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OSCILLATIONS AND CYCLES OF AIR TEMPERATURE IN RUSSIA

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Key words: Oscillations of air temperature, cycles of air temperature, Laplace zonal spherical function, tidal potential, Rossby waves.

Abstract. This paper proposes to demonstrate that in Russia there are air temperature oscillations which produce almost perfect cycles. These are the same cycles previously described in Romania, North America, New Zealand and South America. The large latitude and longitude extent of the territory of Russia determines very different thermal oscillations from one region to another. The Arctic Ocean has a special influence in the evolution of air temperature in Russia, but so does the Pacific Ocean, through the cold "Oya Shivo" current. The warm ocean current "Kuro Shivo" has a reduced influence, only through one of its branches which enters the Sea of Japan from the south.

Introduction

Like in other regions on Terra, there are daily cycles of maximum and minimum temperature on the territory of Russia which are explained through cycles of the atmospheric tides, generated by the attraction of the moon and sun. Some air temperature oscillations from Moscow and Krasnodar are similar to the ones in Winnipeg (Canada) and, respectively, Minneapolis (the USA). Similar to other regions on Terra, there are air temperature cycles on the territory of Russia that can be explained through the zonal spherical Laplace function. This represents another argument that allows us to admit that this function can be applied in meteorology on the territory of Russia as well.

In order to describe air temperature oscillations and cycles, meteorological data from Moscow (accentuated temperate continental climate), Tomsk and Surgut (for the climate of Western Siberia), Oimiakon and Verhoiansk (for the climate of

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Eastern Siberia), Vladivostok (for the climate of the Far East, situated under the influence of the warm ocean current "Kuro Shivo") and Krasnodar (for the temperate continental climate) have been used.

On Russian territory, all air temperature cycles previously described exist both those that last under a year and those whose duration is longer than a year.

1. Air temperature cycles lasting less than a year

On Russian territory, the most frequent cycles from this category are the following:

1.1. The 14-day cycle

This cycle of daily maximum and minimum temperature is attributed to the period of 14 days (more exactly 13.66 days), half of the tropical period of the Moon, which is 27.32 days. The tropical period of the Moon represents the cycle of its declination which determinates a tidal cycle with the same duration.

This period of 14 days is described by the zonal spherical Laplace function(y = 3sin2 x-1) and it is applied to the entire surface of the Earth, having the largest atmospheric tidal oscillations at 35° 16' *North and South latitude.*

The graphics from figure 1 presents air temperature cycles (daily maximum and minimum) in points of different climatic characteristics from the Russian territory. From the analysis of these graphics it can be stated that the largest amplitude of thermic oscillations is registered in Siberia and Far East.

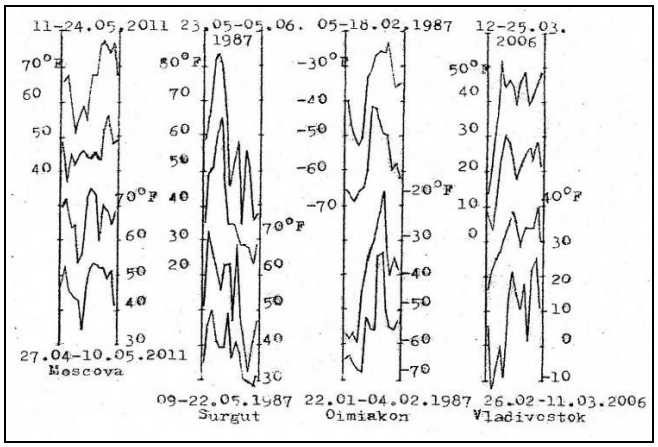

Fig. 1. The 14-day cycles of daily maximum and minimum temperatures in air in Russia.

1.2. The cycle of six calendar months (about 183 days)

This cycle is due to the period of six calendar months (half of the period of the tropic year = 365.24 days) in the evolution of the Sun, the celestial body that causes athmospheric tides with the same duration (fig. 2). This cycle is another application of the zonal spherical Laplace function in meteorology.

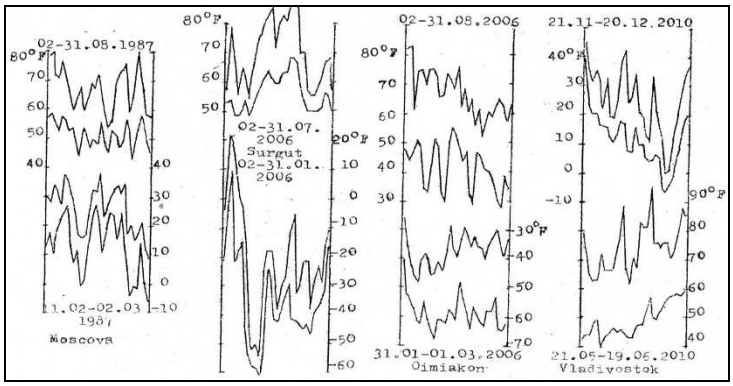

Fig 2. The six-month cycles of daily maximum and minimum temperatures in Russia

The graphics from figure 2 presents the six-month cycle (about 183 days) in the evolution of the daily maximum and minimum temperatures in air in Russia.

From the analysis of the graphics, it can be noted that the highest amplitudes of the air temperature are recorded in Surgut (West Siberia)

1.3. The 246-day cycles (about eight months)

The occurrence of this cycle is due to the fact that, in 246 days (about eight months) there are nine tropics periods of the Moon, according to the following calculation: 246 days: 27.32 days (the tropics period of the Moon) =9.00. It is understood that there is a cycle in the declination of the Moon, which determines a tidal cycle of the atmosphere with the same duration. This, in turn, is reflected in the daily motion of the minimum and maximum temperatures in air.

In figure 3 it is presented, by the graphics, the cycles of daily minimum and maximum temperatures in air lasting 246 days in Russia, in points with different climate conditions.

An analysis of the graphics from figure 3 shows us that the highest thermal amplitudes occur in Eastern Siberia (Verhoiansk), between 0°F and 70°F, from 11.05 to 09.06.2011.

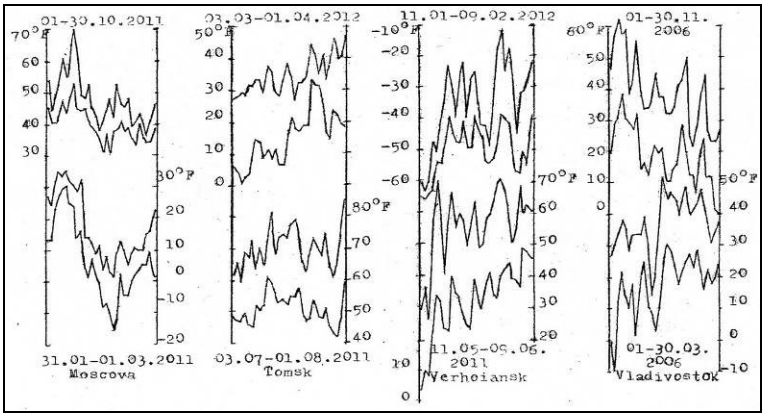

Fig. 3. The 246-day cycles of daily maximum and minimum air temperature in Russia.

In Russia there are other air temperature cycles with less than one year duration (of 28, 55, 82, 110, 137, 164, 192, 220, 274, 301, 328 and 355 days).

2. Air temperature cycles with more than one year duration

These cycles of the daily maximum and minimum air temperatures have a better clarity, because they do not represent only cycles of the tropics of the Moon (27.32 days). At the same time, they are also cycles for the other periods of the Moon (the synodic period = 29.53 days and the anomalistic period = 27.55 days). It is obvious that these lunar cycles are also tidal cycles. From this category, the most important are the cycles that include an entire number of years, such as the ones with a duration of 4, 8, 11, 19, 23 and 27 years.

The better clarity of those cycles is due to the fact that these encompass an tire number of years, which means that the atmospheric tides generated by the Sun have a more precise periodicity.

2.1 The 4-year cycle (approximate 1461 days)

This cycle represents not only a solar cycle, but a cycle for these 3 phases of Moon, according to the following calculation: 1461 days: 27.32 days (the tropical

period of Moon) = 53.5 ; 1461: 27.55 days (the anomalistic period of Moon) = 53,0 and 1461: 29.53 (the synodic period of Moon) = 49.5 . In case of the tropical period of Moon, the atmospheric tides happen identical, irrespective of the declination's mark (+ or -). In case of the synodic period, the atmospheric tides produced from Full Moon to New Moon are identical with those ones produced from New Moon to Full Moon. Thereby, these periods (53.5 and 49.5) represent cycles.

The charts from figure 4 represent cycles of daily maximum and minimal temperatures, in points on the territory of Russia with different climatic conditions, in a 4-year cycle.

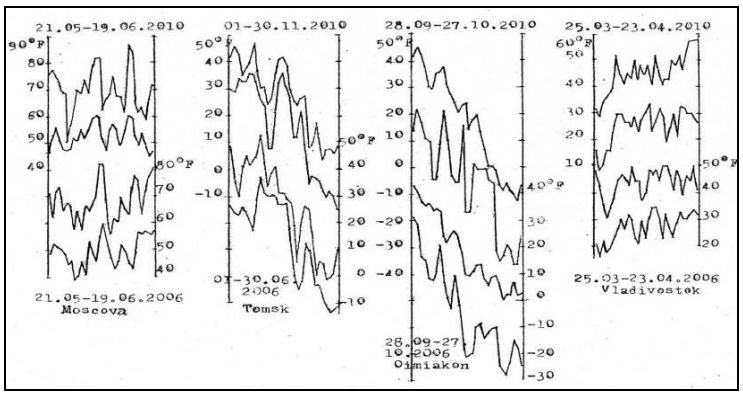

Fig. 4. Cycles of daily minimum and maximum temperatures in the air with the duration of four years, on the territory of Russia.

As in the case of other cycles, the largest thermal amplitude is recorded in Eastern Siberia.(Oimiakon from +40^{o}F to -30^{o}F)

2.2 The 11- year cycle (approximately 4018 days)

As it is known, in the Sun activity there are more cycles, the well-known being the 11-year one. The 11-year cycle is, at the same time, a tidal cycle which, through the Rossby waves (planetary), is reflected in the daily course of daily maximum and minimum temperatures. In 11 years it is produced an entire number of tropical periods of the Moon, according to the following calculation: 4018 days (11 years): 27. 32 days (the tropical period of the Moon) = 147.0, but it takes place an entire number of synodic periods of the Moon, namely 4018:29.53 (the syndical period of the Moon)=136.0.

The graphs from figure 5 represent the daily course of daily minimum and maximum temperatures in an 11-year cycle on the territory of Russia.

It is observable that, from the analysis of the charts in figure 5, the biggest thermal amplitude is recorded in West Siberia (Surgut between +20°F and -60°F).

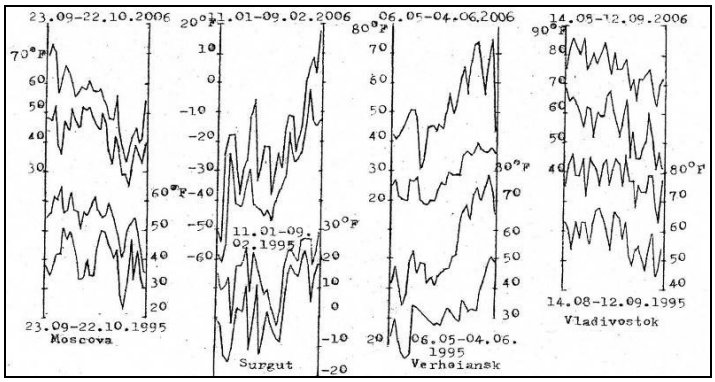

Fig. 5. Cycles with the duration of 11-years in the evolution of daily maximum and minimum temperatures in the air, on the territory of Russia.

2.3. Meton's cycle (19 years, about 6940 days).

The well-known astronomical metonian cycle (19 years) is also found in meteorology, especially in the daily course of maximum and minimum temperatures in the air. In a 19-year cycle it happens 254 tropical lunar periods and 235 synodic periods, according to the next calculation: 6940 days: 27.32 days (the tropical period of the Moon) = 254.0 and 6940: 29.53 days (the synodic period of the Moon) = 235.0 (fig. 6). The astronomical metonian cycle is actually a tidal cycle which reflects through the Rossby waves in the daily course of maximum and minimum temperatures in the air too.

In fig. 6, it is presented, by charts, Meton's cycle in the evolution of daily maximum and minimum temperatures in different points on Russia's territory, in which climatic conditions are different.

The analysis of the charts in fig. 6 points out the fact that the biggest thermal amplitude is recorded in Siberia (Tomsk and Oimiakon), over 60°F. At Vladivostok it is recorded the smallest thermal amplitude, about 30°F, because of the influence of the waters of Japan's Sea, where a branch of the Kuro Shivo stream permanently penetrates and brings warmer waters from the Pacific Ocean.

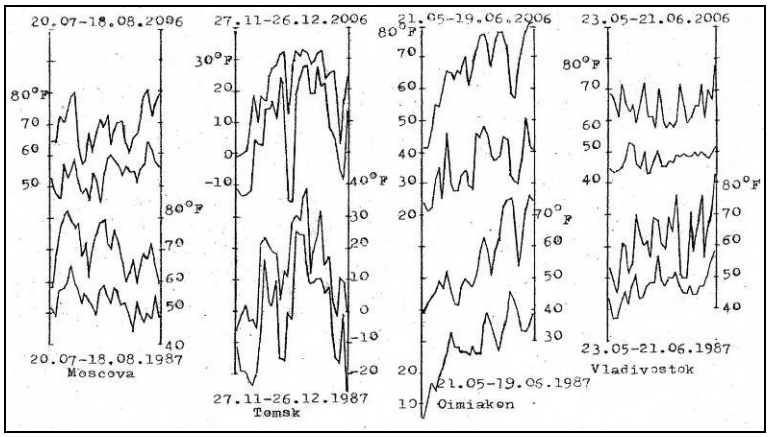

Fig. 6. The Metonic Cycle (approximately 6940 days) in the evolution of the daily maximum and minimum temperatures in the air, on the Russia's territory.

2.4. The 8-year cycle (approximately 2922 days)

As you can see, the 8-year cycle represents the difference between the Metonic Cycle (6940 days) and the 11-year cycle (4018 days). This cycle has the doubled duration of the 4-year cycle. The 8-year cycle is also a lunar phase, because in 2922 days it is completed Moon's 107 tropical periods and 99 synodic periods. The 8-year tidal cycle is both lunar and solar and it is reflected on the daily changes of the maximum and minimum temperatures in the air. The graphics from figure 7 demonstrate its existence on Russia's territory, during different climatic conditions.

After analyzing the graphics from figure 7, you can see that the highest thermal amplitude is found in Western Siberia (in Surgut) with over 70^{o}F (between +30^{o}F and -40^{o}F), during the period 22.11-21.12.1987.

After the completed research it has come to the conclusion that on the Russia's territory it is also registered the other cycles which last a whole number of years. We are talking about the 23-year cycle(approximately 8401 days) and the 27 year cycle(approximately 9861 days).

After analyzing the available meteorological data, on Russia's territory, as well as in other regions on Earth, there is an important category of cycles of the air temperature that last longer than a year and are based on cycles from the progress of the Lunar Perigee. As it is known, while revolving around the Earth, at a certain point, the Moon is nearest to the Earth. The point is called the Perigee. When the Moon is farthest from Earth, the point is called Apogee. The distance between the Moon and the Earth is determined by the lunar parallax, which represents the angle

from which you can see, from the Moon, Earth's equatorial radius horizontal parallax. When the angle (the parallax) is bigger, the distance is smaller and vice versa. With small angles, the distance is bigger.

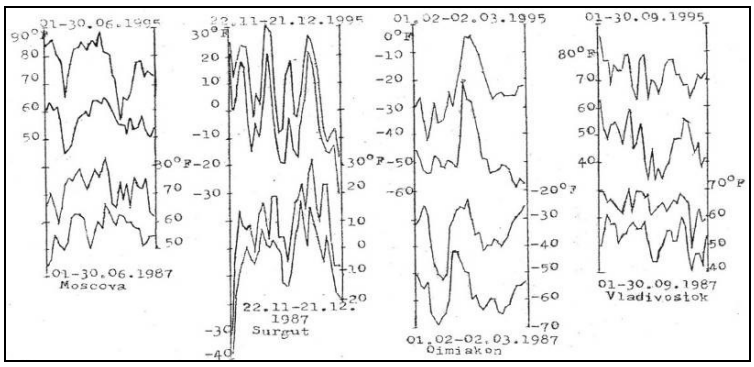

Fig. 7. Cycles of 8 years in the evolution of daily maximum and minimum temperatures in the air, on the territory of Russia

In case of the Climax, the lunar parallax varies very little, between 53'57" and 54'18". Because the Perigee executes a sidereal revolution, with de duration of 3232.6 days, the lunar parallax of this point varies very much, between 59'15" and 61'27". There is a circularity of the Perigee of about 412 days, which means that this period underlies other lunar circles with the duration longer than a year. This category includes more lunar circles, but more important due to their clarity are those with the duration of 18 years and 11 days (The Circle of Saros = 6585 days); 31 years and 2 days (11324 days); 44 years and 7 days (16064 days). All of these lunar circles are also tidal circles, because the tidal potential of the atmosphere depends mostly on the distance variation Earth-Moon. At the Perigee, the atmospheric tides have greater amplitude, in comparison with the situation at the Climax.

2.5 The Cycle of Saros (18 years and 11 days = 6585 days)

This cycle is a selenary one, because in this time period it happens 241 tropical revolutions; 293 anomalistic revolutions and 223 synodic revolutions of the Moon. Also, the Cycle of Saros contains 16 cycles of 412 days, the smallest cycle in the evolution of the Perigee.

On the territory of Russia this cycle has a very good clarity and we find it in all the regions, no matter what the climatic characteristics are.

In fig.8 it is shown, with graphics, the Cycle of Saros on the territory of Russia, in the evolution of the daily maximum and minimum temperatures in the air, in the most important regions.

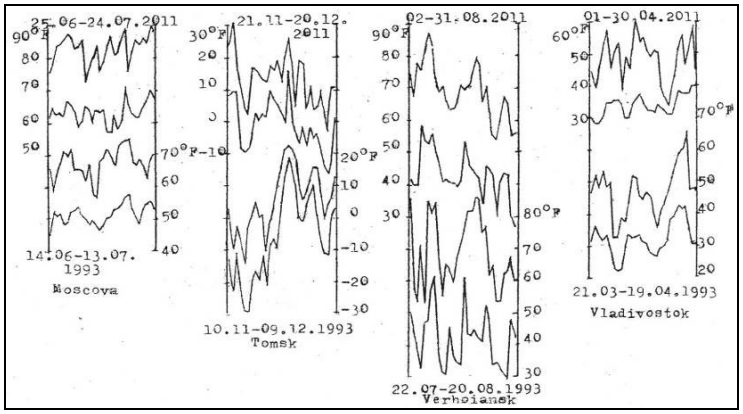

Fig. 8. The Saros cycle in the evolution of daily maximum air temperatures, in Russia

By analyzing the graphics in fig. 8 you can observe the clarity of this cycle in the evolution of the daily maximum and minimum temperatures in the air, especially in East Siberia (Verhoiansk) and in the Extreme Orient (Vladivostok). Also, you can notice that the highest thermal amplitude records at Verhoiansk (East Siberia), over 60 ^{o}F, in the period 02-31.08.2011, between +90 ^{o}F and +30 ^{o}F.

2.6. The cycle of 31 years + 2 days (about 11324 days)

This cycle represents half of the month cycle of 62 years + 4 days (about 22649 days) which includes 55 cycles of lunar Perigee, the period of 412 days. It was chosen cycle on half, because on the NOAA (SUA) weather database there aren't meteorological data for Russia earlier than 1960. In figure 9 it is represented, in graphs, the cycle of 31 years + 2 days (11324 days) in Russia, in different regions.

In the range of 11324 days it is produced 414.5 tropical revolutions; 411.0 anomalistic revolutions and 3835. synodic revolutions of the Moon. Also, it is produced 27.5 cycles of Lunar Perigee, which lasts for 412 days. Instead, double cycle, which lasts 62 years+4 days (about 22649) includes 829 tropic revolutions; 822 anomalistic revolutions; 767 synodic revolutions of the Moon and 55 cycles of Lunar Perigee, which lasts for 412 days. Both selenar cycles are also cycles of

atmospheric tides which through the Rossby waves (planetary waves) are reflected in the evolution of the daily maximum and minimum daily temperatures in the air.

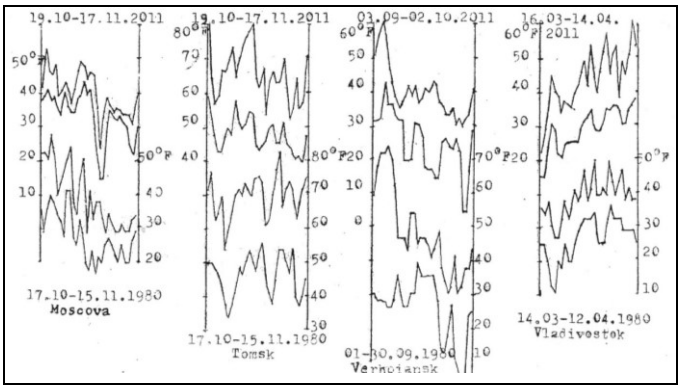

Fig. 9 The cycles of 31 years + 2 days (about 11324 days) of the daily maximum and minimum temperatures in the air in Russia

2.7 The 44 year -7 - day cycle (about 16064 days)

This cycle is a selenar one, because in this period 588 tropical revolutions; 583 anomalistic revolutions; 544 anomalistic revolutions of the Moon take place, as well as other 39 cycles of the Lunar Perigee, with a duration of 412 days. Obviously, this cycle is also a tidal cycle which is reflected in the daily course of daily maximum and minimum temperatures in the air. In figure 10 it is presented, by charts, the 44 year-7 day cycle in the evolution of the daily maximum and minimum temperatures in the air in Russia, in regions that have different climatic characteristics.

By analyzing the graphics in figure 10, it can be concluded that this cycle is the closest to perfection. This aspect is found in all regions of Russia, which were selected for demonstration, but especially in Moscow.

In many situations, the evolution of daily maximum and minimum temperatures in air in the European region of Russia, which has temperate continental climate, resembles to one in the temperate part of North America. In order to demonstrate this resemblance, there were chosen two points in each continent, which have approximately the same latitudes. For the European region of Russia, there were chosen the cities Moscow (about 56 degrees north latitude) and Krasnodar (45 degrees north latitude). From the North American continent,

there were chosen Winnipeg (50 degrees north latitude) and Minneapolis (45 degrees north latitude).

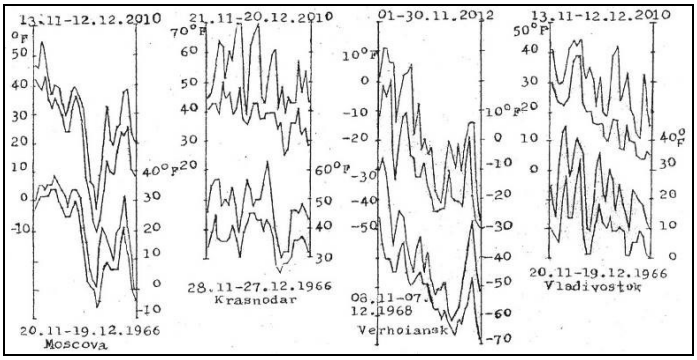

Fig. 10. Cycles of 44 year-7 day (16064 days) in the evolution of daily maximum and minimum temperatures in air, on Russia's territory.

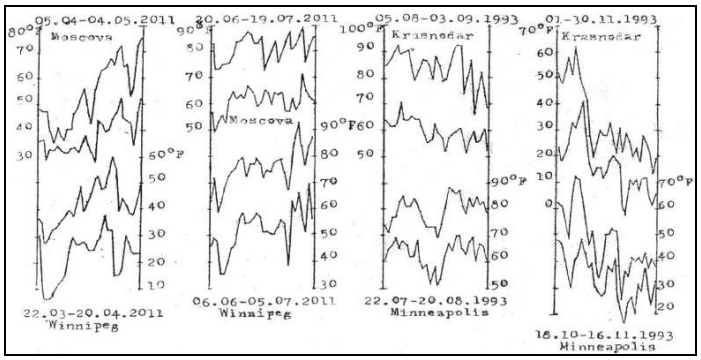

Fig. 11. Resemblances in the evolution of the daily maximum and minimum temperatures in air between Moscow and Winnipeg and between Krasnodar and Minneapolis, with a difference in time of 14 days.

In figure 11 it is presented, in form of graphics, the evolution of daily maximum and minimum temperatures in air in Moscow and Krasnodar, compared to one in Winnipeg and Minneapolis. From analyzing the graphics from fig.11, it is observed that the clearest resemblance (close to identical) is between Minneapolis (18.10-16.11.1993) and Krasnodar (01-30.11.1993), both points having 45 degrees north latitude.

The difference in time over 14 days between the points located in North America and those from the European side of Russia is explained by the time needed by the Rossby wave (planetary) to cover this distance. When the planetary waves have their wave length lower than 5400 km, their circulation is made from west to east, as it is also the general circulation of the atmosphere in the temperate zone of the Nordic hemisphere. When the Rossby waves have a length bigger than 5400 km, their circulation is made from east to west.

Conclusions

The analysis of the cycles and oscillations of the temperature of the air from the main regions of Russia allow us to draw the following conclusions:

- All the thermic cycles described in Romania, New Zeeland, The SUA and South America are also found on Russia's territory;
- On Russia's territory there are also cycles of tha air temperature based the 412 day cycle in the evolution of the selenic Periger;
- A great influence of the oscillations of the air temperature on Russia's territory has the Arctic and the Pacific Ocean;
- The biggest amplitudes of the thermic oscillations are formed in Siberia;
- Some resemblances in the evolution of daily maximum and minimum temperature in air between Moscow and Winnipeg (Canada) as between Krasnodar and Minneapolis (The SUA) can be explained through the circulation of the Rossby waves (planetary);
- Knowing these thermic cycles, there can be elaborated meteorological prognosis for a long time (10 days), for different regions of Russia.

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