Peculiarities of the thermal regime of the Russian plain depending on tidal oscillation Earth rotation speed

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Abstract. Typification of fields of anomaly of temperature in the central part of East European Plain depending on the main phases of the Moon taking into account these tidal fluctuations of speed of rotation of Earth is presented. The main regularities of spatial distribution of anomaly of temperature in December are revealed. The opposite dependence of distribution of anomaly of temperature on antiphases of the Moon is established.

1. Introduction
Despite numerous publications, the emergence of general reports on the problems of changing the contemporary climate [1], interest in this topic is not lost. This is due both to the instability of the modern climate, and to the possible negative and positive consequences of climate change in the natural and socio-economic spheres. There are still different views on the causes of the warming that is occurring [2-7].

The thermal regime of the territory is the main climatic indicator determining the development of economic activity. The increasing instability of weather conditions associated with global warming, currently observed, contributes to the development of long-term forecasting techniques involving various predictors. One of such directions is the use of data of tidal oscillations of the Earth's rotation speed due to the sun-lunar tides established by N. S. Sidorenkov [8]. The thermal regime of the territory in this case is a reflection of the reaction of the change in the atmospheric circulation regime to oscillation in the rotation speed of the Earth.

The purpose of this article is to conduct studies of the temperature anomaly fields in the central part of the Russian Plain, taking into account the data of tidal oscillation of the rotation speed of the Earth. To realize this task, the temperature fields were typified according to the main phases of the moon in the territory under consideration.

2. Materials and methods
The moon is a natural satellite of the Earth, the closest celestial body to the Earth. The phases of the Moon are the periodically changing states of the illumination of the Moon by the Sun. There are four main phases of the moon, which gradually change into one another in the following sequence: new moon (phase I), first quarter (phase II), full moon (phase III), last quarter (phase IV). New Moon (Phase I) - The moon is in conjunction with the Sun; First Quarter (II phase) - The Moon forms the right quadrature with the Sun; Full Moon (III phase) - Moon in opposition to the Sun; The last quarter (phase IV) - The moon forms a left quadrature with the Sun. This cycle is divided into four phases of approximately 7.5 days each. The moon passes its cycle from the new moon to the next new moon in 29.6 days.
Newton established that the motion of all celestial bodies is governed by the force of attraction. For example, the Earth moves in its orbit under the influence of the Sun's attraction, and the Moon - under the influence of the attraction of the Earth. On different days, the moon turns over different parts of the Earth. The moon draws its gravity a little to the atmosphere of the Earth to its side, making the atmospheric column higher, as, respectively, and atmospheric pressure [9]. This relationship between the phases of the moon and atmospheric pressure was first noticed in 1847 [10].

The Earth and the Moon revolve around the common center of gravity (barycenter) of the Earth-Moon system with a sidereal (relative to the stars) period of 27.3 days (day). The Earth presents an orbit that is a mirror image of the Moon's orbit, but its dimensions are 81 times smaller than the lunar orbit. The barycenter is always located inside the Earth, at a distance of about 4670 km from its center. The Earth's body turns without rotation (translationally) around the "stationary" (in the Earth-Moon system) barycenter. As a result of such a monthly rotation of the Earth on all terrestrial particles, exactly such a centrifugal force acts as at the center of the masses of the Earth. The sum of the vectors of the centrifugal force and the force of the Moon's attraction is called the tidal power of the moon. The tidal force of the Sun is determined similarly [8-10].

Tidal oscillations in the Earth’s rotation speed are based on the theory of the moon-solar tidal potential. At present, 62 harmonics of the zone tide with periods from 5 days to 18.6 years are used to calculate tidal oscillations of the Earth's rotation speed [11]. The most significant of these are fluctuations with a half-monthly, monthly and semi-annual periods. The speed of the Earth's rotation is characterized by a relative value and is determined by the formula:

\[ n = \frac{2\pi}{86400} \]

\[ \Pi_3 \] - is the duration of the earth's day; \( T \) - duration of standard (atomic or ephemeris) days, which is equal to 86400 s; \( \omega \) Rad\cdot s\(^{-1}\) - angular velocities corresponding to the earth and standard days. Since \( \omega \) varies only in the ninth to eighth digit, the values of \( v \) are of the order of \( 10^{-9} - 10^{-8} \) [8].

The database that was used for the thermal regime of the central part of the Russian Plain consists of the daily actual meteorological parameters of observations on the state of atmospheric temperature (for December), at the main observation dates, from observations between 1948 and 2016, was placed on the official website of Roshydromet (Meteorological Center - URL: http://meteocenter.net/), at 11 meteorological stations. In the beginning, the total sample size for each station, for the month of December, was 16864 cases. Later, based on the temperature values in the main terms, average daily values were calculated, thereby the sample size decreased to 2108 cases. This sample (2108 cases) was divided into 4 groups corresponding to a certain phase of the Moon. The sample size for each phase of the Moon ranged from 486 to 534 cases. Such a large number of observations indicate a high reliability of the results of the study. For each station, the statistical significance of the results was analyzed at a significance level of \( p = 0.001 \). The reliability level for Arkhangelsk station with a sample length of 486 cases was 1.333084, which is significantly lower than the critical values of Student's t-test (\( P = 0.001 \)) = 3.319 for a given sample length, which indicates high-value results [11, 12]. Similar results were obtained for all stations.

3. Results and their discussion

The spatial distribution of the temperature anomalies in December in the central part of the Russian Plain at the 1st phase (new moon), indicates an insignificant negative temperature anomaly throughout the territory, fluctuating from -0.1 °C Ufa to -0.4 °C Kursk.
Figure 1. Spatial distribution of the temperature anomaly in December at the new moon.

The mean values of the temperature anomalies are within -0.2 °C, with insignificant increases in the central part of the territory under consideration and oriented in the meridional direction along the line Kursk (-0.4 °C), Tambov (-0.3 °C), Kirov (-0.3 °C).

The picture of the distribution of temperature anomalies for phase 2 (the first quarter) in December (figure 2) is more variegated, with negative values in the northwest (Pskov -0.3 °C) and positive foci in the southwest (Kursk 0.3 °C, Voronezh 0.3 °C), and also in the north-east (Kirov 0.3 °C, Ufa 0.2 °C).

Figure 2. Temperature anomalies in December at the first quarter of the moon.

The nature of the distribution of temperature at the full moon (3 phase of the Moon), presented in figure 3, has positive values throughout the field reaching values of 0.6 °C Smolensk, Kursk, Saratov. Not significant positive anomalies are observed in Pskov and Ufa + 0.2 °C.
A distinctive feature of the 4-phase (last quarter) in December (figure 4) is the prevailing large negative temperature anomaly values located in the side altitudes from -0.3 °C (Kostroma, N. Novgorod) to -0.5 °C, Saratov, -0.7 °C Ufa. Negative temperature anomalies, during the 4th phase of the Moon, cover almost 3/4 of the territory of the Russian Plain. A positive focus of the temperature anomaly with a value of 0.3 °C is observed in the northwest of the territory in Pskov area.

4. Conclusions
The analysis of the thermal regime of the territory of the Russian Plain carried out in this way made it possible to reveal the main regularities of the spatial distribution of the temperature anomaly during
different phases in the month of December. An opposite dependence of the distribution of the temperature anomaly on the antiphase of the Moon is established. For example, if negative temperature anomalies predominate in the Russian plain during the new moon (phase 1 of the Moon), then at full moon (phase 3) - positive. At the first quarter (the 2nd phase of the Moon) and in the last quarter of the Moon (4 phase), the signs of the temperature anomaly change to the opposite ones at a constant location of the foci of formation.

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