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CHARACTERISTICS OF ATMOSPHERIC DISTURBANCES WITH A QUASI-TWO DAY PERIOD

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In 1968 the Soviet equatorial meteor expedition to Mogadishu (2°N, 45° E, July, 1968-July, 1970) measured for the first time at an altitude of 80-105 km wind velocity disturbances in the equatorial atmosphere with a quasi-two day period (KASHCHEYEV et al., 1971; KALCHENKO, BULGAKOV, 1973). An example of such disturbances is provided in Fig. 1, which shows time series of wind velocity in the meriodional $V_N(t)$ and zonal $V_E(t)$ directions.

On September 10-17, 1968, the predominant meriodional northward wind velocity was 9.1 mps and that of the predominant zonal westward wind - 38.3 mps. While the time series themselves show convincingly enough the presence of a quasi-two day period in the velocity variations, the results of an harmonic analysis of the time series are given below. This table shows that a significant anisotropy exists in the wind velocity disturbance, with a pronounced meriodional maximum. During the period in question, $\bar{V}_{N48}$ = 64.6 mps and $\bar{V}_{E48}$ = 19.3 mps. The mean values of different harmonic components are compared in Table 1.

Table 1.

Average Values of the Velocity Harmonic Components During the Period From September 10 Through 17, 1968

	V_o $m \cdot s^{-1}$	V_{48} $m \cdot s^{-1}$	V_{24} $m \cdot s^{-1}$	V_{12} $m \cdot s^{-1}$	V_8 $m \cdot s^{-1}$	ϕ_{48} h	ϕ_{24} h	ϕ_{12} h	ϕ_8 h
Meriodional Direction	9,1	64,6	16,6	9,0	13,9	30,0	16,4	11,9	4,6
Zonal Direction	-38,3	19,3	14,9	15,0	7,4	31,0	16,4	7,7	4,6

The table shows that in the meriodional direction the amplitude of the two-day variations exceeds that of the diurnal component almost by a factor of four. In the zonal direction harmonics are commensurable but the two-day component exceeds the diurnal and semi-dirunal components by a factor of 1.3. These results convincingly show that one should take into account the velocity component with a quasi-two-day period when analyzing the wind at mesopause altitudes. The amplitude of the semi-diurnal component in the zonal direction is nearly double that in the meridional direction. The phase of these components is such that the velocity vector of the semi-diurnal tide rotates counter-clockwise. (ϕ_{N12} - ϕ_{E12} = 3.2 h).

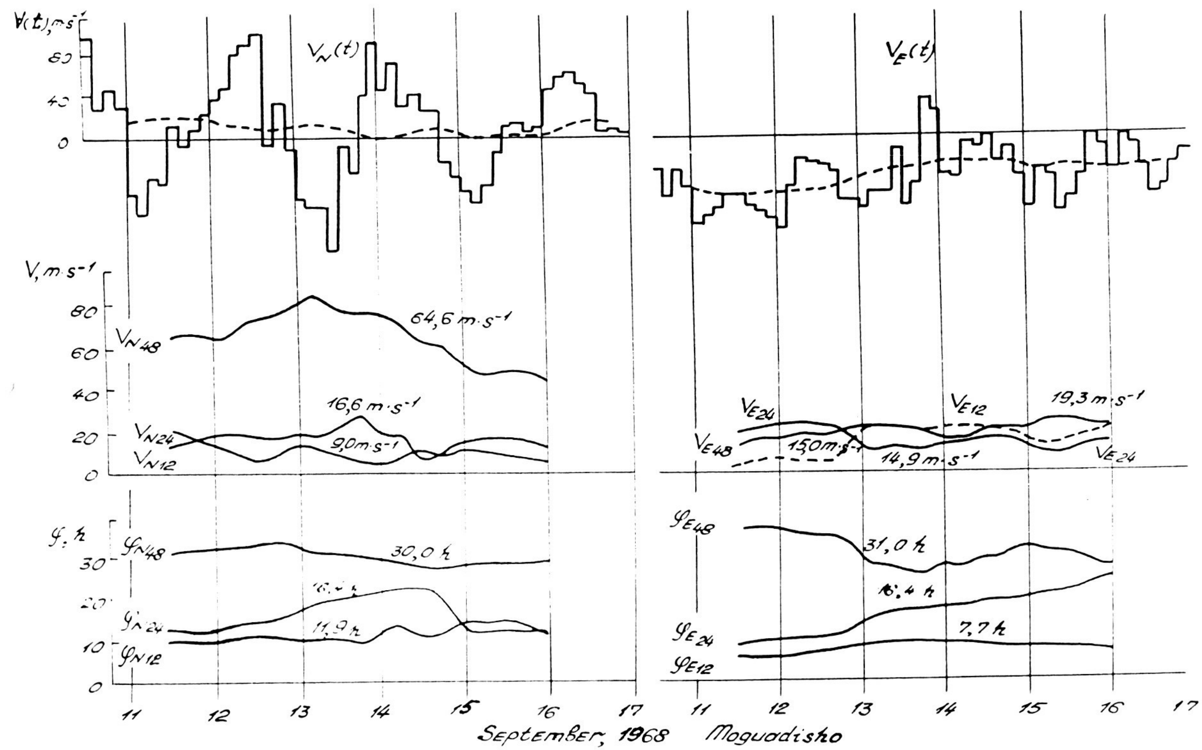

Fig. 1 Wind velocities in the meridional, V_N, and zonal, V_E, directions for the period September 11-17, 1968, over Mogadishu. Mean amplitudes and phases for each periodicity over the measurement interval appear on the curves.

The mean values of the diurnal component phase were the same for both the zonal and the meridional components.

Comparison of results obtained in the equatorial zone with those obtained in Kharkov and Dushanbe showed the global nature of the quasi-two day disturbances, with an amplitude maximum over the equator. The period of the discovered variations may be other than 48 hours. For example in July-August, 1981, T_x = 44, 5 hrs., while in July, 1971, T_x = 52, 5 hrs.

The experiments carried out in the equatorial zone using velocity measuring equipment revealed that the two-day disturbance amplitude is bigger in the upper layers of the meteor zone and the phase either decreases in the upper layers or remains unchanged. Fig. 2 shows the results of observations carried out in February-March, 1970. Three independent height ranges are presented, with average altitudes of 84.3 km, 92.7 km, and 100.8 km, with a distinct two-day wave dominating the highest altitude.

It was noticed that the appearance of quasi-two-day variations is close in time to the change of polarity of the interplanetary magnetic field (IMF). Moreover, the phase of the fluctuations depends on the sign change from "+" to "-" or vice versa.

Experimental data obtained in 1970-1976 (50°N), in 1968-1970 (2°N) and in 1972-1974 (67°S) were used in an analysis of the two-day variations at different latitudes and in different seasons of the year (Obninsk, 1976, iss. 7, 9, 10, 11). For each month the maximum amplitude of the two-day wave was chosen for both the meridional and zonal directions. The velocity values were averaged for each month using available data and the results obtained referred to the middle of each month. Thus, monthly mean values were obtained for an average year. A 10-year analysis carried out for 50°N for all the measured two-day disturbances yielded about the same results. The velocity values V_{48} are denoted by dots for the meridional direction and by circles for the zonal in Fig. 3. One can note that meridional and zonal components have nearly the same amplitudes (50°N and 67°S) and similar transformation laws. In the equatorial zone the meridional component is predominant and its annual variation differs slightly from that of the higher latitudes. The zonal component has the same half-year period just as at 50°N and 67°S. The maximum amplitude of the two-day disturbances is observed in July and January. The results also showed that two-day variations with a definite original phase and large amplitude occur with a sign change of the IMF provided that the polarity remains relatively constant for some days thereafter.

Simultaneous occurrence of quasi-two-day variations was observed more often in geographical points located on the same meridian; for points located at other longitudes such variations occur earlier in the east, i.e., the appearance of the wave moves from the east to the west. According to experimental data the wave number can have values from 3 to 5. Fig. 4 shows a case of quasi-two-day variations observed over Kharkov and Kharbarovsk, the longitude separation between these two points being 98.34°. It is obvious from Fig. 4 that the wind variations of August 17-21 over Khabarovsk or the same as those of August 19-23 over Kharkov. In this case processes observed over Kharkov repeated themselves over Khabarovsk

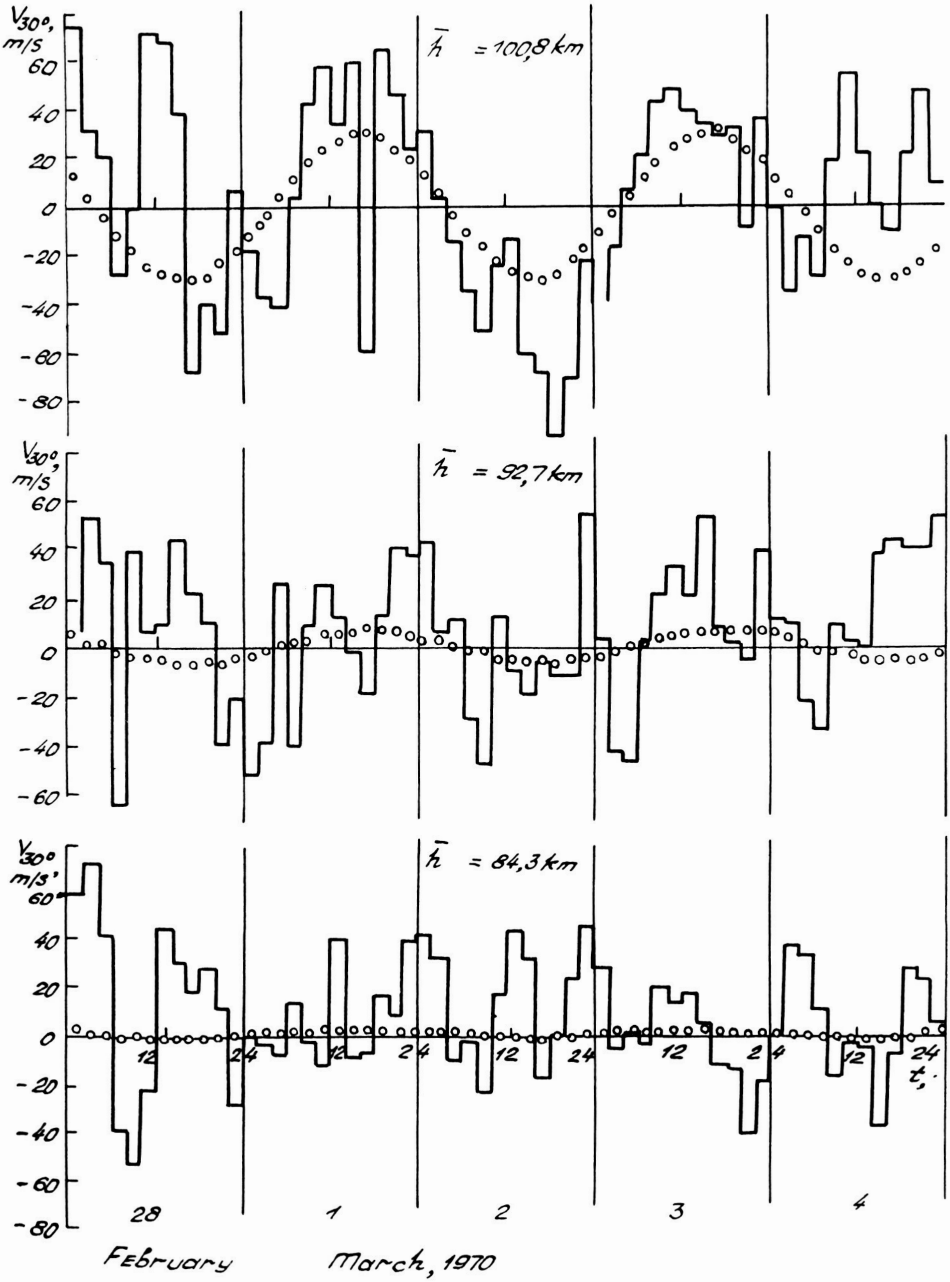

Fig. 2 The wind field at three heights for February 28 to March 4, 1970, with two day wave superimposed. Note the rapid increase in two day wave amplitude with height.

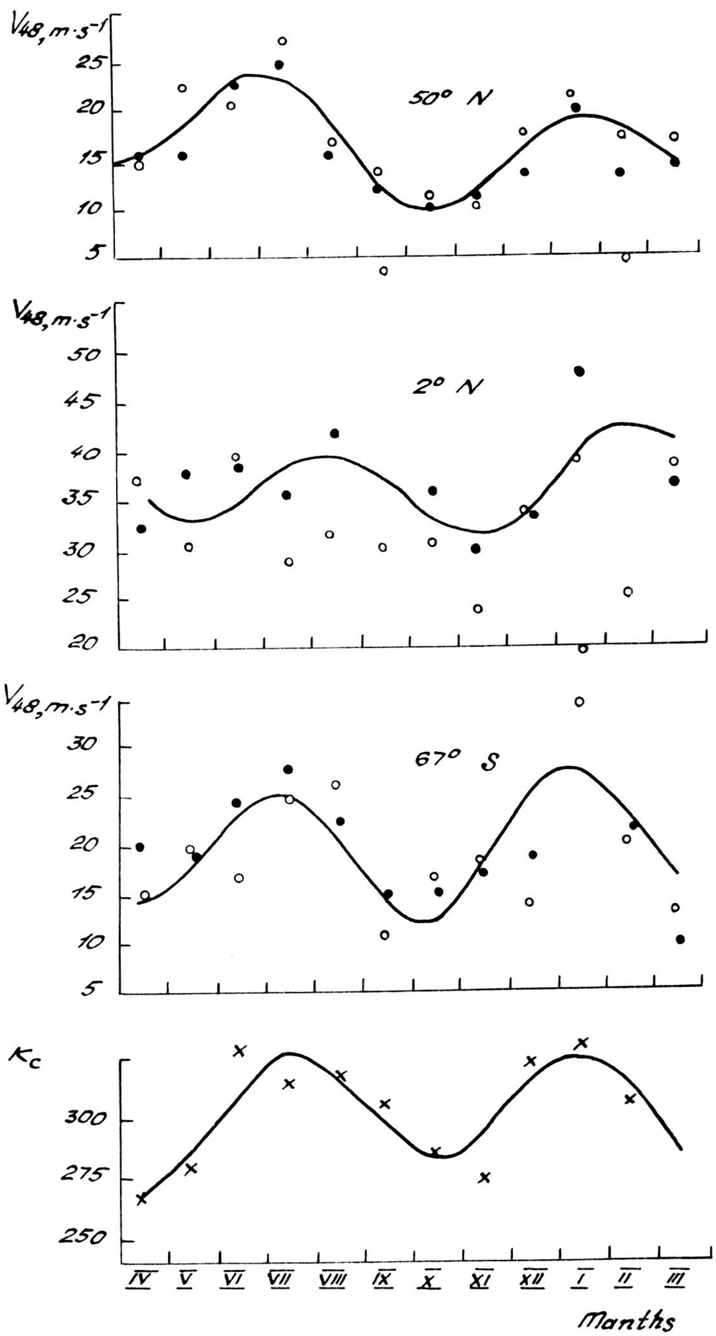

Fig. 3 Average maximum monthly amplitude of the two day wave from data measured at 95 km from Obninsk (50°N, 1970-76), Mogadishu (2°N, 1968-70) and Molodezhnaya (67°S, 1972-74), meridional ●, zonal o; note the obvious correlation with K_c.

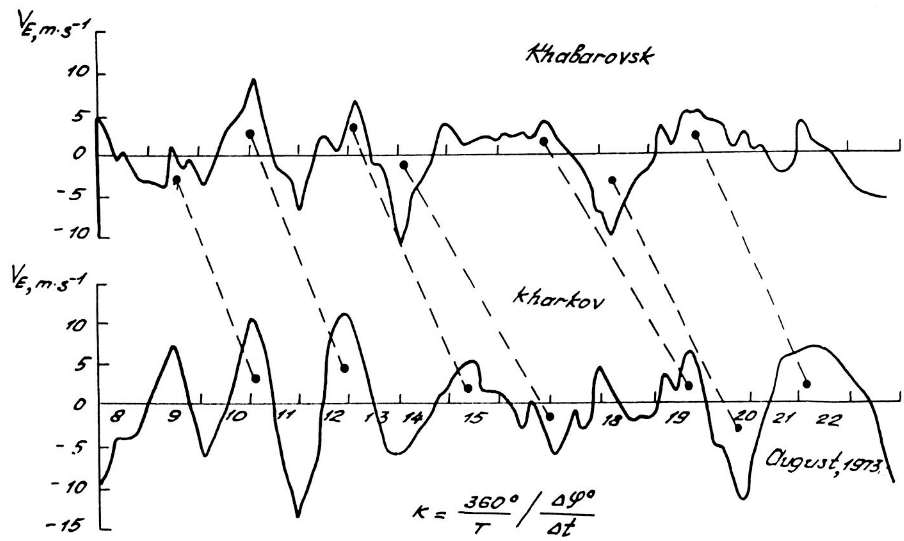

Fig. 4 Quasi two day variations observed simultaneously over Kharkov and Kharbarovsk, separated by 98° in longitude. The phase lag of 62-65 hours corresponds to a zonal wave number of 5.

62-65 hours later which corresponds to a wave number K~5. Similar results were obtained when comparing the measurements from two stations with $\Delta\phi$ = 12° (Kharkov, Kazan) obtained from July 30 to August 9, 1978. From data obtained during January 15-27, 1978 over Obninsk and Kuhlungsborn ($\Delta\phi$ = 24.5°) K = 4.7.

The obtained results show that quasi-two diurnal variations are due to solar activity.

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