The schedule of the Mul'tanovskii's synoptic periods

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This contribution is a continuation of the paper (Sidorenkov, Zhigailo, 2014).
The lunar-solar tides deform the Earth's shape and change the Earth's moment of inertia. As a result, they have a noticeable effect on the velocity of the Earth's daily rotation. The tidal oscillations of the Earth's rotation rate over any time interval can be calculated theoretically (Sidorenkov, 2002, 2009). By way of illustration, Figure 1 shows the tidal deviations of the Earth's daily angular velocity ν in 2016. The Earth's rotation velocity is characterized by the relative value (Sidorenkov, 2002, 2009)

$$\nu \equiv \frac{\delta\omega}{\Omega} = \frac{\omega - \Omega}{\Omega} \approx -\frac{\Pi_E - T}{T} \equiv -\frac{\delta\Pi}{T},$$

where Π_E is the length of Earth’s day; T is the length of the standard (atomic) day, which is equal to 86400 s; and $\omega = \frac{2\pi}{\Pi_E}$ and $\Omega = \frac{2\pi}{86400}$ rad/s are the angular velocities corresponding to the Earth’s and standard days.

It can be seen that, during a tropical month, ν undergoes two semimonthly oscillations with maxima occurring at the maximum distance of the Moon from the celestial equator in both Northern and Southern hemispheres (i.e., at lunar solstices) and with minima occurring when the Moon intersects the equator (i.e., at lunar equinoxes).

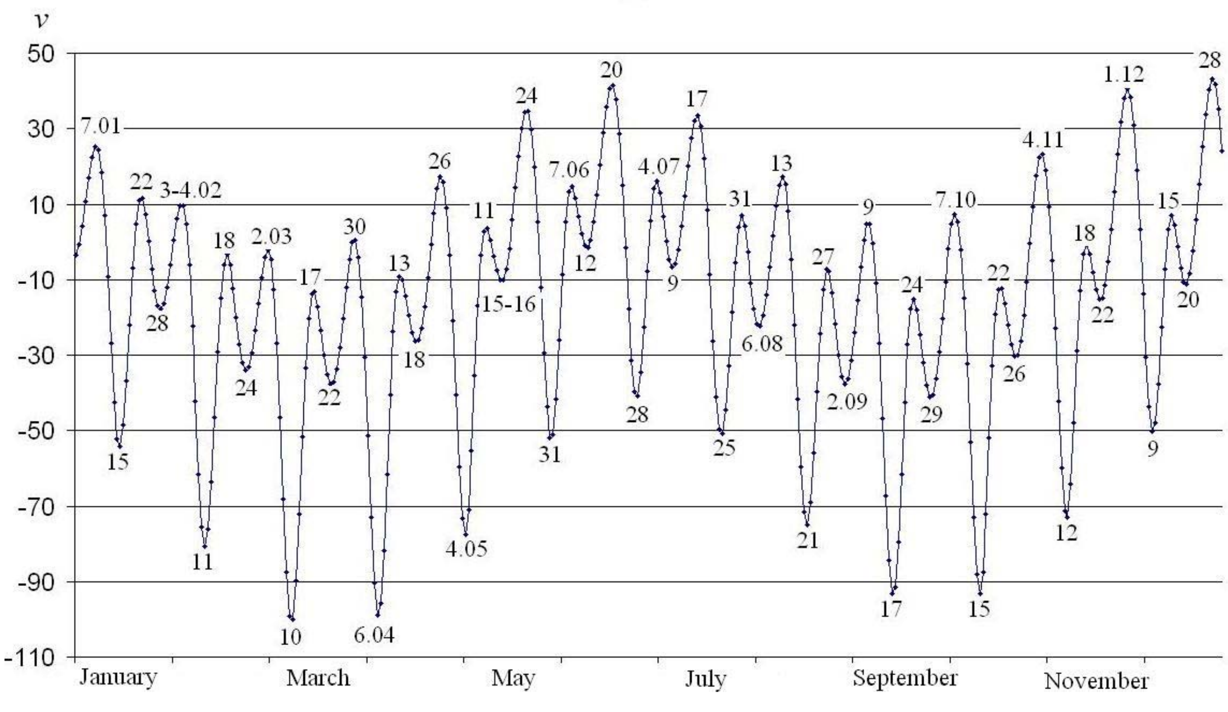

Figure 1. Tidal oscillations of the Earth's rotation velocity ν in 2016. The vertical axis represents the relative deviations of ν multiplied by 10^{10}. Numerals indicate the dates when maxima and minima of ν occurred

The monitoring of tidal oscillations of ν, the evolution of atmospheric synoptic processes, atmospheric circulation patterns, and time variations in hydrometeorological characteristics has shown that most types of atmospheric synoptic processes vary **synchronously** with the tidal oscillations of the Earth's angular velocity (Sidorenkov, 2002, 2009). Using retrospective data, we verified how frequently the extrema (minima or maxima) of ν coincide in time with changes in elementary synoptic processes (ESP) in terms of the G.Ya. Vangengeim classification. A statistical analysis showed that 76% of the extrema of ν coincide in time (up to ±1 day) with ESP changes. In the other 24% of the cases, the extrema of ν are two and more days away from the nearest ESP change (Sidorenkov, 2002, 2009).

The long-time comparative monitoring of tidal oscillations of ν and variations in meteorological characteristics in Moscow, Vladivostok, Toronto, Buenos Aires and other sites clearly suggests that variations in meteorological characteristics agree in time with quasi-weekly extrema of ν **(**http://geoastro.ru **).** Variations in weather elements at other sites of world have been monitored by S.P. Perov and L.V. Zotov. Their results also confirm that variations in meteorological characteristics are synchronized with oscillations of the Earth's angular velocity.

The tidal oscillations in the Earth's rotation velocity represent a perfect index for the features of the Earth's monthly rotation around the barycenter and time variations in the lunisolar tidal forces. They correlate with quasi-weekly and semimonthly variations in atmospheric processes and with local anomalies in the air temperature, pressure, cloudiness, and precipitation amounts depending on those variations.

Changes in weather patterns coincide with extrema of tidal oscillations of ν, which correspond to lunar solstices and lunar equinoxes. By analogy with three-month seasons of the year, which are associated with the Earth's rotation around the Sun, kind of quasi-weekly weather "seasons" can be identified in weather patterns.

Quantized weather patterns were first described by B.P. Mul'tanovskii (1933) 100 years ago. He called them natural synoptic periods (NSPs). The above observations suggest that Mul'tanovskii's NSPs are possibly caused by the monthly rotation of Earth and Moon around their barycenter. Weather is synchronized with the times of lunar equinoxes and solstices. In contrast to solar seasons, the lunar NSPs are not constant: they vary from 4 to 9 days with a mean of 6.8 days. These variations are caused by the frequency modulation of the tidal force oscillations due to the motion of the lunar perigee. Plots of tidal oscillations of ν provide a kind of NSP timetable, demonstrating that variations in NSP lengths are not random. Unfortunately, there still appear works in which the dynamics of NSPs is erroneously treated in terms of Brownian motion.

Note that synchronization does not determine the formation mechanisms of thermobaric structures due to the baroclinic instability of the atmosphere, but rather imposes evolution rhythms close to tidal force oscillations (more precisely, to rhythms in the Earth--Moon--Sun system) on atmospheric processes.

References

B.P. Mul'tanovskii, 1933: Basic Principles of Synoptic Method for Long-Term Weather Forecast. Moscow, TsUEGMS. [in Russian].

N.S. Sidorenkov, 2002: Physics of Instability in the Earth's Rotation. Moscow, Nauka. [in Russian].

N.S. Sidorenkov, 2009: The interaction between Earth's rotation and geophysical processes. Weinheim, WILEY-VCH Verlag GmbH & Co. KGaA.
http://www.geoastro.ru

N.S. Sidorenkov, T.S. Zhigailo, 2014: Atmospheric Effects of the Earth's Monthly Motion. In: WMO/WGNE Research Activities in atmospheric and oceanic modeling, WCRP Report No.11, pp.7-13--7-15.
http://www.wcrp-climate.org/WGNE/BlueBook/2014/individual-articles/07_Sidorenkov_Bluebook.pdf