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Characteristics of on-going changes of Siberia climate

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In spite of the fact that numbers of studies of on-going climatic processes occurring on the Siberia territory revealed their general features, the detailed pattern and its interrelations with territory specifics are still vague due spare net of the meteorological stations in the region and controversial outputs of major global Reanalysis for this domain. To fill this gap and clarify the current situation a special activity aimed at obtaining reliable high resolution meteorological data sets for Siberia was initiated. Firstly, the major Reanalysis data were compared with available meteorological observations results. To perform this comparison a powerful computational block was developed as a part of a targeted web-GIS information-computational system and used. It was shown that dynamics and statistics of surface air temperature in Siberia for the second half of 20th century given by the ECMWF ERA-40 Reanalysis only are in good agreement with instrumental data.

In process of analysis climatic characteristics in terms of averaged values, climate extreme indices and characteristics controlling forest ecosystems dynamics were calculated. Relevant trends were calculated as well and statistical significance was estimated to determine regional climate change dynamics for the second half of 20th century. In particular, trends of annual mean temperature based on ERA-40 Reanalysis data and station observations have shown increase of air temperature on the most part of Siberian territory, equal to 0.4 - 0.6 °C/ 10 years and 0.8 °C/ 10 years - for some regions. Analysis of seasonal and monthly air temperatures has shown that temperature changes in winter (0.7 - 0.9 °C/ 10 years) and spring (0.5 - 0.6 °C/ 10 years) seasons make the main contribution, while contribution of temperature changes in summer and autumn are much less. Along with averaged climatic characteristics analysis extreme behavior of air temperature and precipitation has been investigated. Trend of “Number of frost days” index shows statistically significant decrease of number of days with daily minimum temperature < 5°C and equals 2 days per 10 years. Trend of the number of summer days has not shown significant changes in temperature with daily maximum temperature > 25 °C. Important for biological processes, especially to vegetation productivity climatic characteristics such as duration of warm and growing season, numbers of thaw days have been also calculated. Analysis of duration of warm and growing periods has shown an increase of number of days with daily mean temperature exceeding 0 °C and 5 °C, respectively, by 2-3 days/10 years in average. An increase of number of thaw (daily mean temperature > -2 °C) days by 2-4 days/10 years for the Western Siberia territory was also revealed.

On the next step the mesoscale weather forecast model (WRF) and data assimilation system WRF-VAR (WRFDA) were used to obtain fields of atmospheric and surface layer data for chosen calculation area of Western Siberia (2500x2000 km.). Vertical boundary conditions, as well as initial conditions are formed using ERA-40 reanalysis data, while NCEP data and USGS LULC map with spatial resolution of 9.25 km are used to determine lower boundary conditions. Measurements of weather stations, located within calculation area, are used for analysis nudging. As a result of the model run, we have meteorological fields, which are reanalysis fields’ projections with high spatial resolution (10-20 km) corrected by weather stations’ measurements. At the first stage the time slot considered is 1990-2000.

Joint usage of obtained fields and appearing outcomes of the ERA Interim Reanalysis and APHRODITE Programs should provide us with a basis necessary to understand physics of on-going accelerated warming in the region and its interrelations with global processes and local inhomogeneities that have specific geographical reference to regional ecosystems. The work was partially supported by RFBR (grants No.10-07-00547 and 11-05-01190-), SB RAS Program (projects 4.31.1.5 and 4.31.2.7) and Integration projects Nos. 4, 50 and 66.