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QUANTUM FITOPATOLOGIA: QUANTA BEHAVIOR OF METEOROLOGICAL PARAMETERS ON A THREE HOUR MEASUREMENTS IN THE VEGETATION PERIOD BIRCH

P.M. Mazurkin*, **A.I. Kudryashova**

Volga State University of Technology, Yoshkar-Ola, Russia

Abstract. Factor analysis of three-hour dynamics for the vegetation period of birch leaves from 01.05.2014 to 30.09.2014 of four meteorological parameters: atmospheric pressure; air temperature; relative humidity; dew point temperature was carried out by the method of identification of stable regularities (weather station Yoshkar-Ola, Russia, 2917WMO_ID=27485). Power sample consisted of 1222 of the row. The correlation coefficient 0.4677 is less than 0.5065 for the year between winter solstices, but slightly more than 0.4583 for the seven-year data set. It has been proved that the ontogenesis of birch leaves is most influenced by the relative humidity, the dew point temperature on the second and the air temperature on the third place. By the influence of air pressure the adequacy of the model by the correlation coefficient 0.7241, which is more than 0.6776 for one year. The first term shows the decrease in air pressure from the blooming of birch buds before leaf fall. But the second term shows the stress excitation of air pressure. As a result, the change in pressure in the dynamics of three-hour changes during the growing season are recession and excitation. And two wavelets with constant periods counteract the growth of air pressure the Third member has a cycle of oscillation of 56.3 days, and the second wavelet had a period of 15.4 days. For the influence of air temperature is characterized by two forces directed opposite. The first term according to the law of exponential growth shows an increase in positive temperatures due to increased solar radiation. And the second term of the trend according to the exponential law shows the influence of space on the temperature decrease.As a result of the action of the two forces, the maximum air temperature is observed near the summer equinox. Both wavelets on the sign are aimed at increasing the temperature of the air, which indicates global warming. With a minimum constant period of 0.5 days, a second oscillation with an adequacy of 0.6497 is observed. To this constant dynamics adapted leaves of plants. The influence of relative humidity is characterized by the fact that the first member is the law of death. The second term is the biotechnical law showing the limit of increase. The third term (the first wavelet) characterizes the daily fluctuation with a constant period of 0.5 days (correlation coefficient 0.6638). All four members of the model are aimed at increasing humidity.In comparison with the air temperature, the relative humidity has a more pronounced amplitude with the daily cycle of oscillatory perturbation (correlation coefficient 0.6638 in comparison with 0.6397). In this case, the daily fluctuation for relative humidity is the first oscillation, and for air temperature – the second. To affect the dew point temperature of the first member is the law of death, and the second – biotech law.This gives a maximum of about the summer equinox. Both wavelets are aimed at reducing the dew point temperature. The first oscillation in the form of a tremor can have a starting effect on the start of leaf vegetation with a constant period of 13 days.

Keywords: Weather station, weather, factors, three-hour measurements, vegetation, dynamics, wavelets, binaries, quanta of behavior, regularities.

Corresponding author: Pyotr Matveyevic Mazurkin, Volga State University of Technology, Ploshchad' Lenina, 3, Yoshkar-Ola, Russia, e-mail: *kaf_po@mail.ru*

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1 Introduction

Plant growth is a complex process, it is based on such fundamental phenomena as rhythm, polarity, differentiation, irritability, correlation. These processes are common for the ontogenesis of living organisms.

Ontogenesis individual development of the body from zygote (or vegetative conception) to natural death. Thanks to the active activity of meristems and photosynthetic activity of leaves, the green plant acquires a number of features that characterize its growth. In the process of plant ontogenesis growth is observed during the main stages of its life cycle (Fu et al., 2015; Laube et al., 2014; Polgar & Primack, 2011; Rousi & Pusenius, 2005; Zhang et al., 2014).

The stages of ontogenesis are morphological and functional branching of ontogenesis. They are manifested in changes in the nature of growth, differentiation and functional activity of the body. There are five stages: embryonic, juvenile, maturity, reproduction and old age. These are not isolated periods of development, and mutually passing one into another phase, which are based on slow-moving age-related changes, changes in the body and its individual parts, due to age. Age-related changes in cells, tissues and organs depend on their inherent growth, the General age of the body, as well as on the nature of relationships with other parts of the plant.

The formation and death of leaves in the cycle of ontogenesis are divided into such stages: Bud break, growth and development of leaves, flowering of dying leaves, leaf fall.

Vegetation – a state of plants in which there are processes of visible growth of vegetative and generative organs, and carried out continuous assimilation activity of the leaves. In deciduous species of woody plants, the phenological indicator of the beginning of vegetation is the blooming of vegetative buds, and the indicator of the end is the fall of leaves.

For the first time we considered the dynamics of ontogenesis without division into five stages, that is, integrally during the growing season of birch leaves (Mazurkin & Kudryashova, 2018a; Mazurkin & Kudryashova, 2015b; Mazurkin & Kudryashova, 2018b; Mazurkin & Kudryashova, 2018c). In this case, the groups of leaves are measured without taking them from the tree. For this purpose, several methods were developed in which five patents for inventions of the Russian Federation were obtained.

We have adopted the hypothesis of the continuity of the dynamics of the parameters of leaves throughout the growing season. It is fully proved by the identification of biotechnical polynomial regularities by the method of identification (Mazurkin, 2018a; Mazurkin, 2014; Mazurkin, 2018b; Mazurkin, 2018a; Mazurkin, 2015; Mazurkin & Kudryashova, 2015a). Thus, the beginning of the development of science ***statistical phenology***. It is proved that the maximum length, width, perimeter and area of the leaves is quite possible factor analysis, in which the fifth parameter is the growing season from the moment of Bud break in all the leaves of the tree until the fall of each accounting sheet of Linden or birch. At the same time, the ecological conditions of growth strongly affect even the nature of the biotechnical patterns of ontogenesis dynamics. Later it was found that the main environmental conditions are weather (meteorological) parameters. Then time becomes a system-forming factor that combines the dynamics of the birch leaves parameters common in the Northern hemisphere, in ontogenesis with the weather parameters measured every three hours at the weather station.

This article describes the dynamics within the growing season 01.05 – 30.09.2014 year and was carried out a factor analysis between meteorological parameters. The main factors of meteorology are: P_0 – atmospheric pressure at the level of weather station (mm Hg); T – air temperature (degree Celsius) at a height of 2 meters above the earth's surface; U – relative humidity (%) at a height of 2 meters above the earth's surface at the weather station. For connection with the growing season of birch near this meteorological station, we also take into account the fourth meteorological parameter T_d – the dew point temperature (degree Celsius) at an altitude of 2 meters above the earth's surface.

Perennial plants are affected by weather through annual ontogenesis of foliage. Quanta of leaf behavior, for example, birch (Mazurkin & Kudryashova, 2018a; Mazurkin & Kudryashova, 2015a; Mazurkin & Kudryashova, 2015b), common in the Northern hemisphere, clearly depend on quanta (asymmetric wavelets (Mazurkin, 2014; Mazurkin, 2015) behavior of air temperature and relative humidity. The water regime of meadows (Mazurkin, 2018a) and carbon dynamics in Europe change according to wavelets of universal design (Mazurkin, 2018b).

The dynamics of ontogenesis of birch leaves during the growing season (Mazurkin &

Kudryashova, 2018b; Mazurkin & Kudryashova, 2018c) in 2014 is characterized by biotechnical law [4] and additionally asymmetric wavelets. Since the wavelets of the mathematical construction are the same (invariant) for any objects of research, the purpose of studying the quanta of behavior in binary relations between the considered meteorological parameters from 01.05.2014 to 30.09.2014 was revealed.

There are two types of quantum behavior:

first, in dynamics, each factor is divided into the sum of wavelets, that is, in time, the factor is represented as a bundle of solitary waves (solitons) and this process is characterized as ***quantum unraveling***;

secondly, the mutual influence of the four above factors with the frequency of measurements every three hours additionally obtains ***quantum entanglement*** in some boundaries.

2 Source data

Weather station Yoshkar-Ola, Russia, WMO_ID=27485, the sample was taken from 01.05.2014 to 30.09.2014, all days, during the growing season of birch leaves (Table 1).The power of statistical sampling for four meteorological parameters was 1222 lines.

In factor analysis, time is excluded, and it acts only as a system-forming factor that ensures the relationship between the four weather parameters. Therefore, the adequacy of the dynamics models is taken into account in the diagonal cells of the correlation matrix.

Table 1: Data for the meteorological station of Yoshkar-Ola `http://rp5.ru` (Russia, WMO_ID=27485, sampling 01.05.2014 at 30.09.2014, on all days)

Number in order	Time t, day	Meteorological parameter			
		Air pressure	Temperature	Relative humidity	Temperature dewpoint
1	0.042	742.7	8.0	92	6.7
2	0.167	742.3	6.8	94	5.9
3	0.292	742.2	7.5	94	6.7
4	0.417	742.2	11.4	79	8.0
5	0.542	743.0	14.9	61	7.4
...	...	...	...	...	...
1218	152.417	743.5	9.8	91	8.4
1219	152.542	741.7	11.4	81	8.4
1220	152.667	739.6	10.6	90	9.0
1221	152.792	736.5	9.9	95	9.0
1222	152.917	748.1	8.9	89	7.3

3 Factor analysis identification of the trend

The wavelet signal, as a rule, of any nature (object of study) is mathematically recorded by the wave formula (Mazurkin, 2014) of the form

$$y_i = A_i \cos(\pi x/p_i - a_{8i}), A_i = a_{1i} x^{a_{2i}} \exp(-a_{3i} x^{a_{4i}}), p_i = a_{5i} + a_{6i} x^{a_{7i}}, \quad (1)$$

where A_i is an amplitude (half) of wavelet (axis y), p_i is half period of the wave (the axis x).

According to the formula (1) with two ***fundamental physical constants****e* (the Neper number or the number of time) and π (the Archimedes number or the number of space), ***a quantized wavelet signal*** is formed from within the phenomenon and/or process under study. The concept of wavelet signal allows us to abstract from the physical meaning of many statistical series of measurements and consider their additive decomposition into components in the form of a sum of individual wavelets.

A signal is a material carrier of information. And we understand information as ***a measure of interaction***. A signal can be generated, but its reception is not required. A signal can be any physical process or part of it. It turns out that the change in the set of unknown signals has long been known, for example, through the series of three-hour meteorological measurements. However, there are still no statistical models of both dynamics and mutual connection between the four weather parameters at this weather station.

The trend is formed when the period of oscillation a_{5i} tends to infinity. Most often, the trend is formed from two members of the formula (1).

All models in this paper have been identified in the special case where the model parameter $a_2 = 0$, by a two-term formula

$$y = aexp\left(-bx^c\right) + dx^e \exp(-fx^g), \tag{2}$$

where y is the dependent measure, x is the influencing variable, a, g the model parameters (2) identified in the software environment CurveExpert-1.40.

Table 2 shows ***the correlation matrix*** of binary links and the rating of four factors obtained by the method of identification (Fu et al., 2015) according to Table 1. In our example, in the diagonal cells we put the correlation coefficient of the models of discrete dynamics from 01.05.2014 to 30.09.2014.

Table 2: Correlation matrix of factor analysis and rating of factors after identification by trend pattern (2)

Influencing factors (Characteristic x)	Dependent factors (indicators y)				Sum Σr	Place I_x
	T, ^0C	P_0, mm Hg	U, %	T_d, ^0C		
Air temperature T, ^0C	0.4301	0.1951	0.6397	0.5537	1.8186	1
Atmospheric pressure P_0, mm hg	0.0321	0.2804	0.2773	0.3004	0.8902	4
Relative humidity U, %	0.6224	0.2779	0.4184	0.3972	1.7159	3
Dewpoint temperature T_d, ^0C	0.5043	0.3055	0.3591	0.5500	1.7189	2
Sum Σr	1.5889	1.0589	1.6945	1.8013	6.1436	-
Place I_y	3	4	2	**1**	-	0.3840

The coefficient of correlation variation, that is a measure of the functional relationship between the parameters of the system (weather at the weather station), is $6.1436/4^2 = 0.3840$ which is less than 0.4634 for the period from 22.12.2013 to 21.12.2014. So a year between the December solstices were better than on the adequacy of the models (1) compared to vegetation period.

As the influencing variable on the first place there was a meteorological parameter air temperature, on the second dew point temperature and on the third place relative humidity. This rating fully coincides with the period between the winter solstices, for which a similar rating of meteorological parameters and dependent indicators was obtained.

However, the inclusion of vegetation period has changed the rating dependent parameters. In the first place was the dew point temperature, the second-the relative humidity and only in third place – the air temperature.

4 Factor analysis by wave equation identification

The concept of oscillatory adaptation in nature assumes that there are dependencies in the form of wave equations between the factors selected in Table 1. However, it turned out that there is no wave connection between these four factors, which indicates the presence of a sufficiently strong quantum entanglement of meteorological data.

For the dynamics we managed in the software environment CurveExpert-1.40 (URL: http://www.curveexpert.net/) identify the second wavelet (Table 3).

If the residues after the wavelet analysis are not further modeled, then experts say about some noise. But we believe that noise can be called only such residues that are equal to or less than the measurement error. Therefore, part of the noise exceeding the measurement errors in

Table 3: Correlation matrix of factor analysis and factor rating after trend identification (2) for binary relations and two wavelets (1)

Influencing factors(characteristic x)	Dependent factors (indicators y)				Sum Σr	Place I_x
	T, ^0C	P_0, mm Hg	U, %	T_d, ^0C		
Air temperature T, ^0C	0.7731	0.1951	0.6397	0.5537	2.1616	1
Atmospheric pressure P_0, mm Hg	0.0321	0.7241	0.2773	0.3004	1.3339	4
Relative humidity U, %	0.6224	0.2779	0.7879	0.3972	2.0854	2
Dew point temperature T_d, ^0C	0.5043	0.3055	0.3591	0.7335	1.9024	3
Sum Σr	1.9319	1.5026	2.064	1.9848	7.4833	-
Place I_y	3	4	**1**	2	-	0.4677

binary relations should be attributed to quantum entanglement. And the share of parameter values determined by the revealed regularities should be attributed to quantum unraveling.

The coefficient of correlation variation increased to 7.4833/16 = 0.4677, which is less than 0.5065 for the year between winter solstices, but slightly more than 0.4583 for semilets. The rating of factors changed for dependent indicators: relative humidity became the first, and the dew point temperature became the second.

Thus, it was proved that the ontogenesis of birch leaves is most influenced by the relative humidity, and the air temperature – on the third. Account sheets of birch was taken at a height of 1.5-2.0 m, and the meteorological parameters are measured at a height of 2 m. therefore, the lower leaves of woody plants, the dew point temperature is also affected actively.

5 Regularities of the dynamics of air pressure

As a rule, the models of any dynamics can be brought to a finite set of wavelet signals by the identification method. The criterion for stopping the identification process is only the measurement error. Each wavelet becomes a separate quantum of behavior (the structure of macro-objects in comparison with their behavior can be assumed constant). For example, the average air temperature in Central England for 1659-2017 years according to Hadley Centre Central England Temperature (HadCET) to the measurement error $\mp 0.05^0C$ is characterized by a set of 188 wavelets.

Table 4 shows the values of the model parameters (1) by 14 members. It shows that parts of the trend are special cases of wavelet.

Table 4: The parameters of the models (1) the dynamics of air pressure from 01.05.2014 on 30.09.2014

Number i	Wavelet $y_i = a_{1i} x^{a_{2i}} \exp(-a_{3i} x^{a_{4i}}) \cos(\pi x / (a_{5i} + a_{6i} x^{a_{7i}}) - a_{8i})$								Coef. Cor. r
	The amplitude (half) the fluctuations				The half-period of oscillations			Shift	
	a_{1i}	a_{2i}	a_{3i}	a_{4i}	a_{5i}	a_{6i}	a_{7i}	a_{8i}	
1	752.58329	0	1.29446e-5	1.77686	0	0	0	0	0.7241
2	0.00021001	2.67256	0.00021023	1.62649	0	0	0	0	
3	-38.34348	0	1.11714	0.15474	28.13992	0	0	-0.61258	
4	-3.57725	0	0.0093160	1	7.71514	0	0	-1.70404	
5	-2.84684	0	0.0027442	1	9.38969	0.12388	0.78340	0.016600	0.4415
6	1056.96057	2.98230	6.18690	0.29010	0.11174	0.22278	0.72798	3.88163	0.4203
7	-2.25536e-9	5.92660	0.044402	1.10201	5.95474	0.0030217	1.02087	3.55281	0.2289
8	-0.79410	0	0.0015102	1	14.00598	0.023531	1.17036	2.35290	0.1680
9	-1.31482e-6	4.26835	0.061945	0.97206	8.77909	0.00097783	1.39166	3.00704	0.553
10	0.0078668	1.46978	0.014987	1	3.12557	0	0	-1.17215	0.3233
11	0.27624	0	-0.016659	0.99475	4.99977	-0.0018980	1.02577	0.73450	0.4062
12	1.33493	0	0.018915	1	1.98554	-0.015700	0.32412	0.41771	0.1667
13	3.50015e-7	4.73382	0.071744	0.99286	1.73349	0	0	4.16708	0.2683
14	2.26092e-6	4.19048	0.0532401	1.06128	1.53772	0	0	-2.37002	0.1856

The adequacy of the model (1) according to table 4 by four terms is equal to the correlation coefficient 0.7241 (Fig. 1) what is more 0.6776 for one year. The adoption of vegetation increases the adequacy of the dynamics of air pressure.

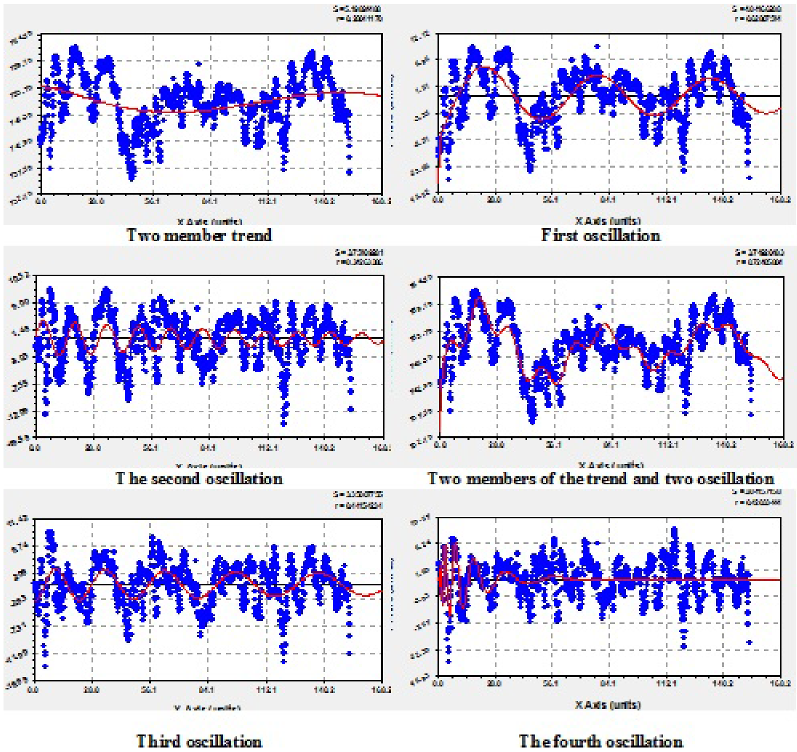

Figure 1: Graphs of six members of the general model (1) air pressure dynamics: S is the variance; r is the correlation coefficient

Further in the article we analyze only the first four terms of the model (1).

The first term according to the modified Laplace law (Fu et al., 2015) shows a decrease in air pressure from the Bud break to the leaf fall. But the second term according to the biotechnical law (Mazurkin, 2014) shows the stress excitation of air pressure. As a result, the change in pressure in the dynamics of three-hour changes during the growing season are two opposite forces (recession and excitation). And two wavelets with constant periods counteract the growth of air pressure, as they have negative signs.

The values of the half-period of oscillation a_{5i} show that the third term has a oscillation cycle of 28.13992$\times$ 2 $\approx$ 56.3 days (less than two months). The second wavelet had a period of oscillation 7.71514 $\times$ 2 $\approx$15.4 days (more than two weeks). From the graphs in figure 1 it can be seen that the first wavelet in amplitude is significant and has the adequacy of the correlation coefficient 0.6281, which is much more than 0.2804 for a two-term trend. The fourth fluctuation with the adequacy of 0.4203 in figure 1 occurred at the beginning of the growing season. This is a graph of a finite-dimensional wavelet showing the air pressure tremor. Therefore, it may be that the pressure surge allows the growth of plant leaves to start.

6 Regularities of air temperature dynamics

Four members of the air temperature (Tab. 5) have a correlation coefficient of 0.7731 (Fig. 2), and for the year of the winter solstice, this meteorological parameter had the highest coefficient 0.9162 (for seven-year data was obtained 0.8924). Of course, the decrease in adequacy is due to the exclusion of negative temperatures in the winter. Plants in the Northern hemisphere just go to rest in the winter. And birch leaves are revived every year. Such discrete revival make the leaves of plants of the quantum object.

Table 5: The parameters of the models (1) dynamics of air temperature 01.05.2014-30.09.2014

Number i	Wavelet $y_i = a_{1i}x^{a_{2i}} \exp(-a_{3i}x^{a_{4i}}) \cos(\pi x/(a_{5i} + a_{6i}x^{a_{7i}}) - a_{8i})$							Coef. Cor. r
	The amplitude (half) the fluctuations				The half-period of oscillations		Shift	
	a_{1i}	a_{2i}	a_{3i}	a_{4i}	a_{5i}	a_{6i}	a_{7i}	a_{8i}
1	13.26197	0	-0.0046798	1.24126	0	0	0	0	0.7731
2	-6.57506e-5	2.88573	0	0	0	0	0	0	
3	3.46357	0	-.0013040	1	-1.43505	5.22098	0.39412	4.18026	
4	5.10325	0	0.0015485	1	0.5	0	0	-2.11550	
5	1.41494	1.06316	0.26339	0.66487	3.43554	0.73050	0.33054	0.57240	0.4686
6	-1.04569	0	-0.0020797	1	5.45360	-0.00019859	1.43651	-3.20143	0.2638
7	-1.06179e8	7.71227	18.19829	0.29724	2.03585	0	0	-1.44492	0.2034
8	1.01039e9	10.03030	29.52445	0.17812	23.39359	-10.01353	0.063432	-2.02526	0.2962
9	-3.91870e-10	6.83016	0.091406	0.99802	14.78784	0.026149	0.97603	3.39594	0.3852
10	6.87921e-5	3.00104	0.057765	0.92471	6.29825	-0.0051960	0.87053	1.90286	0.2355
11	0.0010078	8.05041	7.39287	0.30039	3.6881	0	0	2.17829	0.4324
12	9.31469	0	2.15790	0.044308	5.07042	-0.00087003	1.21105	2.53253	0.2076
13	-1.21475	0	0.0072481	1	2.73165	0	0	0.20328	0.2304
14	-0.72939	0	7.03801e-5	1.44816	3.21714	-0.00070391	1.03348	-2.79015	0.2158

The two forces on the two members of the trend is the opposite. The first term according to the law of exponential growth shows an increase in positive temperatures due to increased solar radiation. And the second term of the trend according to the exponential law (Mazurkin, 2014) shows the influence of space on the decrease in air temperature. As a result of the action of the two forces, the maximum air temperature is observed near the summer equinox.

Both wavelets on the sign are aimed at increasing the temperature of the air, which indicates global warming. There are five more such members with a positive sign in Table 5. The negative sign in front of the component of the model shows the global cooling. With a minimum constant period of 0.5 days, there is a second oscillation with an adequacy of 0.6497, which is much higher than 0.4301 for the trend. To this constant dynamics adapted leaves of plants.

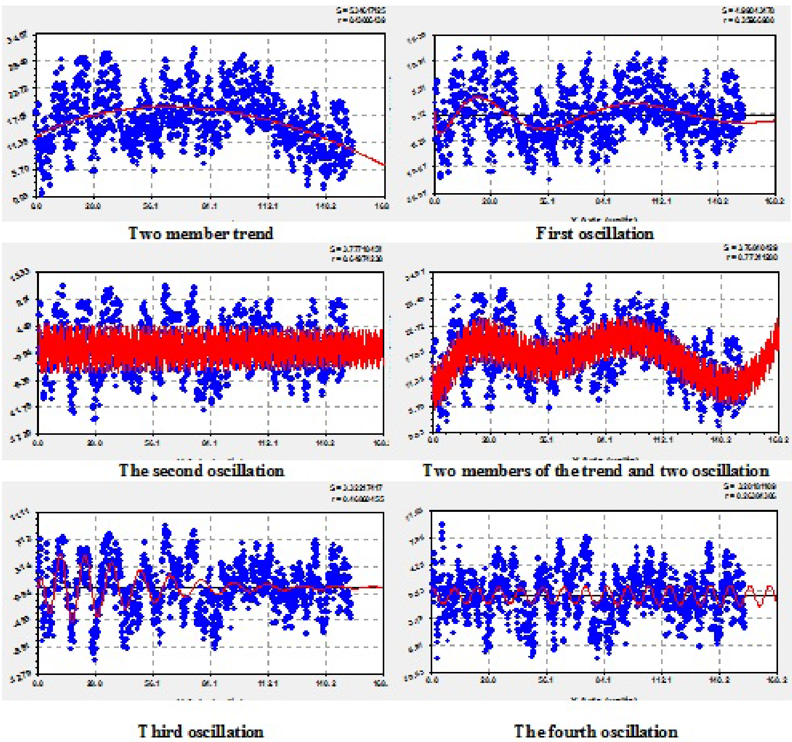

Figure 2: Graphs of the General model (1) air temperature dynamics

Then it becomes clear that the plants have adapted their aerobic (oxygen) breathing to the daily cycles of temperature and relative humidity. The leaves do photosynthesis which is the process of education in the light green plants glucose and oxygen from carbon dioxide and water according to the formula $6CO_2$+$6H_2O$ → $C_6H_{12}O_6$+$6O_2$. Mostly at night leaves back exhale carbon dioxide in accordance with the General equation of the process of cellular respiration: is

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + 38AT\Phi$. In this regard, the influence of relative humidity and air temperature on the ontogenesis of birch leaves throughout the Northern hemisphere becomes decisive in the quantum bonds of phenology and meteorology.

7 Regularities in the dynamics of relative air humidity

Table 6 shows the parameters of 14 members of the model (1), the total correlation coefficient of the first four members is 0.7879, which is more than 0.7373 for the year between the winter solstices. The first six graphs are shown in Fig. 3.

Table 6: The parameters of the models (1) the dynamics of relative air humidity

Number i	Wavelet $y_i = a_{1i} x^{a_{2i}} \exp(-a_{3i} x^{a_{4i}}) \cos(\pi x / (a_{5i} + a_{6i} x^{a_{7i}}) - a_{8i})$							Coef. Cor. r
	The amplitude (half) the fluctuations				The half-period of oscillations			Shift	
	a_{1i}	a_{2i}	a_{3i}	a_{4i}	a_{5i}	a_{6i}	a_{7i}	a_{8i}	
1	61.00958	0	0.023672	1	0	0	0	0	0.7879
2	1.19032e8	4.98204	21.29196	0.12188	0	0	0	0	
3	18.53742	0	0.00071163	1	0.500016	0	0	1.03369	
4	2.18466e-25	22.37791	0.56162	1	34.47904	-0.34292	1.01230	-5.15430	
5	3.84479	0	-0.0018876	1	35.37706	0	0	-1.87000	0.2482
6	-0.00010547	0	-8.75880	0.044023	20.71227	-0.00035306	1.83252	0.024621	0.2409
7	99.66531	0	1.89889	0.13748	6.38048	0.00089350	1.25134	0.82397	0.2805
8	-3.14360	0	0.00041808	1	8.98206	-3.45803	0.083276	-3.06251	0.1880
9	12.51639	0	0.22691	0.45502	1.40274	0.0018390	1.11367	-0.39830	0.2259
10	2.85955	0.90557	0.019764	1.70821	0.41316	0.10487	0.97761	5.74180	0.1556
11	-2.14201	1.25043	0.42684	0.68109	0.82020	0	0	-0.87523	0.1123
12	-3.70475e-5	3.47612	0.045832	1.00874	4.39726	-0.00016787	1.31321	-3.88587	0.1510
13	1.85831	0	-0.00013210	1	2.87682	0.00047549	1.12568	0.31053	0.1247
14	1.39251e-5	3.67200	0.0022402	1.71846	0.60645	0	0	1.25019	0.1287

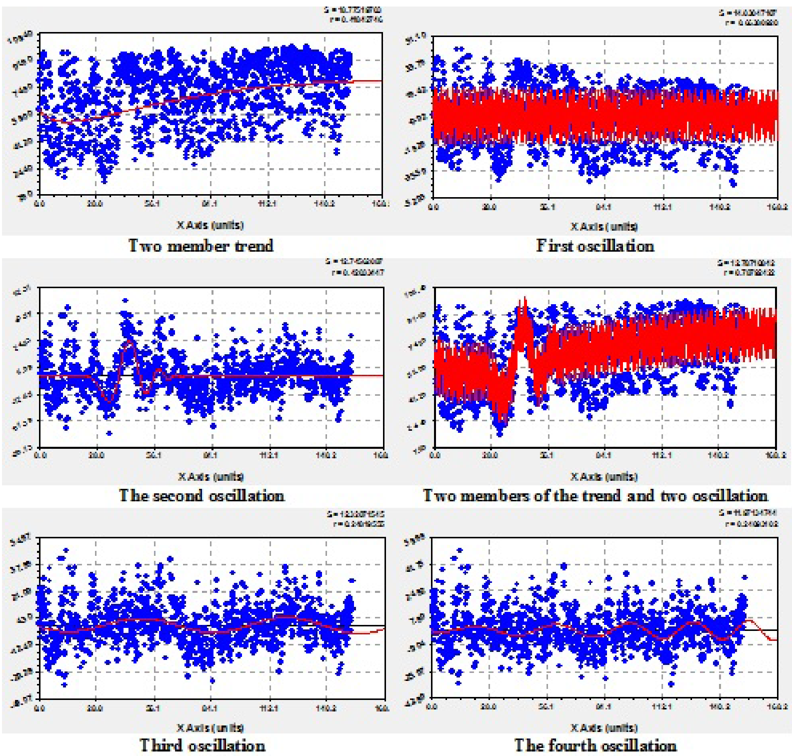

Figure 3: Graphs of the General model (1) relative humidity dynamics

The first term is the law of death according to the known Laplace law (in math), Mandelbrot (in physics), pearl-texts (in biology) and Pareto (econometrics). The second term of the trend is the biotechnical law showing the limit of relative humidity increase up to 30.09.2014. The two term trend refers to classical forms according to equation (2).

The third term (the first wavelet) characterizes the daily fluctuation with a constant period of 0.5 days (correlation coefficient 0.6638 compared to 0.4484 for the trend). All four major members of models (1) to increase the relative humidity of the air.

It can be seen from the graphs in Fig. 3 that in comparison with the air temperature, the relative humidity has a more pronounced amplitude with a daily cycle of changes in the wave of oscillatory perturbation (correlation coefficient 0.6638 in comparison with 0.6397). In this case, the daily fluctuation for relative humidity is the first oscillation, and for air temperature – the second.

The dynamics of relative humidity for plants is more important than air temperature. The other two meteorological parameters (air pressure and dew point temperature) do not have daily fluctuations. Therefore, we are convinced that the oscillatory adaptation of the ontogenesis of foliage adapted to the daily dynamics of relative humidity, and then the air temperature.

As it turned out, humidity has a stronger influence in ontogenesis compared to air temperature (Mazurkin, 2018b; Mazurkin, 2015). To explore their joint influence on the ontogeny of the leaves need not two, but three-factor modeling.

8 Regularities of the dynamics of the dew point temperature

With correlation coefficient 0.7335 (Table 7, Fig. 4) for the first four members of the model (1), instead of 0.8928 for the year between December solstices, this meteorological parameter has a strong influence (not less than 0.7).

Table 7: The parameters of the models (1) the dynamics of the dew point temperature

Number i	Wavelet $y_i = a_{1i}x^{a_{2i}} \exp(-a_{3i}x^{a_{4i}}) \cos(\pi x/(a_{5i} + a_{6i}x^{a_{7i}}) - a_{8i})$							Coef. Cor. r
	The amplitude (half) the fluctuations				The half-period of oscillations		Shift	
	a_{1i}	a_{2i}	a_{3i}	a_{4i}	a_{5i}	a_{6i}	a_{7i}	a_{8i}
1	0.57465	0	0.022429	1	0	0	0	0	0.7335
2	1.35056	0.54441	0.0039031	0.96659	0	0	0	0	
3	-6.71936	0.00057659	0.032296 0.99634	6.48372	0	0	2.79573	0	
4	-0.81046	0	-0.00016613 1.91722	8.79164	0.18201	0.84301	2.39310	0	
5	-2.55279	0	0.0045226	1	8.58024	0.055456	0.91921	3.04307	0.4097
6	-2.73590	0.85318	0.16115	1.10910	1.48852	0	0	1.68965	0.2283
7	9584.82555	3.86328	10.43567	0.23132	0.82783	0	0	1.70256	0.1156
8	-35340.400	0	9.89854	0.015758	2.05076	4.39267	0.083682	0.24059	0.2423
9	-0.52099	0	-0.0012611	1	19.65654	9.9452e-5	1.97701	1.43156	0.1463
10	-6.72837e-8	6.38188	0.78307	0.60862	3.03869	0	0	0.35768	0.2064
11	-0.97248	0	-0.0030558	1	3.10317	0.0050579	0.99497	2.84056	0.3298
12	1.18298e-7	5.91168	0.14635 1.00037	1.39142	6.18891e-5	1.14593	1.02971	0.1214	0
13	-0.17475	0.83082	0.019844	1	4.78604	0.0052437	1	5.12996	0.3510
14	-0.64700	0	0.0042076	1	1.93122	0	0	0.020508	0.1463

At the same time, the inconsistency of the trend is eliminated, and it acquires a classic character. The first member is the Laplace law of death and the second member is the biotechnical law. This gives a maximum of about the summer equinox. Both wavelets are aimed at reducing the dew point temperature due to the negative sign in front of the components. The first oscillation in the form of a tremor can have a starting effect on the start of the vegetation mechanism of plant leaves with a constant period of oscillation in $6.48372 \times 2 \approx 13$days.

We believed that the temperature of the dew point somehow, in a special way, affects the process of ontogenesis of leaves of woody plants. And so it happened, this parameter in table 3 took second place after the relative humidity.

9 Binary relations between meteorological parameters

Binary relations, and without any pre - conditions of selection, are necessary to assess the level of adequacy between the accepted factors.

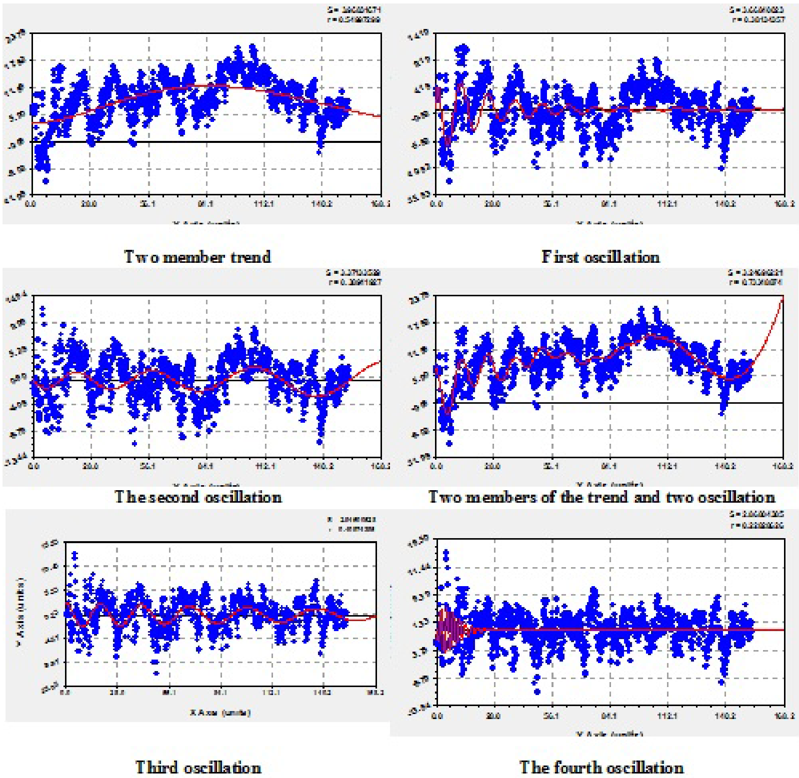

Figure 4: Graphs of the general model (1) dynamics of the temperature of the dew point of the air

Influence of air pressure. The remaining three factors the air pressure is affected by the two-membered formula of the trend (Fig. 5):

- the influence of air pressure on the air temperature during the growing season 2014 0.0321, which is much less compared to the year 0.3092 and even less than 0.2378 in comparison with the data set for seven years, while the design is complicated in the form of the equation

$$T = -345.29592 \exp(-9.43529e - 5P_0^{0.62826}) + 0.39675P_0^{1.20094} \exp(-0.0012356P_0^{1.03148}); \quad (3)$$

- the effect of air pressure on relative humidity changed (the first term became the law of death instead of the law of exponential growth), with a significant increase in the correlation coefficient 0.2773 instead of 0.0855 for the year and 0.1407 for seven years, according to the formula

$$U = 1265.9984 \exp(-0.00024161P_0) - 1.49997P_0^{1.03768} \exp(-0.00021517P_0^{1.12916}); \quad (4)$$

- the influence of air pressure on the dew point temperature decreased little to 0.3004 (instead of 0.3627 for a year and 0.3081 for seven years) with the same design two term trend

$$T_d = 164.63116 \exp(0.0039986P_0^{0.68039}) - 0.12905P_0^{1.12862}. \quad (5)$$

As the air pressure in the surface layer of the atmosphere increases, the temperature and relative humidity decrease according to the modified Laplace law.

So we conducted a factor analysis, the results of which were given in the data of tables 2 and 3. Due to the quantum entanglement of the relations between the factors, the wave equations of (1) for the pair relations between the factors are not obtained, so the trend model (2) was adopted for their identification.

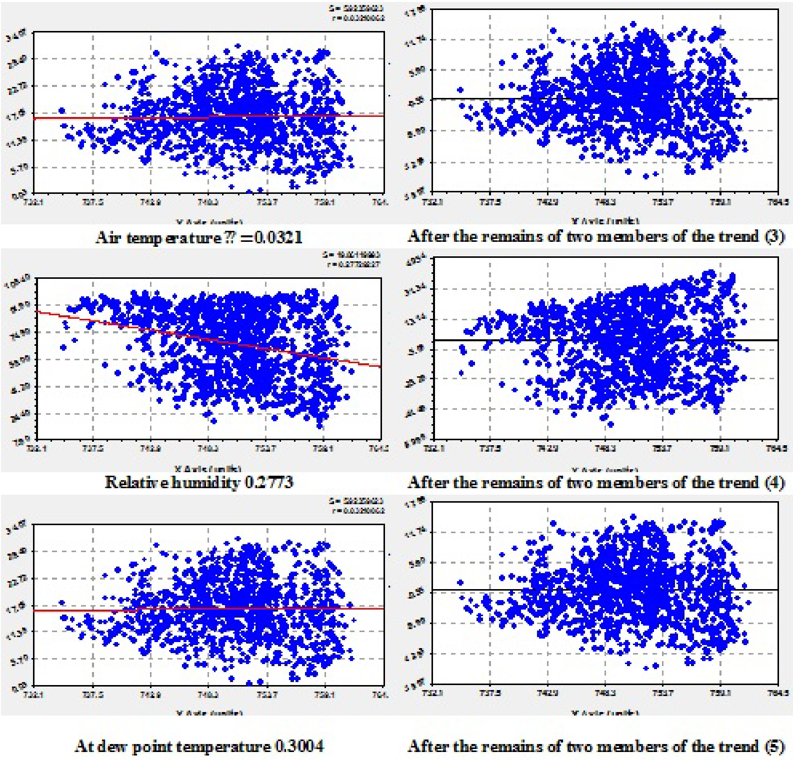

Figure 5: Effect of air pressure on other meteorological parameters: left column – trend charts; right column-trend balances

Effect of air temperature. Fig. 6 shows the effect graphs.

Fig. 6 shows the effect graphs. From literary sources it is known that meteorologists pay attention, first of all, to this meteorological parameter. It is considered to be much more significant than, for example, relative humidity.

The graphs of the left column with quantum certainty (unraveling) are characterized by equations:

- the influence of air temperature (without changing the abscissa by 500 S) on the air pressure by the model design has changed (0.1951 instead of 0.3804 for the year between December solstices and 0.3315 for seven years)

$$P_0 = 758.85065 \exp(-0.0015259T^{1.13597}) + 0.0553356T^{2.25027} \exp(-0.026534T^{1.03840}); \quad (6)$$

- the influence of air temperature on the relative humidity of the model is unchanged (0.6397, which is more than 0.5576 for the year and 0.5267 for seven-year data)

$$U = 82.79797 \exp(2.15174e - 5T^{3.12836}) - 00032542T^{3.18917}; \quad (7)$$

- the influence of air temperature on the dew point temperature is constant (0.5537, which is less than 0.9380 for a year and less than 0.9485 for seven years)

$$T_d = -0.0060812 \exp(7.02010T^{0.065767}) + 5.38090T^{1.10596} \exp(-0.29244T^{0.48277}). \quad (8)$$

Due to the elimination of winter negative temperatures the x-axis has been removed.

Influence of relative humidity. This effect is shown by the graphs in Fig. 7, which were identified by equations of the form:

- influence of relative humidity on air pressure (0.2779, which is more than 0.1127 for a year and 0.1859 for seven years)

$$P_0 = 755.12517 \exp(6.40926e - 6U^{2.04339}) - 0.0086736U^{1.94588}; \quad (9)$$

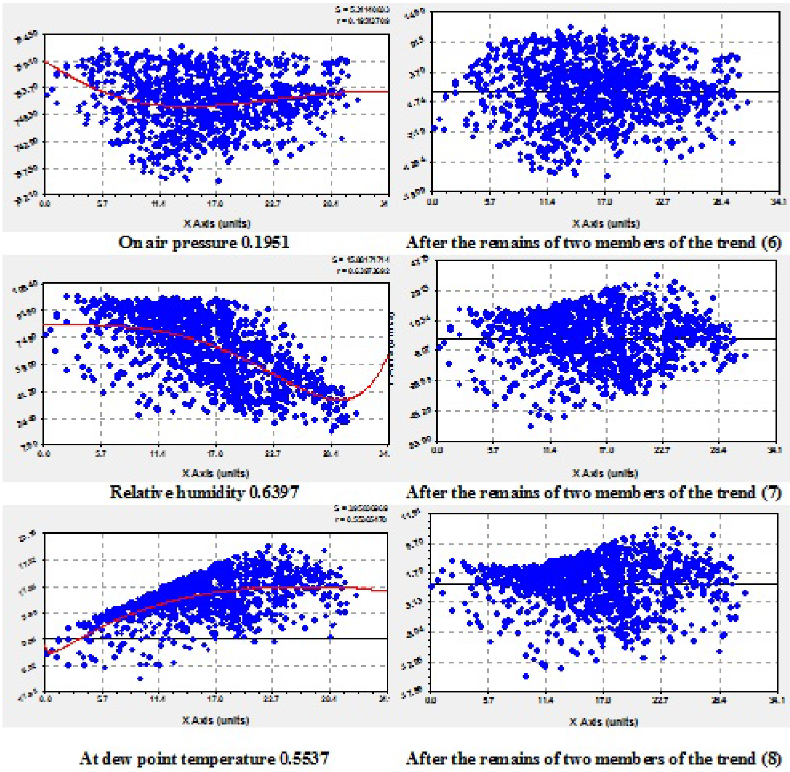

Figure 6: The influence of air temperature and other meteorological parameters: left column – trend charts; right column-trend balances

- influence of relative humidity on air temperature (0.6224 instead of 0.5533 for a year and 0.4490 for seven years)

$$T = 26.23054\exp(0.00023327U^{1.65724}) - 0.030594U^{1.50829}; \qquad (10)$$

- the influence of relative humidity on the dew point temperature (0.3972, which is more than 0.2564 for a year and 0.1853 for seven years)

$$T_d = -11.89464\exp(-0.012834U^{1.29032}) + 1.04575U^{0.70747}\exp(-0.010467U^{0.97817}). \qquad (11)$$

The effect of relative humidity has increased for all three other meteorological parameters. But the design of the influence on the dew point temperature has changed.

Influence of dew point temperature. Other meteorological parameters (Fig. 8) the dew point temperature is influenced by the formulas:

$$P_0 = 762.53668\exp(-0.00052429(T_d+20)) - 0.00011514(T_d+20)^{7.65848}\exp(-0.71220(T_d+20)). \qquad (12)$$

- the influence of the dew point temperature on the air temperature (0.5043, which is much less than 0.9227 for a year and 0.9373 for seven years due to the exclusion of annual cycles), but only the first term according to the law of exponential growth remained

$$T = 6.01514\exp(0.015375(T_d+20)^{1.22626}); \qquad (13)$$

- the influence of dew point temperature on relative humidity (0.3501, which is almost five times more than 0.0636 for a year and 0.0735 for seven years), the sign in front of the second member of the model has changed

$$U = 131.11602\exp(-0.13910(T_d+20)) + 0.0031725(T_d+20)^{6.00027}\exp(-1.85694(T_d+20)^{0.50746}); \qquad (14)$$

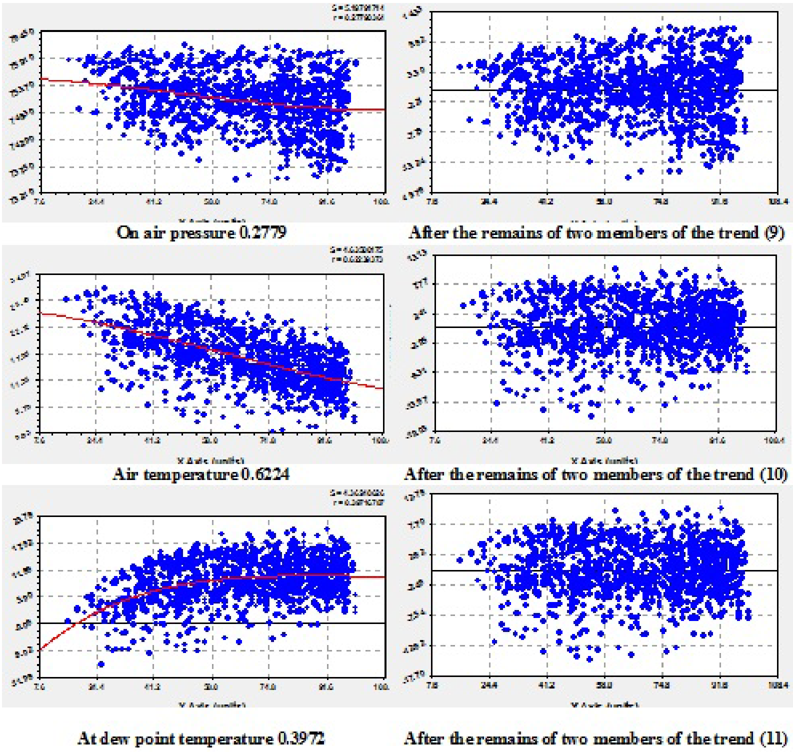

Figure 7: Influence of air humidity on other meteorological parameters: left column – trend charts; right column-trend balances

Here, the model designs have changed a lot, and the origin of the temperature is shifted to the left by 20^0C instead of 50^0C.

At zero values of the influencing variables according to the previous formulas, we obtain the limit theoretical values of the dependent indicators (Table 8). From the data in table 8 it can be seen that the most dangerous is the change in air pressure to zero. The atmosphere will become with a temperature of -345.3^0C(which is less than the absolute zero temperature at -273.15^0C at an extremely high humidity of 1266.0% (close to the surface of Pluto).

Thus, the calculation of the limit values of meteorological parameters makes it possible to compare The earth's atmosphere with other planets of the Solar system.

Table 8: Limit values of meteorological parameters at zero values of influencing variables by equations (3-14)

Influencing factors (characteristic x)	Dependent factors (indicators y)			
	P_0, mmHg	T, ^0C	U, %	T_d, ^0C
Pressure $P_0 = 0$ mmHg	-	-345.3	1266	164.63
Temperature $T = 0^0C$	758.85	-	82.80	-0
Relative humidity $U = 0\%$	755.13	26.23	-	-11.89
Dew point temperature $T_d = 0^0C$	762.54	6.02	131.12	-

On seven-year data comparison was with planet Venus.

10 Quantum entanglement between meteorological parameters

In figures 5-8 quantum entanglement is characterized by residues in the second column of the graphs. The correlation coefficient of quantum entanglement is determined by the expression (Table 9).

We introduce a new concept – ***quantum unraveling***, which shows the adequacy of the

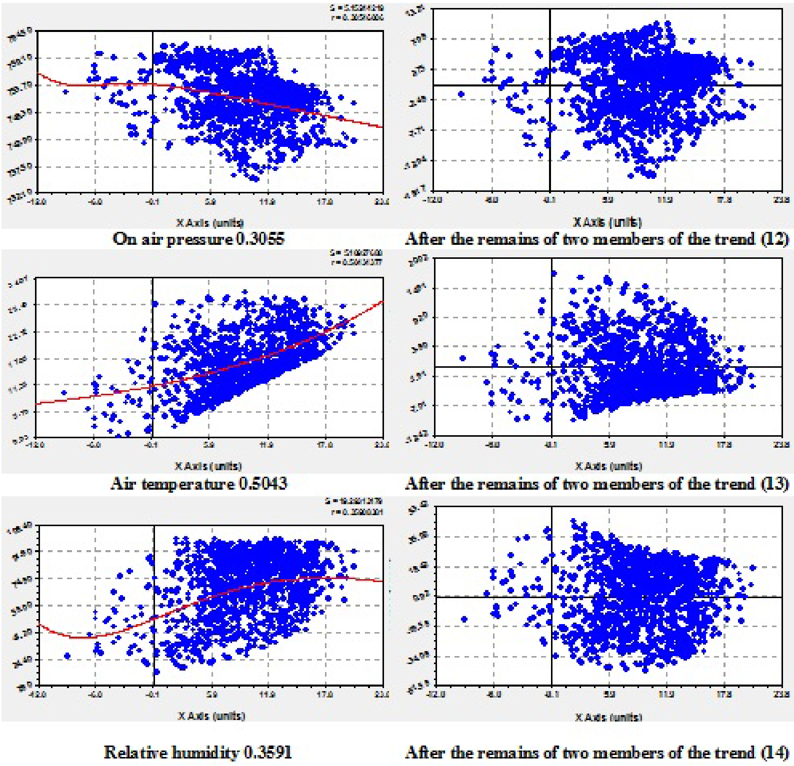

Figure 8: The influence of the dew point temperature meteorological parameters - influence of dew point temperature on air pressure (0.3055, which is less than 0.3882 for a year and 0.3520 for seven years)

detection of mathematical regularities in the form of wavelet signals. Therefore, the adequacy ***of quantum unraveling*** is characterized by the same value of the correlation coefficient, which was obtained during the application of the method of identification of asymmetric wavelets.

Table 9: The values of correlation coefficients according to equations (3-14)

Influencing factors (characteristic x)	Dependent factors (indicators y)	Correlation coefficient quantum behavior	
		unraveling	entanglement
Pressure P_0, mmHg	Temperature T, ^0C	0.0321	0.9679
	Relative humidity U,%	0.2773	0.7227
	Dew point temperature T_d,^0C	0.3004	0.6996
Temperature T,^0C	Pressure P_0, mmHg	0.1951	0.8049
	Relative humidity U,%	0.6397	0.3603
	Dew point temperature T_d,^0C	0.5537	0.4463
Relative humidity U,%	Pressure P_0, mmHg	0.2779	0.7221
	Temperature T,^0C	0.6224	0.3776
	Dew point temperature T_d,^0C	0.3976	0.6024
Dew point temperature T_d,^0C	Pressure P_0, mmHg	0.3055	0.6945
	Temperature T,^0C	0.5043	0.4957
	Relative humidity U,%	0.2591	0.7409
The sum of the correlation coefficients		4.3651	7.6349
The correlative coefficient of variation of quanta		0.3638	0.6362

To characterize a part of the system of meteorological parameters on binary relations (interaction quantum), we introduce a new statistical indicator – ***the coefficient of correlative variation of quanta***. For quantum unraveling in table 9, it will be 0.3638 (0.4067 for one year). At the same time, for seven-year data, this figure is 0.3897.

In the simplest case, the sides along the abscissa and ordinate axes of a rectangle describing a swarm of points become the boundaries of the residuals on the graphs in figures 5-8. From figures 5-8 it can be seen that the swarms of points have a complex shape.

11 Conclusions

First us dynamics of ontogenesis was considered holistically in time of the vegetation period account of birch leaves. In this case, the groups of leaves are measured without taking them from the tree. For this purpose, the methods protected by five patents for inventions of the Russian Federation were developed.

The main environmental conditions are weather (meteorological) parameters. Time combines the dynamics of the parameters of birch leaves, common in the Northern hemisphere, in ontogenesis with the weather parameters measured every three hours at the weather station.

The correlation coefficient 0.4677 is less than 0.5065 for the year between winter solstices, but slightly more than 0.4583 for the seven-year data set. At the same time, the rating of factors changed only for dependent indicators: relative humidity became the first place, and the dew point temperature became the second. Thus, it was proved that the ontogenesis of birch leaves is most influenced by the relative humidity, and the air temperature – on the third.

By the influence of air pressure, the adequacy of the four-term model is equal to 0.7241, which is more than 0.6776 for one year. Then it turns out that the adoption of time for the growing season increases the adequacy of the model of air pressure dynamics. The first term shows the decrease in air pressure from the blooming of birch buds before leaf fall. But the second term shows the stress excitation of air pressure. As a result, the change in pressure in the dynamics of three-hour changes during the growing season are two opposite forces (recession and excitation). And two wavelets with constant periods counteract the growth of air pressure, as they have negative signs. The third term has a oscillation cycle of 56.3 days (less than two months), and the second wavelet had a oscillation period of 15.4 days (more than two weeks).

For the influence of air temperature is characterized by two forces on the two members of the trend, directed opposite. The first term according to the law of exponential growth shows an increase in positive temperatures due to increased solar radiation. And the second term of the trend according to the exponential law shows the influence of space on the decrease in air temperature. As a result of the action of the two forces, the maximum air temperature is observed near the summer equinox. Both wavelets on the sign are aimed at increasing the temperature of the air, which indicates global warming. With a minimum constant period of 0.5 days, a second oscillation with an adequacy of 0.6497 is observed. To this constant dynamics adapted leaves of plants.

The influence of relative humidity is characterized by the fact that the first term is the law of death according to the known Laplace law (in mathematics), Mandelbrot (in physics), Pearl-Cipf (in biology) and Pareto (in econometrics). The second term of the trend is the biotechnical law showing the limit of relative humidity increase up to 30.09.2014. The third term (the first wavelet) characterizes the daily fluctuation with a constant period of 0.5 days (correlation coefficient 0.6638). In this case, all four main members of the model are aimed at increasing the relative humidity. In comparison with the air temperature, the relative humidity has a more pronounced amplitude with the daily cycle of oscillatory perturbation (correlation coefficient 0.6638 in comparison with 0.6397). In this case, the daily fluctuation for relative humidity is the first oscillation, and for air temperature – the second. Already this fact indicates that the dynamics of relative humidity for plants is more important than air temperature. The other two meteorological parameters (air pressure and dew point temperature) do not have daily fluctuations. Therefore, we are convinced that the oscillatory adaptation of the ontogenesis of foliage plants adapted to the daily dynamics of relative humidity, and then the air temperature.

To affect the dew point temperature of the first member is a law of death by Laplace, and the second member of the biotech law. This gives a maximum of about the summer equinox.

Both wavelets are aimed at reducing the dew point temperature. The first oscillation in the form of a tremor can have a starting effect on the start of the vegetation mechanism of plant leaves with a constant period of oscillation in 13 days.

To characterize the system of meteorological parameters on binary relations (interaction quantum), ***the coefficient of correlative variation of quanta*** is introduced. For quantum unraveling, it will be 0.3638 (0.4067 for one year). At the same time, for seven-year data, this figure is 0.3897.

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