRING			SUMMER			AUTUMN			WINTER		
ALTITUDE	AMPLITUDE	PHASE	N	AMPLITUDE	PHASE	N	AMPLITUDE	PHASE	N	AMPLITUDE	PHASE	N
60 KM	12.0(4.1)	6.0(1.0)	26	4.6(3.8)	15.6(4.1)	33	6.9(3.9)	4.2(2.0)	41	9.0(4.0)	2.6(1.6)	46
58 KM	9.4(3.7)	5.7(1.1)	40	5.2(2.1)	10.3(1.4)	56	1.5(1.4)	1.0(3.2)	60	10.1(2.6)	4.7(.8)	64
56 KM	11.4(3.1)	6.1(.7)	57	8.6(1.8)	9.3(.7)	73	3.9(1.8)	6.4(1.2)	77	9.3(2.3)	6.3(.7)	73
54 KM	9.9(2.4)	6.4(.6)	64	8.9(2.1)	8.7(.8)	79	4.6(2.3)	6.2(1.6)	85	11.4(2.6)	7.2(.7)	73
52 KM	11.4(3.1)	7.6(1.0)	68	7.7(2.3)	10.3(1.2)	83	.8(1.6)	8.1(5.5)	88	3.6(2.1)	18.5(2.0)	75
50 KM	8.7(2.7)	9.2(1.4)	68	8.5(2.7)	14.9(.9)	85	2.3(1.6)	12.6(2.3)	87	1.5(1.6)	1.1(4.1)	78
48 KM	6.6(2.3)	12.8(1.2)	70	4.8(1.8)	10.4(1.3)	87	3.5(1.6)	10.9(1.6)	87	5.8(2.0)	9.8(1.2)	79
46 KM	4.5(1.9)	13.8(1.2)	70	6.5(1.9)	10.3(1.1)	87	2.1(1.4)	13.8(1.8)	88	6.3(2.3)	9.6(1.2)	83
44 KM	1.7(1.4)	9.2(2.9)	71	5.4(1.8)	14.4(.9)	88	.8(1.3)	14.1(5.1)	89	4.4(1.8)	14.8(1.1)	84
42 KM	2.8(1.8)	15.3(1.7)	71	5.5(1.6)	16.0(.6)	87	.2(.9)	7.0(6.0)	89	1.5(1.4)	11.1(3.4)	85
40 KM	4.0(1.5)	10.5(1.5)	71	3.7(1.3)	15.4(.8)	87	2.2(.9)	4.6(.5)	89	.9(1.1)	22.1(3.8)	85
38 KM	2.8(1.3)	7.7(1.4)	71	1.8(1.1)	14.8(1.5)	87	1.9(1.0)	18.3(.9)	90	3.6(1.4)	5.6(.9)	86
36 KM	2.1(.9)	1.4(.9)	72	1.2(.9)	2.7(1.4)	87	2.5(1.0)	20.2(.9)	89	4.4(1.3)	5.0(.6)	87
34 KM	4.4(1.4)	4.6(.5)	72	1.3(1.0)	5.1(1.2)	86	2.1(1.2)	19.4(1.4)	89	1.0(.9)	20.4(1.8)	85
32 KM	2.3(1.0)	10.4(1.3)	72	1.3(1.0)	3.9(1.3)	84	1.8(1.1)	16.6(1.1)	90	.5(1.1)	1.1(5.3)	82
30 KM	3.1(1.3)	13.0(1.2)	70	2.4(1.2)	5.8(.9)	77	.7(.9)	20.5(2.7)	89	1.5(.9)	.5(1.2)	81

STATION ANTIGUA

ANALYSIS OF SEASONAL DIURNAL TIDES IN MERIDIONAL WIND, 30 TO 60 KM
AMPLITUDES ARE IN M/S AND PHASES ARE IN LOCAL TIME.
NUMBERS IN PARENTHESES ARE THE ERRORS (M/S OR HOURS)

SEASON	SPRING			SUMMER			AUTUMN			WINTER		
ALTITUDE	AMPLITUDE	PHASE	N	AMPLITUDE	PHASE	N	AMPLITUDE	PHASE	N	AMPLITUDE	PHASE	N
60 KM	20.3(*.2)	11.6(2.2)	20	.3(*.2)	11.6(2.2)	7	16.9(*.3)	12.9(2.3)	15	.3(*.3)	12.9(2.3)	11
58 KM	9.9(7.5)	12.0(3.3)	40	48.3(*.0)	12.1(1.4)	17	6.3(2.7)	22.7(1.5)	44	12.9(*.0)	22.7(4.5)	28
56 KM	6.9(5.5)	.6(3.6)	65	4.1(9.7)	2.3(6.1)	33	4.5(2.1)	21.3(1.6)	70	7.9(9.0)	13.8(5.4)	57
54 KM	2.8(3.8)	14.7(5.0)	90	5.2(8.5)	10.4(5.1)	55	5.8(1.8)	21.4(1.0)	100	2.3(6.3)	9.6(5.6)	79
52 KM	3.1(3.2)	11.9(4.6)	114	18.1(*.1)	12.5(4.0)	74	3.5(1.9)	23.6(1.6)	117	9.5(3.8)	11.5(1.1)	106
50 KM	9.2(3.6)	12.9(.6)	126	13.9(*.0)	13.0(4.8)	87	3.4(1.9)	14.6(1.6)	125	11.4(3.2)	12.1(.6)	127
48 KM	11.2(3.2)	14.1(.5)	138	8.6(2.6)	14.1(.8)	101	2.1(1.4)	16.9(2.2)	133	9.4(2.6)	13.3(.6)	137
46 KM	11.1(2.7)	14.1(.4)	146	5.2(1.5)	14.9(.8)	105	4.5(1.3)	17.0(.8)	140	7.7(2.0)	13.1(.5)	147
44 KM	6.2(1.4)	16.9(.9)	153	2.6(1.1)	17.3(1.1)	112	4.9(1.1)	16.1(.5)	147	5.0(1.8)	14.5(.9)	152
42 KM	4.9(1.2)	16.5(.8)	156	1.2(1.0)	15.1(1.9)	117	1.4(.9)	15.1(1.0)	150	6.8(1.3)	17.4(.6)	155
40 KM	3.1(1.1)	18.5(1.4)	157	.9(.9)	2.4(2.0)	120	1.8(1.2)	13.3(1.5)	152	5.1(1.6)	19.7(.5)	157
38 KM	2.4(1.2)	15.3(1.1)	159	1.2(.8)	1.4(1.0)	120	1.8(.9)	17.9(1.0)	154	4.0(1.0)	1.1(.3)	157
36 KM	2.5(1.2)	10.5(.9)	159	1.2(.8)	9.7(.9)	120	2.1(.3)	13.1(.5)	155	4.2(1.1)	3.2(.5)	157
34 KM	2.0(1.1)	10.4(1.0)	160	2.8(.9)	9.1(.5)	121	.4(.7)	7.9(3.5)	155	2.3(.8)	5.8(.7)	156
32 KM	3.0(1.3)	23.9(.5)	160	1.4(.8)	3.8(1.1)	122	.6(.6)	8.8(.8)	155	2.4(.9)	14.4(.4)	157
30 KM	1.1(1.0)	2.0(1.4)	160	.9(.7)	6.9(1.1)	122	.3(.7)	23.7(3.7)	155	1.7(.8)	3.0(.5)	156

STATION HAWAII

ANALYSIS OF SEASONAL DIURNAL TIDES IN MERIDIONAL WIND, 30 TO 60 KM
AMPLITUDES ARE IN M/S AND PHASES ARE IN LOCAL TIME,
NUMBERS IN PARENTHESES ARE THE ERRORS (M/S OR HOURS)

SEASON	SPRING			SUMMER			AUTUMN			WINTER		
ALTITUDE	AMPLITUDE	PHASE	N	AMPLITUDE	PHASE	N	AMPLITUDE	PHASE	N	AMPLITUDE	PHASE	N
60 KM	5.7(2.3)	6.3(2.2)	80	8.9(2.1)	8.5(1.0)	98	5.6(2.4)	7.9(2.2)	125	12.4(3.8)	5.9(1.5)	82
58 KM	3.3(2.3)	9.8(3.7)	174	6.1(2.0)	9.4(1.3)	195	7.2(2.3)	10.7(1.1)	213	7.3(2.9)	7.6(2.1)	162
56 KM	5.5(2.3)	10.9(1.4)	252	7.5(1.8)	12.5(.8)	273	.8(.9)	11.0(5.3)	284	7.1(2.1)	8.5(1.4)	214
54 KM	6.9(1.9)	12.1(.6)	295	7.8(1.9)	12.1(.7)	327	2.1(1.1)	11.6(2.2)	320	7.6(2.0)	10.7(.8)	248
52 KM	9.6(1.9)	11.9(.4)	313	8.6(1.4)	11.8(.5)	355	3.2(1.1)	13.6(1.2)	349	8.0(2.0)	10.8(.8)	269
50 KM	7.4(2.0)	12.0(.6)	325	6.6(.8)	12.5(.5)	390	2.7(1.1)	13.3(1.4)	370	7.9(2.0)	10.7(.8)	277
48 KM	5.2(1.9)	11.4(1.0)	334	5.6(.8)	12.9(.5)	403	2.1(.9)	15.0(2.0)	375	5.3(1.8)	9.9(1.4)	281
46 KM	6.6(2.0)	12.4(.7)	340	5.0(.7)	13.3(.6)	409	4.2(.9)	14.5(.8)	378	6.5(1.5)	3.1(.9)	286
44 KM	3.1(.9)	16.1(1.5)	344	4.0(.5)	14.4(.5)	412	5.0(.8)	14.1(.5)	381	5.6(1.1)	5.8(1.0)	294
42 KM	3.4(.5)	15.4(.6)	346	3.4(.2)	15.7(.3)	411	2.7(.4)	15.7(.6)	380	1.5(.9)	11.7(3.1)	294
40 KM	1.5(.4)	12.7(.5)	348	1.5(.1)	14.2(.4)	411	1.2(.2)	16.6(.8)	378	1.3(.5)	14.6(1.6)	295
38 KM	2.1(.5)	10.6(.7)	347	.8(.1)	2.5(.6)	404	.7(.2)	19.0(1.3)	380	1.0(.2)	22.1(1.1)	293
36 KM	4.1(.6)	11.7(.3)	347	.9(.1)	1.0(.6)	394	1.0(.1)	18.0(.6)	378	1.8(.2)	3.9(.5)	294
34 KM	1.2(.3)	9.6(.7)	347	.9(.3)	8.8(1.2)	382	1.1(.2)	16.4(1.0)	379	.9(.1)	20.3(1.0)	294
32 KM	2.9(.3)	11.1(.2)	345	1.5(.3)	12.8(.7)	367	.9(.1)	16.7(1.0)	377	4.0(.3)	1.8(.2)	293
30 KM	1.1(.5)	11.1(1.2)	345	2.0(.2)	15.6(.4)	354	.8(.2)	20.9(.7)	374	3.2(.2)	5.0(.3)	293

STATION KENNEDY

ANALYSIS OF SEASONAL DIURNAL TIDES IN MERIDIONAL WIND, 30 TO 60 KM
AMPLITUDES ARE IN M/S AND PHASES ARE IN LOCAL TIME,
NUMBERS IN PARENTHESES ARE THE ERRORS (M/S OR HOURS)

SEASON	SPRING			SUMMER			AUTUMN			WINTER		
ALTITUDE	AMPLITUDE	PHASE	N	AMPLITUDE	PHASE	N	AMPLITUDE	PHASE	N	AMPLITUDE	PHASE	N
60 KM	10.8(2.7)	12.3(.6)	147	4.9(1.8)	12.3(.7)	169	8.7(1.8)	15.6(.6)	159	12.4(2.9)	11.2(.7)	152
58 KM	7.3(1.7)	10.9(.5)	249	7.1(1.5)	10.4(.4)	285	5.3(1.7)	15.7(.9)	245	5.3(2.0)	13.5(1.1)	263
56 KM	6.2(1.4)	11.7(.5)	330	5.3(1.4)	9.7(.6)	368	2.9(1.6)	14.0(1.6)	309	5.0(1.6)	14.8(.9)	363
54 KM	6.2(1.2)	12.5(.4)	400	8.6(1.4)	9.9(.3)	418	3.0(1.6)	14.4(1.5)	361	4.1(1.5)	15.3(1.1)	441
52 KM	6.3(1.2)	12.0(.4)	447	9.0(1.5)	11.0(.3)	448	3.5(1.5)	13.3(1.2)	405	4.4(1.5)	14.6(.9)	487
50 KM	6.7(1.1)	12.3(.3)	471	8.2(1.4)	11.9(.3)	473	5.3(1.5)	13.5(.7)	431	4.4(1.4)	13.1(.8)	516
48 KM	5.9(1.1)	13.2(.3)	489	8.0(1.2)	12.7(.3)	493	7.2(1.4)	13.9(.5)	437	4.5(1.4)	14.0(.8)	540
46 KM	6.6(1.0)	13.8(.3)	500	7.3(1.0)	13.7(.3)	505	7.1(1.3)	15.1(.4)	457	5.5(1.3)	14.6(.6)	560
44 KM	4.4(.8)	14.5(.3)	510	4.6(.8)	15.3(.2)	513	6.0(1.1)	16.2(.4)	468	5.6(1.2)	16.8(.5)	567
42 KM	2.8(.7)	14.8(.2)	513	3.1(.7)	15.9(.2)	513	5.8(.9)	18.1(.3)	475	5.9(1.1)	17.8(.4)	571
40 KM	1.8(.7)	13.9(.3)	512	1.3(.6)	13.8(.3)	514	3.6(.8)	17.7(.4)	479	6.0(1.0)	18.9(.3)	581
38 KM	1.5(.7)	17.5(.4)	509	.5(.6)	11.8(.9)	514	2.3(.7)	17.1(.4)	477	4.2(.9)	22.2(.3)	575
36 KM	1.5(.7)	17.7(.5)	505	.9(.6)	11.1(.4)	513	.4(.7)	16.9(2.0)	475	3.5(.8)	22.7(.4)	578
34 KM	1.0(.6)	4.2(.4)	501	1.1(.6)	11.6(.4)	512	2.2(.8)	10.6(.5)	477	3.3(.9)	1.0(.4)	566
32 KM	1.9(.7)	9.5(.4)	499	1.3(.7)	11.7(.5)	505	2.9(.8)	13.5(.4)	478	1.0(1.0)	4.5(2.1)	562
30 KM	1.9(.7)	12.0(.4)	495	1.6(.6)	15.6(.2)	504	2.7(.7)	15.3(.3)	473	1.7(.9)	13.3(.9)	557

STATION WSMR ANALYSIS OF SEASONAL DIURNAL TIDES IN MERIDIONAL WIND, 30 TO 60 KM
AMPLITUDES ARE IN M/S AND PHASES ARE IN LOCAL TIME,
NUMBERS IN PARENTHESES ARE THE ERRORS (M/S OR HOURS)

SEASON	SPRING			SUMMER			AUTUMN			WINTER		
ALTITUDE	AMPLITUDE	PHASE	N	AMPLITUDE	PHASE	N	AMPLITUDE	PHASE	N	AMPLITUDE	PHASE	N
60 KM	8.0(.7)	13.4(.3)	406	5.2(.4)	11.0(.3)	450	5.7(.8)	11.8(.6)	416	8.4(1.3)	12.9(.6)	356
58 KM	7.4(.6)	12.7(.3)	471	5.0(.4)	10.9(.3)	533	5.5(.8)	11.2(.5)	488	7.3(1.0)	13.0(.5)	408
56 KM	9.8(.6)	12.2(.2)	520	6.6(.4)	12.0(.3)	584	7.3(.8)	11.2(.4)	530	6.2(1.0)	13.4(.6)	460
54 KM	6.3(.5)	11.8(.3)	557	7.8(.5)	11.4(.2)	615	6.9(.7)	11.6(.4)	577	4.9(1.0)	13.7(.8)	485
52 KM	6.6(.5)	12.3(.3)	575	7.7(.5)	11.4(.3)	643	6.8(.7)	13.0(.4)	605	5.0(.9)	12.8(.7)	504
50 KM	8.0(.6)	12.1(.3)	601	7.5(.5)	12.1(.2)	663	6.6(.7)	13.0(.4)	647	5.7(.8)	12.7(.6)	503
48 KM	8.4(.5)	12.2(.3)	617	8.5(.5)	12.5(.2)	676	7.3(.6)	13.6(.3)	662	5.3(.8)	13.1(.5)	516
46 KM	7.3(.5)	13.7(.2)	633	7.7(.4)	12.9(.2)	680	7.3(.5)	14.6(.3)	678	5.2(.7)	13.7(.5)	534
44 KM	4.9(.4)	15.0(.3)	641	5.5(.3)	13.9(.2)	690	5.4(.4)	16.3(.3)	688	3.0(.6)	14.6(.6)	565
42 KM	3.7(.3)	15.8(.2)	653	3.2(.2)	14.9(.2)	696	3.3(.3)	17.9(.3)	699	.3(.3)	15.5(5.4)	575
40 KM	1.4(.1)	18.5(.3)	655	2.0(.1)	16.1(.2)	706	2.2(.2)	19.6(.3)	707	1.6(.3)	1.7(.6)	593
38 KM	.3(.1)	2.1(1.1)	660	1.3(.1)	9.2(.3)	720	.9(.1)	20.5(.6)	710	2.5(.2)	4.9(.3)	603
36 KM	2.0(.1)	8.7(.3)	664	.6(.1)	6.1(.6)	728	.9(.1)	4.8(.6)	716	2.3(.2)	7.2(.4)	608
34 KM	2.4(.2)	9.3(.3)	667	.9(.1)	9.0(.4)	730	1.5(.2)	9.1(.6)	712	2.1(.2)	9.0(.5)	609
32 KM	1.2(.2)	12.0(.6)	665	2.5(.1)	12.5(.2)	731	1.7(.2)	12.5(.5)	717	1.5(.2)	10.5(.5)	617
30 KM	1.7(.2)	11.6(.4)	665	1.9(.1)	14.2(.2)	734	1.7(.2)	16.2(.4)	717	.7(.1)	13.3(.7)	624

STATION PT.MUGU ANALYSIS OF SEASONAL DIURNAL TIDES IN MERIDIONAL WIND, 30 TO 60 KM
AMPLITUDES ARE IN M/S AND PHASES ARE IN LOCAL TIME,
NUMBERS IN PARENTHESES ARE THE ERRORS (M/S OR HOURS)

SEASON	SPRING			SUMMER			AUTUMN			WINTER		
ALTITUDE	AMPLITUDE	PHASE	N	AMPLITUDE	PHASE	N	AMPLITUDE	PHASE	N	AMPLITUDE	PHASE	N
60 KM	11.5(2.8)	12.2(.8)	116	4.1(1.0)	15.9(1.0)	147	6.3(2.2)	9.4(.8)	139	21.7(3.3)	10.3(.4)	131
58 KM	12.8(2.5)	11.0(.5)	233	4.9(1.4)	9.3(.4)	269	6.9(1.7)	11.0(.6)	247	11.4(2.4)	10.5(.6)	227
56 KM	6.9(1.9)	12.9(.9)	322	2.9(1.6)	11.0(1.3)	397	7.1(1.9)	11.6(.7)	339	8.0(2.2)	10.7(.8)	310
54 KM	4.1(1.4)	16.0(1.3)	410	4.0(1.6)	12.8(1.4)	486	8.0(1.9)	12.2(.7)	400	4.1(2.0)	11.1(1.5)	358
52 KM	4.4(1.6)	16.2(1.3)	472	7.6(1.9)	11.7(.7)	533	8.0(1.7)	12.4(.6)	444	6.4(1.9)	11.5(.8)	376
50 KM	4.7(1.6)	14.0(1.3)	497	8.0(1.7)	12.1(.6)	564	7.9(1.6)	12.2(.6)	477	6.2(1.8)	12.1(.8)	393
48 KM	5.2(1.5)	13.7(1.1)	511	9.6(1.6)	12.1(.4)	575	9.0(1.4)	12.4(.4)	493	6.4(1.6)	12.2(.7)	403
46 KM	5.2(1.3)	14.4(.9)	516	7.8(1.2)	12.9(.4)	582	7.2(1.1)	13.2(.4)	499	7.0(1.4)	12.8(.5)	405
44 KM	4.7(1.1)	16.3(.7)	518	5.1(.8)	14.6(.4)	591	4.9(.8)	14.4(.4)	504	5.9(1.2)	13.2(.5)	425
42 KM	4.6(.9)	17.8(.4)	521	3.8(.8)	17.6(.4)	596	3.5(.8)	14.0(.4)	510	3.2(.9)	13.9(.5)	423
40 KM	3.5(.8)	20.5(.2)	523	1.8(.6)	15.6(.5)	598	3.5(.7)	11.5(.1)	510	1.7(.8)	21.5(.5)	429
38 KM	1.5(.8)	9.4(.4)	525	3.0(.7)	11.9(.2)	598	1.2(.9)	10.2(.8)	510	.3(.7)	6.2(4.2)	430
36 KM	3.0(1.0)	10.7(.5)	524	2.3(.7)	10.5(.1)	597	2.1(1.0)	10.6(.7)	510	1.2(.8)	11.4(.8)	433
34 KM	2.3(1.0)	12.3(.8)	522	2.4(.9)	10.4(.3)	596	4.0(1.1)	11.1(.4)	509	2.6(.8)	13.3(.3)	435
32 KM	1.8(.8)	13.3(.7)	524	3.2(.8)	11.8(.3)	591	4.3(.9)	11.7(.3)	510	1.0(.7)	17.7(1.1)	438
30 KM	1.5(.7)	11.7(.2)	522	2.2(.7)	13.9(.4)	588	3.2(.7)	12.4(.2)	503	1.2(.8)	22.9(.8)	443

STATION WALLOPS

ANALYSIS OF SEASONAL DIURNAL TIDES IN MERIDIONAL WIND, 30 TO 60 KM
AMPLITUDES ARE IN M/S AND PHASES ARE IN LOCAL TIME,
NUMBERS IN PARENTHESES ARE THE ERRORS (M/S OR HOURS)

SEASON	SPRING			SUMMER			AUTUMN			WINTER		
ALTITUDE	AMPLITUDE	PHASE	N	AMPLITUDE	PHASE	N	AMPLITUDE	PHASE	N	AMPLITUDE	PHASE	N
60 KM	12.8(2.3)	12.3(.5)	104	10.2(2.3)	14.8(.7)	102	1.3(1.9)	13.7(5.4)	91	10.3(3.7)	12.6(1.2)	100
58 KM	7.9(1.7)	12.3(.5)	163	6.8(1.6)	14.1(.5)	160	2.2(2.2)	12.3(4.3)	144	9.9(3.6)	12.0(1.1)	136
56 KM	9.2(1.8)	12.5(.5)	220	5.5(1.3)	10.9(.4)	224	4.4(2.4)	12.9(1.6)	213	9.4(3.1)	11.6(.9)	167
54 KM	9.0(1.7)	11.9(.4)	291	7.4(1.4)	10.6(.3)	276	2.8(2.0)	13.3(2.4)	267	11.6(2.9)	11.6(.7)	183
52 KM	9.3(1.4)	12.6(.3)	333	7.2(1.3)	11.3(.3)	316	4.8(2.1)	12.8(1.1)	313	11.8(2.6)	12.1(.6)	219
50 KM	7.1(1.2)	13.4(.4)	363	7.3(1.4)	12.4(.3)	355	6.1(1.9)	13.2(.7)	343	7.1(2.6)	12.6(1.1)	239
48 KM	6.1(1.2)	12.8(.4)	383	7.5(1.4)	12.9(.3)	370	6.2(1.9)	13.4(.7)	358	10.1(2.2)	13.5(.6)	249
46 KM	6.2(1.1)	12.5(.3)	394	6.1(1.3)	13.5(.4)	378	6.4(1.7)	14.2(.6)	375	10.1(2.2)	14.0(.6)	266
44 KM	5.2(1.0)	12.8(.3)	397	4.0(1.0)	14.5(.4)	386	4.7(1.4)	15.8(.9)	382	6.9(1.8)	15.1(.8)	285
42 KM	4.5(.9)	13.9(.3)	400	3.9(.8)	14.3(.3)	393	3.3(1.2)	16.7(1.0)	391	4.7(1.4)	15.8(.7)	300
40 KM	2.8(.8)	14.5(.4)	403	2.9(.7)	13.2(.2)	398	2.4(.9)	18.8(1.0)	395	2.1(1.2)	18.8(1.3)	303
38 KM	.2(.7)	21.8(4.6)	405	2.6(.7)	13.0(.2)	401	1.1(.8)	19.9(1.4)	397	2.2(1.0)	.7(.9)	301
36 KM	1.4(.7)	6.9(.5)	403	1.8(.7)	12.0(.3)	397	.5(.8)	3.1(2.7)	397	1.7(.9)	3.4(1.0)	307
34 KM	1.5(.7)	9.4(.4)	405	1.4(.7)	12.1(.4)	393	1.3(.9)	12.6(1.1)	391	2.3(1.0)	7.7(.8)	298
32 KM	1.8(.7)	9.2(.4)	403	1.2(.7)	13.3(.4)	393	3.0(.9)	14.0(.4)	385	1.8(1.0)	9.1(1.2)	298
30 KM	2.3(.7)	10.3(.3)	395	1.4(.7)	12.4(.3)	394	2.3(.9)	13.4(.5)	378	1.6(1.0)	13.8(1.2)	293

STATION CHURCHILL

ANALYSIS OF SEASONAL DIURNAL TIDES IN MERIDIONAL WIND, 30 TO 60 KM
AMPLITUDES ARE IN M/S AND PHASES ARE IN LOCAL TIME,
NUMBERS IN PARENTHESES ARE THE ERRORS (M/S OR HOURS)

SEASON	SPRING			SUMMER			AUTUMN			WINTER		
ALTITUDE	AMPLITUDE	PHASE	N	AMPLITUDE	PHASE	N	AMPLITUDE	PHASE	N	AMPLITUDE	PHASE	N
60 KM	6.7(1.3)	10.6(1.0)	83	12.1(1.8)	10.8(.8)	66	.6(1.7)	12.0(6.1)	102	3.9(2.0)	14.0(2.5)	106
58 KM	6.7(1.0)	10.0(.8)	106	8.9(1.3)	11.6(.7)	93	3.7(1.2)	12.7(1.6)	140	5.2(1.2)	11.5(1.3)	129
56 KM	7.6(1.0)	10.7(.7)	138	10.3(1.2)	12.8(.5)	132	4.4(.8)	11.1(1.0)	192	7.5(1.0)	13.6(.5)	176
54 KM	7.4(.8)	10.6(.6)	167	8.4(1.0)	12.4(.6)	156	5.5(.8)	12.1(.8)	221	3.6(.5)	12.2(.7)	231
52 KM	6.4(.6)	11.5(.5)	190	7.7(1.0)	13.1(.5)	171	6.1(.7)	12.6(.6)	237	2.4(.5)	9.4(1.1)	264
50 KM	6.5(.6)	10.9(.5)	205	7.7(.7)	13.3(.4)	186	6.4(.7)	11.8(.5)	251	.9(.4)	7.4(2.4)	277
48 KM	5.9(.6)	10.9(.6)	208	5.7(.6)	12.9(.4)	192	5.8(.9)	13.0(.7)	255	.9(.5)	4.7(2.2)	284
46 KM	3.8(.5)	9.7(.6)	207	4.8(.5)	13.3(.4)	197	4.0(.8)	12.1(1.0)	256	1.7(.5)	16.5(.9)	294
44 KM	3.3(.5)	8.0(.7)	207	4.8(.4)	13.0(.4)	200	3.7(.7)	12.0(1.0)	260	1.7(.5)	14.8(1.1)	298
42 KM	3.6(.4)	8.1(.5)	213	2.9(.3)	12.5(.5)	200	3.6(.8)	13.9(.9)	269	.9(.6)	16.1(3.2)	284
40 KM	3.1(.4)	8.2(.5)	212	2.2(.2)	12.9(.4)	200	4.1(.9)	14.6(.8)	271	1.1(.7)	5.4(3.8)	255
38 KM	3.5(.5)	6.8(.5)	214	1.5(.2)	11.1(.8)	202	3.2(.8)	13.7(1.0)	266	.7(.7)	17.5(5.1)	249
36 KM	3.6(.5)	8.0(.6)	215	2.6(.3)	10.6(.6)	204	2.2(.7)	12.5(1.5)	269	1.3(.8)	14.2(3.6)	252
34 KM	2.4(.3)	9.6(.8)	215	2.3(.2)	11.4(.5)	209	3.0(.7)	14.1(.9)	271	1.4(.8)	13.8(3.3)	236
32 KM	2.4(.4)	7.6(.6)	222	1.2(.2)	11.6(.6)	210	2.3(.6)	13.8(1.1)	271	.2(.7)	13.9(6.5)	227
30 KM	2.6(.4)	8.6(.7)	221	1.0(.1)	10.8(.7)	211	1.5(.5)	12.7(1.8)	285	.8(.8)	14.4(5.0)	228

STATION ASCENSION

ANALYSIS OF SEASONAL DIURNAL TIDES IN MERIDIONAL WIND, 30 TO 60 KM
AMPLITUDES ARE IN M/S AND PHASES ARE IN LOCAL TIME.
NUMBERS IN PARENTHESES ARE THE ERRORS (M/S OR HOURS)

SEASON	AUTUMN			WINTER			SPRING			SUMMER		
ALTITUDE	AMPLITUDE	PHASE	N	AMPLITUDE	PHASE	N	AMPLITUDE	PHASE	N	AMPLITUDE	PHASE	N
60 KM	11.1(2.3)	23.1(.4)	110	11.7(2.4)	.7(.6)	113	4.1(1.9)	10.0(1.3)	116	2.6(2.7)	5.5(4.4)	111
58 KM	1.9(1.0)	7.2(.9)	219	5.2(1.2)	4.2(.7)	209	6.9(1.5)	8.2(.5)	217	2.2(1.6)	6.2(2.4)	196
56 KM	3.2(.9)	11.2(.4)	271	4.3(1.0)	6.5(.5)	248	6.1(1.3)	9.3(.4)	282	5.6(1.5)	11.4(.6)	253
54 KM	4.8(1.0)	13.2(.4)	293	1.1(1.1)	11.0(2.8)	262	7.1(1.2)	11.8(.4)	310	7.8(1.7)	12.5(.6)	272
52 KM	6.7(1.1)	12.7(.3)	303	2.7(1.4)	21.1(1.3)	268	7.2(1.2)	13.3(.4)	321	8.7(1.8)	12.8(.6)	287
50 KM	6.9(1.1)	13.2(.3)	306	4.8(1.2)	16.8(.6)	272	7.7(1.2)	14.5(.4)	327	7.8(1.8)	13.8(.7)	289
48 KM	5.1(.9)	14.2(.3)	306	4.5(.9)	18.1(.4)	276	6.8(1.1)	15.3(.3)	327	7.1(1.5)	15.6(.6)	293
46 KM	3.6(.8)	15.5(.3)	306	5.4(1.1)	21.9(.4)	276	4.0(.8)	16.3(.3)	329	5.9(1.2)	17.0(.5)	297
44 KM	3.0(.9)	18.3(.5)	310	4.2(1.2)	22.5(.5)	276	3.0(.7)	18.2(.3)	328	3.5(.9)	16.9(.5)	295
42 KM	2.1(.9)	19.1(.8)	303	1.4(1.0)	22.2(1.5)	276	1.6(.7)	21.0(.5)	322	1.4(.7)	19.4(.4)	295
40 KM	.8(.8)	9.2(1.8)	304	.2(.8)	23.2(6.1)	278	1.1(.7)	2.7(.9)	321	.3(.7)	21.8(3.0)	294
38 KM	1.0(.7)	19.2(.9)	304	2.2(.9)	7.5(.7)	278	.7(.7)	7.9(1.0)	320	1.7(.8)	6.7(.5)	294
36 KM	2.1(.8)	1.1(.5)	304	1.8(.8)	6.1(.6)	279	1.8(.7)	4.8(.4)	320	3.5(.8)	4.5(.4)	295
34 KM	2.7(.7)	4.8(.4)	304	1.6(.8)	22.4(.6)	281	1.6(.7)	5.3(.4)	319	4.9(.8)	5.9(.2)	296
32 KM	3.8(.8)	7.0(.3)	304	.6(.7)	20.6(1.2)	281	1.3(.7)	8.1(.5)	319	1.1(.7)	8.2(.4)	295
30 KM	2.9(.8)	10.8(.3)	304	1.3(.7)	10.4(.5)	281	2.1(.7)	12.1(.4)	319	1.6(.7)	10.2(.5)	295

STATION SHERMAN

SEASON	SPRING		
ALTITUDE	AMPLITUDE	PHASE	N
60 KM	9.8(2.3)	14.4(.7)	68
58 KM	1.2(2.4)	14.9(5.8)	93
56 KM	6.1(3.0)	10.8(1.8)	120
54 KM	9.4(2.6)	13.7(.9)	135
52 KM	7.6(1.9)	13.0(.9)	143
50 KM	5.0(1.5)	11.7(1.0)	150
48 KM	4.2(1.3)	12.9(.9)	158
46 KM	5.2(1.2)	16.2(.5)	161
44 KM	2.0(1.1)	21.7(1.4)	163
42 KM	2.4(1.0)	20.2(.8)	162
40 KM	2.5(1.2)	5.1(1.0)	161
38 KM	1.5(1.0)	7.5(1.2)	163
36 KM	2.5(1.2)	5.3(1.0)	165
34 KM	1.6(1.1)	17.0(1.2)	167
32 KM	2.9(1.1)	12.1(1.0)	166
30 KM	2.2(1.1)	9.1(1.3)	166

THULE

SEASON	SUMMER		
ALTITUDE	AMPLITUDE	PHASE	N
60 KM	1.6(1.2)	12.5(4.5)	43
58 KM	5.2(2.4)	13.5(1.6)	72
56 KM	4.9(1.7)	12.7(1.0)	96
54 KM	5.2(1.5)	12.9(.9)	104
52 KM	6.8(1.6)	12.6(.6)	116
50 KM	7.8(1.7)	12.4(.5)	122
48 KM	7.3(1.7)	13.0(.6)	131
46 KM	5.9(1.4)	14.1(.7)	135
44 KM	2.5(.6)	17.1(1.5)	140
42 KM	1.6(.7)	13.4(1.6)	142
40 KM	1.2(.6)	13.5(1.8)	145
38 KM	1.3(.5)	11.3(1.0)	149
36 KM	1.8(.6)	11.7(.8)	151
34 KM	3.2(.7)	12.8(.5)	152
32 KM	1.4(.5)	12.6(.9)	150
30 KM	1.3(.4)	13.0(.8)	154

FT.GREELY

SEASON	SUMMER		
ALTITUDE	AMPLITUDE	PHASE	N
60 KM	12.1(3.9)	10.9(1.2)	157
58 KM	11.0(3.1)	10.3(.9)	212
56 KM	6.7(2.8)	12.4(1.2)	244
54 KM	5.8(2.4)	12.3(1.1)	258
52 KM	6.6(2.3)	12.2(.9)	262
50 KM	6.1(1.9)	12.7(.8)	265
48 KM	5.3(1.6)	13.7(.7)	271
46 KM	3.2(1.2)	15.0(.9)	273
44 KM	3.4(1.1)	12.7(.6)	276
42 KM	2.0(1.0)	14.6(1.0)	281
40 KM	2.4(1.0)	12.7(.7)	281
38 KM	3.1(1.1)	12.6(.6)	280
36 KM	2.5(1.0)	11.4(.7)	276
34 KM	1.1(.9)	10.9(1.3)	276
32 KM	1.5(.9)	11.9(.8)	276
30 KM	.9(.8)	9.6(1.1)	276

APPENDIX B: Mean meridional wind due to the diurnal tide during hours of daylight and darkness. Sunrise/sunset times are for 40 km altitude. Negative winds are from the north.

MEAN TIDAL DAY WINDS (DM/S) FOR MONTH JAN

60.0 KM	0	0	0	39	45	52	56	61	56	50	12	-11	-24	-38	-48
57.5 KM	0	0	0	29	41	53	56	59	51	38	23	0	-12	-27	-27
55.0 KM	0	0	0	28	40	52	55	58	41	30	36	24	0	-13	-12
52.5 KM	0	0	0	18	30	37	48	58	40	30	38	38	28	11	0
50.0 KM	0	0	0	15	22	34	46	54	43	30	32	39	40	16	12
47.5 KM	0	0	0	15	19	33	49	60	47	34	34	32	36	28	23
45.0 KM	0	0	0	9	12	19	36	43	37	25	36	26	43	37	30
42.5 KM	0	0	0	8	9	10	19	23	14	7	30	25	34	22	10
40.0 KM	0	0	0	7	7	7	8	5	-10	-13	8	16	8	-8	-5
37.5 KM	0	0	0	9	7	6	3	-13	-2	-23	-13	-24	-22	-5	-2
35.0 KM	0	0	0	10	9	5	-4	-8	14	-14	-19	-15	-5	-4	-2
32.5 KM	0	0	0	10	9	2	-8	3	11	3	-6	-6	-2	-2	-6
30.0 KM	0	0	0	10	9	-4	-6	9	5	9	-2	-5	-7	-6	-5
LATITUDE	70			60		50		40		30		20		10	0

MEAN TIDAL NIGHT WINDS (DM/S) FOR MONTH JAN

60.0 KM	0	0	0	-20	-27	-35	-41	-48	-46	-44	-11	12	25	42	55
57.5 KM	0	0	0	-15	-25	-36	-41	-46	-42	-33	-20	0	13	30	32
55.0 KM	0	0	0	-14	-24	-35	-41	-45	-34	-25	-33	-23	0	15	15
52.5 KM	0	0	0	-9	-18	-25	-35	-45	-33	-25	-35	-37	-28	-11	0
50.0 KM	0	0	0	-7	-13	-23	-34	-42	-35	-25	-29	-37	-40	-16	-12
47.5 KM	0	0	0	-7	-11	-22	-36	-47	-39	-29	-31	-30	-36	-29	-25
45.0 KM	0	0	0	-4	-7	-12	-26	-33	-30	-21	-33	-24	-43	-38	-33
42.5 KM	0	0	0	-4	-5	-6	-13	-18	-11	-5	-27	-23	-33	-23	-11
40.0 KM	0	0	0	-3	-4	-4	-5	-3	9	12	-7	-15	-7	10	6
37.5 KM	0	0	0	-4	-3	-3	-2	11	3	21	13	25	23	6	4
35.0 KM	0	0	0	-5	-4	-2	4	7	-11	13	18	16	6	5	3
32.5 KM	0	0	0	-5	-4	-1	7	-2	-9	-2	6	7	3	3	8
30.0 KM	0	0	0	-5	-4	3	5	-6	-3	-7	3	6	8	7	7
LATITUDE	70			60		50		40		30		20		10	0

SUNRISE	11.5	9.1	8.3	7.7	7.4	7.1	6.9	6.7	6.5	6.3	6.2	6.1	5.9	5.8	5.7
SUNSET	12.5	14.9	15.8	16.3	16.7	16.9	17.2	17.3	17.5	17.7	17.8	17.9	18.1	18.2	18.3

MEAN TIDAL DAY WINDS (DM/S) FOR MONTH FEB

60.0 KM	*	0	0	0	34	40	47	51	56	52	47	12	-11	-23	-38	-48
57.5 KM	*	0	0	0	25	37	48	51	55	48	36	22	0	-12	-27	-28
55.0 KM	*	0	0	0	24	36	47	51	54	39	28	34	24	0	-13	-13
52.5 KM	*	0	0	0	15	27	33	44	54	37	28	37	37	27	10	0
50.0 KM	*	0	0	0	13	19	31	43	50	40	28	30	38	39	15	11
47.5 KM	*	0	0	0	13	17	30	45	56	44	32	33	31	35	27	23
45.0 KM	*	0	0	0	8	11	17	33	40	34	23	35	25	41	36	30
42.5 KM	*	0	0	0	7	8	10	17	22	13	6	28	24	33	22	10
40.0 KM	*	0	0	0	6	7	6	7	5	-9	-12	8	16	8	-8	-5
37.5 KM	*	0	0	0	8	6	5	3	-12	-2	-21	-13	-23	-21	-5	-2
35.0 KM	*	0	0	0	9	8	4	-4	-7	13	-13	-18	-14	-5	-4	-2
32.5 KM	*	0	0	0	9	8	2	-8	3	11	3	-5	-5	-2	-2	-6
30.0 KM	*	0	0	0	9	8	-3	-5	8	4	9	-2	-5	-6	-6	-5
LATITUDE		70			60		50		40		30		20		10	0

MEAN TIDAL NIGHT WINDS (DM/S) FOR MONTH FEB

60.0 KM	*	0	0	0	-26	-33	-40	-46	-52	-50	-46	-11	12	26	43	56
57.5 KM	*	0	0	0	-20	-30	-41	-46	-51	-46	-35	-21	0	14	31	32
55.0 KM	*	0	0	0	-19	-29	-40	-45	-50	-37	-27	-34	-24	0	16	16
52.5 KM	*	0	0	0	-11	-22	-28	-40	-50	-36	-27	-36	-38	-28	-10	0
50.0 KM	*	0	0	0	-9	-15	-26	-38	-46	-38	-27	-30	-38	-41	-16	-12
47.5 KM	*	0	0	0	-10	-14	-25	-40	-52	-42	-31	-33	-31	-37	-29	-25
45.0 KM	*	0	0	0	-5	-8	-14	-29	-37	-33	-22	-34	-25	-44	-39	-33
42.5 KM	*	0	0	0	-5	-6	-7	-15	-20	-11	-5	-28	-24	-35	-23	-11
40.0 KM	*	0	0	0	-4	-5	-4	-6	-3	10	13	-7	-15	-8	10	6
37.5 KM	*	0	0	0	-5	-4	-4	-2	13	3	22	14	25	24	7	4
35.0 KM	*	0	0	0	-6	-6	-3	5	8	-12	14	19	16	6	6	3
32.5 KM	*	0	0	0	-6	-6	-1	8	-2	-9	-2	6	7	4	3	8
30.0 KM	*	0	0	0	-6	-6	4	6	-6	-3	-8	3	6	8	8	7
LATITUDE		70			60		50		40		30		20		10	0
SUNRISE		7.7	7.1	6.9	6.7	6.5	6.4	6.3	6.2	6.1	6.0	5.9	5.9	5.8	5.7	5.7
SUNSET		16.4	16.9	17.2	17.4	17.5	17.7	17.7	17.9	17.9	18.0	18.1	18.1	18.3	18.3	18.4

MEAN TIDAL DAY WINDS (DM/S) FOR MONTH MAR

60.0 KM	*	0	0	0	37	39	41	42	50	47	46	37	0	-9	-25	-26
57.5 KM	*	0	0	0	36	38	40	47	50	46	41	37	19	-11	-13	-28
55.0 KM	*	0	0	0	36	38	39	46	48	43	38	37	36	14	-14	-28
52.5 KM	*	0	0	0	34	35	36	44	47	43	38	40	52	48	29	0
50.0 KM	*	0	0	0	24	32	38	40	43	45	41	40	49	53	45	24
47.5 KM	*	0	0	0	14	22	34	36	41	42	41	37	39	41	36	30
45.0 KM	*	0	0	0	11	16	24	30	35	35	30	26	27	28	20	15
42.5 KM	*	0	0	0	5	11	20	23	26	6	11	14	16	7	0	11
40.0 KM	*	0	0	0	5	10	14	18	15	-2	8	8	8	5	18	15
37.5 KM	*	0	0	0	0	5	9	13	8	6	11	8	12	16	9	-7
35.0 KM	*	0	0	0	5	4	7	6	5	11	11	5	11	7	-13	-15
32.5 KM	*	0	0	0	4	4	6	5	5	11	6	5	10	-5	-11	11
30.0 KM	*	0	0	0	7	7	6	5	7	10	10	9	4	-9	11	15
	**********															
LATITUDE		70			60			50			40			30		20		10		0

MEAN TIDAL NIGHT WINDS (DM/S) FOR MONTH MAR

60.0 KM	*	0	0	0	-44	-46	-47	-48	-56	-54	-51	-41	0	12	30	31
57.5 KM	*	0	0	0	-43	-44	-47	-54	-56	-52	-46	-41	-21	13	16	33
55.0 KM	*	0	0	0	-43	-44	-45	-53	-55	-49	-42	-41	-40	-15	17	33
52.5 KM	*	0	0	0	-40	-41	-42	-51	-53	-49	-42	-45	-58	-54	-32	0
50.0 KM	*	0	0	0	-29	-37	-44	-45	-48	-51	-46	-45	-55	-60	-50	-26
47.5 KM	*	0	0	0	-16	-26	-39	-41	-46	-48	-46	-41	-44	-46	-40	-34
45.0 KM	*	0	0	0	-12	-19	-28	-34	-39	-39	-34	-28	-29	-31	-22	-16
42.5 KM	*	0	0	0	-6	-12	-22	-26	-29	-6	-11	-15	-17	-7	0	-11
40.0 KM	*	0	0	0	-5	-11	-15	-20	-17	3	-8	-8	-8	-5	-20	-17
37.5 KM	*	0	0	0	0	-5	-9	-14	-9	-5	-11	-8	-12	-17	-9	9
35.0 KM	*	0	0	0	-5	-4	-7	-6	-5	-11	-12	-5	-11	-7	16	18
32.5 KM	*	0	0	0	-4	-3	-6	-5	-5	-11	-5	-5	-11	7	14	-11
30.0 KM	*	0	0	0	-8	-7	-6	-5	-8	-10	-11	-10	-4	12	-12	-16
	**********															
LATITUDE		70			60			50			40			30		20		10		0

SUNRISE	4.9	5.1	5.3	5.4	5.5	5.5	5.5	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6
SUNSET	19.1	18.9	18.7	18.6	18.5	18.5	18.5	18.5	18.5	18.4	18.4	18.4	18.4	18.4	18.4

MEAN TIDAL DAY WINDS (DM/S) FOR MONTH APR

60.0 KM	0	0	0	26	30	33	36	43	42	42	34	0	-9	-25	-26
57.5 KM	0	0	0	26	29	33	40	43	41	38	34	18	-11	-13	-27
55.0 KM	0	0	0	26	29	32	39	42	39	35	34	34	13	-14	-28
52.5 KM	0	0	0	24	27	30	37	41	39	35	37	49	46	28	0
50.0 KM	0	0	0	17	24	31	34	37	40	37	37	46	51	43	23
47.5 KM	0	0	0	10	17	28	31	36	38	38	34	37	39	35	30
45.0 KM	0	0	0	8	13	20	25	30	31	28	24	25	27	19	15
42.5 KM	0	0	0	4	8	16	20	22	6	10	13	15	7	0	11
40.0 KM	0	0	0	4	7	11	15	13	-2	7	7	8	5	17	15
37.5 KM	0	0	0	0	4	7	11	7	5	10	7	11	15	9	-7
35.0 KM	0	0	0	3	3	6	5	5	10	10	5	10	7	-13	-15
32.5 KM	0	0	0	3	3	5	5	5	10	5	5	10	-5	-11	10
30.0 KM	0	0	0	5	5	5	5	7	9	9	9	4	-9	11	15
LATITUDE	70		60		50		40		30		20		10		0

MEAN TIDAL NIGHT WINDS (DM/S) FOR MONTH APR

60.0 KM	0	0	0	-52	-53	-54	-54	-62	-58	-55	-43	0	13	31	32
57.5 KM	0	0	0	-52	-51	-53	-60	-62	-56	-49	-43	-22	14	17	34
55.0 KM	0	0	0	-52	-51	-52	-59	-60	-53	-45	-43	-42	-15	18	34
52.5 KM	0	0	0	-48	-48	-48	-57	-58	-53	-45	-47	-61	-56	-33	0
50.0 KM	0	0	0	-34	-43	-50	-51	-53	-55	-49	-47	-57	-62	-51	-26
47.5 KM	0	0	0	-19	-30	-44	-46	-51	-52	-49	-43	-46	-47	-41	-34
45.0 KM	0	0	0	-15	-22	-32	-38	-43	-42	-36	-30	-31	-32	-23	-16
42.5 KM	0	0	0	-7	-14	-25	-30	-32	-7	-12	-16	-18	-7	0	-12
40.0 KM	0	0	0	-6	-12	-17	-23	-18	4	-9	-9	-9	-5	-20	-17
37.5 KM	0	0	0	0	-6	-11	-16	-10	-6	-12	-9	-13	-18	-9	9
35.0 KM	0	0	0	-6	-5	-8	-7	-6	-12	-13	-5	-12	-7	17	19
32.5 KM	0	0	0	-5	-4	-7	-6	-6	-13	-6	-5	-11	8	14	-11
30.0 KM	0	0	0	-10	-8	-7	-6	-8	-11	-12	-10	-4	12	-12	-16
LATITUDE	70		60		50		40		30		20		10		0

SUNRISE	0.0	2.5	3.4	3.9	4.3	4.5	4.7	4.9	5.0	5.1	5.3	5.3	5.4	5.5	5.5
SUNSET	0.0	21.5	20.6	20.1	19.7	19.5	19.3	19.1	19.0	18.9	18.8	18.7	18.7	18.6	18.5

MEAN TIDAL DAY WINDS (DM/S) FOR MONTH MAY

60.0 KM	*	0	0	0	14	21	26	29	37	38	38	32	0	-9	-24	-26
57.5 KM	*	0	0	0	14	20	26	33	37	36	34	32	17	-10	-13	-27
55.0 KM	*	0	0	0	14	20	25	32	36	35	31	32	32	13	-13	-27
52.5 KM	*	0	0	0	13	19	23	31	35	35	31	35	46	44	27	0
50.0 KM	*	0	0	0	9	17	24	28	32	36	34	35	44	49	42	23
47.5 KM	*	0	0	0	5	12	21	25	31	34	34	32	35	38	34	29
45.0 KM	*	0	0	0	4	9	15	21	26	28	25	22	24	26	19	14
42.5 KM	*	0	0	0	2	6	12	16	19	5	9	12	14	6	0	11
40.0 KM	*	0	0	0	2	5	9	13	12	-1	7	7	7	5	17	15
37.5 KM	*	0	0	0	0	2	6	9	6	4	9	7	11	15	8	-7
35.0 KM	*	0	0	0	2	2	4	4	4	9	10	5	10	6	-13	-14
32.5 KM	*	0	0	0	2	2	4	4	4	9	5	4	9	-5	-11	10
30.0 KM	*	0	0	0	3	4	4	4	6	8	9	8	4	-8	11	14
	**********															
LATITUDE		70		60		50		40		30		20		10		0

MEAN TIDAL NIGHT WINDS (DM/S) FOR MONTH MAY

60.0 KM	*	0	0	0	-59	-59	-59	-58	-67	-62	-58	-45	0	13	32	33
57.5 KM	*	0	0	0	-58	-57	-59	-65	-67	-60	-52	-45	-22	15	17	34
55.0 KM	*	0	0	0	-58	-57	-57	-64	-65	-57	-48	-45	-43	-16	18	34
52.5 KM	*	0	0	0	-54	-53	-53	-61	-63	-57	-48	-49	-63	-58	-33	0
50.0 KM	*	0	0	0	-39	-48	-55	-55	-57	-59	-52	-50	-59	-64	-52	-26
47.5 KM	*	0	0	0	-21	-33	-49	-50	-55	-55	-52	-45	-47	-49	-42	-35
45.0 KM	*	0	0	0	-17	-24	-35	-41	-46	-45	-38	-31	-32	-33	-23	-17
42.5 KM	*	0	0	0	-8	-15	-28	-32	-34	-7	-13	-17	-19	-8	0	-12
40.0 KM	*	0	0	0	-7	-14	-19	-25	-20	4	-9	-9	-9	-6	-21	-17
37.5 KM	*	0	0	0	0	-6	-12	-17	-10	-6	-13	-9	-14	-19	-10	9
35.0 KM	*	0	0	0	-6	-5	-9	-7	-6	-13	-14	-6	-12	-8	17	19
32.5 KM	*	0	0	0	-5	-4	-8	-6	-6	-13	-6	-5	-12	8	15	-11
30.0 KM	*	0	0	0	-11	-9	-8	-6	-9	-12	-12	-11	-4	13	-12	-16
	**********															
LATITUDE		70		60		50		40		30		20		10		0
SUNRISE	0.0	0.0	0.0	2.3	3.1	3.6	4.0	4.3	4.5	4.7	4.9	5.1	5.2	5.3	5.5	
SUNSET	0.0	0.0	0.0	21.7	20.9	20.4	20.1	19.7	19.5	19.3	19.1	19.0	18.9	18.7	18.6	

MEAN TIDAL DAY WINDS (DM/S) FOR MONTH JUN

60.0 KM	*	0	0	0	4	18	23	27	29	25	20	12	13	7	7	8
57.5 KM	*	0	0	0	5	18	24	27	27	19	17	14	15	16	9	9
55.0 KM	*	0	0	0	5	18	24	26	28	25	23	31	34	22	23	13
52.5 KM	*	0	0	0	4	17	23	26	27	30	38	39	41	39	33	24
50.0 KM	*	0	0	0	4	16	22	27	30	34	37	39	36	42	39	32
47.5 KM	*	0	0	0	3	12	18	23	29	34	37	33	29	37	31	28
45.0 KM	*	0	0	0	3	10	14	17	20	26	28	21	15	20	29	30
42.5 KM	*	0	0	0	2	7	10	12	14	14	12	12	11	14	20	27
40.0 KM	*	0	0	0	2	6	8	10	11	8	8	8	2	-0	11	18
37.5 KM	*	0	0	0	1	5	7	8	8	8	2	2	-3	-5	-7	11
35.0 KM	*	0	0	0	1	5	6	7	6	3	2	2	-2	-2	-4	-6
32.5 KM	*	0	0	0	1	4	5	5	5	5	5	5	6	-1	-3	-3
30.0 KM	*	0	0	0	1	2	3	5	6	7	6	6	7	-1	-1	-2
	**********															
LATITUDE		70		60		50		40		30		20		10		0

MEAN TIDAL NIGHT WINDS (DM/S) FOR MONTH JUN

60.0 KM	*	0	0	0	-74	-74	-67	-64	-58	-46	-32	-18	-18	-9	-9	-9
57.5 KM	*	0	0	0	-82	-76	-69	-63	-55	-33	-27	-20	-21	-21	-10	-10
55.0 KM	*	0	0	0	-78	-76	-69	-62	-56	-46	-38	-47	-49	-28	-28	-15
52.5 KM	*	0	0	0	-68	-71	-66	-62	-55	-54	-63	-60	-58	-52	-42	-29
50.0 KM	*	0	0	0	-68	-67	-65	-63	-60	-61	-61	-60	-51	-57	-49	-39
47.5 KM	*	0	0	0	-55	-51	-52	-55	-59	-61	-61	-50	-41	-49	-39	-34
45.0 KM	*	0	0	0	-44	-41	-40	-39	-39	-46	-47	-32	-20	-26	-37	-36
42.5 KM	*	0	0	0	-31	-29	-29	-28	-28	-25	-19	-17	-15	-18	-24	-32
40.0 KM	*	0	0	0	-26	-24	-23	-23	-21	-14	-13	-12	-2	2	-13	-21
37.5 KM	*	0	0	0	-19	-21	-19	-18	-16	-13	-3	-2	7	9	10	-13
35.0 KM	*	0	0	0	-17	-19	-18	-16	-12	-5	-3	-2	4	5	7	9
32.5 KM	*	0	0	0	-13	-15	-13	-12	-10	-8	-7	-6	-8	3	5	5
30.0 KM	*	0	0	0	-8	-8	-9	-10	-11	-12	-10	-8	-10	3	3	4
	**********															
LATITUDE		70		60		50		40		30		20		10		0
SUNRISE		0.0	0.0	0.0	.7	2.3	3.1	3.5	3.9	4.3	4.5	4.7	4.9	5.1	5.3	5.4
SUNSET		0.0	0.0	0.0	23.3	21.7	21.0	20.5	20.1	19.8	19.5	19.3	19.1	18.9	18.8	18.6

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MEAN TIDAL DAY WINDS (DM/S) FOR MONTH JUL

60.0 KM	*	0	0	0	10	21	25	28	30	26	20	12	13	7	8	8
57.5 KM	*	0	0	0	11	21	26	28	28	19	17	14	16	16	9	9
55.0 KM	*	0	0	0	11	21	26	27	29	26	24	32	35	21	23	13
52.5 KM	*	0	0	0	9	20	25	27	28	31	39	40	41	39	34	24
50.0 KM	*	0	0	0	9	18	24	28	31	35	38	40	36	43	39	32
47.5 KM	*	0	0	0	8	14	19	25	30	35	37	34	29	37	31	28
45.0 KM	*	0	0	0	6	12	15	17	20	26	29	22	15	20	30	30
42.5 KM	*	0	0	0	4	8	11	13	15	14	12	12	11	14	20	27
40.0 KM	*	0	0	0	4	7	9	11	11	8	9	8	2	-0	11	18
37.5 KM	*	0	0	0	3	6	7	8	8	8	2	2	-4	-5	-7	11
35.0 KM	*	0	0	0	2	5	7	8	6	4	2	2	-2	-3	-4	-6
32.5 KM	*	0	0	0	2	4	5	6	5	5	5	5	6	-1	-3	-3
30.0 KM	*	0	0	0	1	2	4	5	6	7	7	6	8	-1	-1	-2
LATITUDE			70		60		50		40		30		20		10	0

MEAN TIDAL NIGHT WINDS (DM/S) FOR MONTH JUL

60.0 KM	*	0	0	0	-73	-73	-66	-63	-58	-45	-32	-17	-18	-9	-9	-9
57.5 KM	*	0	0	0	-80	-75	-68	-62	-54	-33	-26	-20	-21	-21	-10	-10
55.0 KM	*	0	0	0	-76	-75	-68	-61	-55	-45	-37	-47	-49	-28	-29	-15
52.5 KM	*	0	0	0	-67	-70	-65	-61	-54	-54	-62	-59	-58	-52	-42	-29
50.0 KM	*	0	0	0	-66	-66	-63	-62	-59	-61	-61	-60	-51	-57	-49	-39
47.5 KM	*	0	0	0	-54	-50	-51	-54	-58	-61	-60	-50	-41	-49	-39	-34
45.0 KM	*	0	0	0	-43	-41	-40	-38	-39	-45	-46	-32	-20	-26	-37	-36
42.5 KM	*	0	0	0	-30	-29	-28	-28	-28	-25	-19	-17	-15	-18	-24	-32
40.0 KM	*	0	0	0	-25	-24	-23	-23	-21	-14	-13	-11	-2	2	-13	-21
37.5 KM	*	0	0	0	-18	-20	-19	-18	-15	-13	-2	-2	6	9	10	-13
35.0 KM	*	0	0	0	-17	-19	-18	-16	-12	-5	-2	-2	4	5	7	9
32.5 KM	*	0	0	0	-13	-13	-13	-12	-10	-8	-7	-6	-8	3	5	5
30.0 KM	*	0	0	0	-7	-8	-9	-10	-11	-12	-10	-8	-10	3	3	4
LATITUDE			70		60		50		40		30		20		10	0

SUNRISE	0.0	0.0	0.0	1.5	2.6	3.3	3.7	4.1	4.3	4.6	4.8	4.9	5.1	5.3	5.4
SUNSET	0.0	0.0	0.0	22.5	21.4	20.7	20.3	20.0	19.7	19.5	19.3	19.1	18.9	18.7	18.6

MEAN TIDAL DAY WINDS (DM/S) FOR MONTH AUG

60.0 KM	0	0	15	25	31	32	34	34	29	22	13	14	8	8	8
57.5 KM	0	0	15	27	31	33	34	32	21	18	15	16	17	9	9
55.0 KM	0	0	14	26	31	33	33	33	29	26	34	36	22	24	13
52.5 KM	0	0	16	23	29	32	33	32	34	42	42	43	41	35	25
50.0 KM	0	0	16	23	28	31	34	35	39	41	43	38	44	40	33
47.5 KM	0	0	14	18	21	25	30	35	39	41	36	31	39	32	29
45.0 KM	0	0	11	15	17	20	21	23	29	31	23	16	21	30	31
42.5 KM	0	0	7	10	12	14	15	17	16	13	13	12	15	20	27
40.0 KM	0	0	6	9	10	11	13	13	9	9	9	2	-0	11	19
37.5 KM	0	0	5	6	9	9	10	10	9	2	2	-4	-6	-7	11
35.0 KM	0	0	4	6	8	9	9	7	4	2	2	-2	-3	-5	-7
32.5 KM	0	0	3	5	7	7	7	6	6	5	5	6	-1	-3	-3
30.0 KM	0	0	2	3	4	5	6	7	8	7	6	8	-1	-1	-2
LATITUDE	70		60		50		40		30		20		10		0

MEAN TIDAL NIGHT WINDS (DM/S) FOR MONTH AUG

60.0 KM	0	0	-60	-65	-67	-61	-59	-54	-43	-31	-17	-17	-9	-9	-9
57.5 KM	0	0	-61	-72	-69	-63	-58	-51	-31	-25	-20	-20	-20	-10	-10
55.0 KM	0	0	-53	-69	-69	-63	-57	-52	-43	-36	-45	-47	-27	-28	-15
52.5 KM	0	0	-62	-60	-64	-60	-57	-51	-51	-59	-57	-56	-50	-41	-29
50.0 KM	0	0	-64	-60	-60	-59	-58	-56	-58	-58	-58	-49	-55	-48	-38
47.5 KM	0	0	-53	-49	-46	-47	-51	-55	-58	-57	-48	-39	-48	-38	-33
45.0 KM	0	0	-41	-39	-37	-37	-36	-36	-43	-44	-31	-20	-25	-36	-36
42.5 KM	0	0	-27	-27	-26	-26	-26	-26	-23	-18	-17	-15	-17	-24	-31
40.0 KM	0	0	-22	-23	-22	-21	-21	-20	-13	-13	-11	-2	2	-13	-21
37.5 KM	0	0	-18	-17	-19	-17	-17	-15	-12	-2	-2	6	9	10	-12
35.0 KM	0	0	-14	-15	-17	-16	-15	-11	-5	-2	-2	4	5	7	9
32.5 KM	0	0	-11	-11	-13	-12	-11	-9	-7	-6	-6	-7	3	5	5
30.0 KM	0	0	-8	-7	-7	-8	-9	-11	-11	-9	-7	-9	3	3	4
LATITUDE	70		60		50		40		30		20		10		0
SUNRISE	0.0	0.0	2.4	3.3	3.7	4.1	4.4	4.6	4.8	4.9	5.1	5.2	5.3	5.4	5.5
SUNSET	0.0	0.0	21.6	20.8	20.3	19.9	19.7	19.4	19.3	19.1	18.9	18.9	18.7	18.6	18.5

MEAN TIDAL DAY WINDS (DM/S) FOR MONTH SEP

60.0 KM	*	0	0	0	18	19	20	21	22	25	31	23	-8	-17	-17	-12
57.5 KM	*	0	0	0	19	20	20	21	21	28	29	21	12	-8	-14	-8
55.0 KM	*	0	0	0	25	24	24	23	25	39	27	14	15	7	-6	-8
52.5 KM	*	0	0	0	29	30	29	28	30	44	24	16	17	21	10	-3
50.0 KM	*	0	0	0	30	33	34	34	36	42	34	17	16	17	15	7
47.5 KM	*	0	0	0	25	27	31	33	37	39	36	26	12	15	19	14
45.0 KM	*	0	0	0	19	20	21	22	24	29	28	25	20	17	17	6
42.5 KM	*	0	0	0	17	18	16	17	14	6	8	8	16	14	6	0
40.0 KM	*	0	0	0	14	12	8	4	0	-3	0	4	7	10	1	-7
37.5 KM	*	0	0	0	15	13	12	3	2	1	3	1	0	6	-5	-3
35.0 KM	*	0	0	0	13	12	11	9	7	4	3	6	7	1	-4	0
32.5 KM	*	0	0	0	11	10	9	9	11	12	14	8	5	-1	-2	0
30.0 KM	*	0	0	0	10	9	9	11	12	12	10	5	4	-2	-2	-0
LATITUDE			70		60		50		40		30		20		10	0

MEAN TIDAL NIGHT WINDS (DM/S) FOR MONTH SEP

60.0 KM	*	0	0	0	-27	-26	-26	-26	-27	-31	-37	-26	10	21	21	15
57.5 KM	*	0	0	0	-29	-27	-27	-26	-26	-34	-35	-24	-13	11	17	10
55.0 KM	*	0	0	0	-37	-33	-31	-30	-31	-48	-32	-16	-17	-7	9	10
52.5 KM	*	0	0	0	-43	-41	-39	-36	-37	-54	-28	-18	-20	-24	-11	4
50.0 KM	*	0	0	0	-46	-46	-45	-44	-45	-52	-41	-19	-18	-19	-17	-7
47.5 KM	*	0	0	0	-37	-38	-41	-43	-46	-48	-43	-31	-14	-17	-22	-15
45.0 KM	*	0	0	0	-28	-28	-27	-28	-30	-36	-34	-29	-22	-20	-19	-6
42.5 KM	*	0	0	0	-25	-24	-21	-21	-17	-6	-9	-8	-18	-16	-6	0
40.0 KM	*	0	0	0	-21	-16	-10	-5	0	5	0	-4	-7	-11	-0	9
37.5 KM	*	0	0	0	-22	-18	-15	-3	-2	-1	-2	-1	0	-6	7	4
35.0 KM	*	0	0	0	-19	-17	-14	-11	-8	-4	-3	-6	-7	-0	6	0
32.5 KM	*	0	0	0	-17	-14	-11	-11	-13	-14	-17	-9	-5	2	3	0
30.0 KM	*	0	0	0	-14	-12	-11	-13	-15	-14	-12	-5	-4	3	3	2
LATITUDE			70		60		50		40		30		20		10	0

SUNRISE	3.3	4.1	4.5	4.7	4.9	5.1	5.2	5.3	5.3	5.4	5.5	5.5	5.5	5.5	5.6
SUNSET	20.7	19.9	19.5	19.3	19.1	18.9	18.9	18.7	18.7	18.7	18.6	18.5	18.5	18.5	18.5

MEAN TIDAL DAY WINDS (DM/S) FOR MONTH OCT

60.0 KM	0	0	0	24	23	24	24	24	28	33	24	-8	-18	-17	-12
57.5 KM	0	0	0	25	24	24	24	24	31	32	22	13	-9	-14	-8
55.0 KM	0	0	0	32	29	28	27	28	43	29	15	16	7	-6	-8
52.5 KM	0	0	0	37	36	34	32	34	49	26	17	18	22	11	-3
50.0 KM	0	0	0	39	40	40	39	40	47	37	18	17	18	16	7
47.5 KM	0	0	0	32	33	37	38	41	43	39	28	13	16	20	14
45.0 KM	0	0	0	25	25	25	26	27	32	31	26	21	18	17	6
42.5 KM	0	0	0	22	22	19	19	16	6	8	8	17	15	6	0
40.0 KM	0	0	0	19	15	10	5	0	-3	0	5	7	10	1	-7
37.5 KM	0	0	0	19	16	14	3	3	2	3	1	0	6	-5	-3
35.0 KM	0	0	0	17	15	13	11	8	4	3	6	7	1	-5	0
32.5 KM	0	0	0	15	13	11	11	13	13	16	9	5	-1	-2	0
30.0 KM	0	0	0	13	11	11	13	14	13	11	5	4	-2	-2	-0
LATITUDE	70			60		50		40		30		20		10	0

MEAN TIDAL NIGHT WINDS (DM/S) FOR MONTH OCT

60.0 KM	0	0	0	-22	-22	-23	-23	-24	-28	-34	-25	10	21	20	15
57.5 KM	0	0	0	-23	-23	-23	-23	-23	-31	-32	-23	-13	11	17	10
55.0 KM	0	0	0	-30	-28	-27	-27	-28	-44	-30	-16	-16	-7	8	10
52.5 KM	0	0	0	-35	-35	-33	-32	-34	-50	-26	-18	-19	-23	-11	4
50.0 KM	0	0	0	-37	-39	-39	-39	-40	-48	-38	-18	-18	-18	-17	-8
47.5 KM	0	0	0	-30	-32	-36	-38	-42	-44	-40	-29	-13	-16	-21	-15
45.0 KM	0	0	0	-23	-24	-24	-25	-27	-33	-32	-27	-21	-19	-18	-6
42.5 KM	0	0	0	-20	-20	-18	-18	-16	-5	-8	-8	-18	-15	-5	0
40.0 KM	0	0	0	-17	-13	-9	-4	0	4	0	-4	-7	-10	-0	9
37.5 KM	0	0	0	-18	-15	-13	-2	-2	-1	-2	-1	0	-5	6	4
35.0 KM	0	0	0	-15	-14	-12	-10	-7	-4	-3	-6	-6	-0	6	0
32.5 KM	0	0	0	-13	-12	-10	-10	-12	-13	-15	-8	-5	2	3	0
30.0 KM	0	0	0	-12	-10	-10	-12	-13	-12	-11	-5	-4	3	3	2
LATITUDE	70			60		50		40		30		20		10	0

SUNRISE	6.4	6.3	6.2	6.1	6.1	6.0	5.9	5.9	5.9	5.9	5.8	5.7	5.7	5.7	5.6
SUNSET	17.6	17.7	17.9	17.9	18.0	18.0	18.1	18.1	18.1	18.2	18.3	18.3	18.3	18.3	18.4

MEAN TIDAL DAY WINDS (DM/S) FOR MONTH NOV

60.0 KM	0	0	0	28	26	27	27	27	30	36	26	-9	-18	-18	-12
57.5 KM	0	0	0	30	28	27	27	26	33	34	23	13	-9	-14	-8
55.0 KM	0	0	0	38	34	32	30	31	47	31	16	16	8	-7	-8
52.5 KM	0	0	0	44	42	39	36	37	52	28	18	19	23	11	-3
50.0 KM	0	0	0	47	47	45	44	44	50	39	19	18	18	16	8
47.5 KM	0	0	0	38	39	42	43	45	47	41	30	13	16	20	15
45.0 KM	0	0	0	29	29	28	29	30	35	32	28	22	18	18	6
42.5 KM	0	0	0	26	25	22	21	17	7	9	9	18	15	6	0
40.0 KM	0	0	0	22	17	11	5	0	-3	0	5	8	11	1	-7
37.5 KM	0	0	0	23	19	16	4	3	2	3	2	0	6	-5	-3
35.0 KM	0	0	0	20	18	14	12	9	5	4	6	7	1	-5	0
32.5 KM	0	0	0	18	15	12	12	[illegible]	14	17	9	5	-1	-2	0
30.0 KM	0	0	0	15	13	12	14	15	14	12	6	4	-2	-2	-0

LATITUDE 70 60 50 40 30 20 10 0

MEAN TIDAL NIGHT WINDS (DM/S) FOR MONTH NOV

60.0 KM	0	0	0	-17	-18	-19	-21	-22	-26	-32	-24	10	20	20	15
57.5 KM	0	0	0	-18	-19	-20	-21	-21	-29	-31	-21	-12	10	17	10
55.0 KM	0	0	0	-24	-23	-23	-23	-25	-41	-28	-15	-16	-7	9	10
52.5 KM	0	0	0	-28	-29	-29	-28	-31	-46	-25	-17	-18	-23	-10	4
50.0 KM	0	0	0	-29	-32	-34	-34	-37	-44	-36	-17	-17	-18	-16	-7
47.5 KM	0	0	0	-24	-26	-31	-34	-37	-41	-37	-28	-13	-16	-21	-15
45.0 KM	0	0	0	-18	-19	-20	-22	-24	-30	-29	-26	-21	-18	-18	-5
42.5 KM	0	0	0	-16	-17	-16	-16	-14	-5	-7	-7	-17	-15	-5	0
40.0 KM	0	0	0	-13	-11	-7	-3	0	4	0	-4	-7	-10	-0	9
37.5 KM	0	0	0	-14	-12	-11	-2	-1	-1	-2	-0	0	-5	6	4
35.0 KM	0	0	0	-12	-12	-10	-9	-6	-3	-2	-5	-6	-0	6	0
32.5 KM	0	0	0	-10	-9	-8	-9	-11	-12	-14	-8	-5	2	3	0
30.0 KM	0	0	0	-9	-8	-8	-10	-12	-11	-10	-4	-3	3	3	2

LATITUDE 70 60 50 40 30 20 10 0

SUNRISE	9.5	8.3	7.7	7.3	7.1	6.8	6.7	6.5	6.3	6.2	6.1	6.0	5.9	5.8	5.7
SUNSET	14.6	15.7	16.3	16.7	17.0	17.2	17.4	17.5	17.7	17.8	17.9	18.1	18.1	18.3	18.3

MEAN TIDAL DAY WINDS (DM/S) FOR MONTH DEC

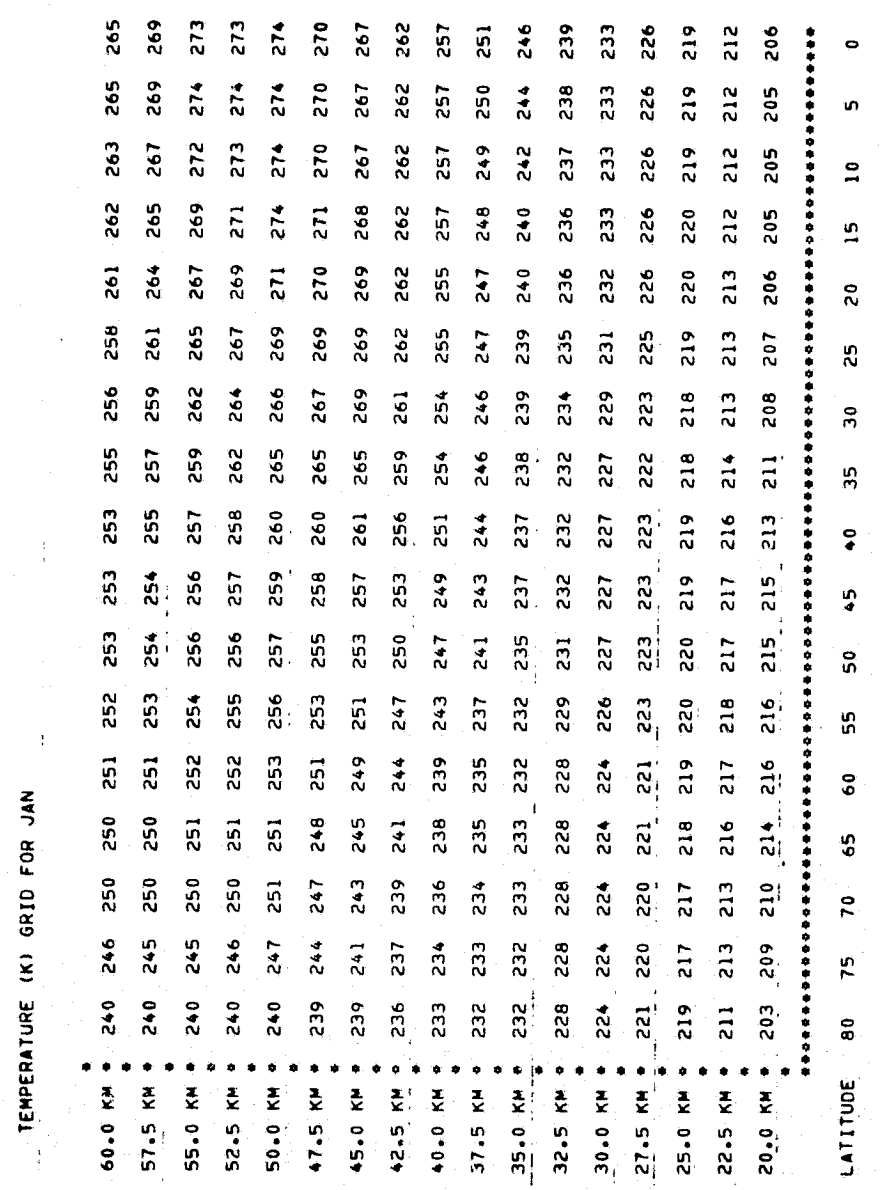
60.0 KM	0	0	0	40	46	53	57	61	56	51	13	-12	-24	-39	-48
57.5 KM	0	0	0	30	42	54	57	60	52	38	23	0	-12	-28	-27
55.0 KM	0	0	0	29	41	53	56	59	42	30	36	24	0	-14	-12
52.5 KM	0	0	0	18	31	38	49	59	40	30	39	38	28	11	0
50.0 KM	0	0	0	15	22	35	47	55	43	30	32	39	40	16	12
47.5 KM	0	0	0	16	20	34	50	61	47	34	35	32	36	28	23
45.0 KM	0	0	0	9	12	19	37	43	37	25	37	26	43	37	30
42.5 KM	0	0	0	9	10	11	19	24	14	7	30	25	34	23	10
40.0 KM	0	0	0	8	8	7	8	5	-10	-13	8	17	8	-8	-5
37.5 KM	0	0	0	9	7	6	3	-13	-2	-23	-13	-24	-22	-5	-2
35.0 KM	0	0	0	10	9	5	-5	-8	14	-14	-19	-15	-5	-4	-2
32.5 KM	0	0	0	10	9	3	-9	3	11	3	-6	-6	-2	-2	-6
30.0 KM	0	0	0	10	9	-4	-6	9	5	9	-2	-6	-7	-6	-5
LATITUDE	70		60		50		40		30		20		10		0

MEAN TIDAL NIGHT WINDS (DM/S) FOR MONTH DEC

60.0 KM	0	0	0	-19	-26	-34	-40	-46	-46	-43	-11	12	25	42	55
57.5 KM	0	0	0	-14	-24	-34	-40	-45	-42	-32	-20	1	13	30	32
55.0 KM	0	0	0	-13	-23	-34	-39	-44	-33	-25	-32	-22	0	16	15
52.5 KM	0	0	0	-8	-17	-24	-34	-44	-32	-25	-34	-36	-27	-10	0
50.0 KM	0	0	0	-7	-12	-22	-33	-41	-35	-25	-28	-36	-40	-16	-12
47.5 KM	0	0	0	-7	-11	-21	-35	-46	-38	-29	-31	-30	-36	-28	-25
45.0 KM	0	0	0	-4	-6	-11	-25	-33	-30	-21	-33	-24	-42	-38	-33
42.5 KM	0	0	0	-3	-5	-6	-13	-17	-11	-5	-26	-23	-33	-23	-11
40.0 KM	0	0	0	-3	-4	-3	-1	-3	9	12	-7	-15	-7	10	6
37.5 KM	0	0	0	-4	-3	-3	-1	11	3	21	13	24	23	6	4
35.0 KM	0	0	0	-4	-4	-2	4	7	-10	13	18	16	6	6	3
32.5 KM	0	0	0	-4	-4	-1	7	-2	-8	-2	6	7	4	3	8
30.0 KM	0	0	0	-4	-3	3	5	-6	-3	-7	3	6	8	7	7
LATITUDE	70		60		50		40		30		20		10		0

SUNRISE	0.0	9.7	8.6	8.0	7.6	7.3	7.0	6.8	6.6	6.4	6.3	6.1	6.0	5.9	5.7
SUNSET	0.0	14.3	15.4	16.0	16.5	16.7	17.0	17.3	17.5	17.6	17.7	17.9	18.1	18.2	18.3

APPENDIX C: Grid point values of the mean temperature, 20 to 60 km, by month from the equator to 80°N.



TEMPERATURE (K) GRID FOR FEB

60.0 KM	264	262	262	261	260	260	260	260	256	254	255	256	258	259	261	263	263
57.5 KM	264	263	263	261	261	261	262	262	259	258	259	260	262	264	266	268	267
55.0 KM	265	264	264	262	262	263	264	265	263	262	263	265	267	269	272	273	272
52.5 KM	263	262	261	259	260	261	263	265	264	264	200	266	268	271	273	274	273
50.0 KM	261	260	258	257	259	260	263	265	266	267	267	268	270	274	275	275	274
47.5 KM	256	254	253	252	253	254	259	263	265	267	267	267	269	271	272	272	272
45.0 KM	251	249	249	247	247	249	256	261	265	267	267	267	268	268	269	269	270
42.5 KM	244	243	243	241	241	243	252	256	260	262	261	261	262	263	264	264	264
40.0 KM	238	238	237	235	236	238	248	252	255	257	256	256	257	258	259	259	259
37.5 KM	231	231	231	231	232	233	239	244	247	249	248	249	250	251	251	251	251
35.0 KM	225	225	226	227	228	228	231	237	240	241	241	243	244	244	244	243	243
32.5 KM	224	223	224	224	224	224	226	231	233	234	235	237	238	238	238	238	238
30.0 KM	223	222	222	222	221	220	221	225	227	228	230	232	232	233	233	233	233
27.5 KM	222	221	220	220	219	218	219	221	223	223	224	226	226	227	227	227	226
25.0 KM	221	220	219	219	218	217	217	218	219	219	219	220	220	221	222	221	220
22.5 KM	215	215	216	218	218	217	216	216	216	215	214	213	213	213	213	213	212
20.0 KM	209	211	214	218	218	218	216	214	213	212	209	207	207	206	205	205	205
LATITUDE	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5	0

TEMPERATURE (K) GRID FOR MAR

60.0 KM	265	265	265	263	263	262	261	260	258	256	256	256	257	257	259	261	261
57.5 KM	264	264	264	263	264	263	263	262	261	259	259	260	261	262	263	265	264
55.0 KM	264	263	264	264	265	265	265	264	264	263	263	264	266	268	268	269	268
52.5 KM	262	262	263	264	264	265	265	265	265	265	265	266	267	269	269	270	270
50.0 KM	261	261	262	264	264	265	265	266	267	267	267	268	269	270	271	272	273
47.5 KM	259	259	259	259	260	261	261	263	265	266	267	267	269	270	271	272	273
45.0 KM	258	258	257	254	256	257	258	261	263	265	267	267	269	270	271	272	274
42.5 KM	254	253	252	249	250	251	252	256	260	260	261	262	264	265	266	267	268
40.0 KM	251	249	248	245	244	246	247	251	257	256	256	257	259	260	262	262	262
37.5 KM	245	243	240	238	237	238	239	245	249	249	250	251	252	253	254	254	254
35.0 KM	240	237	233	231	230	230	232	239	241	243	245	246	246	247	247	247	247
32.5 KM	235	232	230	228	227	227	228	233	234	236	237	239	239	240	240	240	240
30.0 KM	230	228	227	225	224	225	225	227	228	229	230	232	233	233	233	234	234
27.5 KM	224	224	224	223	223	223	223	224	224	225	226	227	227	227	227	227	227
25.0 KM	218	220	221	222	222	221	221	221	221	221	222	222	222	222	222	221	220
22.5 KM	215	219	220	222	221	220	220	219	218	217	216	216	215	215	215	214	213
20.0 KM	212	218	220	222	220	220	219	218	216	213	211	210	209	208	208	207	207
LATITUDE	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5	0

TEMPERATURE (K) GRID FOR APR

60.0 KM	265	267	268	267	265	263	262	261	261	258	256	257	257	258	258	259	259
57.5 KM	267	269	270	270	268	267	266	265	264	262	260	261	262	263	263	263	262
55.0 KM	269	271	272	273	272	271	271	270	268	267	265	265	267	268	268	267	266
52.5 KM	268	270	271	273	273	272	272	271	270	269	268	268	269	270	270	269	268
50.0 KM	268	269	271	273	274	274	274	273	273	272	271	271	272	273	273	272	271
47.5 KM	264	266	267	270	271	272	273	272	271	270	269	270	271	271	272	271	271
45.0 KM	261	263	264	267	269	270	272	271	270	269	268	269	270	270	271	271	271
42.5 KM	255	256	258	260	262	263	265	265	264	263	263	264	264	265	266	266	266
40.0 KM	249	250	252	253	255	257	258	259	259	258	258	259	259	261	261	262	262
37.5 KM	244	244	245	246	247	248	250	250	251	250	251	252	252	254	254	254	254
35.0 KM	239	239	238	239	239	240	242	242	243	243	244	245	246	247	247	246	246
32.5 KM	235	234	233	233	232	233	235	236	236	237	238	240	241	241	241	240	240
30.0 KM	231	230	229	227	226	227	229	230	230	231	233	235	237	236	236	235	235
27.5 KM	228	227	227	225	225	225	225	226	225	226	227	229	230	230	229	229	228
25.0 KM	226	225	225	224	224	223	222	222	221	221	222	223	224	224	223	223	222
22.5 KM	224	224	224	224	223	222	220	220	218	217	217	217	217	216	215	215	214
20.0 KM	223	224	224	224	222	221	219	218	216	214	212	211	210	208	207	207	207
LATITUDE	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5	0

TEMPERATURE (K) GRID FOR MAY

60.0 KM	276	274	272	270	268	266	264	264	262	260	259	259	259	258	258	256	255
57.5 KM	278	277	275	273	271	269	268	267	265	263	262	262	263	262	263	261	260
55.0 KM	281	280	278	276	274	272	272	270	268	267	266	266	267	267	268	267	266
52.5 KM	283	282	280	278	277	275	274	273	271	270	269	268	269	269	270	269	268
50.0 KM	285	284	283	281	280	278	277	276	275	273	272	271	271	272	272	271	271
47.5 KM	279	278	278	278	277	276	275	274	273	272	271	270	270	270	269	269	269
45.0 KM	273	273	274	275	275	274	274	273	272	271	270	269	269	268	267	267	268
42.5 KM	267	267	268	268	268	268	268	267	265	265	264	263	263	263	263	263	264
40.0 KM	262	262	262	262	262	262	262	261	259	259	258	258	258	259	259	260	260
37.5 KM	254	255	255	256	256	256	255	254	253	252	251	251	252	253	253	254	254
35.0 KM	247	248	249	250	250	250	249	248	247	245	245	245	246	247	247	248	249
32.5 KM	242	242	243	243	243	243	242	241	240	239	240	240	241	242	241	242	242
30.0 KM	238	237	237	237	236	236	236	235	233	233	235	235	236	237	236	236	236
27.5 KM	234	233	233	232	231	230	230	229	228	228	229	229	229	230	229	229	229
25.0 KM	231	230	229	228	226	225	224	224	223	223	223	223	223	223	223	222	222
22.5 KM	230	229	228	227	225	224	223	222	220	219	218	217	216	216	216	215	215
20.0 KM	230	229	228	226	224	223	222	220	218	215	213	212	210	209	209	208	208
LATITUDE	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5	0

TEMPERATURE (K) GRID FOR JUN

	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5	0
60.0 KM	275	273	271	269	268	264	261	258	257	257	256	256	256	257	256	255	255
57.5 KM	279	277	276	274	272	268	265	263	262	262	261	261	261	261	260	260	260
55.0 KM	283	282	281	279	276	273	270	268	267	267	266	266	266	265	265	265	265
52.5 KM	284	283	282	280	278	276	273	271	270	269	269	268	268	267	266	267	268
50.0 KM	286	285	284	282	281	279	277	274	273	272	272	271	270	270	268	270	271
47.5 KM	283	283	282	280	279	278	276	274	273	271	270	269	268	268	267	268	269
45.0 KM	281	281	280	279	278	277	276	274	273	271	269	268	267	267	267	267	268
42.5 KM	275	275	274	273	272	271	270	268	267	265	263	262	261	261	261	261	262
40.0 KM	270	269	268	267	267	265	264	262	261	259	258	257	256	256	256	256	257
37.5 KM	263	262	260	260	259	257	257	255	255	253	251	250	250	250	250	251	252
35.0 KM	257	255	253	253	251	250	250	249	249	247	245	244	244	244	244	246	247
32.5 KM	249	248	247	246	245	244	243	242	242	241	240	239	239	239	239	240	241
30.0 KM	242	242	241	240	239	238	237	236	236	235	235	234	234	234	234	235	236
27.5 KM	239	238	237	236	234	233	232	231	231	230	229	229	229	228	228	228	229
25.0 KM	236	235	233	232	230	229	228	227	226	225	224	224	224	223	222	222	222
22.5 KM	234	233	231	230	228	226	224	223	222	220	219	218	217	216	215	215	215
20.0 KM	233	231	229	228	226	223	221	219	218	216	215	213	211	210	209	209	209

LATITUDE

TEMPERATURE (K) GRID FOR JUL

60.0 KM	274	273	270	267	265	262	261	259	258	257	257	257	258	258	258	257	256
57.5 KM	277	276	274	271	269	266	264	263	261	260	260	259	260	260	261	261	260
55.0 KM	280	280	278	276	273	270	268	267	265	263	263	262	262	263	264	265	265
52.5 KM	282	282	280	278	276	273	271	270	268	266	266	265	264	265	266	267	267
50.0 KM	284	285	283	281	280	277	275	273	271	270	269	268	267	267	268	269	270
47.5 KM	282	282	281	279	278	275	273	271	270	269	268	267	266	265	265	266	267
45.0 KM	280	280	279	277	276	274	272	270	269	268	268	267	266	264	263	263	265
42.5 KM	273	274	272	271	269	268	266	264	263	262	262	261	260	259	257	257	259
40.0 KM	267	268	266	265	263	262	260	258	257	256	256	255	255	254	252	252	253
37.5 KM	260	261	259	258	256	256	254	253	252	250	250	249	249	247	246	246	247
35.0 KM	254	255	253	251	250	250	249	248	247	245	244	244	243	241	240	240	241
32.5 KM	248	248	246	245	244	243	242	241	240	239	238	238	238	237	236	236	236
30.0 KM	243	242	240	240	238	237	235	235	234	234	233	233	233	233	232	232	232
27.5 KM	238	237	236	235	234	233	232	232	231	230	229	229	228	227	226	225	225
25.0 KM	233	233	232	231	231	230	229	229	228	227	226	225	223	222	220	219	219
22.5 KM	233	232	231	230	229	227	224	224	223	221	220	219	217	216	214	214	214
20.0 KM	233	232	230	229	227	224	220	219	218	216	215	213	212	210	209	209	210
LATITUDE	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5	0

TEMPERATURE (K) GRID FOR AUG

	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5	0
60.0 KM	270	269	266	264	263	261	260	259	259	257	257	257	257	257	257	257	257
57.5 KM	274	272	269	267	266	264	263	262	261	260	260	260	260	261	261	261	261
55.0 KM	278	276	273	271	269	267	266	265	264	264	263	264	264	265	265	266	266
52.5 KM	279	278	275	273	271	269	268	267	266	265	265	265	265	266	267	268	268
50.0 KM	281	280	278	276	274	272	270	269	268	267	267	267	267	268	269	270	271
47.5 KM	278	278	276	274	272	270	269	267	266	265	265	265	265	266	267	268	269
45.0 KM	276	276	274	272	270	269	268	266	264	264	263	263	264	265	266	267	268
42.5 KM	269	269	268	266	265	264	263	261	259	259	258	258	258	259	260	261	261
40.0 KM	263	263	262	261	260	259	258	256	254	254	253	253	253	254	254	255	255
37.5 KM	257	257	255	255	253	252	250	249	248	247	247	247	247	247	247	248	249
35.0 KM	252	251	249	249	247	245	243	242	242	241	241	241	241	241	241	242	243
32.5 KM	246	246	244	243	241	240	238	238	237	237	236	236	236	236	236	237	237
30.0 KM	240	241	239	238	236	236	234	23	233	233	232	232	232	232	231	232	232
27.5 KM	235	236	234	233	231	231	229	229	228	228	227	227	227	227	226	226	226
25.0 KM	231	232	230	229	227	226	225	225	224	223	223	222	222	222	222	221	221
22.5 KM	230	231	229	228	226	224	223	222	220	219	219	218	217	216	216	216	216
20.0 KM	230	230	228	227	225	223	221	219	217	216	215	214	212	211	211	211	211
LATITUDE	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5	0

TEMPERATURE (K) GRID FOR SEP

60.0 KM	270	268	264	261	255	258	257	257	257	257	257	257	257	258	258	257	256
57.5 KM	270	268	266	264	261	260	259	260	261	261	261	261	261	261	261	261	261
55.0 KM	271	269	268	267	264	262	262	264	265	265	265	265	265	265	265	265	266
52.5 KM	270	269	268	268	266	265	264	266	267	267	267	267	267	267	267	268	269
50.0 KM	269	269	269	269	268	268	267	268	269	270	270	270	270	270	270	271	272
47.5 KM	266	266	266	266	266	266	265	266	267	267	268	268	268	268	268	269	269
45.0 KM	264	264	264	264	264	264	264	264	265	265	266	266	266	266	266	267	267
42.5 KM	257	257	257	258	258	258	258	258	259	259	259	259	260	260	260	262	262
40.0 KM	250	250	251	252	252	252	252	252	253	253	253	253	254	255	255	257	258
37.5 KM	244	245	245	246	246	246	246	246	247	247	247	248	249	250	250	251	252
35.0 KM	239	240	240	240	241	241	241	241	241	241	242	243	244	245	246	246	246
32.5 KM	233	234	234	234	235	236	236	236	236	236	237	238	238	239	240	239	239
30.0 KM	228	229	229	229	230	231	232	232	232	232	232	233	233	234	234	233	233
27.5 KM	225	226	226	226	226	227	228	228	228	228	228	228	227	228	227	227	227
25.0 KM	223	223	223	223	223	224	224	224	224	224	224	223	222	222	221	221	221
22.5 KM	223	223	222	222	222	222	222	221	220	219	218	217	216	216	215	215	215
20.0 KM	223	223	222	222	222	221	220	219	217	215	213	212	211	210	209	209	210
LATITUDE	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5	0

TEMPERATURE (K) GRID FOR OCT

60.0 KM	265	263	260	258	257	258	259	260	258	258	257	257	256	256	258	258	259
57.5 KM	264	263	260	259	258	259	260	261	261	260	260	260	260	261	262	262	263
55.0 KM	263	263	261	260	260	261	262	263	264	263	263	264	264	266	267	267	267
52.5 KM	259	259	258	258	259	260	262	264	265	265	266	267	267	268	269	269	269
50.0 KM	256	256	256	256	258	260	263	265	267	267	269	270	270	271	271	272	272
47.5 KM	250	250	251	252	254	257	260	262	265	265	266	268	269	270	270	271	271
45.0 KM	244	245	247	248	251	254	257	260	263	264	264	267	269	270	270	270	270
42.5 KM	235	236	239	240	243	247	251	254	256	257	258	261	263	264	265	264	264
40.0 KM	227	228	231	233	236	240	246	249	250	251	253	256	258	259	260	259	259
37.5 KM	222	223	225	228	231	235	239	241	243	244	246	249	251	252	253	253	253
35.0 KM	218	218	220	224	227	230	232	234	236	238	240	243	245	246	247	247	247
32.5 KM	215	216	218	221	224	226	228	230	231	233	235	237	239	240	241	241	241
30.0 KM	212	214	217	219	221	223	224	226	227	229	231	232	233	234	235	235	235
27.5 KM	211	213	216	218	219	221	222	223	224	225	226	227	228	228	228	228	228
25.0 KM	210	213	216	218	218	219	220	221	222	222	222	222	223	223	222	221	221
22.5 KM	213	215	217	219	218	218	218	218	218	217	216	216	216	216	215	215	215
20.0 KM	216	217	219	220	219	218	217	216	215	213	211	210	210	209	209	209	209
LATITUDE	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5	0

TEMPERATURE (K) GRID FOR NOV

60.0 KM	265	264	262	261	259	257	257	255	255	255	256	256	257	257	257	259	259
57.5 KM	262	261	260	260	259	258	258	257	258	258	259	260	261	262	263	263	263
55.0 KM	259	259	259	259	259	260	260	260	261	262	263	264	266	267	269	268	267
52.5 KM	255	256	256	256	257	258	259	261	262	264	265	267	268	269	270	270	269
50.0 KM	252	253	253	254	255	256	259	262	264	266	268	270	271	271	272	272	272
47.5 KM	243	244	245	246	248	250	254	258	261	263	266	268	270	270	271	271	272
45.0 KM	235	236	238	239	241	245	249	255	259	261	264	267	269	270	270	271	272
42.5 KM	228	229	231	233	235	238	243	249	252	254	257	259	261	263	263	265	266
40.0 KM	222	223	225	227	229	232	237	243	246	248	250	252	254	256	257	259	261
37.5 KM	217	218	220	222	224	228	232	236	239	242	244	246	248	250	251	252	254
35.0 KM	212	213	215	217	220	224	227	230	233	236	238	240	242	244	245	246	247
32.5 KM	209	210	212	215	218	221	223	225	228	231	234	235	237	238	239	240	241
30.0 KM	206	208	210	213	216	218	220	221	223	227	230	231	232	233	234	234	235
27.5 KM	205	208	211	214	216	217	219	219	220	223	225	225	226	227	228	228	228
25.0 KM	205	208	212	215	217	217	218	218	218	219	220	220	221	221	222	222	222
22.5 KM	207	209	212	215	217	218	217	216	215	215	215	214	215	215	215	215	215
20.0 KM	209	210	213	216	218	219	217	215	213	211	210	209	209	209	208	208	208
LATITUDE	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5	0

TEMPERATURE (K) GRID FOR DEC

60.0 KM	273	271	269	266	264	264	261	260	258	256	255	257	259	260	261	263	264
57.5 KM	268	267	266	265	263	264	262	262	261	260	260	261	263	264	266	266	266
55.0 KM	264	264	264	264	263	264	264	264	264	265	265	265	267	268	271	269	268
52.5 KM	256	257	258	260	260	261	262	265	266	267	267	267	269	270	272	270	269
50.0 KM	249	250	253	256	257	258	260	266	268	270	270	270	271	272	273	272	271
47.5 KM	241	242	245	247	249	251	255	263	266	269	269	269	269	269	270	270	270
45.0 KM	234	235	237	238	241	245	251	260	265	268	269	268	267	266	267	269	269
42.5 KM	230	230	232	232	234	237	245	253	258	260	261	261	260	260	261	262	263
40.0 KM	226	226	227	226	227	230	239	247	251	253	254	254	254	255	255	256	257
37.5 KM	218	218	220	220	222	224	231	239	243	245	246	247	247	248	249	249	250
35.0 KM	210	211	213	215	217	219	224	231	235	237	239	240	241	242	243	243	244
32.5 KM	206	208	211	213	215	217	221	226	229	231	233	235	236	236	237	237	238
30.0 KM	203	206	210	212	214	216	218	221	224	226	228	230	231	231	231	232	232
27.5 KM	201	204	209	213	215	216	217	219	220	222	224	225	226	226	226	226	226
25.0 KM	200	203	209	214	217	217	217	217	217	219	220	221	221	221	221	221	221
22.5 KM	202	204	209	214	217	217	217	216	215	215	215	215	214	214	213	213	213
20.0 KM	204	205	210	214	217	218	218	216	214	212	210	209	208	207	206	205	205
LATITUDE	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5	0

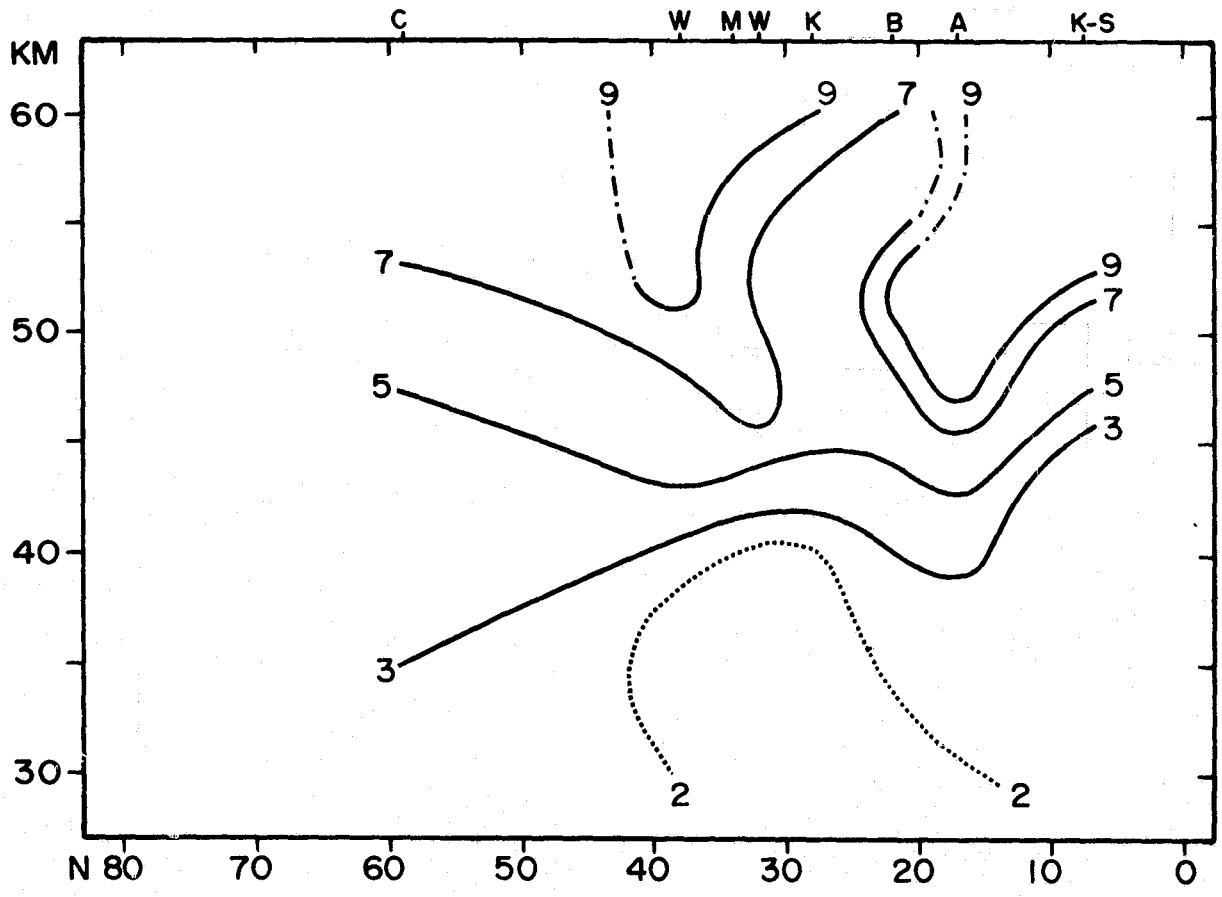


Figure 1. Amplitude (m/s) of the diurnal wave in meridional wind in spring. Letters at top of the figure refer to rocket stations used. A dash-dot line is used to indicate uncertainty of the analysis due to large statistical errors or a lack of stations. Intermediate isolines are dotted.

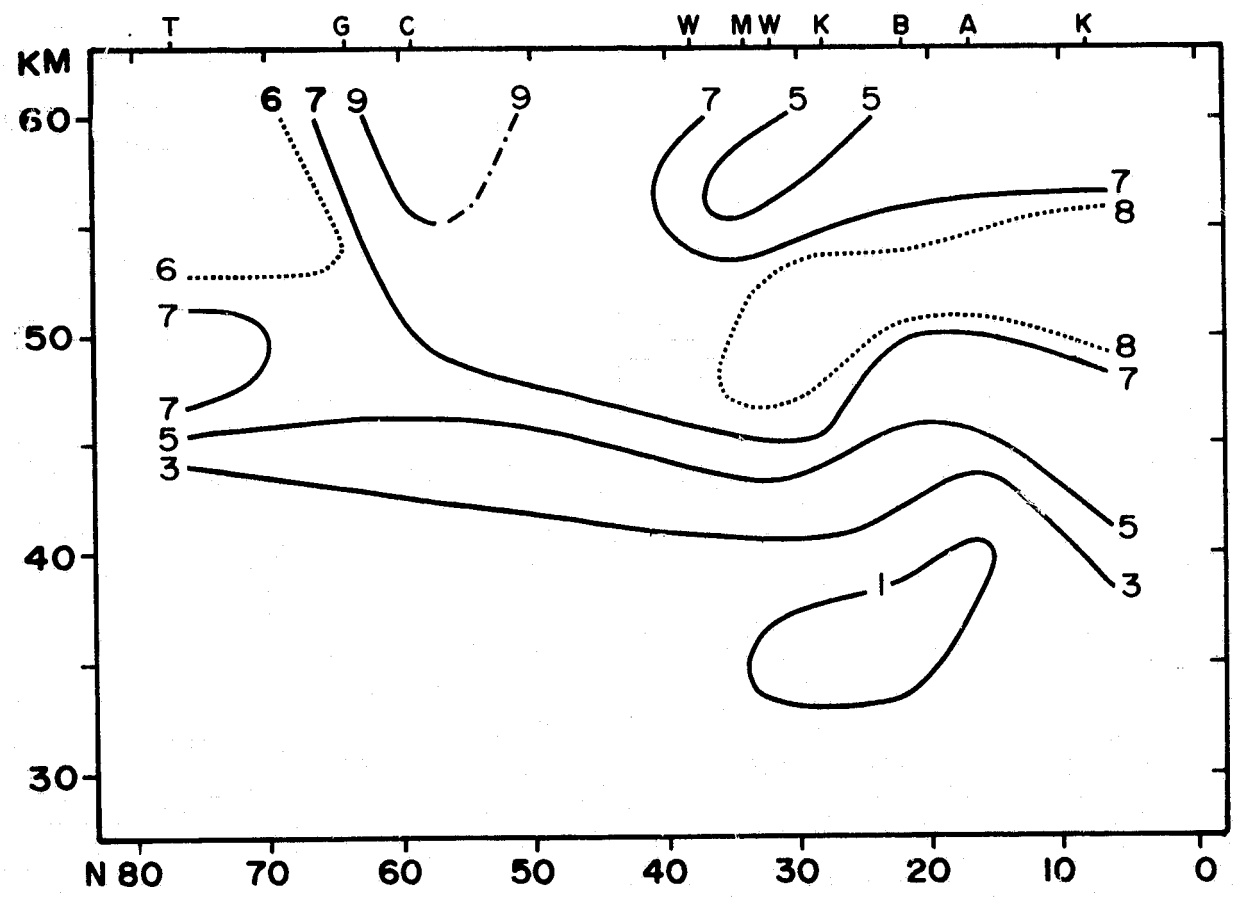


Figure 2. As in Figure 1 except for summer.

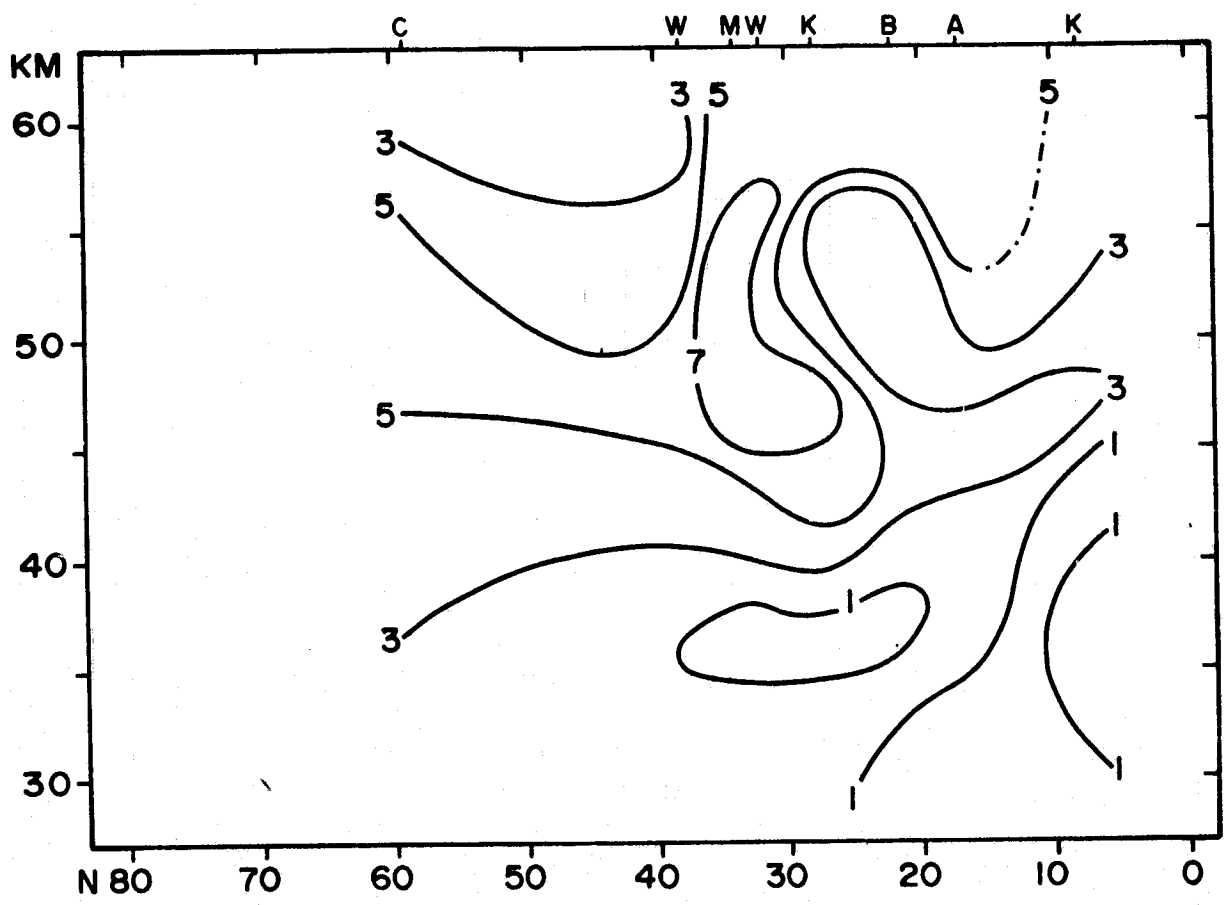


Figure 3. As in Figure 1 except for autumn.

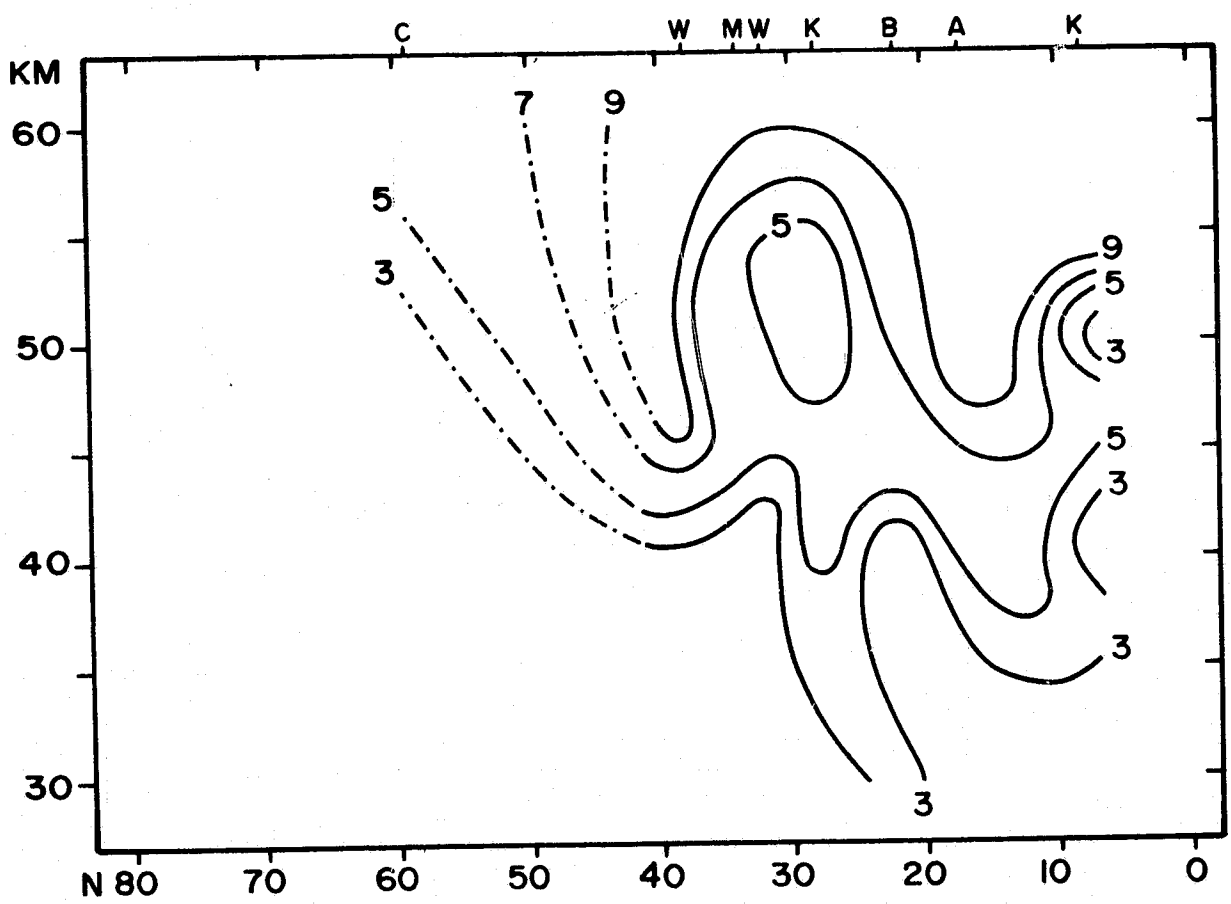


Figure 4. As in Figure 1 except for winter.

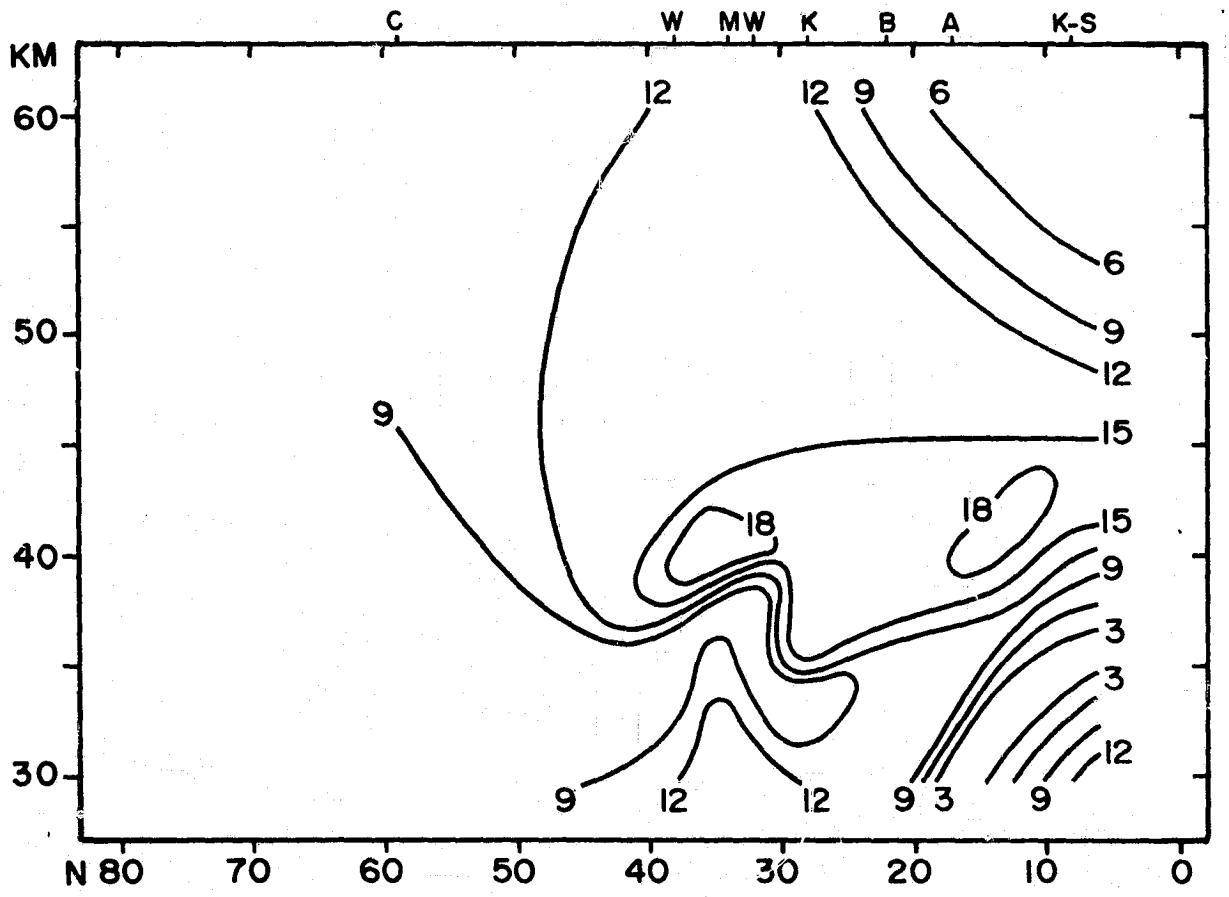


Figure 5. Phase (hour of maximum northward speed) of the diurnal tide in meridional wind in spring. Letters at top of the figure refer to rocket stations used.

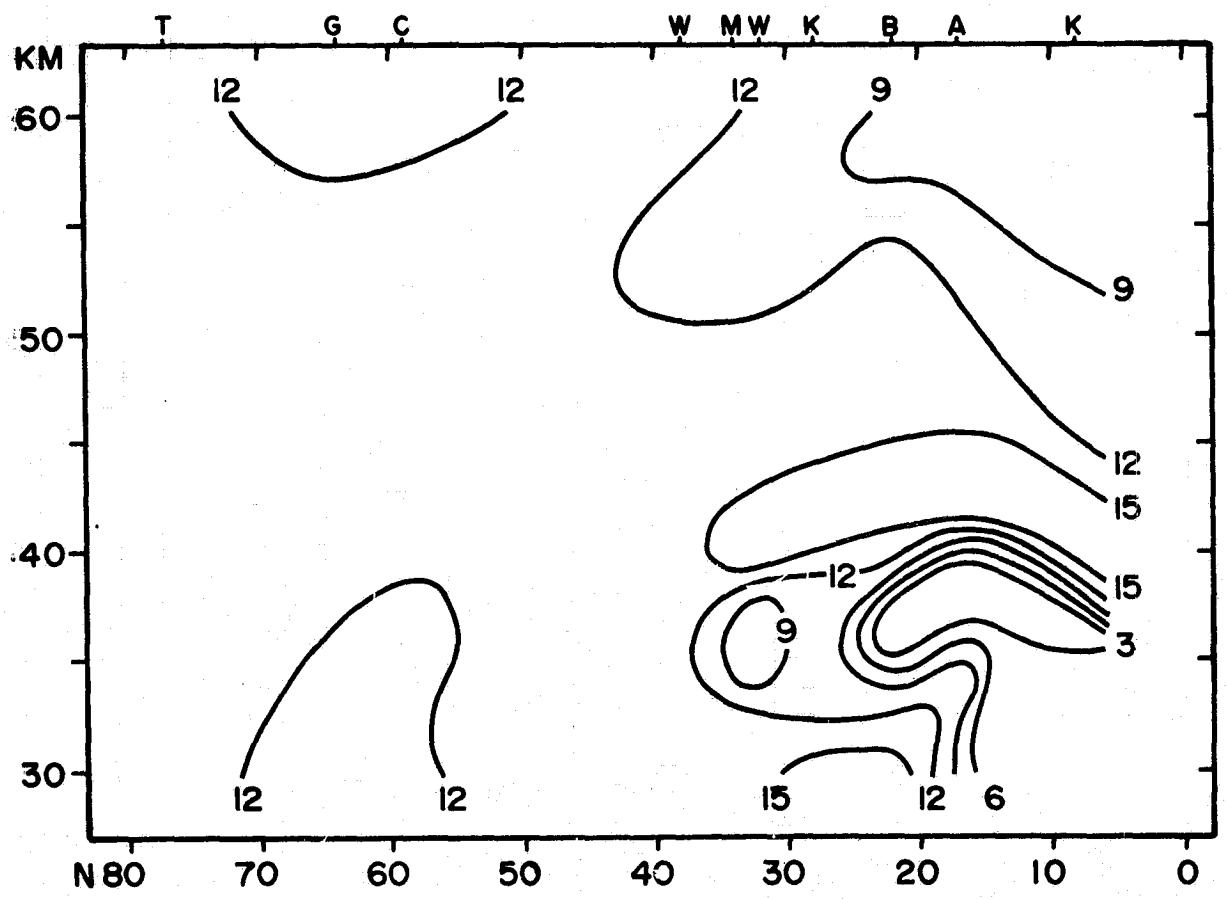


Figure 6. As in Figure 5 except for summer.

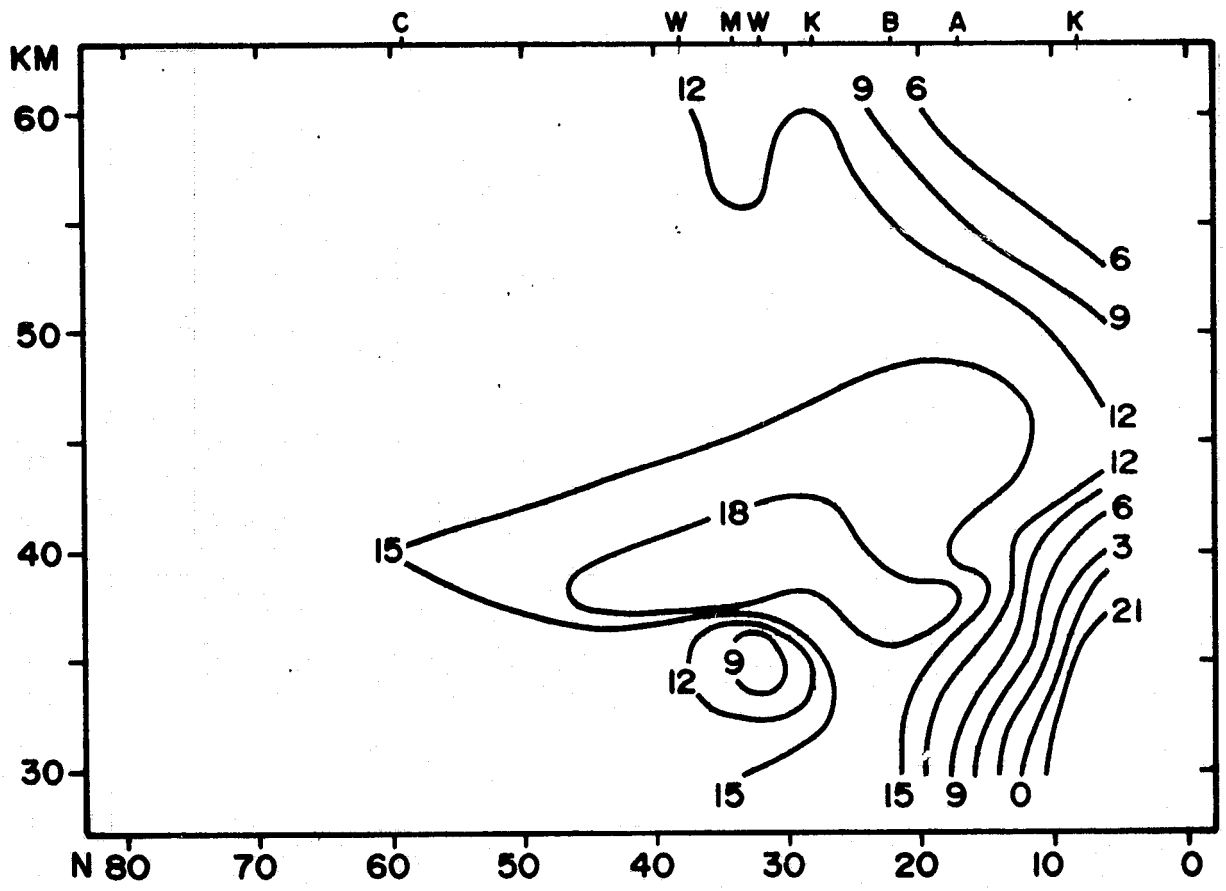


Figure 7. As in Figure 5 except for autumn.

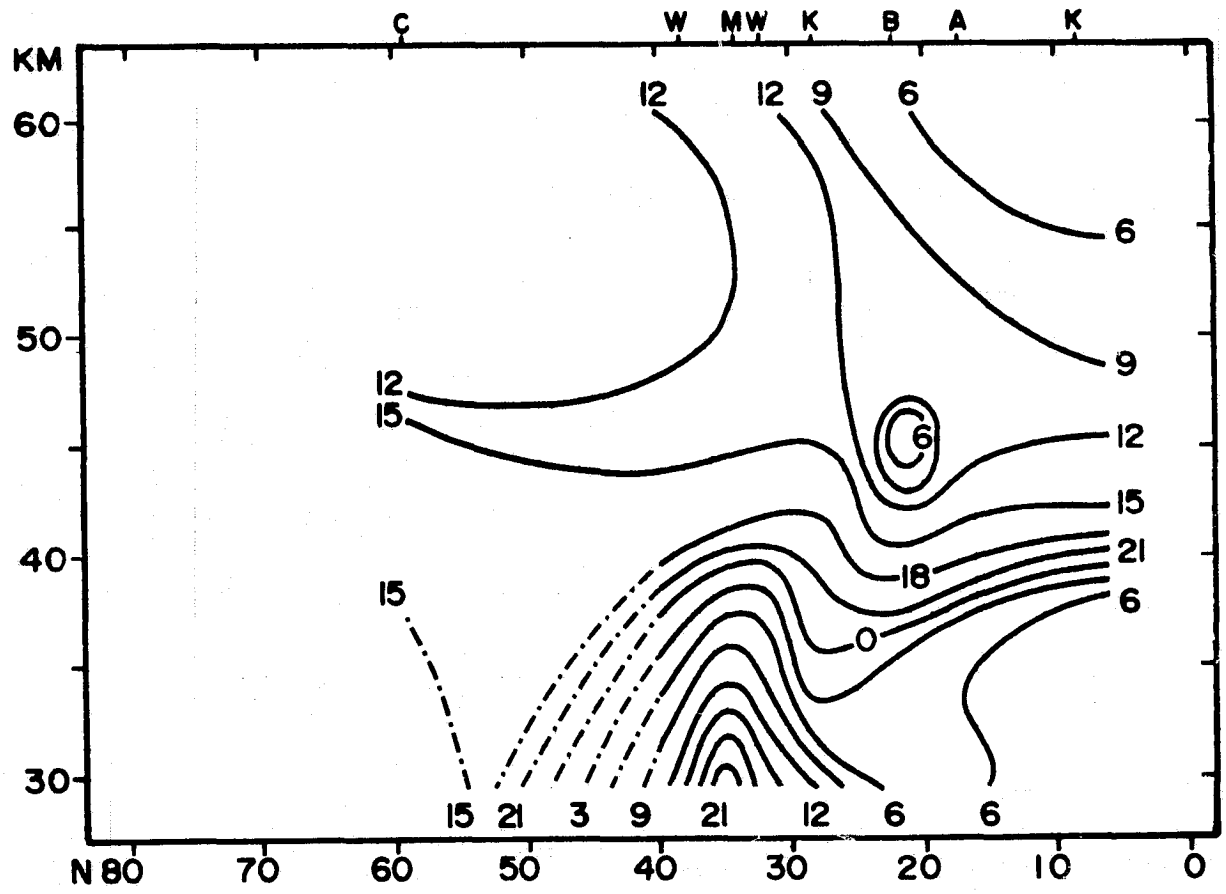


Figure 8. As in Figure 5 except for winter.

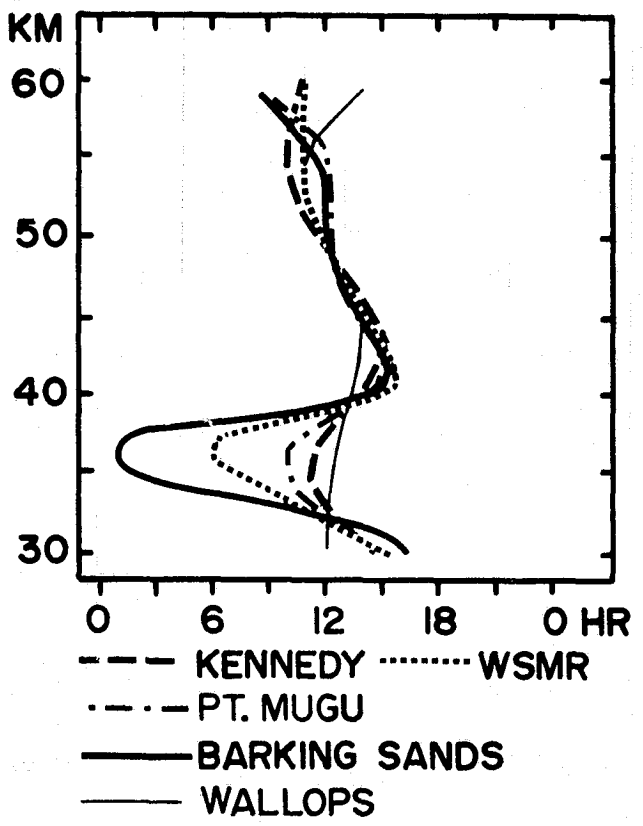


Figure 11. Phase of the diurnal tide in meridional wind in summer at selected rocket stations.

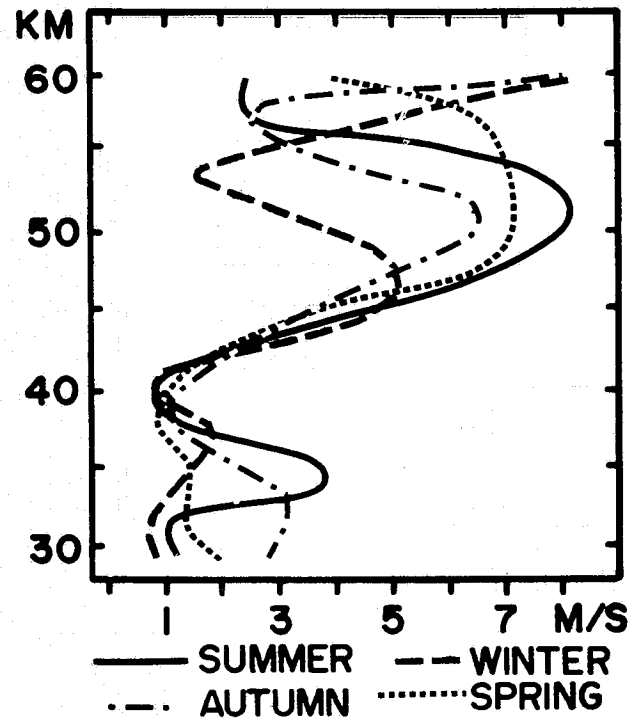


Figure 9. Amplitude of the diurnal tide in meridional wind at Ascension Island for each Southern Hemisphere season.

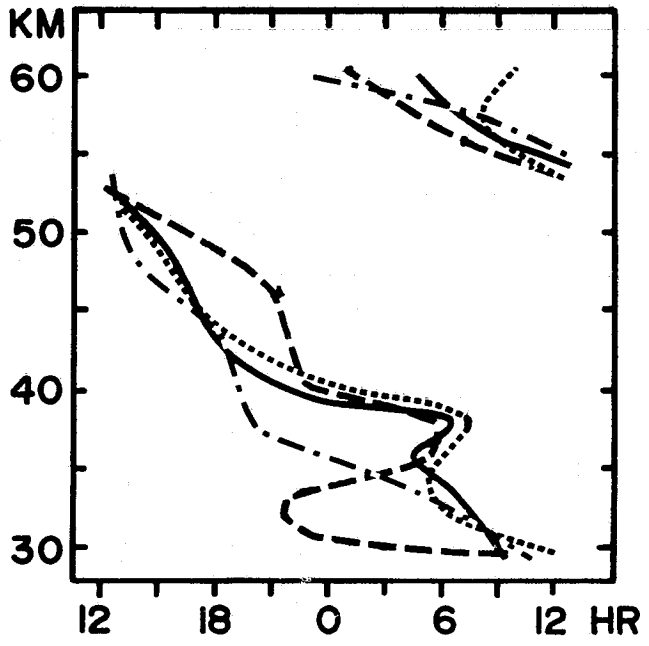


Figure 10. Phase (hour of maximum southward speed) of the diurnal tide in meridional wind at Ascension Island for each Southern Hemisphere season.