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ARTICLE

Quantum Atmospheric Biophysics: A Comparison of Four Weather Stations in India on Average Monthly Temperatures Since 1892 and Forecasts to 2150

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ABSTRACT

The identification method revealed asymmetric wavelets of dynamics, as fractal quanta of the behavior of the surface air layer at a height of 2 m, according to the average monthly temperature at four weather stations in India (Srinagar, Jolhpur, New Delhi and Guvahati). For Srinagar station, the maximum for all years is observed in July, for Jolhpur and New Delhi stations it shifts to June, and for Guvahati it shifts to August. With a high correlation coefficient of 0.9659, 0.8640 and 0.8687, a three-factor model of the form was obtained. The altitude, longitude and latitude of the station are given sequentially. The hottest month for Srinagar over a period of 130 years is in July. At the same time, the temperature increased from 23.4 °C to 24.2 °C (by 3.31%). A noticeable decrease in the intensity of heat flows in June occurred at Jolhpur (over 125 years, a decrease from 36.2 °C to 33.3 °C, or by 8.71%) and New Delhi (over 90 years, a decrease from 35.1 °C to 32.4 °C, or by 7.69%). For almost 120 years, Guvahati has experienced complex climate changes: In 1902, the hottest month was July, but in 2021 it has shifted to August. The increase in temperature at various stations is considered. At Srinagar station in 2021, compared to 1892, temperatures increased in June, September and October. Guvahati has a 120-year increase in December, January, March and April. Temperatures have risen in February, March and April at Jolhpur in 125 years, but have risen in February and March at New Delhi Station in 90 years. Despite the presence of tropical evergreen forests, the area around Guvahati Station is expected to experience strong warming.

Keywords: India; 4 weather stations; Average monthly temperature; Waves of behavior; Sum of wavelets; Verification; Forecasts

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1. Introduction

The farmers of India since ancient times waged a real war with the forests. They had to win back plots for crops [1]. Based on descriptive statistics from a large number of statistical samples, Kumar et al. [2] concluded that deforestation is the main cause of global warming and climate change.

Ullah et al. note that mountain ecosystems are considered sensitive indicators of global warming; even small variations in temperature can lead to significant shifts in the local climate [3].

The main causes are greenhouse gases and deforestation. Appropriate policies are needed to conserve forests, wildlife, prevent hunting, control pollution, increase plantations, awareness, of climate change control, etc.

The climate of India is very diverse. Four types can be distinguished: Dry tropical, humid tropical, subequatorial monsoon and high mountain. In the north, the country is fenced off from the cold Asian winds by the Himalayas, and in the northwest, a large territory is occupied by the Thar Desert, which attracts warm, humid monsoons. They determine the peculiarities of the Indian climate [4].

The results indicate that significant concentrations of areas with maximum dryness are located in the west-central part of India. In general, there is a gradual increase in the extent of the arid zone over a 60-year period, and spatially there is a maximum degree of percentage change in the area of aridity [5].

Many countries have made ambitious commitments to increase forest area to mitigate climate change. However, the availability of land to achieve these goals is not yet well understood [6].

The purpose of the article is to identify asymmetric wavelets of dynamics, as fractal quanta of the behavior of the surface air layer at a height of 2 m, by the method of identification [7-11], based on the average monthly temperature on the territory of four weather stations in India (Srinagar, Jolhpur, New Delhi, Guvahati) from 1892 to 2021, i.e. over a period of 130 years, analyze the wave patterns of the regional climate, compare critical heat waves with forest types, and calculate monthly average temperature forecasts up to 2150.

2. The concept of quantum biophysics of the atmosphere in India

With the bifurcations of the atmosphere and climate, many natural landscapes do not change for thousands of years, for example, the grass cover of the steppes [10,11]. The grass appeared on the land about 100 million years ago. Maybe grass, as the strongest type of vegetation among the first three classes of soil cover according to the UN classification (grass, shrubs and trees—appeared about 400 million years ago), has such values of oscillatory adaptation parameters that it will survive any climate changes in the future. What are these limits of grass cover life?

For example, the Eurasian steppe is 8000 km long from Hungary to Inner Mongolia China? We believe that in India, the Thar desert should first be turned into steppes with grass cover. The succession processes of the vegetation cover are such that at first grass appears on human-modified land plots after a few years. After 7-10 years, bushes appear among the grass. And only after a few decades, the first deciduous forests appear on the grass cover and shrubs, which are replaced by conifers after 60-100 years.

Why such a natural order of change of types of vegetation cover?

The answer lies in the latest fundamental research on mushrooms.

Trees do not live without symbiosis with fungi. Only grass and shrubs begin to form mycelium. Therefore, even modern technologies for planting large-sized seedlings will lead to the almost complete death of trees, especially in strong heat waves and lack of precipitation for the months of the year.

To answer the questions of the symbiosis of plants and fungi, it is necessary not only to study the interactions between woody plants and fungi, but also to develop forecasts of meteorological climate parameters for specific land plots. In many ways, critical temperature waves on the ground appear due to the gradual reduction of forests, as higher plants live only in symbiosis with fungi. Harvesting timber not only reduces forests, but also eliminates the symbiotic interaction between trees and mushrooms.

Then it is necessary to identify not only the behavioral quanta of the surface air layer at different points and regions of the Earth according to weather stations in the form of long time series, but also at least approximately determine the moments of a succession of the vegetation cover.

The role and mechanisms of climatic impact on plant productivity are multifaceted. Among the meteorological variables, the humidity index was found to have the greatest effect on plants. Climates, such as air temperature and rainfall, varies greatly between urban core and periphery areas, resulting in different growing conditions for trees [12].

Roya et al. characterized and mapped the distribution of vegetation types in India by area, percentage of protected area covered by each vegetation type, altitude range, mean annual temperature and precipitation over the past 100 years. The natural vegetation was subdivided into forests, bushes and pastures, and these three types together make up the vegetation cover. This vegetation-type map is the most complete for India [13].

However, over 100 years, the vegetation cover in this area has changed dramatically. First, forests die out, then the productivity of bushes and grass decreases. Desertification is taking place. At the same time, the temperature of the surface layer of the atmosphere at a height of 2 m rises sharply. But much more increases the temperature on the surface of the soil and especially roads. As a rule, this is the anthropogenic impact on the climate. Without man, all natural objects are in ecological balance. They have oscillatory adaptation to changes in each other's parameters and maintain climate stability for millennia. Under trees, bushes and grass, the temperature is lower compared to open ground, and even less so compared to roads.

The materials of the article [13] state well the state of the vegetation cover in India. However, a detailed classification of vegetation cannot be linked to the temperature dynamics over 100 years, since the average annual temperature and precipitation are taken only as averages over 100 years. In further studies, two points should be taken into account: First, instead of the average annual values of temperature and precipitation, we should switch to average monthly values for 100 years; secondly, to adopt a system of vegetation quality parameters according to their typology, which will make it possible to identify at least rough trends in future changes in vegetation cover.

3. Materials and methods

We will not rush to identify cause-and-effect relationships in sharp warming in India according to four weather stations (Srinagar, Jolhpur, New Delhi, Guvahati), but we will compare these weather stations by the average monthly temperature for all years of measurements and show stable patterns of the dynamics of the average monthly temperature for 1892-2021. The series of mean monthly surface temperatures at a height of 2 m were taken from the site http://www.pogodaiklimat.ru/history/42182.htm (Accessed 06/23/2022).

Table 1 gives fragments of initial data arrays for identifying asymmetric wavelets of the average monthly temperature dynamics.

The year 1892 (τ = 0 January 1) was adopted as the beginning of the time reference τ (years) according to the dynamic temperature series of three meteorological stations (Srinagar, Jolhpur, Guvahati). For each month, its specific time is taken according to the expression (Year – 1892) + month / 12. Here the month is taken as follows: January = 1; February = 2, etc. Then 130 years have passed from January 1892 to December 2021, so the indicative forecast can be made for the forecast horizon equal to the forecast base, that is, until 2021 + 130 = 2151 years. Our calculations were performed until 2150. However, due to the sharp increase in temperature at Guvahati station, the forecast was only valid until 2080. At the same time, the temperature in New Delhi starts only from 1931, so a separate time scale was adopted for this time series.

Table 1 gives a fragment of the data array of the average monthly temperature of the surface air layer

Table 1. Average monthly air temperatures (°*C*) at four weather stations in India.

Year	January		…	July		…	December	
	Time *τ*	Temperat. *t*		Time *τ*	Temperat.*t*		Time *τ*	Temperat.*t*
Weather station Srinagar, Montane Forests [5], 0.092-0.226 MgC/ha								
1892	0.083	4.7	…	0.583	23.4	…	1	3.2
1893	1.083	0.6	…	1.583	23.4	…	2	3.9
…	…	…	…	…	…	…	…	…
2020	128.083	1.9	…	128.583	24.5	…	129	3.9
2021	129.083	–0.1	…	129.583	24.2	…	130	3.0
Weather station Jolhpur, Tropical Thorn Forests, 0.000-0.092 MgC/ha								
1897	5.083	17.1	…	5.583	32.6	…	6	18.6
1898	6.083	19	…	6.583	32.1	…	7	18.4
…	…	…	…	…	…	…	…	…
2020	128.083	15.6	…	128.583	32.6	…	129	19.1
2021	129.083	16.4	…	129.583	32.3	…	130	17.7
Weather station New Delhi, Tropical Thorn Forests, 0.000-0.092 MgC/ha								
1931	0.083	15.4	…	0.583	31.7	…	1	15.5
1932	1.083	15.6	…	1.583	31.7	…	2	14.7
…	…	…	…	…	…	…	…	…
2020	89.083	13.7	…	89.583	31.5	…	90	15.2
2021	90.083	12.9	…	90.583	31.5	…	91	14.5
Weather station Guvahati, Tropical Evergreen Forests, 0.226-0.524 MgC/ha								
1903	11.083	15.6	…	11.583	29.4	…	12	17.4
1904	12.083	16.8	…	12.583	28.8	…	13	16.9
…	…	…	…	…	…	…	…	…
2020	128.083	17.6	…	128.583	29.1	…	129	19.5
2021	129.083	17.9	…	129.583	29.0	…	130	19.1

at a height of 2 m according to measurements at meteorological stations. In it, in the largest first array, there are 130 × 12 = 1560 values of average monthly temperature in total. The representativeness of the time series is 100%.

Oscillations (asymmetric wavelet signals), as quanta of the behavior of a prism layer of air at a height of 2 m in New Delhi, in the general case, are written by the wave formula [7-10] of the general form:

$$y = \sum_{i=1}^{m} y_i \,,\; y_i = A_i \cos(\pi x / p_i - a_{8i}) \,,$$

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

where y is the indicator (dependent factor), i is the number of the component of the model (1), m is the number of members in the model (1), x is the explanatory variable (influencing factor), $a_1 ... a_8$ are the parameters of the model (1) that take numerical values during structural and parametric identification program environment CurveExpert-1.40 (URL: http://www.curveexpert.net/) according to statistical data, A_i is the amplitude (half) of the wavelet (axis y), p_i is the half-period of oscillation (axis x).

4. Results and discussion

4.1. Comparison of monthly average temperature at weather stations

Average temperature for all years of measurements

Table 2 compares four meteorological stations according to the total average monthly temperature for all years (**Figure 1**).

The maximum temperature for each weather station is different. For example, for Srinagar station, the maximum for all years is observed in July, for Jolhpur and New Delhi stations, the maximum shifts to June, and for Guvahati station, it shifts to August.

Table 2. Average temperature of four weather stations in India for all years.

Month	Srinagar	Jolhpur	New Delhi	Guvahati
Jan	1.57	17.23	14.04	15.77
Feb	3.69	19.84	17.17	17.67
Mar	8.77	25.36	22.66	21.16
Apr	13.59	30.66	28.81	23.38
May	17.73	34.24	32.82	24.61
Jun	21.69	34.34	33.66	25.99
Jul	24.20	31.71	31.17	26.52
Aug	23.68	29.89	30.02	26.60
Sep	20.02	29.94	29.38	25.95
Oct	13.86	28.2	26.07	24.04
Nov	7.89	23.16	20.37	20.34
Dec	3.41	18.8	15.49	16.78

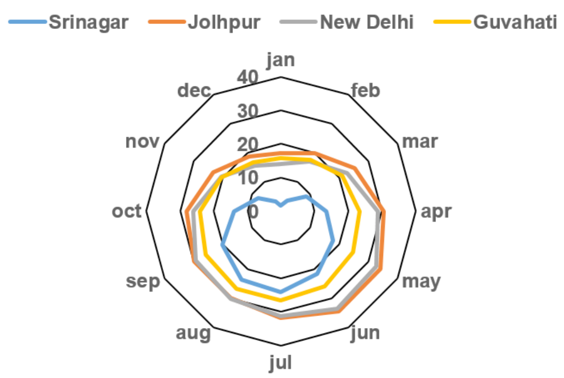


Figure 1. Monthly average temperature charts for all years.

Figure 1 shows that Srinagar has the lowest temperatures as it lies within the other charts. Then the Guvahati chart is visible, after New Delhi. The hottest weather is observed for Jolhpur station in India.

Influence of geographic coordinates on average temperature

Table 3 shows the geographical coordinates of four weather stations compared with the average monthly temperature for all years.

With a high correlation coefficient of 0.9659, 0.8640 and 0.8687, a three-factor model was obtained (**Figure 2**), which is valid only in the intervals of change of each influencing variable, of the form:

$$\bar{t} = 45.16459 - 0.0083426h - 0.16343\beta - 0.18818\alpha \quad (2)$$

The maximum relative error of 1.99% was obtained for the Jolhpur weather station. As a result, the three-factor model (2) receives a relative error of less than 5%, that is, the geographical location of weather stations greatly affects the overall average monthly temperature. Then a new direction opens in the geographical modeling of the parameters of global and regional climatic and meteorological processes.

Figure 2 shows the graphs of the linear pattern for each of the influencing variables, and also shows the graph of the residuals after formula (2).

The linear model is the simplest in design. To identify an asymmetric wavelet (1), it is necessary to accept a data table for at least 15 stations.

The range of average monthly temperature at weather stations

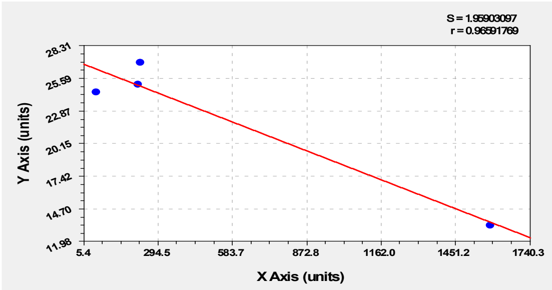
It is important to know the intervals of change of the average monthly temperature for all the years of measurements.

Table 4 shows such data for four weather stations.

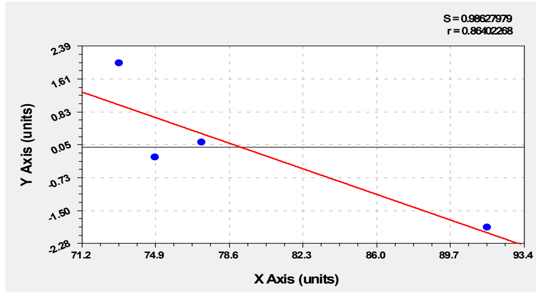
The hottest month for Srinagar station over a period of 130 years at an altitude of 2 m is in July. At the same time, the temperature increased from 23.4 °C to 24.2 °C (an increase of 3.31%). A noticeable decrease in the intensity of heat flows in June occurred at Jolhpur stations (over 125 years, a decrease from 36.2 °C to 33.3 °C, or by 8.71%) and New Delhi (over 90 years, a decrease from 35.1 °C to 32.4 °C,

Table 3. Geographical coordinates of weather stations and average temperature.

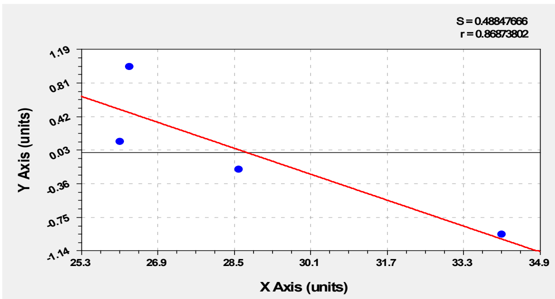
Weather station	The months n, pcs.	Latitude α, °	Longitude β, °	Height h, м	Temperature $\bar{t}$, °C	Error Δ, %
Srinagar	1560	34.08	74.83	1587	13.34	0.43
Jolhpur	1500	26.30	73.02	224	26.95	**1.99**
New Delhi	1092	28.58	77.20	216	25.14	–0.91
Guvahati	1428	26.10	91.58	54	24.47	–1.50



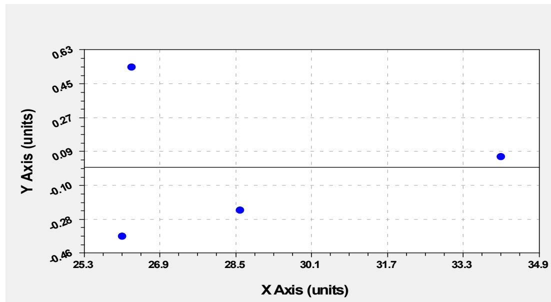
Altitude above the Baltic Sea



Effect of East longitude



Influence of northern latitude



Residuals from the three-factor model

Figure 2. Graphs of the influence of the geographical coordinates of four weather stations in India on the average monthly temperature for all years from 1892 to 2021. (In the upper right corner: *S* standard deviation; *r* correlation coefficient.)

or by 7.69%). For almost 120 years, the Guvahati weather station has experienced complex climate changes: In 1902, the hottest month was July, but in 2021 it has shifted to August. However, at the same time, the maximum average monthly temperature decreased from 29.4 °C to 29.3 °C, or by 0.34%.

Table 4. Range of average monthly temperature at weather stations in India.

Month	Srinagar		Jolhpur		New Delhi		Guvahati	
	1892	2021	1897	2021	1931	2021	1902	2021
Jan	4.7	–0.1	17.1	16.4	15.4	12.9	15.6	17.9
Feb	5.6	5.8	18.9	21.3	15.2	18.6	18.3	20.3
Mar	10.8	10.1	24.3	27.8	21.2	25.0	22.1	24.1
Apr	16.3	12.8	30.2	31.6	29.7	28.6	25.7	26.4
May	18.2	17.5	35.7	32.8	33.1	30.4	26.8	26.9
Jun	19.5	22.1	36.2	33.3	35.1	32.4	27.6	28.7
Jul	23.4	24.2	32.6	32.3	31.7	31.5	29.4	29.0
Aug	23.1	23.3	30.7	31.5	30.3	30.9	28.5	29.3
Sep	18.9	21.9	30.5	29.7	28.6	29.0	28.4	29.0
Oct	12.3	14.0	26.9	28.2	25.3	26.0	27.1	27.8
Nov	6.9	6.0	22.8	22.1	19.1	18.8	22.1	22.2
Dec	3.2	3.0	18.6	17.7	15.5	14.5	17.4	19.1

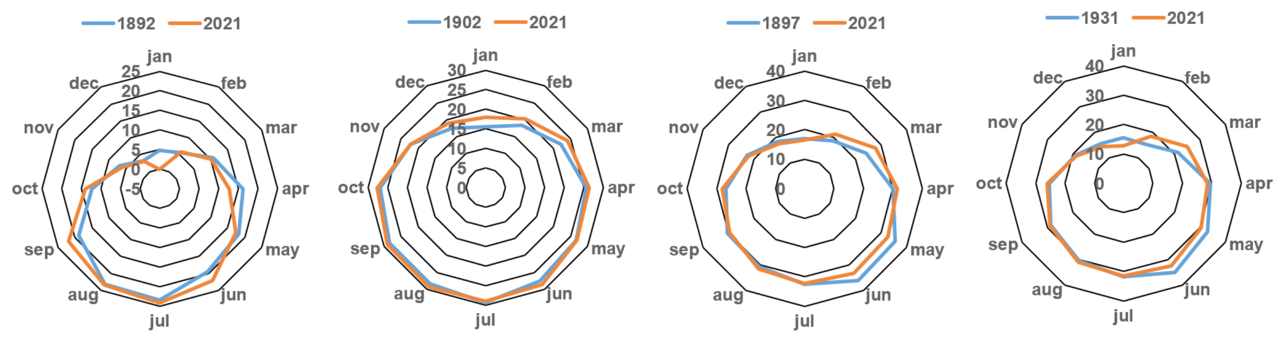
Figure 3 shows charts of the average monthly temperature.

Consider the rise in temperature at various stations. At Srinagar station in 2021, compared to 1892, there was an increase in the average monthly temperature in June, September and October. At Guvahati Station, the 120-year increase occurred in December, January, March, and April. In the remaining months, there was a slight increase in temperature. At Jolhpur weather station, temperatures have risen in February, March and April for over 125 years, but at New Delhi, for over 90 years, temperatures have risen in February and March.

Temperature is a physical quantity that is a measure of the average kinetic energy of the translational motion of molecules, in our case, air molecules in the surface layer at a height of 2 m above the land surface near weather stations. Therefore, the average monthly temperature is a continuous physical quantity, a number of values of which should not be subjected to transformations. Grouping by time intervals for subsuming under linear models is not allowed.

4.2 Wavelets of dynamics of mean monthly temperature

For calculations in the Excel software environment, we used all 11 significant figures in the models



Weather station Srinagar   Weather station Guvahati   Weather station Jolhpur   Weather station New Delhi

Figure 3. Diagrams of ranges of average monthly temperature.

obtained after identification (1).

Model of monthly average temperature dynamics at Srinagar station

The model with four components is written by the expression (**Figure 4**):

User-Defined Model: y=a*exp(-b*x^1.36897)+ c*x^d*exp(e*x^0.86543)-f*exp(-g*x^h)*cos (pi*x/0.5-i)-j*exp(k*x^l)*cos(pi*x/0.25+m). (3)

Coefficient Data:

a = 1.24394048550E + 001 b = 7.45229338864E – 004

c = 1.16911968898E – 001 d = 7.21207009207E – 001

e = 9.20205784898E – 003 f = 1.14194992983E + 001

g = 1.73618132791E – 006 h = 2.26550391088E + 000

i = 5.58834408527E – 001 j = 5.76818844755E – 001

k = 1.88218346333E – 002 l = 7.55117790741E – 001

m = 3.32301367687E – 002.

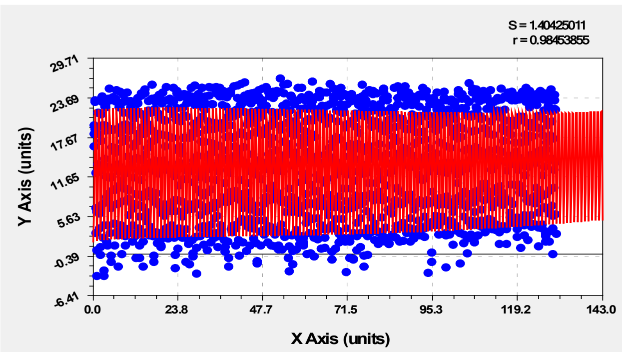


Figure 4. Plot of the four-term model for Srinagar station.

The method of identifying asymmetric wavelets (1) was performed with up to four components in series, while revealing the previous pattern. The arithmetic means a value of the mean monthly temperature was taken at the beginning of the simulation.

In formula (3), a two-term trend was then revealed, containing two regularities. The first component is the Mandelbrot law (in physics) $y = a\exp(-bx)$ after modification by us with the intensity parameter 1.36897 of the exponential decrease in the mean monthly temperature. This exponential formula shows the natural trend from 1892 to 2021 of a slow decrease in the average monthly temperature. Such a natural cause of the decline is the cosmic cold that endlessly surrounds the planet Earth. Therefore, with any oscillatory perturbations of the global or local climate in the Earth's atmosphere, the planet will eventually cool down in billions of years.

The second component of the trend for Srinagar over 130 years increases with a mathematical power function $y = ax^b$. But it turned out that the influence of the Himalayas gives an increase in the average monthly temperature even according to the law of "double" growth according to the formula of the anomalous biotechnical [9-13] law of prof. P.M. Mazurkin $y = ax^b \exp(cx^d)$. Here, the sign of the process inhibition activity parameter in the model got a positive value , therefore, a product of two growth laws was formed - a power law and a modified Mandelbrot law of exponential growth under the condition $d \neq 1$.

A trend is always a special case of an asymmetric wavelet (1), provided that the half-period a_5 of the oscillation is many times greater than the measurement time interval, in our case, several times more than 130 years.

The first oscillation in formula (3) is an infinite-dimensional wavelet, that is, it starts much earlier than 1892 and will continue much further than 2021. This infinity is provided by the amplitude, which decreases with time according to the Mandelbrot law modified by us. Therefore, a distinctive feature of the annual cyclicity is the continuous decrease in the amplitude of the fluctuation, which will favorably affect the regional climate of India. In addition, the negative sign in front of the third component shows that the annual fluctuation is directed against the growth of the average monthly temperature.

The second fluctuation in formula (3) with a semi-annual cyclicity is typical not only for air temperature, but also for the concentrations of various greenhouse gases, especially for CO_2. For carbon dioxide, it was assumed that the cycles of half a year are influenced by the vegetation cover of both hemispheres of the Earth.

However, the second wavelet, due to the negative sign, is also directed against the temperature increase, has an increasing amplitude according to the Mandelbrot law modified by us in the form of an exponential growth. Then it turns out that the mountain forests around the Srinagar weather station in the oscillatory adaptation of the local climate allow to reduce the monthly temperature.

All these four components were identified together in the CurveExpert-1.40 software environment. The standard deviation of model (3) in **Figure 4** is 1.4043 °C. At the same time, the correlation coefficient as a measure of adequacy is 0.9845, that is, the level of adequacy is much higher than 0.95 (super strong connection).

Model of monthly mean temperature dynamics at Jolhpur station

Similarly, a regularity was obtained (**Figure 5**):

User-Defined Model: y=a*exp(b*x)-c*x^d*exp(-e*x^f)-g*exp(-h*x^i)*cos(pi*x/0.5-j)+k*exp(l*x^m)*cos(pi*x/0.25-n). (4)

Coefficient Data:

a = 2.70877885923E + 001 b = 5.92285934347E – 005
c = 8.65551142868E – 025 d = 1.40728547169E + 001
e = 3.08093570746E – 004 f = 2.26785746713E + 000
g = 2.25700322305E + 001 h = 9.83571749288E – 001
i = 2.44372396061E – 002 j = 2.85014519160E – 001
k = 2.47130290654E + 000 l = 6.08247660824E – 004
m = 1.05183293355E + 000 n = 4.49918652932E + 000.

In formula (4), the first component is the Mandelbrot law (in physics) of exponential growth. The same law is known in mathematics as the Laplace law, in biology—Zipf-Pearl, in econometrics—Pareto. It shows the natural trend from 1897 to 2021 of an increase in the average monthly temperature. Moreover, desertification, of course, began much earlier. Apparently, the vegetation cover (grass + shrubs + trees) of India for 4000 years was severely depleted by people for the needs of agriculture. And now it is even proposed to relocate people and animals.

As a result, for the future, due to the first component around the Jolhpur weather station, local climate change coincides with the rate of global warming predicted in the IPCC CMIP5 report.

The second component of the trend for Jolhpur for 125 years is subtracted (negative sign) according to the biotechnical law of prof. P.M. Mazurkin. It may turn out that this dynamic is the result of environmental measures to combat desertification. The subsequent component with an annual cycle also has a negative sign, however, the Thar desert still wins due to the growth of the first component according to the Mandelbrot law.

In addition, people's will and strength are weakening in the fight against the Thar Desert, as the amplitude of the annual fluctuation decreases.

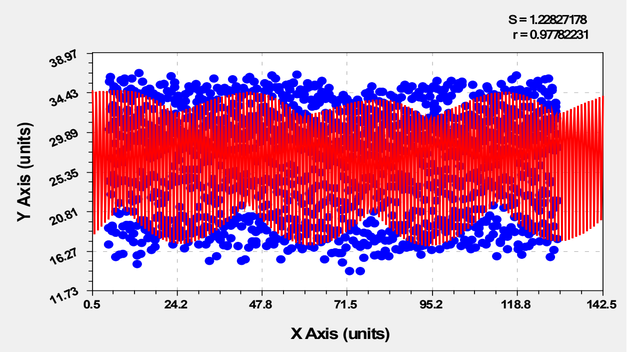


Figure 5. Plot of the model with four components for the Jolhpur station.

The second fluctuation (fourth component) in formula (4) with a semi-annual cyclicity has a positive sign and therefore acts in the direction of temperature increase. In this case, the oscillation amplitude increases according to the modified Mandelbrot law. Apparently, the quality of vegetation around Jolhpur station is deteriorating further. This sad conclusion comes from the fact that semi-annual cycles characterize the influence of vegetation cover.

The standard deviation of the model (4) in **Figure 5** is 1.2283 °C, which is less in comparison with the previous weather station 1.4043 °C. At the same time, the correlation coefficient of 0.9778 is slightly less than 0.9845 for the previous weather station. But, the adequacy level is also much higher than 0.95 (super strong connection).

Model of monthly average temperature dynamics at New Delhi station

For a time interval of 90 years from 1931 to 2021, a model was obtained (**Figure 6**):

User-Defined Model: y=a*exp(-b*x)+c*x^d*exp(e*x^f)-g*exp(-h*x)*cos(pi*x/0.5-i)+j*exp(k*x^l)*cos(pi*x/0.25-m). (5)

Coefficient Data:

a = 2.39931742757E + 001 b = 3.19834420708E – 003
c = 7.01935956544E – 001 d = 3.80930974140E – 001
e = 1.45040504760E – 002 f = 8.45501296252E – 001
g = 9.20090113775E + 000 h = 2.52299200889E – 004
i = 3.32186333451E – 001 j = 1.18493842254E + 000
k = 6.52201603490E – 001 l = 2.17933213594E – 002
m = 4.37689258906E + 000.

In formula (5), the first component is the Mandelbrot law (in physics) $y = a \exp(-bx)$ of exponential decay. It shows a natural trend from 1931 to 2021 of a decrease in the average monthly temperature. Moreover, the New Delhi weather station is located on the northern border of the Thar Desert, so desertification, apparently, began much later than at the Jolhpur station. So far, the cosmic cold still showers on the natural first component.

The second component of the trend for New Delhi for 90 years is aimed at an increase in heat flux (positive sign) according to the anomalous biotechnical law of prof. P.M. Mazurkin. It may turn out that these dynamics are the result of the influence of two main reasons: firstly, desertification due to the excessive intensity of the reduction of vegetation and its replacement with agricultural plants; secondly, the blockade of the Himalayan mountains to the penetration of northern winds from the Takla-Makan desert.

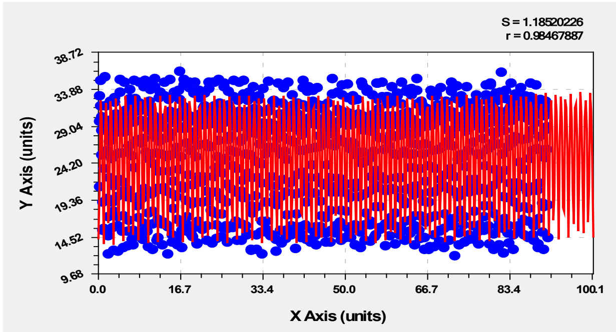


Figure 6. Plot of the model with four components for the New Delhi station.

The third component in the form of an asymmetric wavelet of a constant annual cycle reduces the temperature (negative sign). But this decrease in amplitude is due to the influence of the heat of the Thar desert.

The second fluctuation (fourth component) in formula (5) with a semi-annual cyclicity is similar in dynamics to the Jolhpur weather station. This fluctuation has a positive sign and therefore also acts in the direction of temperature increase. In this case, the oscillation amplitude increases according to the modified Mandelbrot law. It appears that the quality of vegetation around Jolhpur and New Delhi stations will deteriorate further. This conclusion comes from the fact that semi-annual cycles characterize the influence of vegetation cover.

The standard deviation of the model (5) in **Figure 6** is 1.1852 °C, which is less compared to the previous weather stations Srinagar (1.4043 °C) and Jolhpur (1.2283 °C). At the same time, the correlation coefficient of 0.9847 is higher than in the previous meteorological stations (respectively 0.9778 and 0.9845). The adequacy level is also much higher than 0.95 (super-strong relationship).

Model of monthly mean temperature dynamics at Guvahati station

A model was identified for this weather station (**Figure 7**):

User-Defined Model: y=a*exp(b*x^c)+d*x^e*exp(f*x^g)-h*exp(-i*x)*cos(pi*x/0.5-j)-k*exp(-l*x)*cos(pi*x/0.25-m). (6)

Coefficient Data:

a = 2.09342600977E + 001 b = 1.27606820953E – 001
c = 4.10051447152E – 002 d = 1.71595614539E – 014
e = 5.53047984248E + 000 f = 3.88234968065E – 001
g = 5.15888320178E – 001 h = 5.82759794304E + 000
i = 4.57908193581E – 004 j = 5.54099068359E – 001
k = 1.52263826552E + 000 l = 1.59877864528E – 004
m = 6.54574758515E – 001.

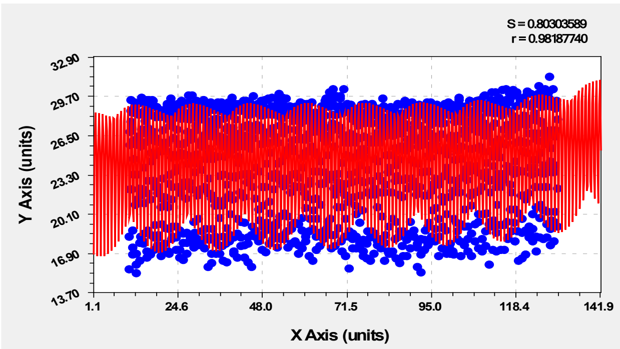


Figure 7. Plot of the model with four components for the station Guwahati.

The first component is the Mandelbrot law (in physics) $y = a\exp(-bx)$ of the exponential decrease in the mean monthly temperature. This formula shows a natural trend from 1902 to 2021 of a slow decrease in temperature. The reason for this decrease is cosmic cold.

But it turned out that the influence of the Himalayas gives an increase in the average monthly temperature according to the second component for 120 years according to the law of "double" growth according to the formula of the anomalous biotechnical law $y = ax^b\exp(cx^d)$. It is this formula that has sharply raised the temperature according to the graph in **Figure 7** in recent decades.

The first fluctuation in the formula (6) of the annual constant cycle also continuously decreases in amplitude. But, because of the negative sign before the third component, its influence will favorably affect the climate around the Guvahati station.

The second fluctuation in formula (6) with a semi-annual cyclicity is typical not only for air temperature, but also for the concentrations of various greenhouse gases, especially for CO_2. The negative sign before the fourth component is affected by tropical evergreen forests around Guvahati station. However, according to Mandelbrot's law, the amplitude decreases over the years. That is, forests have an increasingly less favorable effect (this only means that people simply destroy their vegetation cover).

The standard deviation of the model (6) in **Figure 7** is 0.8030 °C and it is significantly less in comparison with other weather stations Srinagar (1.4043 °C), Jolhpur (1.2283 °C) and New Delhi (1.1852 °C). At the same time, the correlation coefficient of 0.9819, as well as at other stations (Srinagar 0.9778, Jolhpur 0.9845, New Delhi 0.9847), is above the adequacy level of 0.95 (super strong connection).

Relative errors of dynamics models

Table 5 shows the values of the relative modeling error for models containing four components each.

Table 5. Relative error (%) of the dynamics of the average monthly temperature.

Month	Srinagar	Jolhpur	New Delhi	Guvahati
Jan	167.17	5.38	5.26	3.48
Feb	146.88	5.69	5.92	3.33
Mar	15.84	4.43	4.83	3.33
Apr	8.19	3.63	3.80	3.32
May	7.19	2.60	3.18	2.32
Jun	4.96	2.79	3.57	1.66
Jul	3.72	2.59	3.10	1.47
Aug	2.72	3.36	2.51	1.30
Sep	4.54	3.29	2.81	1.52
Oct	7.09	3.40	2.71	1.93
Nov	9.58	4.13	3.30	2.67
Dec	44.18	4.49	4.82	2.85

It can be seen from the data in **Table 5** (**Figure 8**) that the model for the Guvahati station has the smallest error of 1.30%. At the same time, August is the most accurate for the models of three weather stations. Only Jolhpur station receives the most accurate model in July.

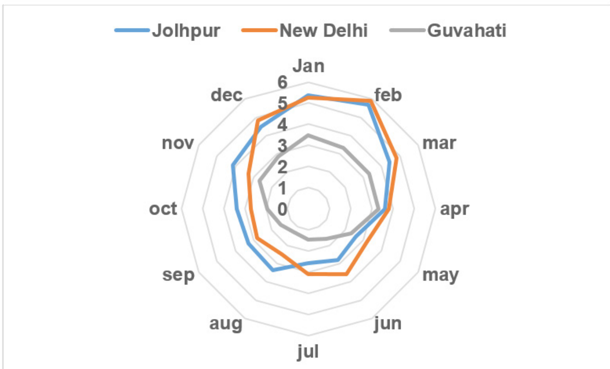


Figure 8. Diagrams of the relative error of three weather stations.

The Guwahati meteorological station has the lowest values of relative error.

5. Temperature forecast by months

Forecasting capabilities decrease with an increase in the number of wavelets in the general model (1) due to the fact that new micro-oscillations appear in the near future, which can dramatically change forecasting trends for the distant future. To verify the forecasts, it is enough to wait only one year (12 months) to obtain the actual average monthly temperature. Then, a predictive model is re-identified, which contains wavelets that affect the future. From the predictive model, those components are excluded, after identifying the wavelets according to formula (1), which are inside the basis of the forecast. This is how the forecasts are refined in the iterative forecasting mode every year.

5.1 Monthly average temperature forecast at Srinagar station

After calculations in the Excel software environment using formula (3), graphs (**Figure 9**) of the average monthly temperature for each month from 1892 to 2150 were obtained.

The charts for all 12 months narrow over time. Due to this behavior of the local climate, the temperature, for example, in January, the monthly temperature rises more rapidly than in August. For 260 years, the surface layer of air at a height of 2 m at Srinagar station receives more warming in winter and autumn.

For forecasts in the month of August from **Table 5** with a minimum relative error (**Figure 10**).

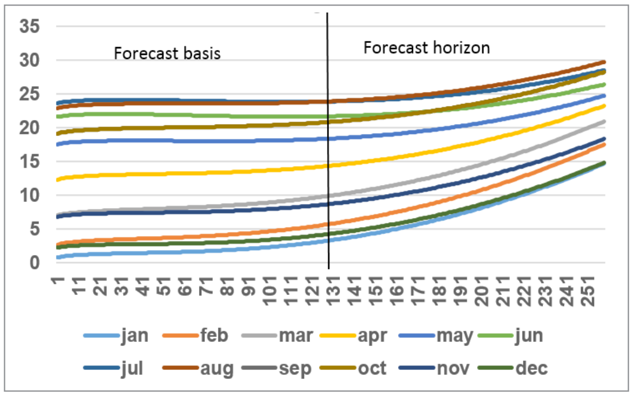


Figure 9. Srinagar monthly average temperature forecasts to 2150.

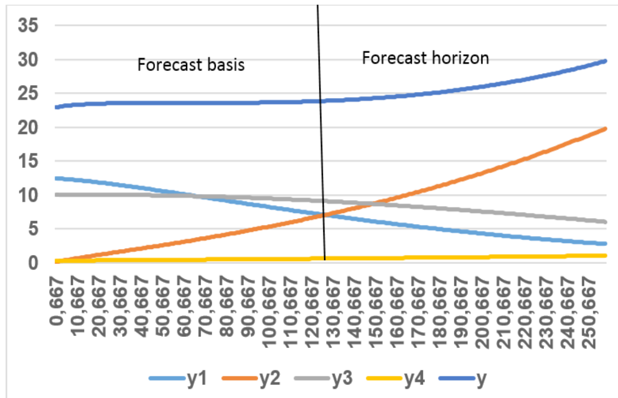


Figure 10. Temperature forecasts for Srinagar in August until 2150.

The first component of the influence of cosmic cold from 1892 to 2150 decreases. That is, the decline in the natural tendency will occur by 12.43 – 2.78 = 9.65 °C. But, for the same period of time in 260 years. According to the second component in the form of an anomalous biotechnical law, the average August temperature will increase from 0.09 °C to 19.83 °C. That is, the increase in heat will be 19.74 °C. This growth was influenced by two major reasons: Firstly, the anthropogenic reduction of the vegetation cover of India in favor of agricultural plants; secondly, the increasing geophysical influence of the Himalayas on plugging and isolating India's climate.

The annual cycles had a significant decrease in the dynamics of the August temperature from 10.07 °C to 6.06 °C, or the decrease occurred by 4.01 °C. This decrease, of course, was influenced by the breath of the local mountain forests. However, their productivity and quality are declining due to anthropogenic influence.

For the fourth component of the semi-annual cycle, there will be a slight increase in the August temperature from 0.31 °C to 1.07 °C, that is, an increase of 0.76 °C.

The critical thermal wave is created by the second component (3).

The total temperature at Srinagar station will increase from 22.91 to 29.75 over 260 years, or the increase in heat flow will be 6.84 °C. In 2021, the temperature was actually 23.3, theoretically 23.91, so the growth over the next 130 years will be 5.84 °C.

5.2 Average monthly temperature forecast at Jolhpur station

The graphs in **Figure 11** show that the Thar Desert ecosystem has become stable and therefore the monthly heat fluxes remain roughly the same for 250 years.

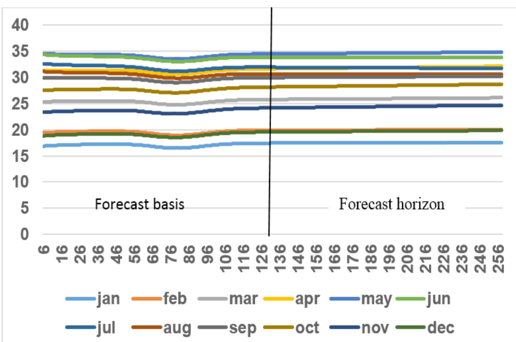


Figure 11. Jolhpur monthly average temperature forecasts up to 2145.

According to **Table 5**, July has the minimum relative error (**Figure 12**).

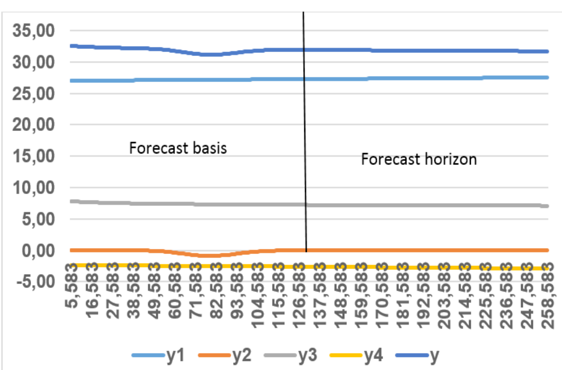


Figure 12. Temperature forecasts for Jolhpur in July until 2145.

The first component according to the law of exponential growth (Mandelbrot's law) from 1897 to 2145 in July increases from a temperature of 27.10 °C to 27.50 °C, that is, according to the global warming scenario predicted in the IPCC report CMIP5 for the entire land of the Earth, there will be an increase of 0.40 °C. But, for the same period of time in 250 years. According to the second component in the form of a negative biotechnical law, there will be a change in the July temperature along a concave curve from 0.00 to 0.00 with a minimum of –0.89 °C in 1963-1967.

The annual cycles affected the July temperature dynamics by a slight decrease from 5.60 to 5.06, or the decrease occurred by 0.54 °C.

For the fourth component of the semi-annual cycle, there will be a slight increase in the July temperature from 1.83 to 2.25, that is, an increase of 0.42 °C.

The critical thermal wave is created by the first component (4).

The total temperature at Jolhpur station will increase from 34.53 to 34.82 over 250 years, or the increase in heat flow will be 0.29 °C. In 2021, the temperature was actually 32.3, theoretically 31.94, so the growth over the next 125 years will be 2.88 °C.

5.3 Monthly average temperature forecast at New Delhi station

As can be seen from **Figure 13**, all 12 graphs continue smoothly, but at the same time there will be an increase in the average monthly temperature.

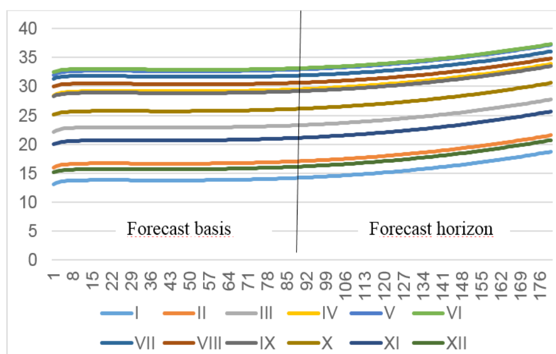


Figure 13. New Delhi monthly average temperature forecasts to 2110.

Further, for August, we consider separately the changes in the average monthly temperature for four components over the time interval from 1931 to 2110.

Figure 14 shows graphs for August, built according to formula (5).

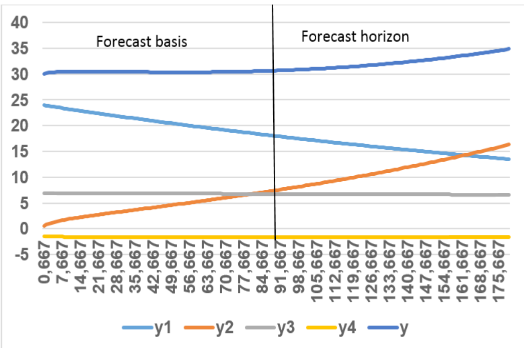


Figure 14. Temperature forecasts for New Delhi in August until 2110.

The first component of the effect of cosmic cold from 1931 to 2110 decreases from a temperature of 23.94 °C to 13.51 °C, that is, the decline in the natural tendency will occur by 23.94 – 13.51 = 10.43 °C. But, over the same period of 180 years, according to the second component in the form of an anomalous biotechnical law, the average August temperature will increase from 0.61 °C to 16.31 °C. That is, the increase in heat will be 15.70 °C. This growth was influenced by two major reasons: firstly, the anthropogenic reduction of the vegetation cover of India in favor of agricultural plants and the formation of the Thar Desert; secondly, the strengthening of the geophysical influence of the Himalayas on the blockage and isolation of the climate of the foothill regions of India.

The annual cycles affected the August temperature dynamics by a slight decrease from 6.93 to 6.63 or a decrease of 0.30 °C.

For the fourth component of the semi-annual cycle, there will be a slight decrease in August's temperature from –1.47 °C to –1.60 °C, that is, a decrease of 0.13 °C.

The critical thermal wave is created by the second component (5).

The total temperature at the New Delhi station will increase from 30.01 to 34.85 over 180 years, or the increase in heat flow will be 4.84 °C. In 2021, the temperature was actually 30.9, theoretically 30.68, so the growth over the next 90 years will be 4.17 °C.

5.4 Average monthly temperature forecast at Guvahati station

Despite the presence of tropical evergreen forests, the area around Guvahati station is expected to experience strong warming in the future. The article [14] shows a map of the types of vegetation in India, which clearly shows a strong mosaic of the vegetation cover. The fragmentation of forest land plots indicates a strong anthropogenic influence by the transformation of forests into agricultural land.

Figure 15 shows graphs of strong warming. At the same time, the rate of warming is much higher compared to the rate of the global warming scenario predicted in the IPCC report CMIP5 for the entire land mass of the Earth.

The graphs show an even change within the months of the year, but at the same time, all months begin to rise steeply in the direction of increasing temperature.

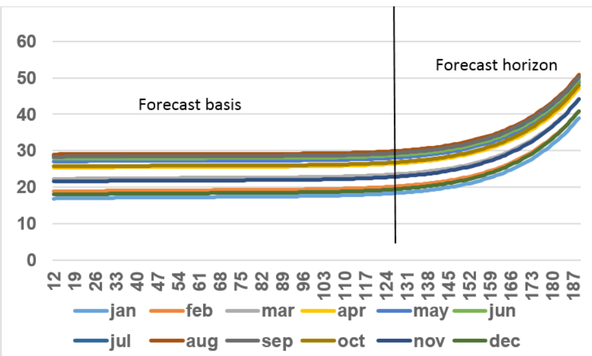


Figure 15. Guvahati monthly temperature predictions until 2080.

Due to a sharp increase in temperature, the forecast was stopped until 2080. Indian specialists will find ways to radically stop the sharp warming in the area around the Guvahati station.

According to **Table 5**, August has the minimum relative error (**Figure 16**).

The first component according to the law of exponential growth (the Mandelbrot law modified by us) from 1902 to 2080 in August at the Guvahati station increases from a temperature of 24.10 °C to 24.50 °C, that is, according to the global warming scenario predicted in the IPCC CMIP5 report for the entire land mass of the Earth, growth by 0.40 °C.

However, over the same time period of 180 years, according to the second component in the form of a positively directed anomalous biotechnical law, there will be a sharp increase in the August temperature from 0.00 to 21.70. At the same time, the zero value continued until 1956, that is, for 55 years. Therefore, climatologists in India can compare these years with the events that were taken during this period. The average rate of warming will be equal to 21.70 / 125 = 0.174 °C.

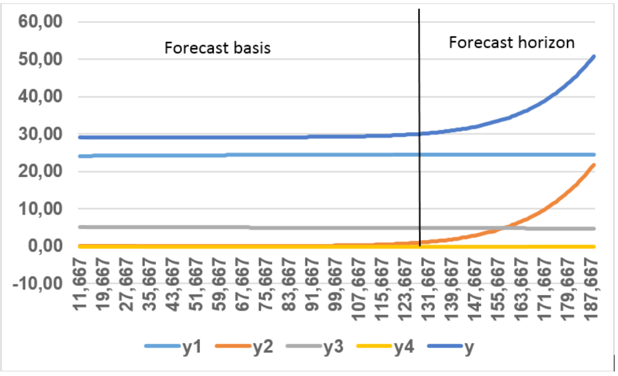


Figure 16. Temperature forecasts for Guvahati in August until 2080.

The annual cycles had a slight decrease from 5.10 to 4.70 on the dynamics of the August temperature, or a decrease of 0.40 °C. For the fourth component of the semi-annual cycle, there will be a constant value of the August temperature –0.19 °C.

The critical thermal wave is created by the second component (6).

The total temperature at the Guvahati station will increase from 29.02 to 50.78 over 180 years, or the increase in heat flow will be 21.80 °C. In 2021, the temperature was actually 29.3, theoretically 30.69, so the growth over the next 60 years will be 20.09 °C.

5.5 Comparison of monthly average temperature forecasts

For 2080, a comparison was made (**Table 6**, **Figure 17**) of weather stations.

Table 6. Predicted temperature values for 2080.

Month	Srinagar	Jolhpur	New Delhi	Guvahati
Jan	7.09	17.49	16.6	38.98
Feb	9.69	19.95	19.44	40.88
Mar	13.56	25.92	25.63	44.21
Apr	17.15	31.85	31.80	47.13
May	20.14	34.62	35.14	48.74
Jun	22.78	33.87	35.30	49.47
Jul	24.94	31.83	34.03	49.47
Aug	25.45	30.60	32.82	50.15
Sep	23.04	30.08	31.44	50.78
Oct	17.85	28.40	28.49	50.33
Nov	11.77	24.41	23.53	47.96
Dec	7.70	19.70	18.58	40.87

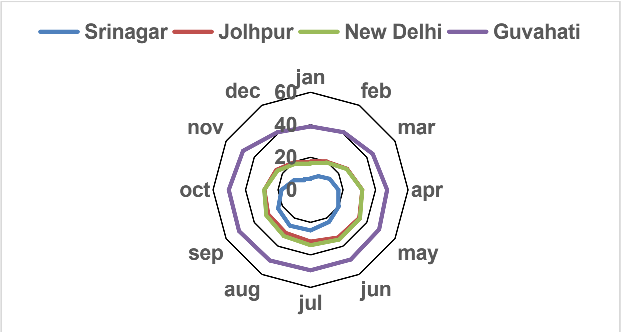


Figure 17. Diagrams of temperature forecasts up to 2080.

From a climatic point of view, the Guwahati station becomes the most dangerous.

6. Conclusions

Using the identification method [7-11], according to the actual data of the average monthly temperature, asymmetric wavelets of dynamics were identified as fractal quanta of the behavior of the surface air layer at a height of 2 m, on the territory of four weather stations in India (Srinagar, Jolhpur, New Delhi and Guvahati), an analysis of wave patterns was carried out.

The maximum temperature for each weather station is different. For example, for Srinagar station, the maximum for all years is observed in July, for Jolhpur and New Delhi stations, the maximum shifts to June, and for Guvahati station, it shifts to August.

With a high correlation coefficient of 0.9659, 0.8640 and 0.8687, a three-factor model of the form was obtained $\bar{t} = 45.16459 - 0.0083426h - 0.16343\beta - 0.18818\alpha$. For this formula, the maximum relative error of 1.99% was obtained for the Jolhpur weather station. As a result, the three-factor model receives a relative error of less than 5%. That is, the geographical location of weather stations greatly affects the overall average monthly temperature. Then a new direction opens in the geographic modelling of the parameters of global and regional climatic and meteorological processes.

The hottest month for Srinagar station over a period of 130 years at an altitude of 2 m is in July. At the same time, the temperature increased from 23.4 °C to 24.2 °C (an increase of 3.31%). A noticeable decrease in the intensity of heat flows in June occurred at Jolhpur stations (over 125 years, a decrease from 36.2 °C to 33.3 °C, or by 8.71%) and New Delhi (over 90 years, a decrease from 35.1 °C to 32.4 °C, or by 7.69%). For almost 120 years, the Guvahati weather station has experienced complex climate changes: In 1902, the hottest month was July, but in 2021 it has shifted to August. However, at the same time, the maximum average monthly temperature decreased from 29.4 °C to 29.3 °C, or by 0.34%.

The increase in temperature at various stations is considered. At Srinagar station in 2021, compared to 1892, there was an increase in the average monthly temperature in June, September and October. At Guvahati Station, the 120-year increase occurred in December, January, March, and April. In the remaining months, there was a slight increase in temperature. At Jolhpur weather station, temperatures have risen in February, March and April for over 125 years, but at New Delhi, for over 90 years, temperatures have risen in February and March.

Despite the presence of tropical evergreen forests, the area around Guvahati station is expected to experience strong warming in the future. At the same time, the rate of warming is much higher compared to the rate of the global warming scenario predicted in the IPCC report CMIP5 for the entire land area of the Earth.

The first component of the model of four components according to the law of exponential growth (the Mandelbrot law modified by us) from 1902 to 2080 in August at Guvahati station increases from a temperature of 24.10 °C to 24.50 °C, that is, according to the global warming scenario predicted in the IPCC report CMIP5 for the entire land of the Earth, there will be an increase of 0.40 °C.

However, over the same period of 180 years until 2080, according to the second component in the form of a positively directed anomalous biotechnical law, there will be a sharp increase in the August temperature from 0.00 to 21.70. At the same time, the zero temperature value lasted from 1902 to 1956, that is, for 55 years. Climatologists in India can compare these years with the events that took place during this period. The average rate of warming until 2080 will be equal to 21.70 / 125 = 0.174 °C.

The annual cycles had a slight decrease from 5.10 to 4.70 on the dynamics of the August temperature at Guvahati station, or a decrease occurred by 0.40 °C. For the fourth component of the semi-annual cycle, there will be a constant value of the August temperature –0.19 °C. The critical heat wave is created by the second component. The total temperature at the Guvahati station will increase from 29.02 to 50.78 over 180 years, or the increase in heat flow will be 21.80 °C. In 2021, the temperature was actually 29.3, theoretically 30.69, so the growth over the next 60 years will be 20.09 °C.

Conflict of Interest

There is no conflict of interest.

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