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Synchronous manifestations of 160-min pulsations in the atmospheric pressure at widely separated stations

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The oscillations of ground pressure with a period of about 160 min in December 2003 and March 2004 relative to the zero meridian are studied by 5-min data of four widely separated cosmic ray stations sia (Moscow, Apatity, Yakutsk, Tixie). The choice of time is caused by the fact that the territory of Russia for such conditions in December is the closest towards the center of the Galaxy (through the Earth). The most distance from this direction of a zero meridian is realized in March. If we suppose that the gravitational wave responsible for 160-min pressure pulsations. comes from the center of the Galaxy then the most synchronous manifestations of them on the territory of Russia are expected only in December. The authors assume that 160-min pulsations of the ground pressure are not associated with brightness pulsations of the Sun. The most favorable time for their observations coincides with the time of location of stations near directions to the center of the Galaxy.

1. Introduction

In 1970-80th the oscillations of the Sun as a star have been discovered with a period *P* about 160 minutes [1-5]. The oscillations with the period of 160 min are inherent in the brightness pulsations of the Sun and many other stars and even in the brightness of galactic nuclei [6-9].

A manifestation of the 160-min variations in the ground air pressure has been noted earlier by Novikov et al. [10]. These authors considered the only fact of their discovery by the method of spectral analysis. Below we raise a task to determine the amplitude, phase and form of those oscillations, to reveal their variations as well as to make clear a question of possible independence of their manifestation at the Sun and in the Earth's atmosphere. In particular, it is important to ascertain if the 160-min variations are a continuous flow of pulsations or they are a sum of the discrete "packets" ("quanta")?

We propose a new method of investigation, namely, a use of the planet Earth as a single device for the study of synchronous detection of 160-min pulsations at two or more remote points at the Earth's surface.

2. Analysis of Observational Data

For our analysis we selected 5-min values of the ground pressure at Moscow (with an accuracy up to 0.01 mb) and Yakutsk (with an accuracy up to 0.1 mb) since 1 January to 1 March 2000. A total number of observational points at both stations was n = 34848. Before the data processing, it was taken into account that a difference between the positions of Moscow and Yakutsk inside their time zone is ≈ +2°, so that all Yakutsk data were reduced to a common phase corresponding to this shift, namely, to the origin of the Moscow ground pressure data at 00:00 UT 01 January 2000. The amplitudes of expected 160-min variations in the ground pressure are very small. Therefore, one should apply a filtration method, i.e., to subtract from the pressure data all the variations with the periods larger than 160 minutes. Figure 1 presents a fragment of the data as a function of ordinal number of the 5-min intervals starting from number 7552 up to number 8288. With the purpose of visualization, the data in Figure 1 are divided into the 160-min intervals (by thirty two 5-min intervals) with allowance for that a reference point for the phase is 00:00 UT of 1 January 2000. Upper curve corresponds to the variations of ground pressure in Moscow (in units of mb), and middle curve presents the pressure variations in Yakutsk (with a shift of the data by 0.5 mb below relative to their absolute values). Lower panel is the half-sum of ground pressure changes in Moscow and Yakutsk, with a subtraction of 1.0 mb.

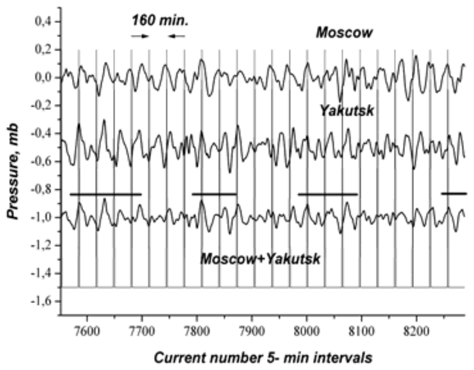

Figure 1. Variations of ground pressure in Moscow (upper curve) and Yakutsk (middle curve) (a fragment from a total data array). Lower curve presents the variations of a half-sum of the Moscow and Yakutsk data

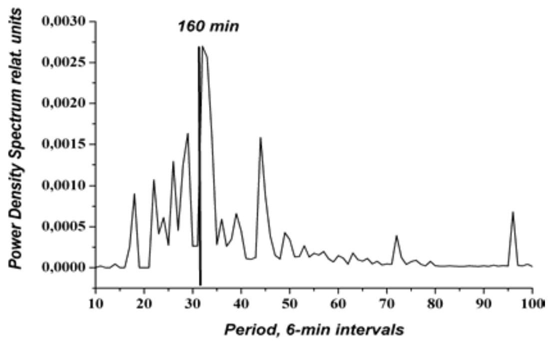

Figure 2. Power density spectrum obtained after a filtration of the Moscow ground pressure data.

One can judge of the filtration quality by the power density spectra (PDS) obtained due to the procedure described above. As an example, Figure 2 shows a PDS for the Moscow pressure data, where a 160-min “peak” is distinctly seen (dashed line).

In Figure 1 one can see the manifestations of 160-min variations of ground pressure both by the Moscow and Yakutsk data. In the current work, it was raised a goal to reveal even slight but common features of the pulsations in the Moscow and Yakutsk data for the same moment of time.

A motivation of this goal was an expectation that the manifestation of the 160-min pulsations will prove to be global in nature. In particular, it was suggested that a single pulse form should be approximately the same in Moscow and Yakutsk. Note that the pulsations presented in Figure 1 also contain a considerable portion of the “noise” pulses, so, one cannot expect for absolute coincidence in the forms of individual pulses in Moscow and Yakutsk. However, sometimes such a coincidence should manifest itself quite distinctly. This may be seen in Figure 1 by an example of the pulses for the second and third 160-min intervals: although those pulses are distorted, however, they are rather similar. It is characteristic that in the second interval the pulse has two maximums with a gap between them, and corresponding pulse in Yakutsk has a form with similar “details”. Just to separate coinciding details for the Moscow and Yakutsk pulses, we carried out a summing of the Moscow and Yakutsk data sets. It was expected that, due to this operation, an effect of synchronous manifestation of the pulsations would be enhanced. And in fact, the coincidence takes place in the pressure variations in Moscow and Yakutsk for considerable number of events. Thick horizontal segments in Figure 1 mark the intervals of coincidence roughly. There is also no absolute repetition (reiteration) of the 160-min pulsations at each station: continuously a phase “shift” happens at different directions (increases and decreases). Judging from the data of Figure 1, a spread in the amplitudes of separated individual pulsations is concentrated within the interval of ≈ 0.05÷0.25 mb, and inside the coinciding "packets" – within the interval of ≈ 0.1÷0.2 mb.

3. Discussion

Investigations of 160-min oscillations in visible emission of the Sun points out very large fluctuations in the phase of these pulsations (from $-\pi$ to $+\pi$). However, its mean value is preserved for large time intervals [8]. As to our case, one can see that the phase also undergoes very large changes. It is interesting to make clear if a single common phase does exist in average in the pressure pulsations in Moscow and Yakutsk? Let us apply the method of superposed epochs to the half-sum of pressure changes in Moscow and Yakutsk. The result of superposition of segments for 32 points is given in Figure 3. One can see that mean 160-min variation is a composition of cosine curve with small additional pulses in its maximum and minimum. At the curve maximum an additional pulse is summarized with the cosine curve, but at the minimum it is subtracted from the curve. Thus, at least, within the interval between 1 January and 1 March 2000 the phase retains its value. Does the value obtained in the phase for ground pressure remain the same at other time intervals? This question may be answered only by further studies.

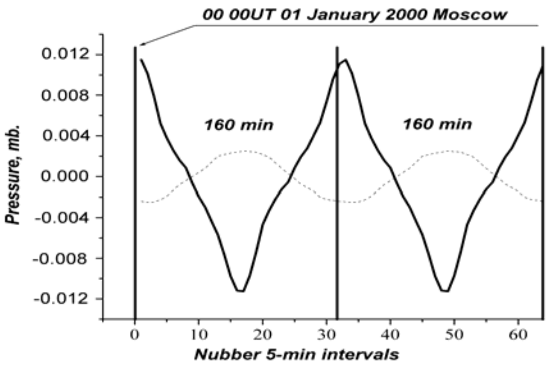

Figure 3. Results of the superposition of separated segments for the half-sum of ground pressure changes in Moscow and Yakutsk (solid curve) by 32 observational points with allowance for an initial phase at 00:00 UT of 1 January 2000 (for the purpose of visualization, two 160-min periods are shown). Dashed curve presents a mean 160-min pulsation of the Sun's brightness (in relative units) for the period of 1974-1995 (Kotov, 1996).

According to [7-9], the phase of 160-min oscillations does not undergo the changes, even within large time intervals. As an example, in Figure 3 a mean 160-min pulsation of the Sun's brightness (in relative units) is shown for the period of 1974-1995. During this interval an initial phase 00:00 UT did not change [7]. It is suggested that the phase in ground pressure shown in Figure 3 will remain stable for a long time.

The fact attracts our attention that an enhancement of the Sun's visible emission within the interval of 160 minutes is followed by decreasing of ground pressure (and vice versa). The authors suggest to explain this fact as follows. The Earth and Sun experience a disturbing influence of the same external source in the form of gravitational wave, probably coming from the center of Galaxy. Such a possibility is now discussed in scientific literature. As a result, when the amplitude of this wave increases, the Sun experiences a small compression, and its radius decreases that causes a decrease in visible emission flux (and vice versa). At the Earth's surface during such periods an increase of air pressure will take place due to increasing of gravity by gravitational wave (and vice versa).

In order to prove that the 160-min changes of ground pressure are conditioned by some other external source, but not by the Sun, the authors are guided by following arguments. If the 160-min oscillations of the Sun's brightness were the cause of the 160-min oscillations in ground pressure then a significant diurnal pressure variation manifested itself certainly. But this effect is absent all over the data set, as their spectral analysis confirmed. On the same reason a gravitational influence of the Sun with a period of 160 minutes should be also excluded, otherwise a pulsation of ground pressure from atmospheric tide influences the diurnal pressure variation with the period of 160 minutes, but this kind of pulsation is absent, too.

From Figure 1 it is seen that mean amplitude of coinciding oscillations is ≈ 0.15±0.04 mb if the procedure of summing by the method of epoch superposition is applied, without allowance for the phase value (for example, by taking into account the maximum positions only). The phasing being taking into account, mean amplitude value is equal to ≈ 0.011±0.0006 mb, i.e., one order of magnitude less (see Figure 3). This may be explained by strong scatter of the phases of the 160-min oscillations (from -180° to +180°). A coincidence of 160-min pulsations in Moscow and Yakutsk takes place mainly in the form of “packets” containing from two to five of 160-min periods. Inside the “packets” the phases are mainly preserved, however, a mean phase of some individual “packet” may differ significantly from the phase of the other one.

4. Conclusions

1. Pulsations of ground pressure with a period of 160 min are manifested themselves in Moscow and Yakutsk synchronously, mainly in the form of “packets” containing from 2 to 5 periods (160-min oscillations).
2. The mean amplitude of synchronous pressure variations for Moscow and Yakutsk is equal to 0.011±0.0006 mb.
3. The form of 160-min variation in ground pressure is a composition of cosine curve with small additional pulses. At the curve maximum an additional pulse is summarized with the cosine curve, but at the minimum it is subtracted from the curve.
4. The mean phase of ground pressure variations coincides with a phase of 160-min oscillations of the Sun’s brightness. The onset of phase is at 00:00 UT of 1 January 2000.
5. The phase difference between certain packets and single oscillations undergoes large scatter (from $-\pi$ to $+\pi$), however, the phases inside the packets are mainly preserved. It is shown that a phase retains its value, at least, within the interval between 1 January and 1 March 2000.

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