About some climatic change in Russia

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There is a difference between temperature seasonal plots for various years. To evaluate the long-period change the approximation

$$T(t) \approx S + P\cos(t/L) + R\sin(t/L) \ ,$$

where L = 1 year, may be useful. The first Fourier coefficients S, P, R for a certain year are evaluated by a standard formulae by synoptic station observations in 9 Russian cities separately for the period 2005-2020. The oscillations' amplitude: $A = \sqrt{P^2 + R^2}$ and phase: $\varphi = arctg\left(R/P\right)$ are more informative and visual than the coefficients P, R:

$$T_{jk}(t) \approx S_{jk} - A_{jk}\cos(t/L - \varphi_{jk}),$$

where j is the number of year, k is the number of a city.

Let us evaluate by the least squares method (see, e.g. [1]) the temporal tendencies for these cities for a 16-year period. We approximate every function $f\left(j\right) \approx f_0 + f_1 \cdot \left(j - \frac{1+16}{2}\right)$ and obtain

$$S(j,k) \approx S_0(k) + S_1(k)(j-8{,}5);\ A(j,k) \approx A_0(k) + A_1(k)(j-8{,}5);\ \varphi(j,k) \approx \varphi_0(k) + \varphi_1(k)(j-8{,}5),$$

where j = 1,…,16 is the year number. The results are presented in the Table.

We can see that the positive tendencies $A_1(k)$ of the mean temperature are observed for every city (k=1,…,9), although the tendency for Krasnoyarsk is 13 times higher than for Yuzhno-Sakhalinsk. The tendencies $A_1(k)$, $\varphi_1(k)$ are negative for all cities. In other words, the winters become warmer and the seasons begin essentially earlier.

The similar tendencies of the temperature seasonal oscillations for the periods 1936–1965 and 1966–1995 were obtained in [2].

The chronology of the last (before 1 July) frost and the first (after 1 July) frost was evaluated for the cities in the period, too. The essential tendencies are absent and a significant volatility of the days is observed for every city.

Thus, the statement: the Earth's climate is becoming warmer is too simple for the reality description. Its evolution is more complicated.

The use of these tendencies may be important for Russian agriculture, transport, and construction.

Literature

[1] V.A.Gordin. How It Should Be Computed? Computer Assimilation of Meteorological Information. Moscow Center of Mathematical Continuous Education, 2005, 280p. (in Russian).

[2] S.M. Semenov, E.S. Gelver. Sine approximation of the annual course of daily mean air temperature in Russia in the twentieth century. Russian Meteorology and Hydrology, 2002, № 11, PP.17-21.

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Table. Temperature tendencies for 9 Russian cities for the period 2005 – 2020.

City	Moscow	Saint Petersburg	Stavropol	Arkhangelsk	Yekaterinburg	Krasnoyarsk	Irkutsk	Khabarovsk	Yuzhno-Sakhalinsk
Index	27612	26063	34949	22550	28440	29570	30758	31735	32150
S_1 C°/year	0.0775	0.068	0.0471	0.0659	0.0276	0.1296	0.105	0.0603	0.0096
A_1 C°/year	-0.112	-0.131	-0.042	-0.122	-0.065	-0.097	-0.137	-0.125	-0.045
φ_1 rad/year	-0.0051	-0.0061	-0.0086	-0.0075	-0.0089	-0.0083	-0.005	-0.0043	-0.0063
φ_1 day/year	-0.30	-0.35	-0.50	-0.44	-0.52	0.48	0.28	0.25	0.37
ΔN_{last} day/year	-0.2	-0.2	-0.1	-0.2	-1	-0,1	0	0.2	-0.2
ΔN_{first} day/year	0.9	-1.2	-0.4	0	-0.1	1.1	1.2	0.2	0.9