Available online at http://www.journalijdr.com

IJDR

ISSN: 2230-9926

International Journal of Development Research
Vol. 10, Issue, 01, pp. 32946-32957, January, 2020

RESEARCH ARTICLE OPEN ACCESS

QUANTUM FITOMETEOROLOGY: FACTOR ANALYSIS OF THE THREE-HOUR MEASUREMENTS OF FOUR METEOROLOGICAL PARAMETERS DURING THE VEGETATION PERIODS 2012-2018

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ARTICLE INFO

Article History:
Received 09th October, 2019
Received in revised form
21st November, 2019
Accepted 16th December, 2019
Published online 29th January, 2020

Key Words:

Weather station, Weather, Factors, Three hours of measurement, Birch, Vegetation period, Quanta behavior patterns.

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ABSTRACT

Text of annotation. Factor analysis of three-hour dynamics from 01.01.2012 to 31.10.2018 of four meteorological parameters: atmospheric pressure; air temperature; relative humidity; dew point temperature was carried out by the method of identification (weather station Yoshkar-Ola, Russia, WMO_ID=27485).Power selection when accounting periods of the growing season of birch from 01.05 till 30.09 made 8558 instead 19713 lines in comparison with the continuous series, while there have been significant changes in the laws. The coefficient of correlative variation became equal to 0.3887, which is less in comparison with the full range of data 0.4583. The rating of factors stood on influencing variables equally with a full range: on the first place there is an air temperature, and on the second – dew point temperature. But according to the dependent indicators, due to the introduction of the periodicity of the birch vegetation, the dew point temperature comes first. According to the first wavelet for 7 years of birch vegetation, the oscillatory disturbance in the amplitude of the relative humidity of the air decreases, and for the other three meteorological parameters – increases. The second wavelet gives a decrease in the amplitude in the dynamics of the air temperature, and other meteorological parameters are increased. The countdown of the growing season increases the importance of air pressure. The first wavelet has a one-year oscillation cycle, but it increases, starting on the date 01.01.2012 half-period of 173.42 days for air pressure, 182.70 for air temperature, 161.15 days for relative humidity and 183.71 days for dew point temperature. The sensitivity of the vegetation period to relative humidity is much higher compared to the full range. The second wavelet shows that the period of pressure fluctuation is 21.98 days and it remains constant in the future, and for the dew point temperature is 86.62 days and it decreases with time. The dynamics of air temperature occurs with a constant daily period, and the dynamics of relative humidity is approaching the daily cycle. The frequency characteristics of the air temperature and relative humidity do not depend on the type of series. The values of the oscillation amplitude depend on it.

Citation: Mazurkin, P.M. and Kudryashova, A.I. 2020. "Quantum fitometeorology: factor analysis of the three-hour measurements of four meteorological parameters during the vegetation periods 2012-2018", *International Journal of Development Research*, 10, (01), 32946-32957.

INTRODUCTION

Meteorological conditions are strong factors in the activity of biological objects, such as amphibians, and for this purpose, article (Mazurkin, 2018). Assesses the effect of temperature, precipitation, atmospheric pressure and humidity on the phenology of amphibian accumulations in South-East Queensland, Australia. The role and mechanisms of climate impact on plant productivity are multifaceted. It was found that among the meteorological variables, the humidity index had the maximum effect on plants (Mazurkin, 2015). Climate, such as air temperature and rainfall, varies widely between urban Central and peripheral areas, resulting in different growing conditions for trees (Babushkina, 2018). A priori, it is also clear that the weather affects the course of development and growth (ontogenesis), especially of annual plants. And perennials weather is affected through annual ontogenesis of leaves. Quanta of leaf behavior, for example, birch, common in the Northern hemisphere, clearly depend on quanta (asymmetric wavelets (Mazurkin, 2015 and Mazurkin, 2018) behavior of air temperature and relative humidity (Mazurkin, 2015 and Mazurkin, 2015). The dynamics of carbon in Europe changes according to the wavelets of the universal design (Mazurkin, 2018). Dynamics of ontogenesis of birch leaves during the growing season (Dahlhausen, 2018; Mazurkin, 2014; Mazurkin, 2014 and Plenderleith, 2018) 2014 the years are characterized

Data for the meteorological station of Yoshkar-Ola http://rp5.ru (Russia, WMO_ID=27485, from 01.01.2012 to 31.10.2018, the days of the growing season of birch leaves)

№ p / p	Term (date and hours)		Time *t*, day	Meteorological parameter			
				Air pressure	Temperature	Relative humidity	Dew point temperature
				Growing season 2012			
1	1.5.2012	1	121.042	750.1	3.6	78	0.1
2	1.5.2012	4	121.167	750.4	2.0	89	0.4
3	1.5.2012	7	121.292	750.1	2.7	88	0.9
4	1.5.2012	10	121.417	748.9	6.7	61	-0.3
…	…	…	…	…	…	…	…
1220	30.9.2012	13	273.542	753.0	14.0	65	7.6
1221	30.9.2012	16	273.667	752.5	13.5	52	3.8
1222	30.9.2012	19	273.792	751.6	11.5	66	5.5
1223	30.9.2012	22	273.917	752.0	10.2	82	7.3
				The vegetation period in 2018			
7336	01.05.2018 00:00		2312	5.5	747.6	94	4.6
7337	01.05.2018 03:00		2312.125	5.0	749.0	94	4.1
7338	01.05.2018 06:00		2312.25	5.2	751.0	91	3.8
7339	01.05.2018 09:00		2312.375	8.2	752.2	78	4.6
…	…		…	…	…	…	…
8555	30.09.2018 12:00		2464.5	5.8	754.1	69	0.4
8556	30.09.2018 15:00		2464.625	7.7	754.0	48	-2.6
8557	30.09.2018 18:00		2464.75	5.5	754.3	64	-0.9
8558	30.09.2018 21:00		2464.875	2.9	754.6	79	-0.4

by the biotechnical law (Mazurkin, 2015) and additionally asymmetric wavelets. Since the wavelets of the mathematical construction are the same (invariant) for any objects of research, this article aims to study the quanta of behavior in binary relations between the considered meteorological parameters. Fitopatologia differs from meteorology to the fact that during the environmental measurements are taken of the vegetation periods of the years. However, at each weather station the beginning and the end of vegetation are different. Phyto meteorology deals with *point and spatial distributions* of weather and climate factors within vegetation periods, in our case for the city of Yoshkar-Ola, annually from 01.05 to 30.09. The main factors are: P_0 - atmospheric pressure at the level of the 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 vegetation period 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. For each ground-based weather station, it turns out that to identify quanta of behavior, it is necessary to study *the point distributions* of meteorological measurements every three hours on the above four parameters. Pair connections between these parameters allow us to study *the quanta of weather behavior* for different durations of time: long-term and annual periods of plant ontogenesis. As a result, the dynamic series with gaps characterizing the seasonal rest in the life of plants are formed. We distinguish two types of quanta of the behavior of the weather within the annual growing seasons:

first, in dynamics, each factor is subdivided into the sum of wavelets, that is, in discrete time, the factor is represented as pieces of a bundle of solitary waves 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, regardless of the number of pieces of the harness, additionally obtains *quantum entanglement* in some boundaries of the mutual influence of meteorological parameters.

Then any phenomenon or process of ontogenesis of any plant species can be estimated by the level of adequacy (correlation coefficient) of decomposition of the functional connectivity of the system of weather parameters in summer time into quantum unraveling and quantum entanglement. For example, such a wavelet analysis was implicitly performed on the parameters of a population of more than 250 genes (Mazurkin, 2018). We believe that plants have learned over 180 million years of evolution on Earth to understand the quantum behavior of seasonal weather through the biological mechanism of oscillatory adaptation to changes in temperature, pressure and humidity. They have developed a discrete mode of life during the growing season and rest outside the growing season. Of course, the beginning and the end of the growing season also depend on the dynamics of meteorological parameters, so it is different not only for different weather stations, but also for different years. However, for simplicity, we will take the growing periods constant over the years.

Source data: Weather Station Yoshkar-Ola, Russia, WMO_ID=27485, the sample was accepted from 01.01.2012 to 31.10.2018, and only days annually from 01.05 to 30.09. 01.01.2015 changed the form of representation of meteorological data (Tab. 1). The power of statistical sampling for four meteorological parameters was 8558 rows in discrete series pieces instead of 19713 in continuous series.

First, a wavelet analysis of the time series is performed, then the identification method is applied to the binary relations between the factors. Therefore, the adequacy of the dynamics models is taken into account in the diagonal cells of the correlation matrix. In the future, factor analysis excludes time, and it acts only as a system-forming factor that provides binary relations between the four weather parameters.

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 [6] of the form

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

$$p_i = a_{5i} + a_{6i} x^{a_{7i}}, \qquad (1)$$

where A_i - amplitude (half) of wavelet (axis y), p_i - 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

$$y = a\exp(-bx^c) + dx^e \exp(-f_i x^g) \quad \text{.......(2)}$$

where y_i – the dependent measure, x – influencing variable, $a-g$ – 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 [5] according to table 1. In our example, in the diagonal cells we put the correlation coefficient of the trend on the models of discrete dynamics from 01.05.2012 to 30.09.2018.

In contrast to the continuous series in 19713 points on a discrete series of 8558 lines *correlation coefficient of variation*, that is, a measure of the functional relationship between the parameters of the system (weather at the weather station), is 4.2764 / 4^2 = 0.2673 instead of 0.3018. Also, as for the full range of data, as the influencing variable in the first place was the meteorological parameter «Air temperature», on the second – «Dew point temperature» and on the third place – «Relative humidity». However, the dependent indicators have changed places: in the first place instead of «Air temperature» in table 2 is the meteorological parameter «Dew point temperature», and only in the second – «Air temperature», and in the third place is «Relative humidity» instead of the meteorological parameter «Air pressure». Then it turns out, as an indicator of the dew point temperature becomes a decisive factor not only for grass plants and shrubs, but also for the leaves of trees, especially from the bottom of the crown at a height of about 2 m.

Factor analysis by wave equation identification: At the information technology level, the 23rd Hilbert problem (development of variational calculus methods) was solved by us [6]. At the same time, *the variation of functions* is reduced to the conscious selection of stable laws and the construction of adequate stable laws on their basis. We adhere to the concept of Descartes on the need to apply an algebraic equation of a General form directly as a finite mathematical solution of unknown differential or integral equations. For this purpose, a new class of wave functions (1) was proposed. 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 error should be attributed to quantum entanglement. And the share of parameter values determined by the revealed regularities should be attributed to quantum unraveling (certainty). The adequacy of the models in table 3 is given by three terms of the General model (1) containing two

Table 2. Correlation matrix of factor analysis and rating of factors in birch ontogenesis for 7 years by trends (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	0.0461	0.0915	0.5829	0.6415	1.3620	**1**
ATMOSPHERIC PRESSURE P_0, MM HG	0.0123	0.0390	0.2300	0.2027	0.4840	4
RELATIVE HUMIDITY U, %	0.5555	0.2300	0.0294	0.3864	1.2013	3
DEW POINT TEMPERATURE T_d, ⁰C	0.6130	0.2068	0.3473	0.0620	1.2291	2
SUM Σr	1.2269	0.5673	1.1896	1.2926	4.2764	-
PLACE I_y	2	4	3	**1**	-	0.2673

Table 3. Correlation matrix of factor analysis and rating of factors in birch ontogenesis for 7 years by trend and annual wave of dynamics

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	0.5232	0.0915	0.5829	0.6415	1.8391	2
ATMOSPHERIC PRESSURE P_0, MM HG	0.0123	0.2849	0.2300	0.2027	0.7299	4
RELATIVE HUMIDITY U, %	0.5555	0.2300	0.3670	0.3864	1.5389	3
DEW POINT TEMPERATURE T_d, ⁰C	0.6130	0.2068	0.3473	0.6749	1.8420	**1**
SUM Σr	1.7040	0.8132	1.5272	1.9055	5.9499	**-**
PLACE I_y	2	4	3	**1**	-	0.3719

trend terms (2) and another wave equation for the diagonal cells of the correlation matrix. The correlative coefficient of variation was equal 5.9499 / 4^2 = 0.3719 that is less than the value 0.4421 for a complete range of meteorological data. However, there have been significant changes in the ranking of factors. In the first place as an influencing variable and as a dependent indicator stood meteorological parameters «Dew point temperature», and the air temperature has shifted to second place. This fact proves that plants with their vegetative organs not only adapt to their environment, but also create favorable conditions for their growth and development. The latter is especially noticeable in forest meteorology. 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 even in a truncated number of meteorological data. The dynamics for 2495 days on 8858 points allows to identify only two of a wavelet. For the dynamics we managed in the software environment CurveExpert-1.40(URL: http://www.curveexpert.net/) identify the second wavelet (tab. 4). The standard program does not allow to identify more than four members at the same time and it is difficult to perceive the number of points more than 3300. Therefore, for factor analysis with many wave members of large data sets, we need a special software environment for our computational scenarios. The coefficient of correlation variation increased to 6.2193 / 16 = 0.3887, which is less than the full range of data 0.4583. At the same time, the rating of factors stood on the influencing variables equally with the full range: the air temperature is in the first place, and the dew point temperature is in the second place.

But dependent indicators because of the introduction of the periodicity of the vegetation of birch, in the first place finally gets the dew point temperature. With the introduction of new distinguishing features for the decomposition of the full range of meteorological factors rating may well change. Then it turns out that the dynamics of meteorological parameters should be considered separately by the method of wavelet analysis, and the binary relations between the parameters become objects of quantum physics of the behavior of macro-objects (in our example, the weather at the weather station, taking into account the growing season of the birch tree). In comparison with the quantum physics of micro-objects below the level of atoms, there are no quantum structural States in quantum phytometeorology, that is, the structure of macro-objects in comparison with their behavior will be considered constant in time.

Regularities of dynamics of meteorological parameters: We take dynamic models containing four terms (two for trend and two asymmetric wavelets). As a rule, the models of any dynamics (at different time counts: year, month, day, hours) can be brought to a finite set of wavelet signals by the method of identification. The criterion for stopping the identification process is only the measurement error. Each wavelet becomes a separate *quantum of behavior* (for macro-objects in comparison with their behavior, *the structure quanta* can be assumed constant). For example, the average air temperature in Central England for 1659-2017. according to Hadley Centre Central England Temperature (HadCET) to the measurement error ∓*0.050*C is characterized by a set of 188 wavelets. Table 5 shows the values of the model parameters (1). It shows that parts of the trend are special cases of wavelet. It is noticeable that the trend in the dynamics of the air temperature and the

Table 4. Correlation matrix of factor analysis and trend rating of factors (2) for binars and two wavelets (1) dynamics in birch ontogenesis

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	0.7155	0.0915	0.5829	0.6415	2.0314	**1**
ATMOSPHERIC PRESSURE P_0, MM HG	0.0123	0.3324	0.2300	0.2027	0.7774	4
RELATIVE HUMIDITY U, %	0.5555	0.2300	0.3854	0.3864	1.5573	3
DEW POINT TEMPERATURE T_d, ⁰C	0.6130	0.2068	0.3473	0.6861	1.8532	2
SUM Σr	1.8963	0.8607	1.5456	1.9167	6.2193	-
PLACE I_y	2	4	3	**1**	-	0.3887

Table 5. The parameters of models of the dynamics of meteorological data for the growing season of birch

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}	
Air pressure dynamics									
1	751.55011	0	-1.59539e-6	1	0	0	0	0	0.3324
2	1.00419e-8	2.39029	0	0	0	0	0	0	
3	3.13165	0	-0.00053375	0.95975	173.41552	0.0020381	1.01189	0.87566	
4	0.66360	0	-4.16206e-5	1.31769	10.98880	0	0	1.79931	
Dynamics of air temperature									
1	7.52303	0	4.79122e-5	1.17530	0	0	0	0	0.7155
2	-12.43356	0	-7.56495e-5	1	182.70470	0.0020607	0.76853	0.12287	
3	-4.17607	0	2.68267e-7	1	0.49998	0	0	1.21891	
Dynamics of relative humidity									
1	80.74435	0	2.38926e-5	0.92930	0	0	0	0	0.3854
2	-6.34265e-5	2.01418	0.0017968	0.98661	0	0	0	0	
3	15.02276	0	0.00015561	1	161.15490	0.0070672	1	-0.23262	
4	2.55094	0	-2.24927e-5	1	0.50071	9.97600e-7	1	-0.72045	
Dew point temperature dynamics									
1	-0.17425	0	-0.0019637	0.90133	0	0	0	0	0.6861
2	-14.19933	0	-2.39373e-5	1	183.71032	-0.00018041	1.00324	0.30506	
3	0.41940	0	-0.00050810	0.99687	43.30895	-0.00090267	1.01383	-5.01980	

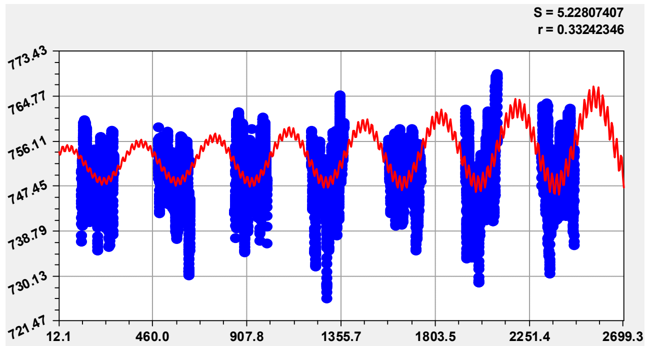
point received only one component in the form of the exponential law of death (for air temperature) growth and death (for the dew point temperature). This fact indicates that in the growing season from 01.05 to 30.09 anthropogenic influence on the exponential law is excluded. In the area around the meteorological station WMO_ID=27485 anthropogenic influence is only in the winter. A negative sign in front of the model component shows that it is a crisis to increase the values of the meteorological parameter. At the same time, in the dynamics of air pressure, all four members have a positive sign and the adequacy of 0.3324 is greater than 0.3028 for a continuous series of pressure. The first term of the model (2) of the trend is the law of Laplace (in mathematics), Mandelbrot (in physics), Zipf-pearl (in biology) and Pareto (in econometrics). It shows the exponential decrease in temperature and relative humidity over time and the exponential increase in pressure and temperature of the dew point during the growing season of birch 2012-2018 years at the weather station WMO_ID=27485. As a rule, the first term of the model is a natural component, and the second and subsequent members of the model show anthropogenic influence. Then it turns out that the second term according to the exponential growth law gives a dynamic increase in air pressure. Reduction of relative humidity occurs according to the biotechnical law [6]. Both temperatures do not have a second member.

The last two terms have the amplitude of oscillation according to the law of exponential growth or death (Laplace's law). Both wavelets are infinite-dimensional, since due to Laplace's law the amplitude change shows the continuation of the values until 2012 and after 2018. According to the first wavelet for 7 years of birch vegetation, the oscillatory disturbance in the amplitude of the relative humidity of the air decreases, and for the other three meteorological parameters – increases. The second wavelet gives a decrease in the amplitude in the dynamics of the air temperature, and other meteorological parameters are increased. In General, model (1) the highest adequacy for air temperature with a correlation coefficient of 0.7155 together with 0.8924 for the complete series. Relative humidity has an adequacy of 0.3854 instead of 0.5893, and the dew point temperature, respectively, - 0.6861 and 0.8654. Thus, the timing of the growing season increases the importance of air pressure. From the values of the half-period of oscillation it can be seen that the first wavelet has a one-year oscillation cycle, but it increases to the norm of 182.63 days (365.25 / 2), starting on the date 01.01.2012, the half-period of 173.42 days for air pressure, 182.70 for air temperature, 161.15 (instead of 181.15) days for relative humidity and 183.71 days for dew point temperature. Thus, the first wavelet has variable values that differ in the maximum relative humidity on the date 01.01.2012. 100 (182.63 – 161.15) / 182.63 = 11.76 % (instead of 3.98% air pressure for the complete range). Then it becomes clear that the sensitivity of the growing season to relative humidity is much higher compared to the full range.

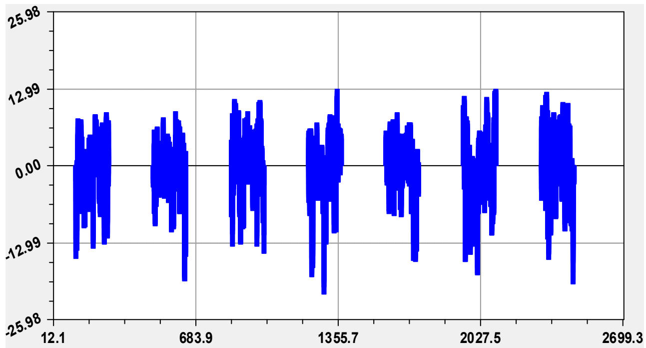
From the second wavelet is seen that the period of pressure fluctuations on 01.01.2012 equal 2×10.98880 ≈ 21.98 days and he subsequently remains constant and the temperature of the dew point it is 86.62 hours and it decreases with time. For the full range of data, this shift was different (102.28 days for air pressure and 79.41 days for relative humidity). In this case, the dynamics of air temperature occurs with a constant daily period, and the dynamics of relative humidity is approaching the daily cycle. It can be assumed that the air temperature and relative humidity do not depend on the type of series. 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 svetilniki plants glucose and oxygen from carbon dioxide and water according to the formula $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$. Mostly at night leaves back exhale carbon dioxide in accordance with the General equation of the process of cellular respiration: is $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ + 38АТФ. In this regard, the influence of air temperature and relative humidity on the ontogenesis of birch leaves throughout the Northern hemisphere becomes a decisive process in the quantum bonds of phenology and meteorology.

Graphs of meteorological parameters dynamics

Air pressure dynamics. The adequacy of the model (1) according to table 5 is equal to the correlation coefficient 0.3324 (Fig. 1). With a decrease in the period of time to one vegetation period, the level of adequacy will significantly increase, reaching a correlation coefficient of 0.99 on the influence of the sums of temperatures and relative humidity on the ontogenesis of tree leaves.



Two members of the trend and two wavelet

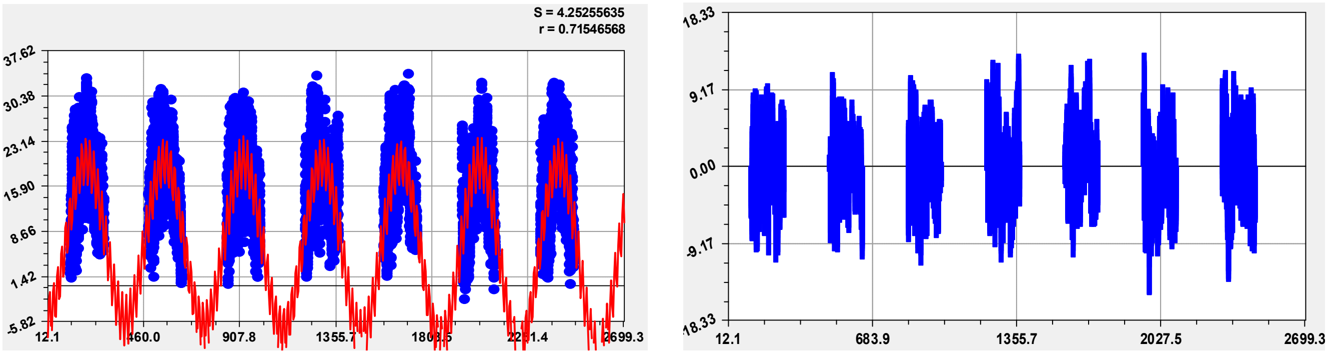


The residues of the model from table 5

Figure 1. Graphs of four members of the general model (1) air pressure dynamics: S **- variance;** r **- correlation coefficient**

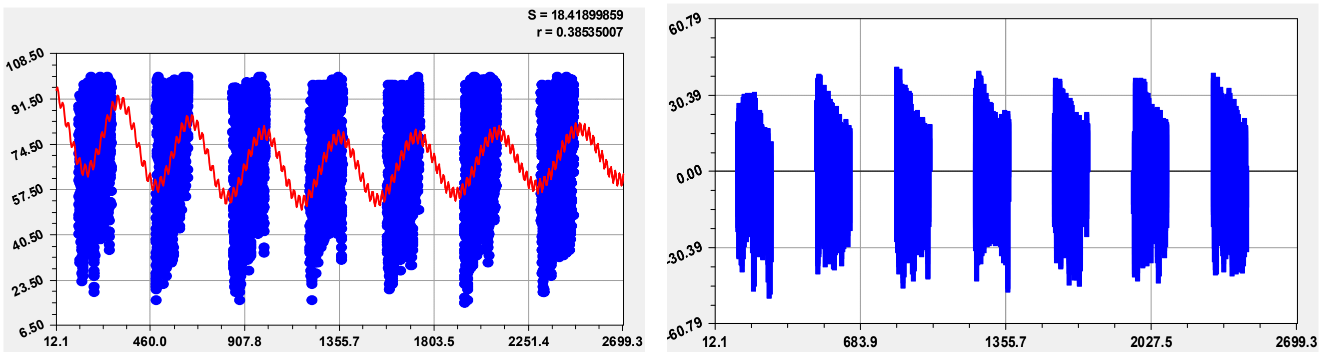
The graph shows that the pressure minima are observed in the middle of the growing season of birch. The residuals, i.e. the absolute error of the model (1), in figure 1 show that other oscillations are possible.

Dynamics of air temperature: For three members with a correlation coefficient of 0.7155, the model (1) with the parameters in table 5 refers to the level of adequacy of strong links (Fig. 2) with correlation coefficient not less than 0.7. Highs of air temperature are observed in the middle of the growing season of birch.



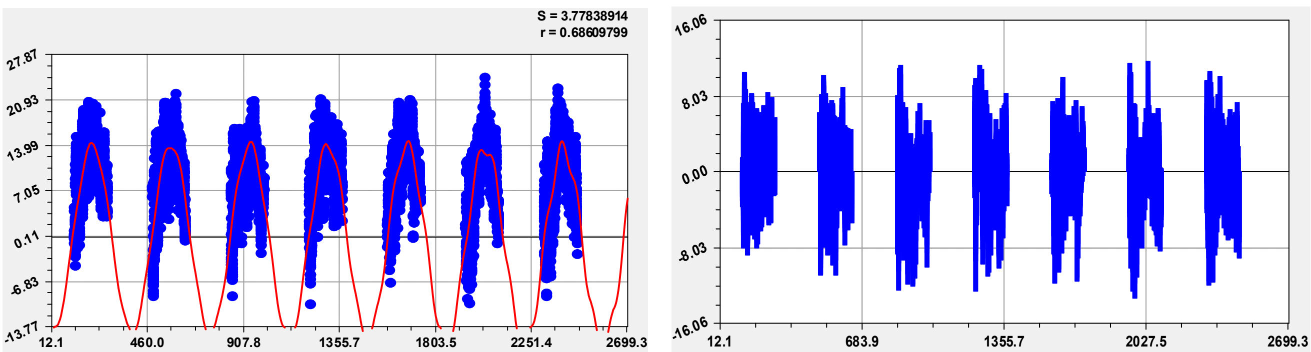
One trend term and two wavelets The residues of the model from table 5

Figure 2. Graphs of the general model (1) air temperature dynamics



Two members of the trend and two wavelet The residues of the model from table 5

Figure 3. Graphs of the general model (1) relative humidity dynamics



One trend term and two wavelets The residues of the model from table 5

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

The remains of a possible identification and other vibrational disturbances. However, a large array of data did not allow the CurveExpert-1.40 software environment to identify Them. In addition, 7 years were taken for exploratory factor analysis of discrete series of three-hour dynamics of four meteorological parameters.

Dynamics of relative humidity. With the correlation coefficient 0.3854, that is, at a weak level of adequacy with the correlation coefficient from 0.3 to 0.5, the graphs in figure 3 were obtained. The growing season of birch is located on the rising part of the wave, and the rest period of birch leaves-on the falling part of the cosine function. At the same time on the date 01.05 is the minimum relative humidity, and the maximum humidity is almost at the right end of the growing season. Then it turns out that the birch leaves grow and develop in the mode of increasing humidity. The residues in figure 3 show the possibility of further identification of wavelets, so the correlation coefficient, with the growth of the set of oscillations, quite a few tens of quanta of behavior, can reach 1. Therefore, the level of adequacy of models depends on the number of their members. Four terms were adopted to compare models of different meteorological parameters.

Dew point temperature dynamics: Compared with the air temperature, this meteorological indicator (Fig. 4) obtained a smaller correlation coefficient 0.6861 (average correlation coefficient 0.5 – 0.7). In many ways, these two signs of weather are meaningful, apparently, equally significant. The dew point temperature somehow affects the process of ontogenesis of leaves of woody plants. It may be that this factor has a greater impact on low-growing plants less than 2 m high, such as leaves of grass and herbaceous plants, as well as shrubs and agricultural plants. However, as can be seen from the data in table 4, as a dependent indicator of the dew point temperature rating came in first place. Therefore, in the future, this factor for the assessment of ontogenesis of birch leaves hanging at a height of about 2 m will need to be taken into account. For leaves on top of birch it can be excluded.

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. Due to the quantum entanglement of the relations between the factors, the wave equations by (1) are not obtained, so the trend model (2) was adopted for identification.

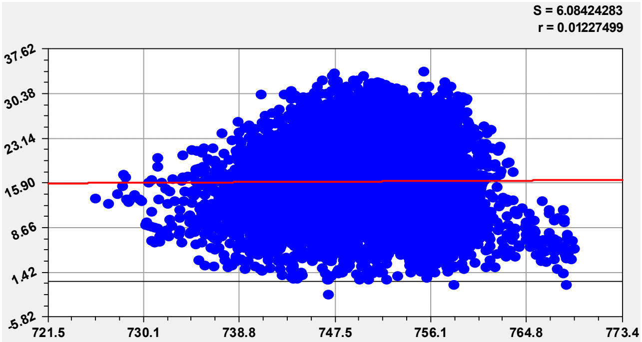
Effect of air pressure: The remaining three factors the air pressure is affected by the two-membered formula of the trend (Fig. 5):

$$U = 695.65605\exp(-3.74285 P_0^{0.99744}) - 0.84870 P_0^{0.99276};$$ (4)

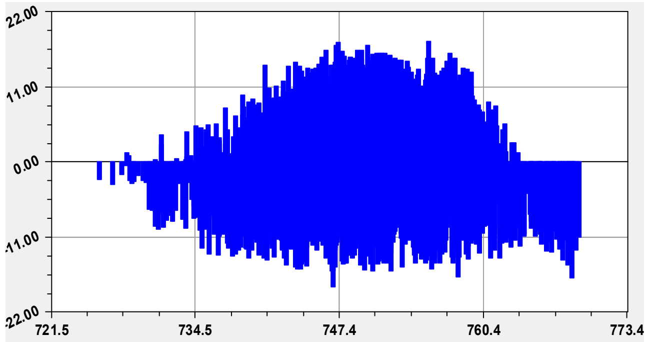
- influence of air pressure on dew point temperature (does not change)

$$T_d = 152.13272\exp(8.46810e-6P_0) - 0.18838 P_0^{1.00203}.$$ (5)

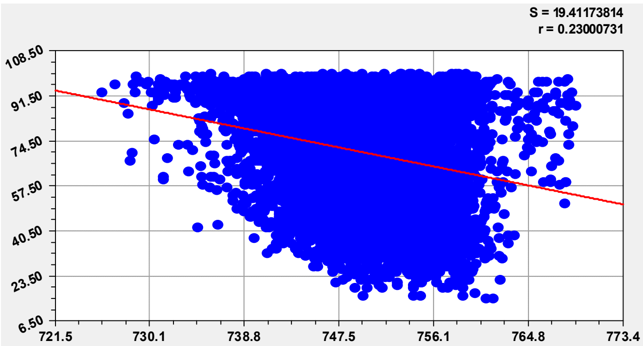
With increasing air pressure in the surface layer of the atmosphere by the modified Laplace law increases the air temperature and dew point temperature.



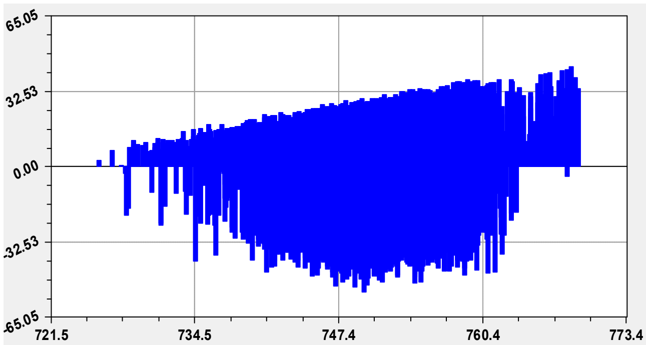
Air temperature r =0.0123



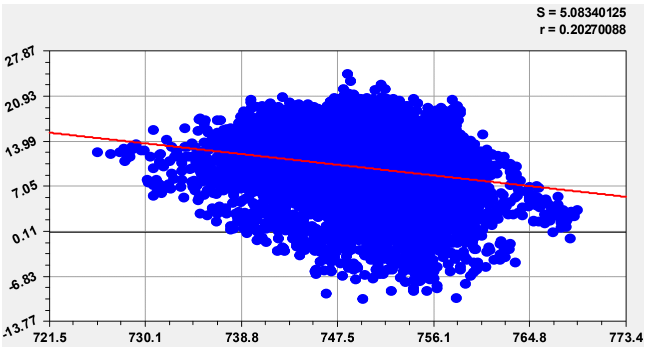
Residues from the two membered trend (3)



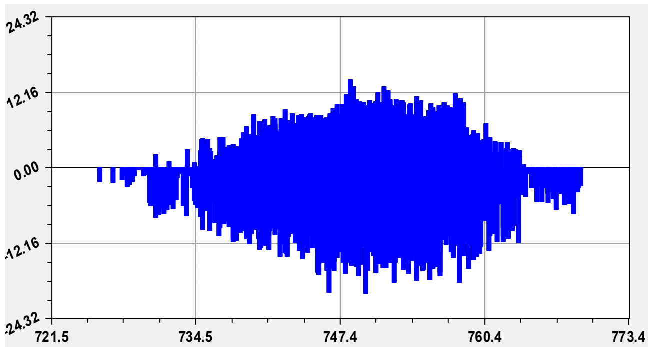
Relative humidity 0.2300



Residues from the two membered trend (4)



At dew point temperature 0.2027



Residues from the two membered trend (5)

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

- the influence of air pressure on the air temperature (in comparison with the full range of data, the second term is positive, that is, it increases the air temperature, and the design of the model is brought to the biotechnical law [6])

$$T = 2.84054\exp(0.00015686 P_0) + 0.018068 P_0^{1.06666}\exp(-0.00064644 P_0);$$ (3)

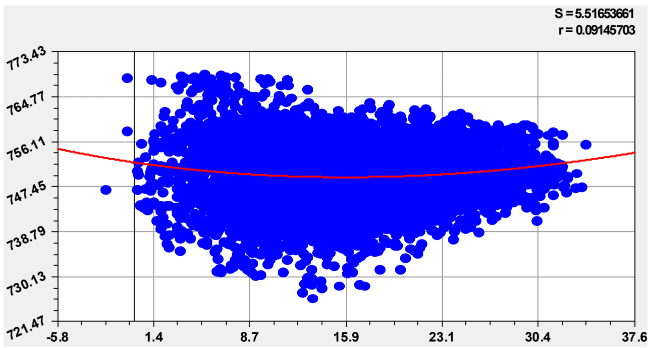
- influence of air pressure on relative humidity (the sign before the second term is kept, however the formula gets the indicative law instead of the biotechnical law)

But the second term in the air temperature is positive, and the dew point temperature is negative. And relative humidity on this natural regularity decreases with deduction of the second term.

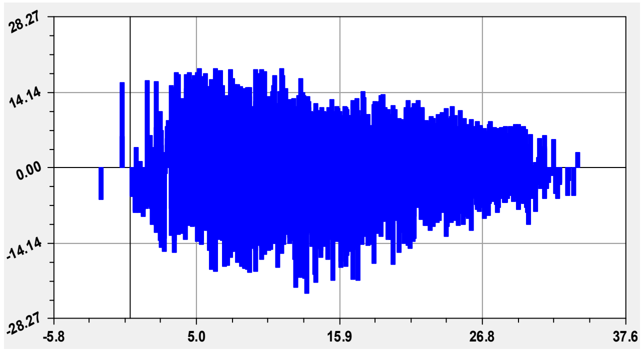
Effect of air temperature. Figure 6 shows the effect graphs.

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

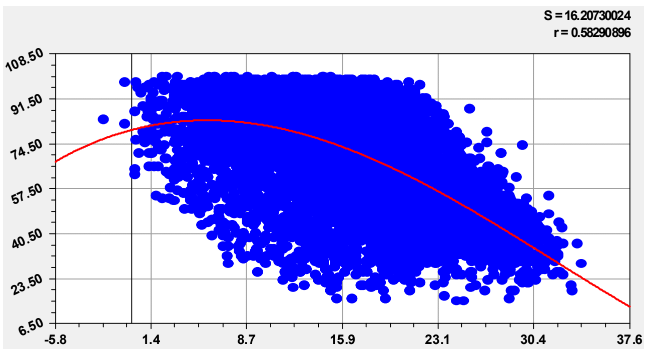
- influence of air temperature on air pressure (instead of subtraction of the second term at a full number there is a



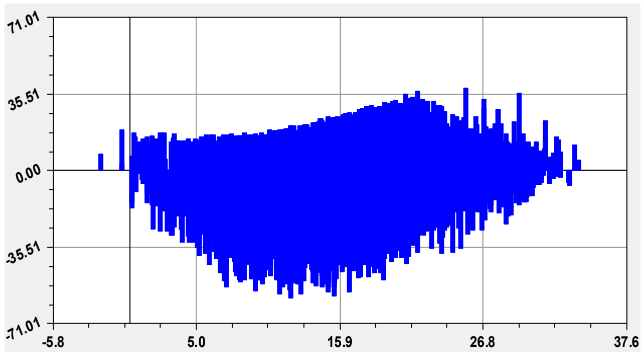
On air pressure 0.0915



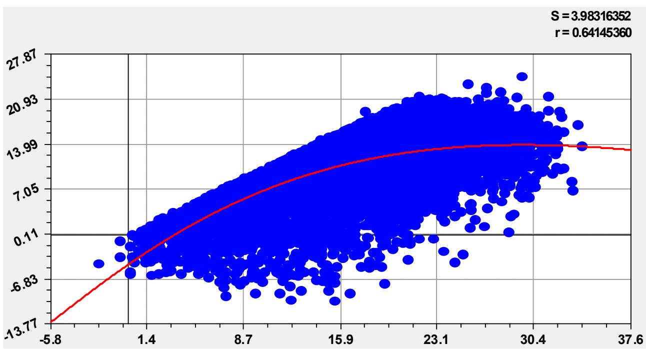
Residues from the two membered trend (6)



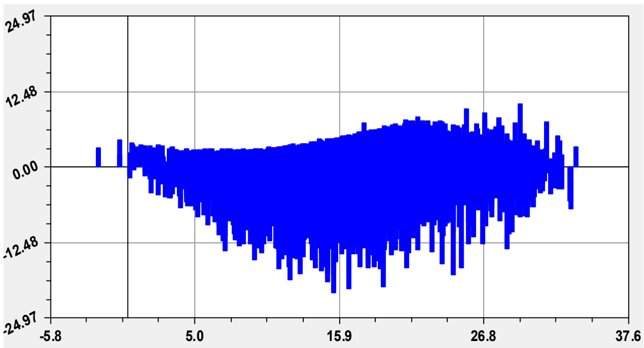
Relative humidity 0.5829



Residues from the two membered trend (7)



At dew point temperature 0.6415



Residues from the two membered trend (8)

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

summation at transformation of the biotechnical law into the indicative law for the periods of vegetation)

$$P_0 = 757.34584\exp(-0.00094998(T+10)^{1.02435}) + 0.046854(T+10)^{1.70046}$$; (6)

- the influence of air temperature on relative humidity (the first term became the law of growth instead of the exponential law of death)

$$U = 50.85770\exp(0.10906(T+10)^{0.77597}) - 0.15326(T+10)^{2.06077};$$ (7)

- the influence of air temperature on the dew point temperature (the first term received a negative sign with the law of death instead of the law of growth, while the second term became positive instead of negative for the complete series)

$$T_d = -19.16388\exp(-9.36773e-5(T+10)^{0.54948}) + +1.01793(T+10)^{1.30032}\exp(-0.032967(T+10)^{0.94950}). \quad (8)$$

Because of the negative temperature values, the abscissa axis was shifted by only 10 instead of 50 ^{0}C for the complete series.

Thus, on a discrete series of meteorological data, the influence of air temperature has changed significantly.

Effect of relative humidity. This effect is shown by the graphs in figure 7.

The influence of graphs was identified by equations of the form:

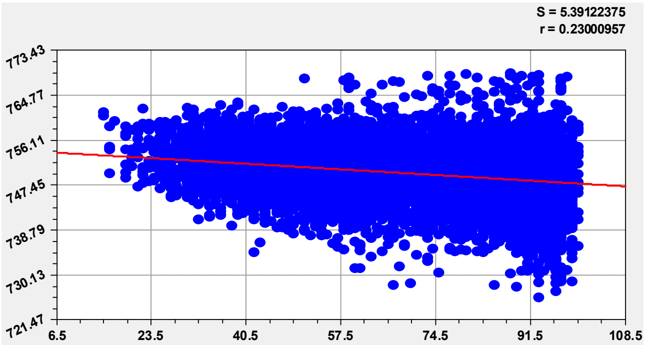
- the influence of relative humidity on air pressure changed in the first term on the exponential law of death

$$P_0 = 754.11674\exp(-2.79526U^{1.18635}) - 0.057661U^{1.00275};$$ (9)

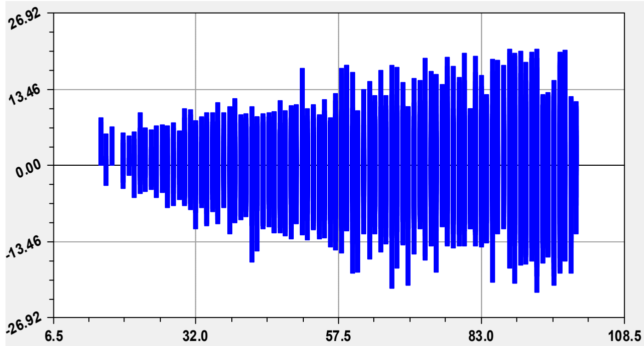
- the influence of relative humidity on the air temperature in the design of the model remains unchanged, but instead of the indicative law, the second member received a biotechnical law

$$T = 18.41909\exp(0.011076U^{0.94808}) - 4.96466e-5U^{3.35410}\exp(-0.020311U^{1.00319}); \quad (10)$$

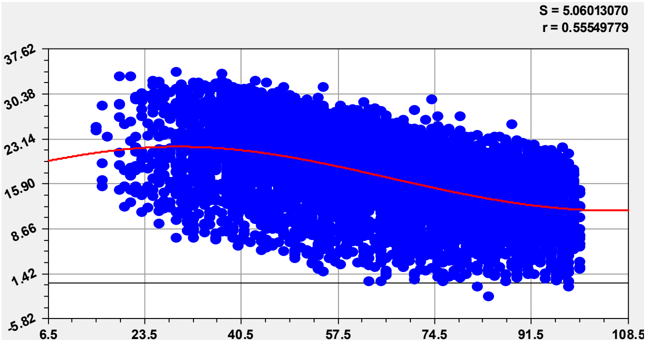
- the influence of relative humidity on the dew point temperature has changed significantly (the first term received a



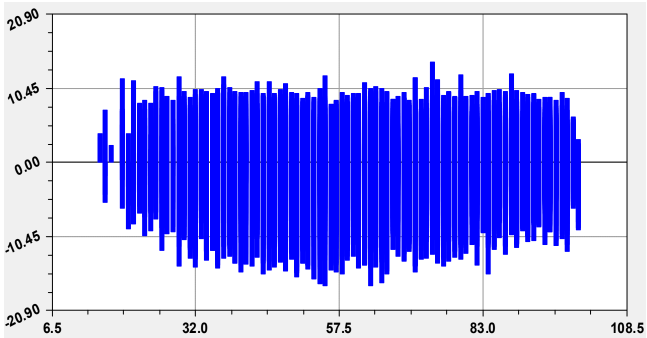
On air pressure 0.2300



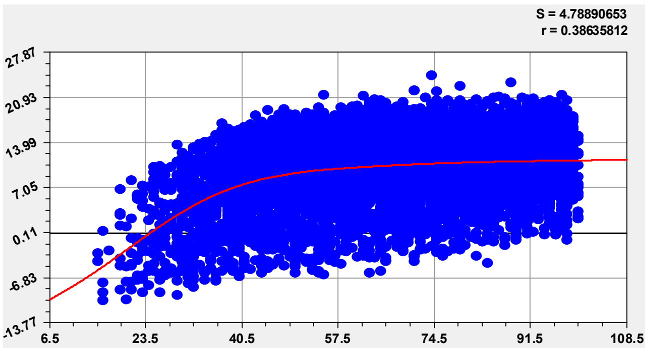
Residues from the two membered trend (9)



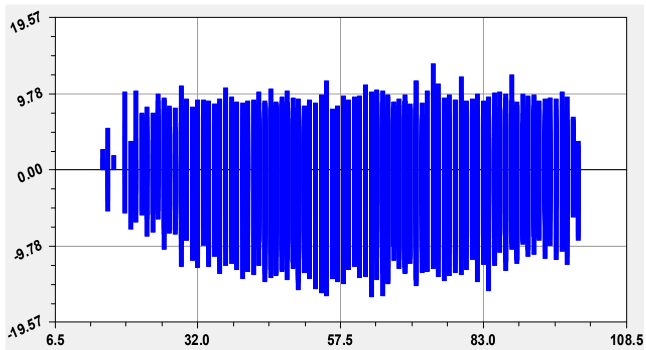
Air temperature 0.5555



Residues from the two membered trend (10)



At dew point temperature 0.3864



Residues from the two membered trend (11)

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

negative sign according to the law of exponential death, and the second term was formed with a positive sign)

$$T_d = -14.15534\exp(-0.00040137U^{2.33465}) + 1.12754U^{0.68102}\exp(-0.034912U^{0.68911}) \quad (11)$$

There have also been changes in the influence of relative humidity on all three meteorological parameters.

Influence of dew point temperature. Other meteorological parameters (Fig. 8).

The dew point temperature is influenced by the formulas:

- the influence of dew point temperature on air pressure changed by the first term (instead of the law of death exponential growth law)

$$P_0 = 755.71647\exp(0.00030266(T_d+15)^{1.24319}) - 0.26081(T_d+15)^{1.40452}\exp(-0.0050474(T_d+15)^{1.20277}) \quad (12)$$

- the influence of the dew point temperature on the air temperature also changed by the first term (instead of the law of growth exponential law of death)

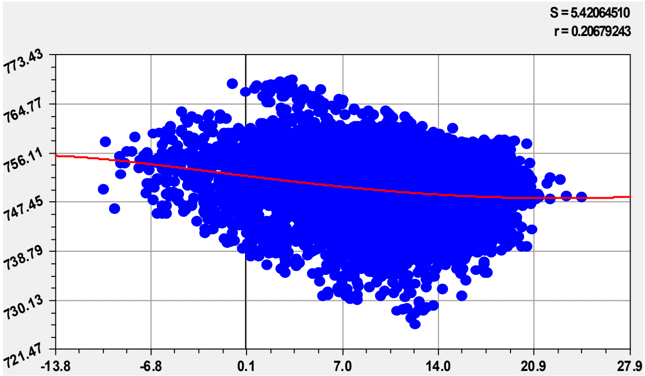
$$T = 20.56816\exp(-0.085073(T_d+15)^{1.16031}) + 0.047210(T_d+15)^{1.84517}\exp(-0.00026666(T_d+15)^{1.99070}) \quad ....(13)$$

- the influence of the dew point temperature on the relative humidity was obtained with a positive sign in front of the second member, and the second member received a complete design in the form of biotechnical law

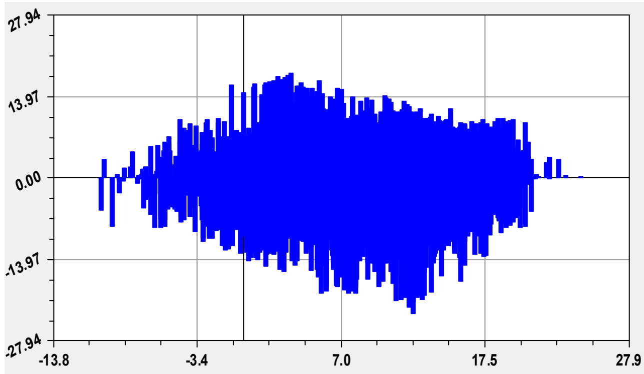
$$U = 0.12357\exp(0.0097449(T_d+15)^{1.17928}) + 2.63793(T_d+15)^{1.37810}\exp(-0.042320(T_d+15)^{1.02428}) \quad ....(14)$$

Here, too, the origin of the temperature is shifted to the left by 15^0C instead of 50^0C for the full range of meteorological data. Then it turns out that the beginning of the growing season on average for birch is in the temperature range of 10-15^0C. but for each year of vegetation begins differently.

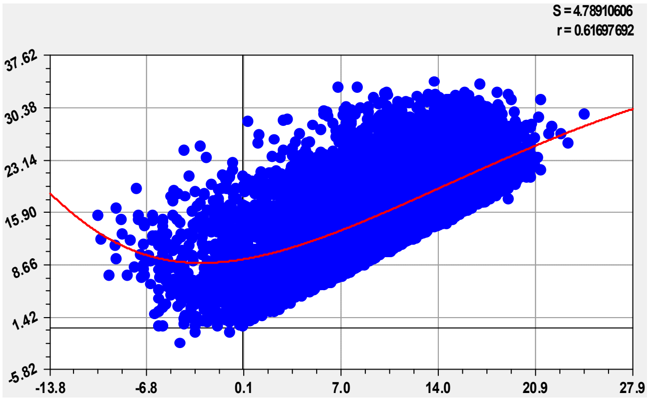
At zero values of the influencing variables according to the previous formulas, we obtain the limit theoretical values of the dependent indicators (Tab. 6). From the data in table 6 it can be seen that the most dangerous is the change in air pressure to zero.



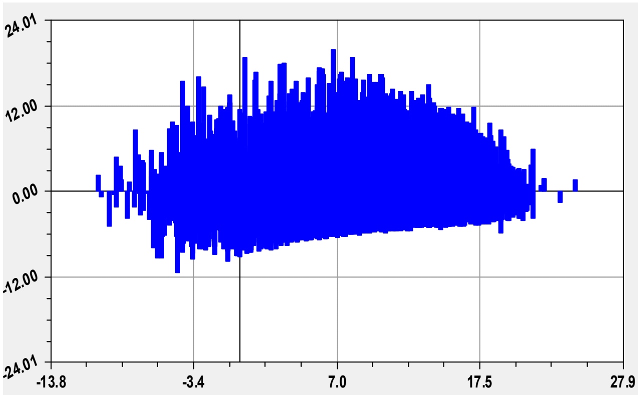
On air pressure 0.2068



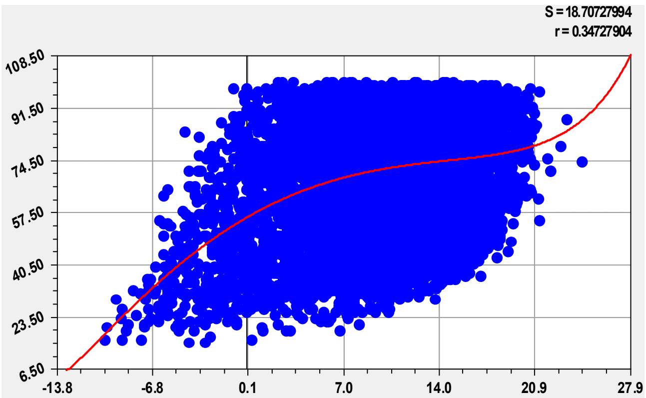
Residues from the two membered trend (12)



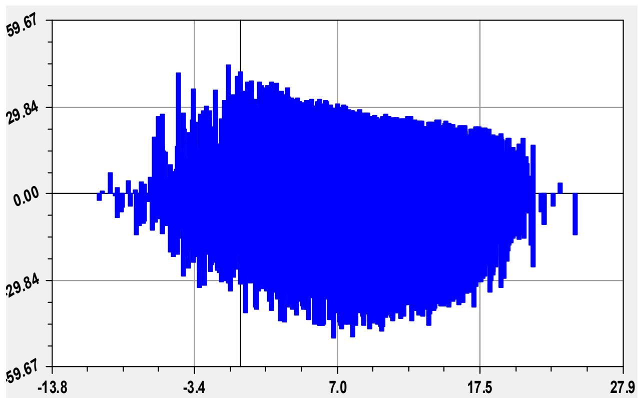
Air temperature 0.6170



Residues from the two membered trend (13)



Relative humidity 0.3473



Residues from the two membered trend (14)

Figure 8. Influence of dew point temperature on meteorological parameters: left column – trend charts; right column-post-trend balances

Table 6. 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, MM HG	T, ^{0}C	U, %	T_d, ^{0}C
Pressure $P_0 = 0$ mm Hg	-	2.84	695.66	152.13
Temperature $T = -10^0$C	757.35	-	50.86	-19.16
Relative humidity $U = 0\%$	754.12	18.42	-	-14.16
Dew point temperature $T_d = -15^0$C	755.72	20.57	0.12	-

The atmosphere on humidity will become, almost as on Venus, under extremely high humidity in 695.66 %. The limits of other meteorological parameters do not cause concern. Therefore, we believe that in every geographical point of the earth's land at weather stations it is necessary to pay close attention to the air pressure drops.

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 $1-r$ (Tab. 7).

Table 7. 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, mm Hg	Temperature T, ^{0}C	0.0123	0.9877
	Relative humidity U, %	0.2300	0.7700
	Dew point temperature T_d, ^{0}C	0.2027	0.7973
Temperature T, ^{0}C	Pressure P_0, mm Hg	0.0915	0.9085
	Relative humidity U, %	0.5829	0.4171
	Dew point temperature T_d, ^{0}C	0.6415	0.3585
Relative humidity U, %	Pressure P_0, mm Hg	0.2300	0.7700
	Temperature T, ^{0}C	0.5555	0.4445
	Dew point temperature T_d, ^{0}C	0.3864	0.6136
Dew point temperature T_d, ^{0}C	Pressure P_0, mm Hg	0.2068	0.7932
	Temperature T, ^{0}C	0.6170	0.3830
	Relative humidity U, %	0.3473	0.6527

From the data of table 7 it can be seen that the highest quantum entanglement is observed in the influence of pressure on the air temperature on the discrete series of meteorological parameters for the growing periods of birch.

Conclusion

The main features of the three-hour dynamics of meteorological parameters are daily cycles (periods of the earth's revolution around itself) and annual cycles (periods Of the earth's revolution around the Sun). For each ground-based weather station it is necessary to study *point distributions* of meteorological measurements every three hours on four parameters. Pair connections between meteorological parameters allow us to study *the quanta of weather behavior* for different periods of time: long-term, annual, seasonal and ontogenesis of plants. Any phenomenon or process can be estimated by the level of adequacy (correlation coefficient) of the decomposition of the functional connectivity of the system into quantum unraveling and quantum entanglement. 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. Accounting periods of the growing season of birch at the weather station WMO_ID=27485 showed that compared with continuous rows of substantially changing the construction of wavelets (1) and two members of trends (2). At the same time, these changes confirm that plants grow and develop annually under favorable weather conditions from 01.05 to 30.09. When taking into account the periods of birch vegetation in the ranking of factors in comparison with continuous series there were significant changes. The coefficient of correlative variation became equal to 0.3887, which is less in comparison with the full range of data 0.4583. At the same time, the rating of factors stood on the influencing variables equally with the full range: the air temperature is in the first place, and the dew point temperature is in the second place. But according to the dependent indicators, due to the introduction of the periodicity of the birch vegetation, the dew point temperature comes first. With the introduction of new distinguishing features for the decomposition of the full range of meteorological factors rating may well change. According to the first wavelet for 7 years of birch vegetation, the oscillatory disturbance in the amplitude of the relative humidity of the air decreases, and for the other three meteorological parameters – increases. The second wavelet gives a decrease in the amplitude in the dynamics of the air temperature, and other meteorological parameters are increased. Model (1) the adequacy of air temperature with a correlation coefficient of 0.8924 0.7155 together for a complete range. Relative humidity has an adequacy of 0.3854 instead of 0.5893, and the dew point temperature, respectively, - 0.6861 and 0.8654. Thus, the timing of the growing season increases the importance of air pressure. From the values of the half-period of oscillation a_{5i} it can be seen that the first wavelet has a one-year oscillation cycle, but it increases to the norm of 182.63 days (365.25 / 2), starting on the date 01.01.2012, the half-period of 173.42 days for air pressure, 182.70 for air temperature, 161.15 (instead of 181.15) days for relative humidity and 183.71 days for dew point temperature. Thus, the first wavelet has variable values that differ in the maximum relative humidity on the date 01.01.2012. 100 (182.63 – 161.15) / 182.63 = 11.76 % (instead of 3.98% air pressure for the complete range). Then it becomes clear that the sensitivity of the growing season to relative humidity is much higher compared to the full range. From the second wavelet is seen that the period of pressure fluctuations on 01.01.2012 equal 2×10.98880 ≈ 21.98 days and he subsequently remains constant and the temperature of the dew point is 86.62 hours and it decreases with time. For the full range of data, this shift was different (102.28 days for air pressure and 79.41 days for relative humidity). In this case, the dynamics of air temperature occurs with a constant daily period, and the dynamics of relative humidity is approaching the daily cycle. It can be assumed that the frequency characteristics of the air temperature and relative humidity do not depend on the type of series. The values of the oscillation amplitude depend on it.

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