

Early Holocene vegetation – climate interactions in the central part of European Russia

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The new Early Holocene vegetation and climate reconstruction (approximately 10100 -7800 cal. yr. BP) for the forest zone the central European Russia are based on pollen records from three key regions located in taiga, mixed coniferous-broadleaved and broadleaved forest zones.

The climatic parameters (the mean annual temperature and precipitation) and total forest coverage during the early Holocene were reconstructed using the Best Modern Analogue technique. Information about moistening conditions was revealed from reconstructions of actual evapotranspiration (ET) and potential evaporation (PET). For calculation of the annual ET and PET rates of the forest landscapes a regression model was applied. The model is based on nonlinear approximations of annual values of ET and PET provided by the Levenberg–Marquardt method using the results of numerical simulations of ET and PET carried out by a Mixfor-SVAT model for the forests with different species compositions under various thermal and moistening conditions. Mixfor-SVAT is an one-dimensional model of the energy, H₂O and CO₂ exchange between vertically structured mono- and multi-specific forest stands and the atmosphere (Olchev et al., 2002).

Obtained results showed that the considered period was characterized by relatively low air temperatures and high precipitation compared with modern conditions. Analysis of the long-term pattern of the mean annual temperature for all three regions reveal two synchronous significant cooling periods observed in 9100-9300 cal. yr. BP and 8100-8500 cal. yr. BP as well as rapid growth of the air temperature in 8100-7800 cal. yr. BP, when the annual temperatures increased by 3°C during about 300 years. The cooling phase of 8100-8500 cal. yr. BP could be corresponded to the distinct “8.2 ka event” widely recorded across Europe. Periods of climate warming are coincided with periods of precipitation rise whereas the cool phases are characterized by its decrease. The lowest ET and PET rates were obtained for northern sites in taiga and mixed coniferous-broadleaved forest zone. In particular during the cooling phases of 9100-9300 and 8100-8500 cal. yr. BP ET fell down to 220-230 mm per year and PET - to 400-410 mm year⁻¹. For the southern region ET and PET were some higher but not exceeded 320 and 470 mm per year. The ratio of actual evapotranspiration and precipitation amount showed significant decrease of the ratio in period of cooling phases (down to 0.27). It can be a clear indicator of overwatering of the ground surface and high probability for mire formation.

Relatively cold and moist climate provided relatively unfavorable conditions for forest growth. According to made reconstructions the birch and pine-birch woodlands spread over the vast area of European Russia during the Boreal and early Atlantic periods of the Holocene (10100-7900 cal. yr. BP). Forests occupied not more then 30-50% of the study area and dense forests situated only on the south of modern forest zone. The climate warming after 7900 cal. yr. BP was accomplished by expansion of broad-leaved tree species and significant increase of total forest coverage.

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