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Georeferenced database on soil and air climate parameters of Russia and its cartographic implications

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Many theoretical and applied problems related to the assessment of ecosystem response to climate changes imply simultaneous analysis of data on air and soil climate. In particular, soil temperature is a very important characteristic allowing us to judge sensitivity of ecosystems to climatic fluctuations and anthropogenic impacts. It is also of great importance for predicting the functioning of terrestrial biocenoses, geocryological and engineering conditions of the territory, etc.

The vast territory of Russia is characterized by the great diversity of soil climatic conditions and by differently directed tendencies of their recent changes. A combined study of the spatial and temporal changes in the parameters of soil and atmospheric climates of Russia and their cartographic modeling are of great interest. Russia has a well-developed network of weather stations, at which measurements of soil temperatures at standard depths have been performed using the same methods for more than a century.

The analysis of these data with the use of geographic information systems seems to be promising. For this purpose, a georeferenced database on the parameters of soil and atmospheric climate is being developed. Such a database in the GIS environment makes it possible to develop a system of cartographic models of the climate of Russian soils, including data on the climatic norm (1960–1990) and on its changes in the recent decades. This system will be used for assessing soil climatic conditions in the subjects of the Russian Federation and in separate soil-geographic provinces.

A series of small-scale preliminary maps of soil temperature parameters was included in the National Soil Atlas of the Russian Federation (2011). These maps indicate that the mean annual soil temperature in Russia varies from –14.5 to +15.2ºC, and the accumulated daily temperatures >10ºC increase in the southward direction from 0 to 4800ºC (degree-days). The duration of the period with soil temperatures >10ºC in the root zone (20 cm) changes from 0–2 months (in the permafrost zone) to 6–8 months (in the North Caucasus region). The accumulated daily temperatures below 0ºC vary from –3000 to –5000ºC (in the permafrost zone) to less than –50ºC in the northwestern part, in the North Caucasus, and on some islands. Some other cartographic models (e.g., the depth of penetration of temperatures >10ºC and <0ºC into the soil) have also been developed.

These models, together with other cartographic and literature data, have been used to characterize soil climatic conditions for 67 plain and 31 mountainous soil provinces of Russia shown on the Map of Soil Ecological Zoning of the Russian Federation on a scale of 1:2.5 M (2013).

The databases on the parameters of soil and atmospheric climates and digital cartographic models created on their basis should serve as the information basis for the assessment and prediction of changes in thermal state of Russian soils, for the organization of monitoring programs, and for the study of the effect of climate changes on crop growing, permafrost conditions, and other important environmental issues.