# Modern Changes of the Climatic Conditions and Rhythmicity of the Long-Term Oscillations of the Mode Parameters of Water Bodies as the Integral Index of the Climate Fluctuation(based on the Urals example)

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**Abstract**
The mechanism of how global factors of terrestrial and extraterrestrial origins influence the natural objects is very complicated and has not been fully studied yet. The majority of scientists think that the lunar and solar tidal forces produce an effect on the water surface of the sea, making the ocean currents pulse under certain rhythms. Their pulsation causes changes in the global moisture and heat transfer on the Earth. As a result, there appear complex rhythmic oscillations of the planets climate and inland waters. This article represents an analysis of the reasons for the modern climate fluctuations, including those at the local level (the Urals region).
**Keywords** Rhythmicity of the long-term river flow oscillations; Dependence on cosmo and geophysical factors; Prevailing atmospheric circulation type C (longitudinal); Rossby waves

## 1 Introduction

Determining the rhythms of natural phenomena and their reasons represents one of quite important tasks of the modern science. Rhythmicity is the major parameter of the long-term oscillations of the natural processes in time and space. The major rhythms that determine the development character of the natural phenomena are the cosmic cycles. The cosmic rhythms of various durations and different origins permeate through and regulate every development process of the Earth. The authors have found out that the reasons for the modern climate fluctuations in the Urals, along with the major rhythms, are the longitudinal atmospheric circulation type C, which prevails in the Zauralie area, and the Rossby waves. To determine the major rhythms, the authors used Fourier analysis and the difference integral curve method. To reveal the connection between the long-term oscillations of the hydrological characteristics and the cosmo- and

geophysical factors which represent a reflection of the climate fluctuations, cluster analysis was used. The accuracy of the research results was estimated using the mathematical statistics methods.

## 2 Material & Methods

There are two essentially different rhythm categories in nature: the limited set of the cosmic rhythms and the unlimited number of the derivative interaction rhythms or environment rhythms. Unlike the interaction rhythms which appear in particular environments and in limited territories, the cosmic rhythms reveal themselves, with amazing stability, in every geocomponent and geosphere. According to their duration, rhythms are divided into centuries-old and interdecadal ones. Among the centuries-old rhythms, those with durations of 120, 300, 600, and 1,200 to 2,000 years are the most often found in nature. But it is not only natural phenomena that obey the rhythmicity laws. L.N. Gumilev [1] noticed that even ethno-social processes taking place on Earth are also subject to rhythms, and E.V. Maximov [2] found that the passionary shocks described by Gumilev [1] , which lead to disappearance of some nations and birth of some others, are connected with the cosmic rhythms, and in particular with one of the most important cosmic rhythms with the duration of about 1,800 years. On the shores of the picturesque Lake Zurich there are two ancient terraces: high cliffs where, in the rock strata, once can clearly distinguish the strata of different eras. In these stratified rocks, scientists found some very clear evidence of the 1,800-year rhythm. The same rhythm was also determined in the sequence of the oozy deposits, the glacier movements, humidification oscillations, and after all in the climate fluctuations.

Of course, we cannot observe any rhythms of such durations in that short life we live. However, there are a whole series of space-generated interdecadal rhythms the effects of which can be felt during our lifetime: 80 to 90, 28 to 35, 21 to 22, 15, 11 to 13, 5 to 8, and 2 to 4 years. These are the interdecadal rhythms.

The interconnection between the terrestrial and cosmic phenomena becomes the most evidential if based on the example of the rhythms occurring in the physical and geographical processes recorded by means of instrumental observations which are introduced in Table 1.

Today, the overwhelming majority of researchers have no doubt that rhythmicity is an integral natural law of the Earths geosphere, and that its rhythmical fluctuations are caused by the cosmic rhythms. The cosmic rhythms give rise to rhythms in the geosphere, similar to themselves, while derivative rhythms produced by their interference cause accidental fluctuations.

Rhythmical oscillations have been found in the solar activity, the Earths magnetic field, atmospheric precipitations, air and water temperature, tides, and

many other natural phenomena. They are conditioned by three groups of factors: astronomical, geophysical and circulating.

**Table** 1 Average annual indices reflecting the connection between the long-term oscillations of the annual river flow and the cosmo- and geophysical factors

| Dendro-gram number | Index | Factors represented by the index | Symbol | Unit of measure |
|---|---|---|---|---|
| 175 | Relative numbers of sunspots (Wolf numbers) | Solar activity | W | N/A |
| 195 | Troposphere-effective indices of solar activity (according to Loginov) | | T | |
| 186,187 | 19-year constituent of the lunar and solar tide-generating force potential at 56° and 60° North | Polar tide | $F_{19}$ | $cm^2/sec^2$ |
| 188 | Average annual values of the day length fluctuations | Earth axis nutation | $\triangle$T | of 0.00005 sec |
| 176,177 | Longitudinal and latitudinal coordinates of the Icelandic Low | Activity of pressure formations | $\varphi$,$\lambda$ | degree |
| 178 | SOI (Southern Oscillation Index) | Intensity of ocean currents | $I_{SOI}$ | mb |
| 179 | NAO (North Atlantic Oscillation Index) | | $I_{NAO}$ | mb |
| 185 | Longitudinal circulation indices in the northern Atlantic (January) | | $R_N$ | mb |
| 189,190 | Water temperature anomalies in the northern Atlantic in Smed Squares D and E | | $\triangle$t° | degree |
| 180,181 | Annual number of days with cyclones in the $4^{th}$ and $8^{th}$ Vitels zones | Global atmospheric circulation | $Z_4$, $Z_8$ | days |
| 192 | Recurrence of the western type a.c. | | W | |
| 193 | Recurrence of the eastern type a.c. | | E | |
| 194 | Recurrence of the longitudinal type a.c. | | C | |
| 184 | Annual anomalies of the surface air temperature in the Arctic | Underlying surface humidification Long-term river flow oscillations in the Urals | T | degree |
| 182,183 | Aridity index DM (ETP,ATP) | | DM | N/A |
| 197-199,301-317 | Humidification coefficient | | $C_{humid}$ | N/A |
| | | | Q | $m^3$/sec |

The oscillations of the hydrological parameters of water bodies (river flows and levels) are taken as the integral index of the climate fluctuations. The mechanism of how global factors of terrestrial and extraterrestrial origins influence the natural objects is very complicated and has not been fully studied yet. The majority of scientists think that the lunar and solar tidal forces produce an effect on the water surface of the sea, making the ocean currents pulse under certain rhythms. Their pulsation causes changes in the global moisture and heat transfer on the Earth. As a result, there appear complex rhythmic oscillations of the planets climate and inland waters.

The fluctuations of the solar activity, in its turn, is connected with the gravitational effect of the planets in the Solar System and with the effect produced on it by other space bodies: comets, asteroids and meteorites coming to us from outer space and breaking the abovementioned rhythms. In particular, the average rhythm of meteoric impacts on the Earth is about 80 years[3].

As for the nature of various cycles, scientific literature still introduces quite contradictory hypotheses. The coincidence in the durations of the cycles of specific phenomena is normally considered to be the major argument for the existence of some connections between the external factors and the oscillations of the hydrometeorological elements. But this kind of approach is one-sided and insufficient to make statements on the existence of those connections and to reveal their nature.

## 3 Results

So we spread our research both in the time and space aspects. As it was said above, we used the Fourier analysis and difference integral curves to determine the rhythms, and cluster analysis was used to reveal the connection between the natural phenomena and cosmic rhythms. The research resulted in the map (Fig. 1) that the author made using the cartographic method.

According to the studies that have been performed [4] the full 80-year solar rhythm can be observed in the series with execution lengths of over 100 years, such the Wolf numbers, the NAO (North Atlantic Oscillations) indices, the SOI (El Niño - Southern Oscillation Indices), and others. It means that all the rhythms are the reflection of the solar rhythms and have the cosmic origin. But unfortunately, their accuracy is so low that determining such a rhythm requires series of 250 years (3 x 80) and more.

The map (Fig. 1) shows that the rhythm of 80-90 years (the full solar rhythm), the rhythm of 28-35 years (the Brückner cycles), as well as others, are actually cosmic rhythms which should be considered as inherent features, not only of the entire planet but also of the Urals in particular.

The duration of every rhythm gets longer southwards; the rhythms of 28-35

and 80-90 years are no exception. In the North, the duration of the Brckner cycle in the flow of the rivers in the mountain taiga areas is 28 years (7%-14% of the total dispersion of the characteristic), while in the South it increases up to 34-35 years.

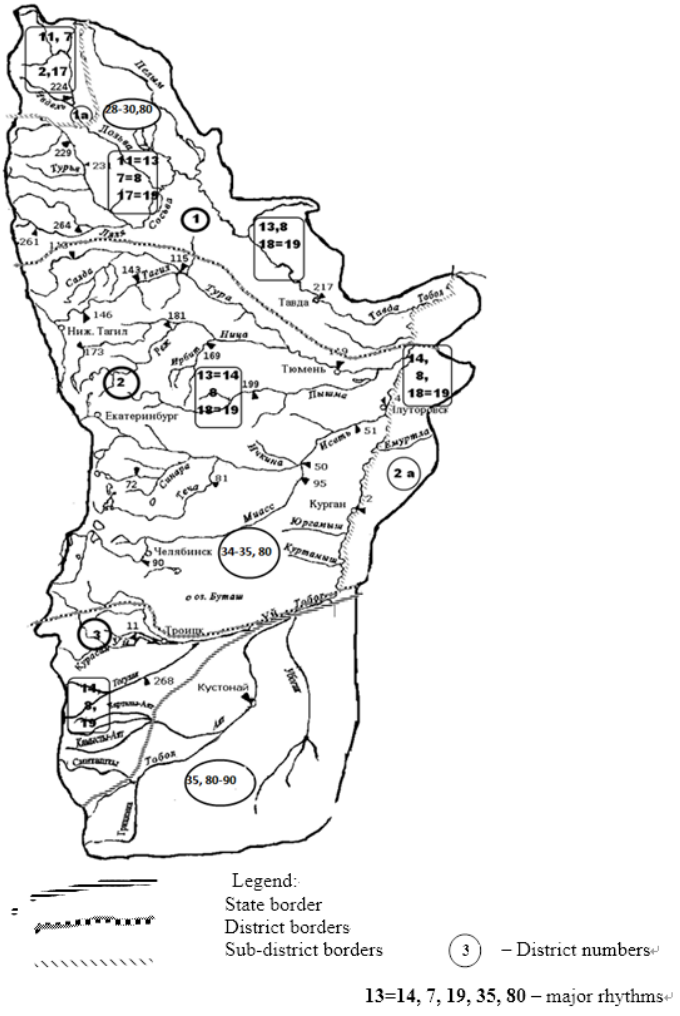


**Fig.** 1 Schematic map of the major rhythms in the long-term oscillations of the river flow in the basin of the Tobol River.

As for the 80-to-90-year rhythm, it increases up 90 (3 x 30) years southwards. The difference integral curves also prove the presence of the abovementioned rhythms in the flow of the rivers in the Urals. The difference integral curves, an example of which is represented on Fig. 2 below, show that there are rhythm

elements with durations of about 35 and 80 years. As it was said above, those rhythms are of global character and are typical of the entire geosphere.

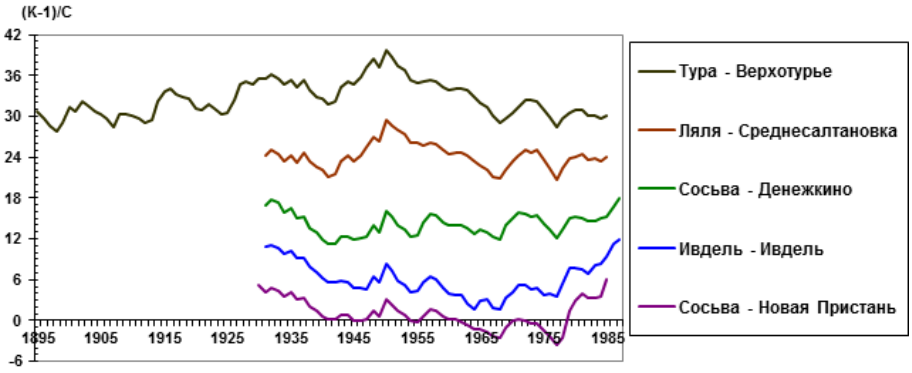


**Fig.** 2 Difference integral curves of the long-term oscillations of the river flow in the basin of the Tobol River.

Rhythms of 30 to 35 years have been found in the geological deposits, in the growth of the annual rings, which is related to the humidification dynamics, and in the spectrum of the air haziness caused by volcanic eruptions. In the hydrosphere, the 30-year periods have been found in the oscillations of the water level of the Caspian Sea.

At the same time, we have to mention that the long-term river flow osciallations are inert to the cosmo- and geophysical factors. The delays of the long-term flow oscillations are caused by the peaks of the solar activity and the large-scale processes taking place in the atmosphere and hydrosphere.

As for the modern climate fluctuations, the authors have determined three reasons for the climate fluctuations occurring in the Southern Urals this years:

(1)the prevailing longitudinal atmospheric circulation type in the Zauralie area is C;

(2)the 35-year rhythmic oscillations (the Brückner cycles) that depend on the cosmic rhythms;

(3)Rossby waves.

## 4 Discussion

1. The longitudinal air mass transport in the Zauralie area is the one that prevails, for the Ural mountains are located longitudinally and the West Siberian Plain is open to the invention of the Arctic air masses, and it takes them about 6 hours to reach the Southern Urals. If the process is directed southwards, it causes sharp temperature falls, and if it goes northwards, then in wintertime it gives rise

to warm air masses with large amount of precipitations. In the flat land it leads to thaws and snowdrifts and to heavy snowfalls, avalanches and mudflows in the mountains.

Lately, the frequency of the longitudinal processes has been growing, which leads to weather anomalies: extremely high and low air temperatures, heavy rains and snowfalls, and longer droughty periods. As for the territory of the region, in summertime low air pressure prevails there. Arctic air masses come there from the Barents Sea and Kara Sea, while tropical air masses travel from the south, from Kazakhstan and Central Asia. When continental tropical air comes, hot and dry weather sets in. Western winds from the Atlantic Ocean bring humid and changeable weather. Representative for this region is the period comprising several a.c. epochs.

To explore the effect produced by the cosmo- geophysical factors on the climate fluctuations in the region, we used the values of the water discharge and river level variations. A period when the longitudinal circulation prevails (C epoch) was chosen as the period of the study. The research was carried out using the cluster analysis. The analysis results were represented in the form of a dendrogram (Fig. 3). The optimal connectivity level was taken as 0.3 (according to the connectivity criterion [4]), where 8 clusters are determined.

The first cluster at the level of 0.3 is formed by the rivers of the forest and forest-steppe zones of the territory that was explored, with the probability of the connection between the objects (rivers) of 85% to 99%.

The second cluster consists of two sub-clusters combined at the level of 0.3. The first sub-cluster is represented by a group of rivers of the Urals forest-steppe and mountain taiga zones situated at approximately the same latitude. They become combined at the level of 0.7, with the connection probability of 94% to 97%. The second sub-cluster is represented by the rivers of the Zauralie and Preduralie areas (forest and forest-steppe zones; R=0.8, P=99,9%), which proves the synchronism of the long-term oscillations of the river flows in the basins of the rivers Kama and Tobol during the C epoch. At the level of 0.6, this sub-cluster is joined by the index of the water temperature anomalies in the North Atlantic (Smed Square D, the southwestern part of the North Atlantic), which proves the interrelation of the processes occurring in the hydrosphere and atmosphere. And with the probability of the connection between the objects of 88% to 93%, we can suppose that there are also some other factors producing their effects on the long-term river flow oscillations.

The next cluster also consists of two sub-clusters. The first sub-cluster comprises three factors: tide-generating force index (at $\varphi$=60°). Wolf numbers and the index of the numbers of cyclones in the Zauralie area (Z8) (R=0.7, P=94% - 95%). Their combination proves the close interconnection between the cosmic

factors and the processes occurring in the atmosphere and hydrosphere. In the second sub-cluster, we observe a correlation between the tide-generating force index (at $\varphi$=56°) and the air aridity index at (R=0.7, P=99%), which proves that the abovementioned conclusion is right. The sub-clusters get combined at the level of 0.3. The connection probabilities between the objects in the sub-clusters exceed 95%, except for the connection between the indices Z8 and DM (P=83%) and between Z8 and F19 (at $\varphi$=56°) (P=85%).

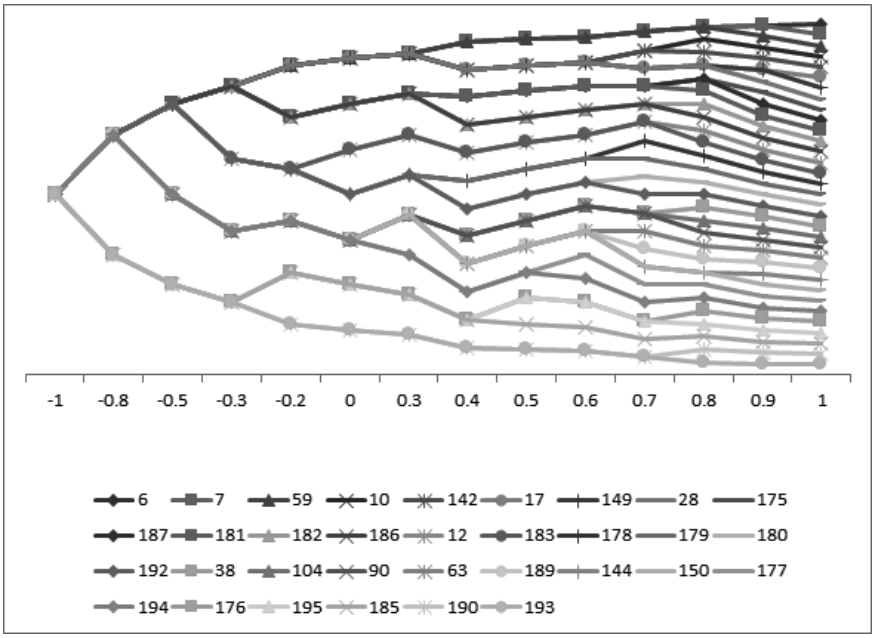


**Fig.** 3 Dendrogram of the connection between the river flow and the cosmo- and geophysical factors during the C epoch

The C epoch also reveals a considerable connection between the intensity indices of the ocean currents, the SOI and NAO indices (R=0.6, P=97%). At the level of 0.6, we see the indices of the number of cyclones ($Z_4$) at ETP (the Preduralie area) combine with those of the process recurrence of the W form (P=85%). At the level of 0.3, they get reunited with the SOI and NAO indices. The connection probability between the SOI and NAO indices and the recurrence index of the western form of the atmospheric circulation is quite considerable (94% - 95%), which proves the fact of their close interconnection. But the accuracy of the connection between the SOI and NAO indices and $Z_4$ is not high (P<80%).

The recurrence value of the eastern form processes of the atmospheric circulation (E) correlates with the index of the water temperature anomalies in the northeastern part of the North Atlantic, which proves yet again that the there is

a connection between the processes in the atmosphere and hydrosphere.

In the C epoch, the recurrence of the processes of this form depends on the position of the longitudinal center of the Icelandic low ($\lambda_{Icl.low}$), which is proved by the combination of those indices at the level of 0.5 with the connection probability of 94%. The latitudinal coordinate of the Icelandic low ($\varphi_{Icl.low}$) correlates with the longitudinal circulation index in the North Atlantic and the troposphere-effective index of the solar activity (the connection probabilities of 93% and 97% relatively).

This allows representing the interrelation chain as follows:

**SOLAR ACTIVITY →...→ SEA LEVEL OSCILLATIONS →...→ LARGE-SCLE ATMOSPHERIC PROCESSES →...→ ANNUAL RIVER FLOW**

Moreover, in the dendrograms of the other periods under study, we found stable and reliable connections within the cosmo- and geophysical factors themselves and also between them and the long-term oscillations of the annual river flow:

(1)the index of the number of cyclones in the Zauralie area (Z8) correlates with the solar activity (W);

(2)the latitudinal value of the center of the Icelandic low ($\varphi_{Icl.low}$) correlates with the NAO index and the recurrence of the W form processes;

(3)the recurrence of the C form processes correlates with the long-term changeability of the annual river flow of all the natural zones, except for the rivers situated in the area of the Stovas critical parallels (59° - 62°), where the major influence is produced by the W form.

Hence, according to the results of the studies, the chain of the interrelations between the cosmo- and geophysical factors and the long-term river flow oscillations, represented in the most detailed way, looks as follows:

**SOLAR ACTIVITY → LARGE-SCALE ATMOSPHERIC PROCESSES → OCEAN CURRENTS → NUMBER OF CYCLONES (Z) AND ANTICYCLONES (AZ) → AIR HUMIDIFICATION** (aridity indices) → **ANNUAL RIVER FLOW.**

2. Along with the average climate conditions and the abovementioned climatic cycles, the peculiar thing about the climatic regime is its variations. The modern period is characterized by a global temperature trend. It is subject to interannual and decadal (with characteristic rhythmicity of about a decade) variations. If we consider the period of instrumental observations only, we can state that finding the planetary average appears more reasonable. But if we excluded, from our consideration, the 19th century instrumental observations as the least reliable, the modern 100-year trend would totally disappear. Instead, we could only speak of the temperature growth that started in the 1980s and in the first decade of the third millennium and consider it an example of the positive temperature

anomaly of the 1940s warming type. At the same time, it would be reasonable to distinguish changeability from changes. Changeability is understood as variations around some average condition, but changes is what characterizes a trend, a transition to a brand new state, with the changes occurring both to the average regime itself and the changeability condition. This differentiation is methodologically convenient, but the physical value of this approach is doubtful, for a lot of things depend on the time scale taken into consideration: the same phenomenon may act both as changeability and changes if viewed from different time scales.

As appears on Fig. 1, the major rhythms in the Zauralie area are those of about 13.8, 19 and 35 years. In 2014, we could observe the 35-year Brckner cycle (it may vary from 28 to 35 years; it is closer to 35 years in the Zauralie area). The authors have determined this rhythm as one of the major ones. A similar abnormally cold summer was observed in the Southern Urals in 1980. According to the scientists forecast, the next anomalous summer is expected in 2050, and climatologists even promise us a minor ice age then.

Hence, the rhythms of nature represent a result of the joint effect produced on it by the space and geophysical factors.

3. Not so long ago, scientists found a correlation between the anomalous weather phenomena[5]: the hardest frosts[6] in the past 20 years in the USA (50 below zero C°) and the thaws at the beginning of the year in Russia. The reason for the climate changeability on the opposite sides of the Earth is the Rossby waves. They may occur in different seasons (K. Nyullis, Press Secretary of the World Meteorological Organization).

Last summer, during a two-month period, there was a blocking anticyclone "hanging" over Russia. Such blocking anticyclones are typical representatives of a natural phenomenon called Rossby solitons (spatial solitary waves).

Rossby waves are air waves which are generated in the atmosphere at moderate altitudes and are moving from the east towards the west. They participate in the formation of cyclones and anticyclones. The atmospheric Rossby waves appear in the atmospheres of planets as a result of the shift in the vortices due to the effect of the Coriolis forces during latitudinal variations of the area. Such waves were first determined in the Earths atmosphere in 1939 by Carl-Gustaf Arvid Rossby.

Such formations are not unique; they are found at different levels of the organization of matter, and in particular, the Rossby soliton is exactly what determines the spiral structure of the galaxies. The most striking and best-known Rossby soliton example is Jupiters Great Red Spot which has been observed for more than 300 years [7].

In theory, these waves had been known since the late $19^th$ century. Back in 1893, the Academy of Sciences of Vienna published an article by Max Margules, where the author stated that in a rotating liquid or gaseous environment there

appear drift waves caused by the global rotation of the environment where they are developing. A little later, in the works by the German geophysicist and oceanologist Bernhard Haurwitz, those waves were considered as an additional element of the Earths ocean. But it was in 1939 when the Swedish geophysicist Carl-Gustaf Rossby became the first to draw special attention to the extremely important role played by those waves in the global atmospheric circulation. Since then those drift waves, as well as the global vortices they cause, have been named after him.

The oceanic Rossby waves cause fluctuations of the height of the sea surface. It had been difficult to determine the wave lengths before satellite altimetry was invented. The observations made with the NASA/SNES TOPEX/Poseidon satellite proved the existence of the oceanic Rossby waves. The satellite observations showed the majestic progress of Rossby waves in every ocean basin, at low and middle latitudes in particular. The waves may live for months or even years, so that they cross the Pacific Ocean. Rossby waves have also been considered as an important mechanism to monitor the warming of Europas ocean. Most probably, Rossby waves also participate in the generation of magnetic fields in nature and are capable of causing local fluctuations of the condition of the lower troposphere.

## 5 Conclusions

According to our studies, the following phenomena accumulated in the Zauralie area in summer 2014: a) recurrence of the Brückner cycle with the duration of 34 years (1980 - 2014); b) intensification of the longitudinal shift that prevails in the Zauralie area and is caused by El Niño (Rossby waves are the “conductor” of El Niño); c) the shift being blocked in the Zauralie area by a Rossby wave; d) “hanging” of the weather conditions caused by El Niño [8].

Thus, the rhythms observed in nature are the results of the effect produced on it by the cosmo- geophysical factors. In particular, “interference” in this interaction between the geophysical factors (Rossby wave) and celestial bodies in the Solar System and outside it is able to “disturb” that interaction and lead both to local (Zauralie) and global climate fluctuation, which has been observed more than once in the history of our planet.

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