ON THE FEATURES IN THE SPECTRA OF METEOROLOGICAL VARIABLES IN WIDE BAND OF FREQUENCIES

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There is a great deal of investigations of power spectra of meteorological variables time series [1-2 and other]. In the most of them, attention is focused on especial, relatively narrow, spectral bands. The object of this paper is the study of form and features of power spectra of meteorological variables in wide spectral band. Four time sets for surface and upper-air levels were used for the study. The geographical location of observing site for surface data series is middle part of European Russia, near Moscow. The surface data are following. **M1** is the 44-year series with 3 hour sampling rate, **M2** is 15-day series with 10 sec sampling rate, **M3** is 3-hour set with 0.1 sec sampling rate. The frequency band for surface data covers periods from seconds to years. The upper-air series are the radiosonde measurements for 10 year with 1 day sampling rate.

The power spectra of surface temperature and pressure are given in Fig.1 and Fig.2 in $ln(\omega)$ - ω $S(\omega)$ coordinates. The thick line denotes the **M1** spectra, the thin line denotes **M2** spectra, and dotted line denotes **M3** spectra. It can be seen that maximal temporal variability takes place in spectral band of $\Delta\omega$ $5*10^{-7}$-$1*10^{-6}$ sec^{-1} (periods of 20-10 days). Spectral density increases with frequency for spectral band less than 10^{-6} sec^{-1} and decreases as ω^{-2} in spectral band $5*10^{-6}$ sec^{1} to 0.1 sec. The ω^{2} and ω^{-2} functions are shown in the figures as crosses. Besides annual and diurnal oscillations, there are periodicities of scale from years to hours in temperature and pressure spectra. The annual periodicity is two power more than diurnal one, which, in turn, is a power more than 10-20 day maximum. Biennial maximum is two power less than seasonal one. 20-50 days periodicities in pressure spectra are of special interest. One of probable explanations for their appearance is effect of some planetary waves, for instance Madden-Julian Oscillations **(MJO),** which are known to be detected both in the tropics and in the middle latitudes [3-4] at high levels.

Power spectra for surface wind speed and its components are shown in Fig. 3 and Fig. 4. The well-known Van-der-Hoven spectrum in reduced form is given in Fig.3 too. Unlike temperature and pressure, wind speed spectra show maximum of spectral density in band $(2\text{-}3)*10^{-6}$ sec^{-1} (periods of 4-5 days). There is mesometeorological minimum and turbulent maximum. Spectra of wind speed differ from spectra of its zonal **(U)** and meridional **(V)** components. The synoptic band of variability is much more in zonal and meridional components than in module of wind speed.

To detect possible oscillations of **MJO** scale at upper-air time series, we studied the spectra of upper-air meteorological time series.. Ten stations within European Russia were selected, and the spectra of data on standard pressure levels were estimated. These spectra were averaged over 10 stations. The averaged spectra for geopotential height and U-wind for 850 and 200 hPa are shown in Fig. 5. It can be seen that a considerable fraction of power corresponds just to MJO scale processes. However, further studies are needed to explain if these MJO-like oscillations in mid-latitudes are of the same origin as the tropical MJO.

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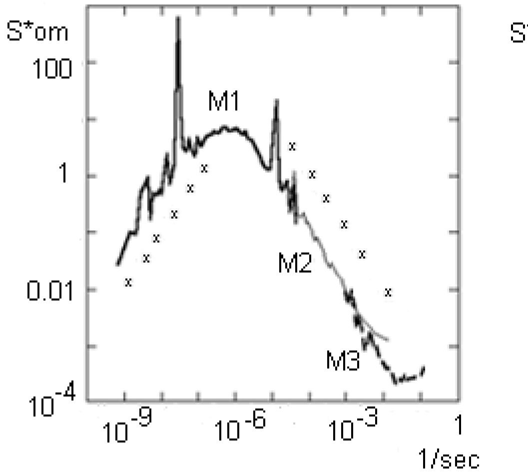

Fig.1. The spectrum of surface temperature

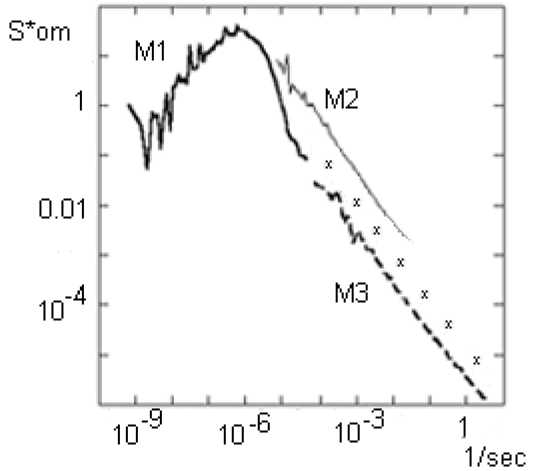

Fig.2. The spectrum of surface pressure

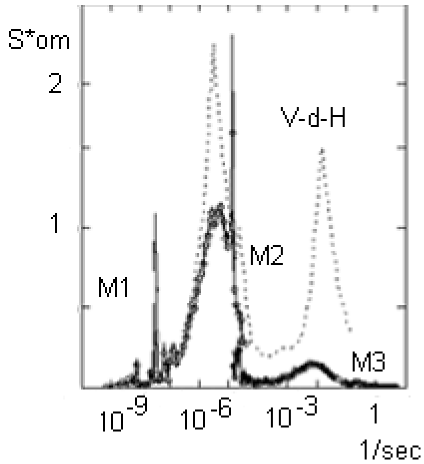

Fig.3. The spectrum of wind speed.

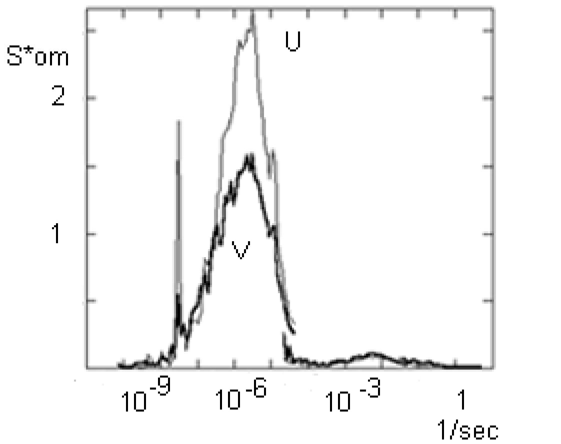

Fig.4. The spectra of wind speed components.

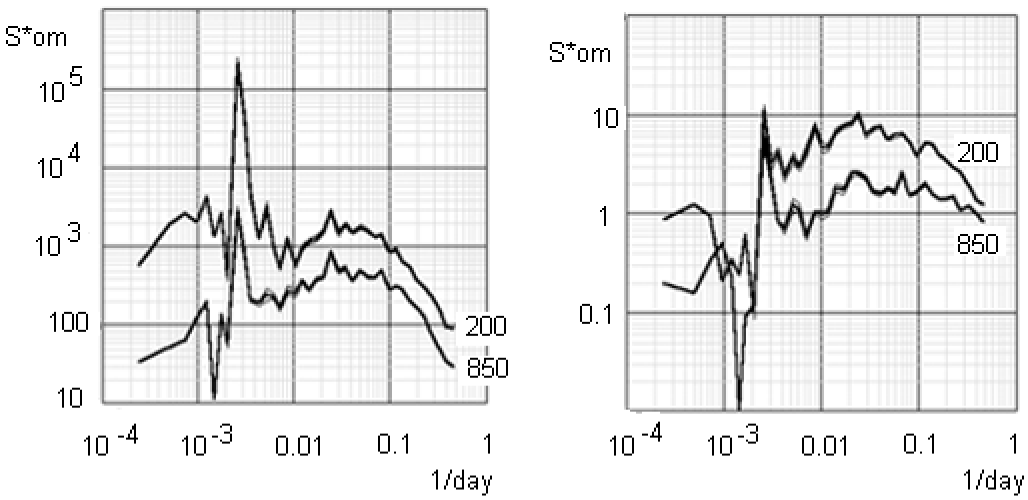

Fig.5. The averaged spectra of geopotential height (left) and U-wind (right) for 850 and 200 hPa.