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Factor Analysis of Annual Global Carbon Dynamics (According to Global_Carbon_Budget_2017v1.3.xlsx)

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Abstract

The method of identification of stable regularities carried out a factor analysis of the annual dynamics of six parameters of the global carbon budget from 1959 to 2016, and four-term equations with two members of the trend and two wavelets with variable amplitude and period of oscillations. For the growth vector of the global carbon budget, positive and negative wavelets. In addition to the first member showing the natural process, all other components of the general model characterize, as a rule, a natural-anthropogenic or even anthropogenic impact. The coefficient of correlative variation, that is, a measure of the functional relationship between the parameters of the system, is 0.7475. In comparison with trends, the adequacy of the system of factors increased 1.5 times. Identification of wavelets can continue. This fact means that in [1] good data are given and the hypothesis of vibrational adaptation of six factors to each other is confirmed. The rating of factors by trends, and then by wavelets, turned out to be the same. As the influencing variable in the first place was the parameter ≪ Fossil fuel and industry C_{fi} ≫, on the second – ≪ Ocean sink C_{os} ≫ and in third place – ≪ Atmospheric growth C_{ag} ≫. As the dependent indicator in the first place is ≪ Ocean sink C_{os} ≫, on the second – ≪ Fossil fuel and industry C_{fi} ≫ and the third – ≪ Land-use change emissions C_{le} ≫.

Keywords: Carbon; Budget; Factors, Rating; Analysis; Regularities

Introduction

To model the annual global carbon dynamics from data [1] (in part Historical CO_2 budget в файле Global Carbon Budget) we applied first trends and then wavelets, i.e. wave equations with variable amplitude and period of oscillations. The role of European forests in the accumulation of carbon increases over the years [2]. By the method of identification [3], we have determined the regularities of geographical distribution of stand parameters over the trial areas of birch forests of Northern Eurasia [4]. A detailed simulation of the dynamics of the parameters of trees of the multi-tiered Siberian pine was carried out in articles [5-7]. It is proved that in one population of the pine trees there are the so-called dendrology with the same biotechnical nature of the change parameters.

Examples of factor analysis by the method of identifying trends and wave patterns are given in our publications [8-15]. All phenomena and processes in nature occur by wave adaptation to the environment. This principle exists not only on Earth, but throughout the Universe. Therefore, it is possible to look for stable wave patterns in the binary relations between the factors that make up the unified system. Such factors are called system parameters, in particular, in this article the system of global carbon dynamics according to annual data from 1959 to 2016. Here the authors [1], identified six factors.

Factor analysis is defined as a set of methods of multivariate statistical analysis used to study the relationships between the values of the studied parameters as indicators of the system and at the same time as their explanatory variables. From the known methods of factor analysis (principal components method, correlation analysis and maximum likelihood method) we apply the correlation analysis by regression method. We pass to the methodology of heuristic, structural and parametric identification of stable laws by the method of identification [3-15].

The method of factor analysis in our case is understood as mathematical actions. It is understood as the identification of stable patterns of changes in the values of each of the set of parameters of the studied system, as well as mathematical relationships between all the selected factors. Verification of the truth of the obtained knowledge at the quantitative level, that is, the quality, completeness and error of the measurements, become the main conditions for the input control of the simulation. The control is performed according to the adequacy of the laws of rank distributions or the dynamics of the factors values.

The truth of stable laws is accepted as an axiom. Therefore, there is no need to choose an empirical formula – it is a priori given.

Our method of factor analysis allows not only to establish a posteriori cause-effect relationships, but also to give them a quantitative characteristic, provides an assessment of the level of influence of factors (as influencing parameters) on the results of functioning or activity (as dependent parameters). This makes factor analysis an accurate method, and conclusions-quantitatively justified and, based on the analysis of posteriori information, meaningful in the course of identification of composite biotechnical patterns.

First, we assume that the system is divided into fact. The same term «factor» has two different interpretations. Of them select the first factor is the circumstance that is the hallmark. Then compare the definitions of the three words «act», «factor» and «fact». Then it becomes clear that an act – is an action, a fact – is the result of an action, and a factor – is a distinctive feature within a given action. If the factor is located on the abscissa axis, the same factor becomes the explanatory variable, and when located on the ordinate axis – dependent indicator.

When revealing mathematical connections between quantitatively measured factors of the system «The Global Carbon Budget 2017» the following basic principles are taken into account:

I. Correlative variation according to Charles Darwin (the estimated statistical parameter–is the coefficient of correlation variation);

II. The complementarity of the various measurements made by different authors in different parts of the Earth's biosphere (ecological superposition);

III. Barry Commoner's law in the environment «Everything is connected with everything», that is, any factor in the quantitative measure (correlation) affects the change in the values of other factors;

IV. Heuristic (meaningful, intuitive, speculative, contemplative, qualitative) laws and patterns in the general phytocenology;

V. Biotechnical law and its mathematical formula of interaction of two multidirectional forces of action and counteraction for identification of regularities [3-15].

Source data

The Global Carbon Budget 2017 is a collaborative effort of the global carbon cycle science community coordinated by the Global Carbon Project [1].

The following symbols of the parameters from Table 1 are accepted:

- C_{fi} - Emissions from fossil fuel combustion and industrial processes (uncertainty of ±5% for a ±1 sigma confidence level);
- C_{le} - Emissions from land-use change (uncertainty of ±0.7 GtC/yr);
- C_{ag} - The atmospheric CO_2 growth rate (variable uncertainty around 0.2 GtC/yr from 1980) is estimated directly from atmospheric CO_2 concentration measurements, NOAA/ESRL;
- C_{os} - The ocean sink (uncertainty of ±0.5 GtC/yr) is estimated from the average of several global ocean biogeochemistry models that reproduce the observed mean ocean sink of the 1990s;
- C_{ls} - The land sink (uncertainty of ±0.9 GtC/yr on average) was estimated from the average of several dynamic global vegetation models that reproduce the observed mean total land sink of the 1990s;
- C_{bi} - The budget imbalance is the sum of emissions (fossil fuel and industry + land-use change) minus (atmospheric growth + ocean sink + land sink); it is a measure of our imperfect data and understanding of the contemporary carbon cycle.

Table 1: Data from Global Carbon Budget [1].

Year	fossil fuel and industry	land-use change emissions	atmospheric growth	ocean sink	land sink	budget imbalance
	C_{fi}	C_{le}	C_{ag}	C_{os}	C_{ls}	C_{bi}
1959	2.45	1.77	2.04	0.77	0.98	0.44
1960	2.57	1.64	1.51	0.78	1.81	0.11
1961	2.58	1.57	1.65	0.65	1.02	0.83
1962	2.69	1.53	1.19	0.75	1.62	0.66
1963	2.83	1.47	1.21	0.88	1.03	1.19
...	...	...	...	...	...	...
2012	9.67	1.38	5.05	2.38	2.08	1.54
2013	9.77	1.41	5.17	2.42	3.2	0.39
2014	9.85	1.38	4.24	2.51	3.66	0.82
2015	9.83	1.52	6.23	2.57	1.5	1.05
2016	9.88	1.27	6.04	2.61	2.73	-0.23

In factor analysis, time is excluded, and it acts only as a backbone factor that provides relationships between the six parameters of the carbon budget.

Factor analysis identification of the trend

Wavelet signal of any nature is mathematically recorded by the formula of the form

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

Where,

A_i – amplitude (half) of a wavelet (axis y),

p_i – a half-cycle of fluctuation (axis x).

The concept of a wavelet signal allows to abstract from physical sense of statistical ranks of measurements (generally not only dynamic ranks) and to consider their additive decomposition on separate components in a look wavelets.

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

A signal – is a material carrier of information. And we understand information as a measure of interaction. The signal can be generated but is not required. Any physical process or part of it can be a signal. It turns out that the change in the set of unknown signals has long been known, for example, through the series of measurements [1]. However, there are still no statistical models for the interconnection between the six carbon parameters.

The trend is formed under the condition that the period of oscillation tends to infinity. Most often, the trend is formed from two members of the formula (1).

All models in the article were identified in the particular case, when , by formula

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

Where,

y – the dependent measure,

x – influencing variable,

$a - g$ – model parameter (2).

Table 2 shows the correlation matrix of binary relationships and the rating of six factors according to the Table 1. The preference preorder for each of the six factors can be multidirectional in rank. In our example, in the diagonal cells we put the correlation coefficient of the trend in the dynamics models from 1959 to 2016.

Table 2: Correlation matrix of factor analysis and rating of factors in identifying the trend law (2).

INFLUENCING FACTORS x	DEPENDENT FACTORS (INDICATORS y)						AMOUNT $\sum r$	PLACE I_x
	C_{fi}	C_{le}	C_{ag}	C_{os}	C_{ls}	C_{bi}		
Fossil fuel and industry C_{fi}	0.9933	0.7668	0.7430	0.9700	0.5156	0.3802	4.3689	**1**
Land-use change emissions C_{le}	0.2660	0.8476	0.1390	0.3193	0.1999	0.5731	2.3449	4
Atmospheric growth C_{ag}	0.7364	0.3665	0.7179	0.7288	0.2460	0.3155	3.1111	**3**
Ocean sink C_{os}	0.9664	0.7471	0.7217	0.9820	0.4856	0.3878	4.2906	**2**
Land sink C_{ls}	0.5248	0.2494	0.0449	0.5048	0.4995	0.2577	2.0811	5
Budget imbalance C_{bi}	0.1821	0.4456	0.3255	0.2335	0.3564	0.3779	1.9210	6
AMOUNT $\sum r$	3.6690	3.4230	2.6920	3.7384	2.3030	2.2922	18.1176	-
PLACE I_y	**2**	**3**	4	**1**	5	6	-	0.5033

At first, by the two-term trends of the dynamics model, all six factors were ranked in descending order of the correlation coefficient:

- Fossil fuel and industry 0.9933;
- Ocean's 0.9820;
- Land-uses 0.8476;
- Atmospheric emission 0.7179;
- Lands 0.4995;
- Carbon budget imbalance 0.3779.

a) The coefficient of correlative variation, that is, a measure of the functional relationship between the parameters of the system, is 18.1176 / 6² = 0.5033. As influencing variable in the first place was the option «Fossil fuel and industry C_{fi} ≫, on the second – «Ocean sink C_{os} ≫ and in third place – «Atmospheric growth C_{ag} ≫. As a dependent indicator in the first place is ≪ Ocean sink C_{os} ≫, on the second – «Fossil fuel and industry C_{fi} ≫ and in third – «Land-use change emissions C_{le} ≫. Strong factor relationships are shown in the Table 3.

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Table 3: Correlation matrix of strong binary relations by trend model (2) with correlation coefficient not less than 0.7.

INFLUENCING FACTORS x	DEPENDENT FACTORS (INDICATORS y)					
	C_{fi}	C_{le}	C_{ag}	C_{os}	C_{ls}	C_{bi}
Fossil fuel and industry C_{fi}		0.7668	0.7430	0.9700		
Land-use change emissions C_{le}						
Atmospheric growth C_{ag}	0.7364			0.7288		
Ocean sink C_{os}	0.9664	0.7471	0.7217			
Land sink C_{ls}						
Budget imbalance C_{bi}						

In total, there were eight strong regularities in the formula (2). The values of the parameters of these formulas are given in Table 4. We will not analyze trends and immediately move on to wavelets. At the information technology level, the 23rd Hilbert problem (development of the methods of variational calculus) was solved by us [3]. 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. In this case, 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 was proposed (1).

Table 4: Parameters of strong trend binary relations (2).

x	y	1ST MEMBER OF THE TREND			2ND MEMBER OF THE TREND				Correl. coef. r
		a	b		d	e	f	g	
C_{fi}	C_{os}	2.91514e-24	-4.96514	1.03310	0.23327	1.52546	0.10349	1.07093	0.9700
C_{os}	C_{fi}	5.45111e-9	-17.96364	0.14364	3.08059	0.63696	0	0	0.9664
C_{fi}	C_{le}	23.76545	2.55953	0.057457	0.00039944	4.88111	0.00019061	5.37202	0.7668
C_{os}	C_{le}	135.51729	4.48642	0.042448	-0.13333	3.76032	0.0068571	10.13145	0.7471
C_{fi}	C_{ag}	1.22136e-22	-5.28706	0.98914	0.52811	1.07151	4.80930e-5	3.95071	0.7430
C_{ag}	C_{fi}	3.53384	0.79393	1	2.35427	1.59433	0.37149	0.80880	0.7364
C_{ag}	C_{os}	0.23341	-1.46064	0.25055	2.22506e-43	104.77207	0.84214	2.95949	0.7288
C_{os}	C_{ag}	9.80015e-5	-0.67411	2.77171	2.02702	0.87968	0	0	0.7217

The concept of vibrational adaptation assumes that there are dependencies in the form of wave equations between the factors selected in [1]. From the data in Table 2, you can see that the effect of the parameter «Budget imbalance C_{bi}» the correlation coefficient has a maximum value of 0.4456, which is less than the right border of the interval of the «weak link» adequacy level (from 0.3 to 0.5). Therefore, this parameter as an influencing variable is excluded further, but it is left as a dependent indicator. The adequacy of the models in Table 5 is given by four members of the general model (1), containing two trend terms (2) and two more wave equations.

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The software environment CurveExpert-1.40 (URL: http://www.curveexpert.net/) does not allow to identify more members at the same time. Therefore, factor analysis with a large number of wave members requires a special software environment created according to our scenarios.

Table 5: Correlation matrix of factor analysis and rating of factors in identifying the law (1).

INFLUENCING FACTORS x	DEPENDENT FACTORS (INDICATORS y)						AMOUNT Σr	PLACE I_x
	C_{fi}	C_{le}	C_{ag}	C_{os}	C_{ls}	C_{bi}		
Fossil fuel and industry C_{fi}	0.9988	0.8756	0.8368	0.9843	0.7319	0.6223	5.0497	**1**
Land-use change emissions C_{le}	0.6169	0.9580	0.5519	0.5794	0.4549	0.6511	3.8122	5
Atmospheric growth C_{ag}	0.8469	0.6869	0.7706	0.8663	0.6861	0.6596	4.5164	**3**
Ocean sink C_{os}	0.9788	0.8544	0.7624	0.9906	0.6777	0.6532	4.9171	**2**
Land sink C_{ls}	0.6900	0.7159	0.5191	0.7531	0.6974	0.7536	4.1291	4
AMOUNT Σr	4.1314	4.0908	3.4408	4.1737	3.248	3.3398	22.4245	-
PLACE I_y	**2**	**3**	4	**1**	6	5	-	0.7475

The coefficient of correlative variation, that is, a measure of the functional relationship between the parameters of the system, is 22.4245 / (56) = 0.7475. In comparison with the trends in Table 2, the adequacy of the system increased by 0.7475 / 0.5033 $\approx$ 1.5 times. The identification of wavelets can be continued further. This fact means that in [1] good data are given. At the same time, the rating of factors in Tables 2 and 5 remained.

Strong binary relationships between factors

At the level of adequacy of not less than 0.7, 12 sets of four equations were obtained, the correlation coefficients of which are given in Table 6. Four influencing variables (the «Land-use change emissions C_{le}» factor fell out) and all six parameters as dependent indicators have strong connections. Next, consider each group in the hierarchy of four influencing variables.

Table 6: Correlation matrix of factor analysis and rating of factors in identifying the law (1) with a correlation coefficient of not less than 0.7.

INFLUENCING FACTORS x	DEPENDENT FACTORS (INDICATORS y)					
	C_{fi}	C_{le}	C_{ag}	C_{os}	C_{ls}	C_{bi}
Fossil fuel and industry C_{fi}		0.8756	0.8368	0.9843	0.7319	
Land-use change emissions C_{le}						
Atmospheric growth C_{ag}	0.8469			0.8663		
Ocean sink C_{os}	0.9788	0.8544	0.7624			
Land sink C_{ls}		0.7159		0.7531		0.7536

Strong effects of fossil fuels and industry

Table 7 shows the values of the model parameters (1) for four effects, each of which also has four equations. It shows that parts of the trend are special cases of wavelet. The negative sign in front of the parameter a_{1i} shows that this component is a crisis for this direction of influence. Then it turns out that the impact on the ocean fourth component of the model is a crisis, and the first three are aimed at increasing the impact of fossil fuels and industry on the ocean. To influence land use, on the contrary, the formulas show that after the first term all three components «work» to reduce the indicator. In addition, each wave can be analyzed by the method of amplitude-frequency response. We do not conduct such an analysis here, but we will give only explanations of the graphs.

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Table 7: The parameters of models of the influence of fossil fuel and industry.

Number i	Wavelet $y_i = a_{1i} x^{a_{2i}} \exp(-a_{3i} x^{a_{4i}}) \cos(\pi x (a_{5i} + a_{6i} x^{a_{7i}}) - a_{8i})$								Correl. coeff. r
	amplitude (half) of oscillation				half-period fluctuations			shift	
	a_{1i}	a_{2i}	a_{3i}	a_{4i}	a_{5i}	a_{6i}	a_{7i}	a_{8i}	
Influence «Fossil fuel and industry C_{fi} »at «Ocean sink C_{os} »									
1	2.03438e-28	0	-5.17607	1.08686	0	0	0	0	0.9843
2	0.34824	1.10638	0.083206	0.85674	0	0	0	0	
3	202235.5	10.33184	17.46517	0.34575	0.054366	0.020645	1.26349	0.12732	
4	-0.00040497	6.52071	1.07926	0.98797	0.098233	-0.00028597	1.09091	5.42295	
Influence «Fossil fuel and industry C_{fi} »at «Land-use change emissions C_{le} »									
1	34.14114	0	2.70621	0.10203	0	0	0	0	0.8756
2	-0.011120	2.63710	0.00057178	4.67781	0	0	0	0	
3	-0.072595	0	-4.72623e-5	4.57923	0.59493	0.045676	0.99492	-5.62640	
4	-1.10400e-51	90.32975	5.46173	1.24068	0.17453	-0.00057423	1.14532	-3.86701	
Influence «Fossil fuel and industry C_{fi} »at «Atmospheric growth C_{ag} »									
1	1.25279e-22	0	-5.29022	0.98939	0	0	0	0	0.8368
2	0.53281	1.08526	4.74297e-5	3.97994	0	0	0	0	
3	-1.39156e-11	26.98663	3.81712	1.01338	0.026174	0.0069911	1.10850	0.51457	
4	-0.0034516	6.28505	1.01411	1	-0.0096707	0.16998	0.059336	4.93387	
Influence «Fossil fuel and industry C_{fi} »at «Land sink C_{ls} »									
1	-9.57666e-29	0	-6.59522	1	0	0	0	0	0.7319
2	0.85056	0.26388	-0.091278	1	0	0	0	0	
3	0.11176	1.91649	2.21359	0.0026525	0.55067	-0.13925	0.23667	-0.20554	
4	3.45470e-5	24.75032	5.93869	1	0.17540	-0.0021138	1	-1.14276	

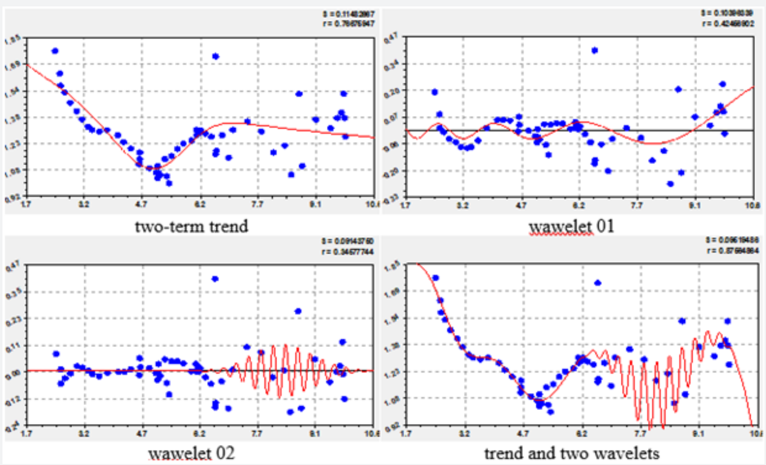

Figure 1: Graphs of the first four members of the general model (1) effects of fossil fuel and industry on the ocean: S - dispersion; r - correlation coefficient.

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The influence of the ocean: On a two-term trend as fossil fuels and industry increase, the impact on the global budget of carbon in the ocean increases (Figure 1). Moreover, the trend graph shows that to the right edge of the abscissa, this effect is accelerating. At the first fluctuation, a strong impact on the ocean is observed at the level of fossil fuels and industry from 2.0 to 7.7. In this interval, there is a strong oscillatory adaptation of the ocean to the growth of carbon in fossil fuels and industry. With the increasing influence of abscissa, the aperiodic oscillation tends to calm down from the growth of the period. The amplitude also decreases. As a result, it turns out that for the global carbon budget, the ocean plays the role of a good damper. The second wavelet is ongoing and with further increase of the abscissa. The overall graph of all four members shows the accelerated growth of the impact of the fuel and industry on the carbon content of the ocean.

Impact on land use: With the increasing trend of fossil fuel and industry impact on land use to the level of 6.2 was changed at the falling laminar dependence (Figure 2). With the further growth of the influencing variable, there is a turbulent change in the carbon budget from land use. This turbulence is expressed by the second wavelet (the fourth member). The overall graph shows that with further increases in carbon budget from fossil fuels and industry, a sharp decrease in carbon in land use is expected.

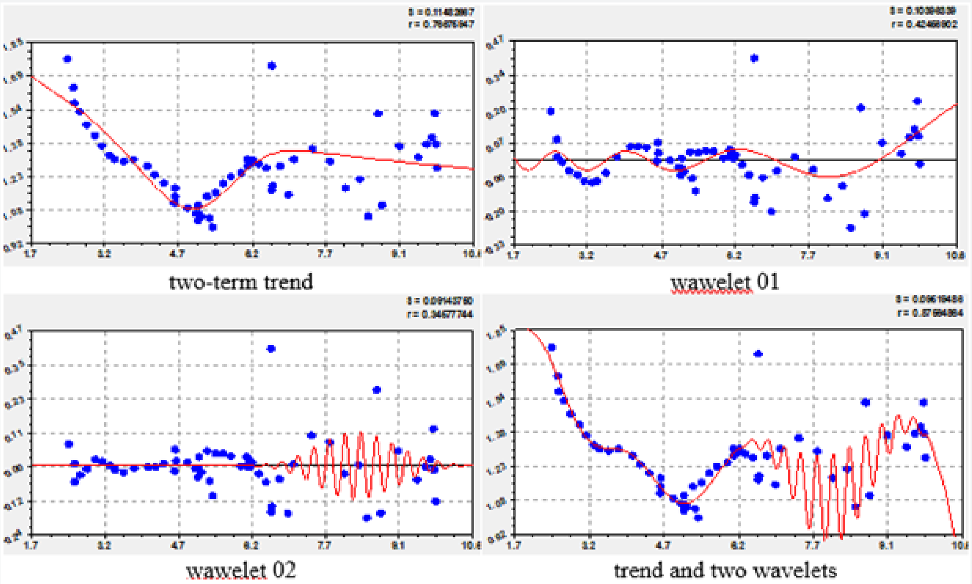

Figure 2: Graphs of the first four members of the general model (1) impact of fossil fuels and industry on land use.

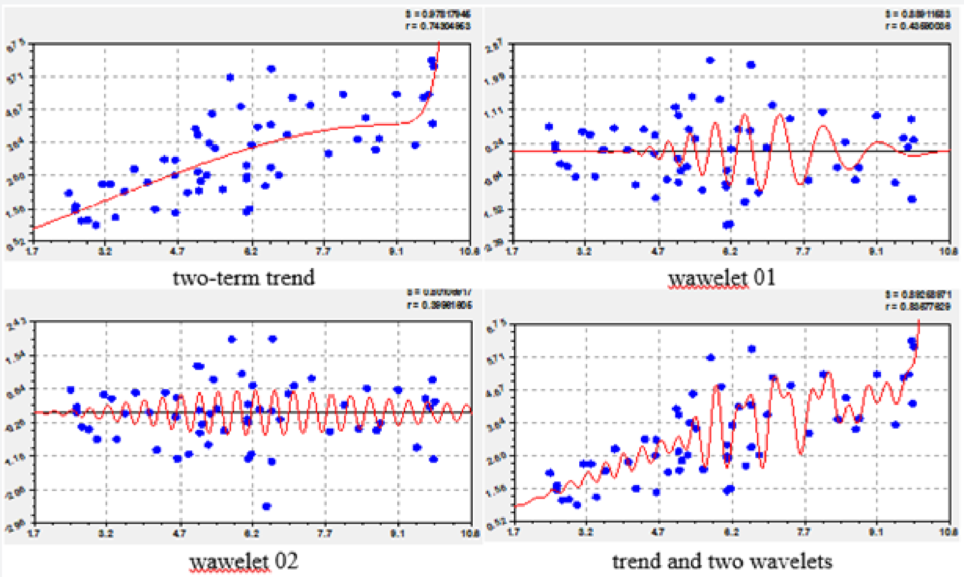

Figure 3: Graphs of the first four members of the general model (1) effects of fossil fuels and industry on air emissions.

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Effects on emissions to the atmosphere: Carbon budget in the atmosphere is increasing (Figure 3), and sharply in excess of carbon from fossil fuels and industries above 9.3. The turbulence is reduced, but there is always a risk of a sharp increase in emissions into the atmosphere with further increase in fossil fuels and industry. Both wavelets are crisis ones and show, apparently, the attempts of mankind to reduce fuel consumption and air emissions from industry.

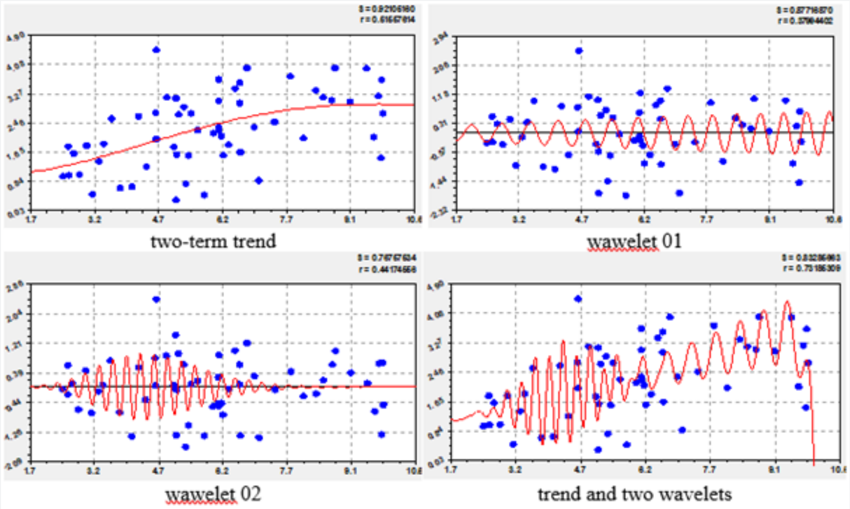

Figure 4: Graphs of the first four members of the general model (1) impact of fossil fuels and industry on the earth.

Impact on land: Wavelets and the second part of the trend are aimed at increasing the impact of fuel and industry on the earth (Figure 4). The danger is also that the half-period of oscillation with increasing influence of fuel and industry decreases, that is, the frequency of oscillation increases. Then, with the further increase of the influencing variable, there is a danger of transition to the tremor.

Strong binary relations the influence of the ocean

Ocean crisis two wavelets constrains the growth of the carbon budget from the growth of fossil fuels and industry, as well as from increasing emissions into the atmosphere (Table 8). But at the same time increases the carbon budget in land use. Thus, the ocean performs the function of a capacitor, in which the frequency of discharges increases (negative signs in front of the model parameter a_{6i}) with the growth of the influence of the ocean.

Table 8: The parameters of models of the influence of the ocean.

Number i	Wavelet $y_i = a_{1i}x^{a_{2i}}\exp(-a_{3i}x^{a_{4i}})\cos(\pi x/(a_{5i}+a_{6i}x^{a_{7i}})-a_{8i})$								Correl. coeff. r
	amplitude (half) of oscillation				half-period fluctuations			shift	
	a_{1i}	a_{2i}	a_{3i}	a_{4i}	a_{5i}	a_{6i}	a_{7i}	a_{8i}	
Influence «Ocean sink C_{os} »at «Fossil fuel and industry C_{fi} »									
1	6.58906e-9	0	-17.40037	0.16764	0	0	0	0	0.9788
2	3.20583	0.63696	0	0	0	0	0	0	
3	-0.19917	0	-0.057909	3.42206	0.75208	-0.14401	0.60204	-1.85413	
4	-1.14769	1.83509	1.10304	1.39664	-0.00088017	0.070062	0.58053	4.33823	
Influence «Ocean sink C_{os} »at «Land-use change emissions C_{le} »									
1	137.93433	0	4.53808	0.035064	0	0	0	0	0.8544
2	-0.087129	4.98107	0.012058	9.54314	0	0	0	0	
3	8.68594	0	4.65423	0.31989	0.25015	-0.018746	1.48958	-2.39893	
4	5.76051e8	188.66107	77.68244	0.99890	0.067488	-0.0059046	0.86542	-0.76599	
Influence «Ocean sink C_{os} »at «Atmospheric growth C_{ag} »									

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1	0.00016695	0	-2.93707	1.16486	0	0	0	0	0.7624
2	2,14533	0.70316	0	0	0	0	0	0	
3	-8910.2618	4.13469	11.03405	0.19257	2.86814	-2.33523	0.12456	-0.19935	
4	-17.18650	3.40255	3.88892	0.71217	2.18683	-1.12027	0.48291	-3.79905	

Impact on fossil fuels and industry: The ocean influences by two laws of growth according to the trend (Figure 5). The first component is the law of exponential growth, which shows the natural tendency of mutual exchange between these two factors. A similar law was observed in Table 7. The design of the second trend term is different: the influence of the ocean on fuel is performed according to the law of exponential growth, and the direct influence of fuel on the ocean according to Table 7 is performed with some braking according to the biotechnical law. As a result, the ocean becomes a dangerous regulator of the global carbon budget.

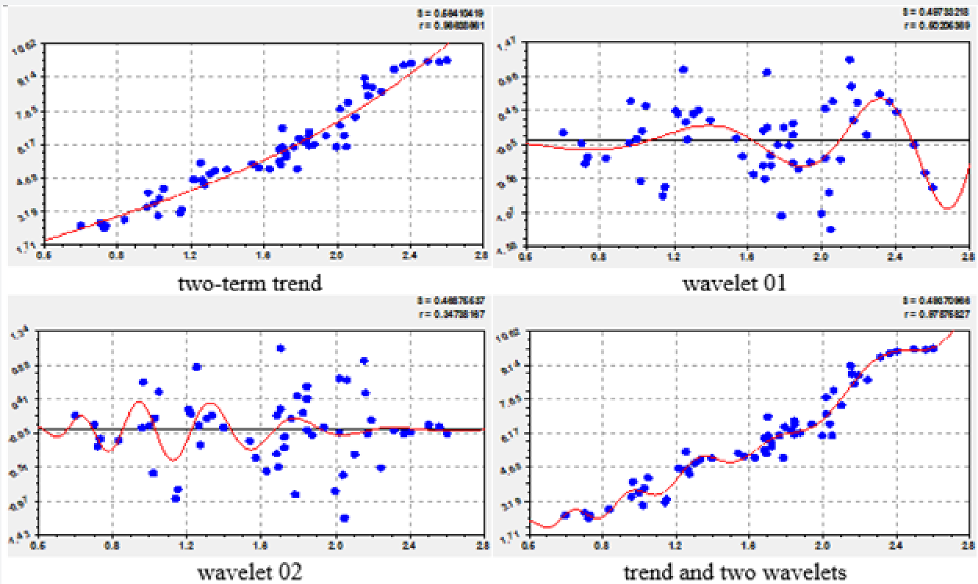

Figure 5: Graphs of the first four members of the general model (1) ocean impacts on fossil fuels and industry

The overall graph from the four members of the model (1) is having a rapid growth of fossil fuel and industry. As a result, the ocean acts as a living creature, accelerating together with humanity the consumption of fossil fuels and developing industry. The growth of humanity and its consumption lead to an increase in the influence of the ocean.

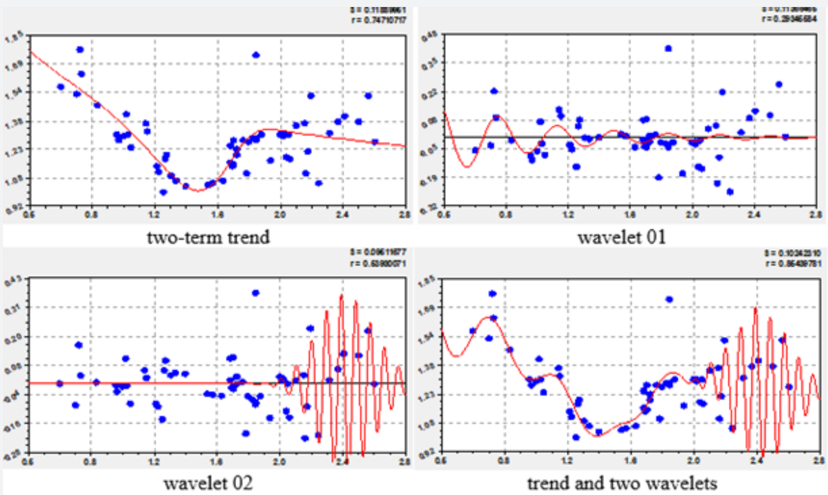

Figure 6: Graphs of the first four members of the general model (1) ocean land-use impacts.

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Impact on land use: Natural first term of the trend according to the law of exponential loss shows the desire of the ocean to reduce the carbon budget from land use (Figure 6). The second member of the trend according to the biotechnical law creates a kind of energy hole with the values of the ocean influence about 1.5.

Thus, in the global carbon budget, there is a minimum impact of the ocean on land use. After level 2.0 of ocean influence in land use, high turbulence occurs, which is then eliminated by the finite-dimensional second wavelet. The first wavelet decreases in amplitude and has the highest values at low ocean influence values. Then we can offer a global carbon budget of the ocean as an indicator of quality of land use: we need to seek the influence of the ocean in the range of 1.3-1.5.

Effects on emissions to the atmosphere: Both wavelets according to Table 8 inhibit the increase in carbon from emissions into the atmosphere (Figure 7). But the trend is a sharp increase in the two laws, especially under the influence of the ocean more than 2.4. Ocean performs the function of the vibrating absorber of emissions, but itself to increase its own budget carbon sharply increases and budget corner-a kind from air emissions. Then it can be assumed that after the level of influence of ocean 2.4 there is an additional release of carbon into the atmosphere from the depths of the ocean.

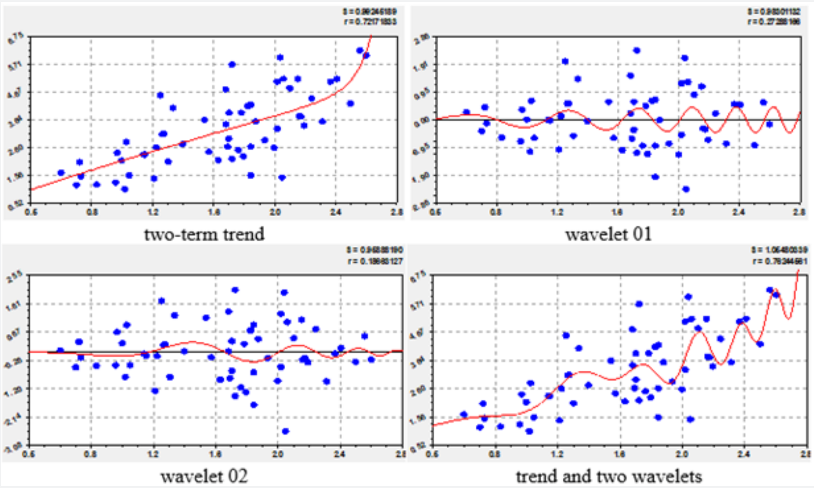

Figure 7: Graphs of the first four members of the general model (1) ocean effects on air emissions.

Strong binary relationships of the effect of emissions on the atmosphere

Table 9: Parameters of models of influence of emissions to atmosphere.

Number i	Wavelet $y_i = a_{1i}x^{a_{2i}}\exp(-a_{3i}x^{a_{4i}})\cos(\pi x(a_{5i}+a_{6i}x^{a_{7i}})-a_{8i})$								Correl. coeff. r
	amplitude (half) of oscillation				half-period fluctuations			shift	
	a_{1i}	a_{2i}	a_{3i}	a_{4i}	a_{5i}	a_{6i}	a_{7i}	a_{8i}	
Influence «Atmospheric growth C_{ag} » at «Ocean sink C_{os} »									
1	0.25546	0	-1.39408	0.25055	0	0	0	0	0.8663
2	1.25866e-74	187.94258	1.62702	2.95949	0	0	0	0	
3	0.21297	0.98315	0.00052728	6.64175	0.25766	-0.041187	0.39424	2.94488	
4	9.21450e-22	100.20575	22.51768	1.00804	0.016915	0.0098342	1.07216	4.14502	
Influence «Atmospheric growth C_{ag} » at «Fossil fuel and industry»									
1	7.04436	0	2.09444	1	0	0	0	0	0.8469
2	4.13020	1.44446	0.59398	0.66907	0	0	0	0	
3	-2.67640e8	3.33471	19.53517	0.15151	0.14646	0.0095580	0.93123	0.38730	
4	-0.016370	0	-2.06031	0.47827	1.38965	-0.81072	0.065915	-0.40203	

Fossil fuels, the ocean and emissions into the atmosphere form the most significant triad. In this case, all mutual binary relations in the triad have a strong level of adequacy (Table 9). Then we can assume that there are multi-factor relations between

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the five factors (not only binary, but also between three, four and even five factors). Such multi-factor relations can be studied in a separate article. Such multi-factor relations can be studied in a separate article. So in three factors are formed strong mutual binary relations.

Thus, global carbon in the atmosphere becomes an active participant of exchange processes on the planet Earth. The atmosphere, like the ocean, acts as a living. With them, in fact, there is a competition of growth of number of mankind. It seems that factor analysis of other greenhouse gases can be carried out similarly.

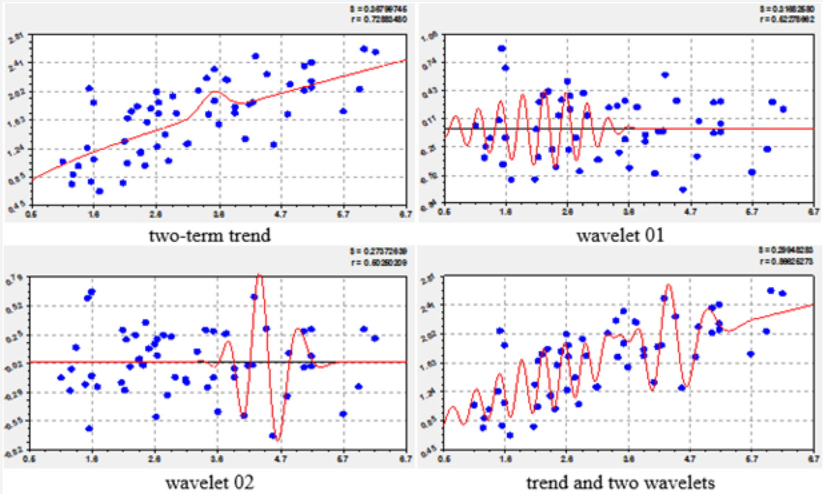

Figure 8: Graphs of the first four members of the general model (1) effects of atmospheric emissions on the ocean.

The influence of the ocean: All four members of the influence of emissions on the atmosphere contribute to the growth of carbon in the ocean (Figure 8). But both wavelet exist in small and medium-influence of the atmosphere. Therefore, it seems from the general graph in Figure 8 that after level 5.5 the ocean stops oscillating adaptation and moves to a new qualitative state. Up to this level of the ocean, as a living creature, trying to adapt to changes in carbon emissions into the atmosphere. Similar, apparently, occurs and on other gases.

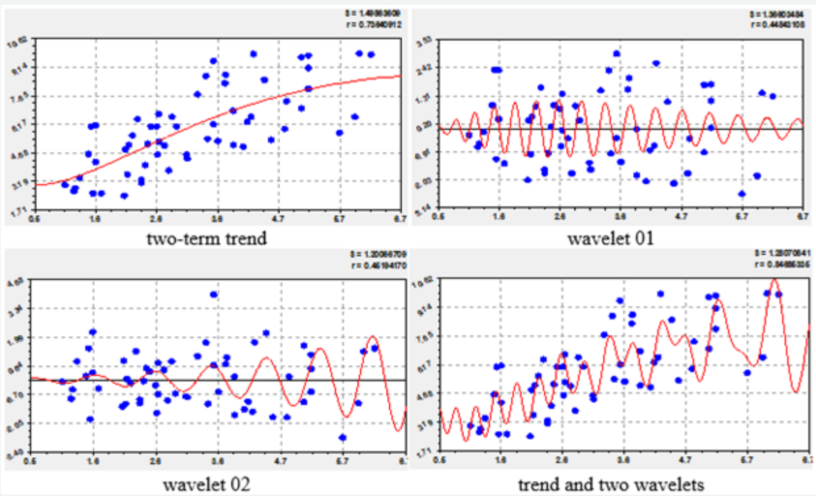

Figure 9: Graphs of the first four members of the general model (1) effects of fossil fuel emissions and industry.

Impact on fossil fuels and industry: And the growth of fossil fuels and industry is affected differently by the increase in atmospheric emissions (Figure 9). Both wavelets are directed against the growth of the effect of emissions into the atmosphere, although the second wavelet increases its amplitude. The first natural term of the trend shows that with the increasing impact of emissions into the atmosphere, fossil fuels and industry may even decline. The second term, as a result of anthropogenic impact, is changed by the biotechnical law of stress excitation. This stress of mankind should gradually decrease due to the increasing awareness of the fact that it is necessary to achieve waste-free consumption of the required fuel and create a waste-free industry. Unsustainable environmental policies on emissions into the atmosphere, as seen in the General graph in Figure 9, could lead to a strong build-up of the carbon budget in the fuel and industry in question. And it becomes a dangerous process for the future.

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Strong binary relations of the influence of the earth's surface

Table 10: Parameters of models of the earth's surface influence.

Number i	Wavelet $y_i = a_{1i} x^{a_{2i}} \exp(-a_{3i} x^{a_{4i}}) \cos(\pi x (a_{5i} + a_{6i} x^{a_{7i}}) - a_{8i})$								Correl. coeff. r
	amplitude (half) of oscillation				half-period fluctuations			shift	
	a_{1i}	a_{2i}	a_{3i}	a_{4i}	a_{5i}	a_{6i}	a_{7i}	a_{8i}	
Influence «Land sink C_{ls} » at «Budget imbalance C_{bi} »									
1	1.23479	0	1.03297	1	0	0	0	0	0.7536
2	-2.90914e-5	12.51721	4.97441	0.32151	0	0	0	0	
3	-0.59710	0	0.29942	1	0.44874	0.058340	1	-4.17378	
4	-0.96791	0.52141	0.035371	3.00086	-0.026619	0.064431	0.18311	5.28491	
Influence «Land sink C_{ls} » at «Ocean sink C_{os} »									
1	5.04749	0	4.06527	1	0	0	0	0	0.7531
2	1.39917	0.94695	0.24920	1	0	0	0	0	
3	8.47034e8	5.25578	20.82847	0.28660	-0.012314	0.17255	0.42401	5.28847	
4	-3.67277	0.46789	2.36322	0.31338	0.13162	-0.020905	0.28367	-3.76227	
Influence «Land sink C_{ls} » at «Land-use change emissions C_{le} »									
1	0.039996	0	-3.90730	0.088981	0	0	0	0	0.7159
2	-27.49811	2.28234	3.77259	0.30389	0	0	0	0	
3	1.22718e7	3.13379	17.82937	0.21026	0.19822	8.65030e-5	2.68274	2.93119	
4	-1.65484e-12	201.23918	64.96234	1.00113	0.046343	-2.42284e-5	1	0.75277	

New in this effect high adequacy of changes in global carbon budget and land use imbalance becomes (Table 10). The budget for ocean carbon also depends heavily on the state of the earth's surface.

The impact on the imbalance of the carbon budget: The imbalance in the natural trend term decreases with the increase of the earth's influence. Apparently, this change depends on the reduction of the measurement error with the increase of the carbon budget of the earth's surface. The second term with a negative sign shows stress excitation, especially scientists who seek to improve the accuracy of measurements. Both wavelets are also aimed at reducing the carbon imbalance. They show that the efforts of scientists occur with varying success. However, as can be seen in Figure 10, with an increase in the impact of the earth more than 4.0, the carbon imbalance increases sharply in the negative side. This behavior is also apparently not acceptable imbalance should oscillate around the zero value.

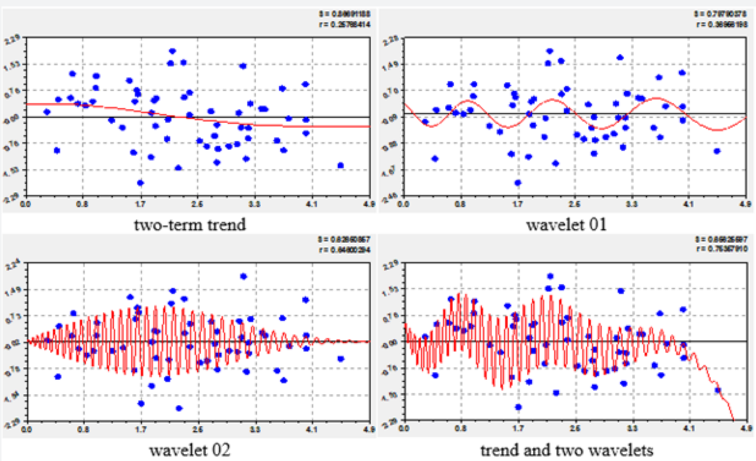

Figure 10: Graphs of the first four members of the general model (1) earth's impact on global carbon budget imbalance.

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The influence of the ocean: Trend according to the natural term decreases by the law of exponential death, and by the biotechnical law receives stress excitation (Figure 11). In the end, both members obtained a minimum of influence of the earth about 0.8 of the ocean. Both wavelets lose the properties of vibrational adaptation of the ocean with the growth of the earth's carbon. The overall graph in Figure 11 shows that as the carbon budget increases, the ocean on the earth's surface stabilizes. Then it is recommended to reduce the second trend term in different ways.

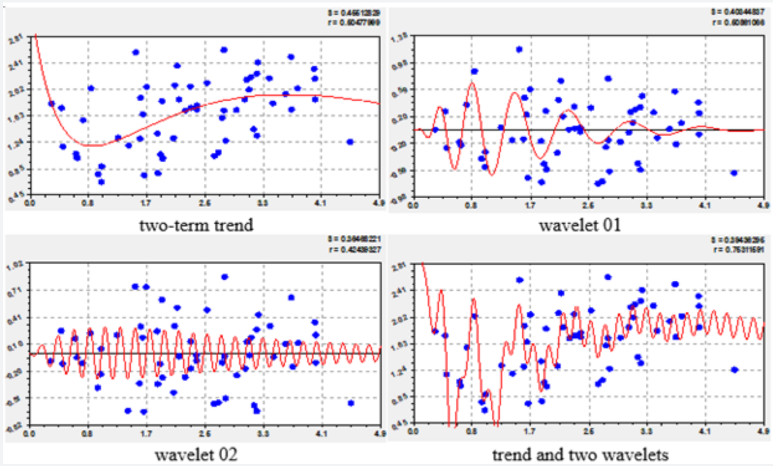

Figure 11: Charts of the first four members of the general model (1) of the influence of land on the ocean.

Impact on land use. This effect is complex (Figure 12). The natural trend shows the growth of the carbon budget in land use with the increase of land, mainly due to the increase in plant cover. The second term of the trend in the form of biotechnical law with a negative sign shows anthropogenic depletion of vegetation on land. The first wavelet helps to increase the influence of the earth, decreasing in amplitude. The second wavelet shows a temporary tremor, and the overall graph in Figure 12, after the level of land influence 3.8, shows a slow growth of the carbon budget in land use. For further analysis, it is necessary to know that heuristically incorporated in the scope of concepts of each factor of the global carbon budget.

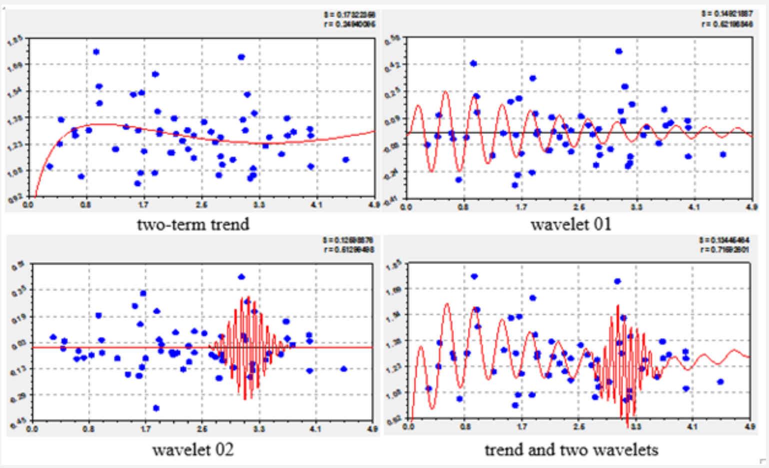

Figure 12: Graphs of four members of the general model (1) land use impact.

Conclusion

The presented regularities with the wave components of the oscillatory perturbation obtain high values of the criterion of tightness in comparison with the trends. The revealed regularities have shown that the trend has a rough accuracy, but it can be used for approximate calculations, as well as for making estimate recommendations. Using the example of global carbon dynamics from 1959 to 2016, the applicability of wavelet analysis by the method of identification of the equation (1) of oscillations with variable am-plate and the period of oscillations is proved. For factor analysis in all equations, the first four terms were obtained from the computational capabilities of the CurveExpert-1.40 software environment, of which the first two terms are related to the trend. We understand the trend as the sum of wave components that have a period of oscillation approaching infinity. The concept of vibrational adaptation in the global carbon budget exists, as between the selected [1] factors there are wave equations.

The coefficient of correlative variation, that is, a measure of the functional relationship between the parameters of the system, is 22.4245 / (56) = 0.7475. in comparison with the trends in Table

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2, the adequacy of the system increased by 0.7475 / 0.5033 ≈ 1.5 times. The detection of wavelets can be continued further. This fact means that in good data are given. The rating of factors on trends and wavelets was the same. As an influencing variable, the parameter ≪ Fossil fuel and industry C_{fi} ≫ was in the first place, ≪ Ocean sink C_{os} ≫ was in the second place, and «Atmospheric growth C_{ag} ≫ was in the third place. As a dependent indicator in the first place is ≪ Ocean sink », the second – ≪ Fossil fuel and industry C_{fi} ≫ and the third – ≪ Land-use change emissions C_{le} ≫.

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