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Application of paleoecological data to predict possible future vegetation changes in the boreal forest zone of European Russia

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New multi-proxy records of pollen, testate amoebae, and charcoal were used to reconstruct the vegetation dynamics in the boreal forest area of the southern part of Valdai Hills (the area of the Central Forest Biosphere Reserve) during the Holocene and to predict their possible future changes. We focused our study on the southern boundary of the boreal forest zone. Taking into account the modern trend of increases in global air temperature, forest communities in the area can be very sensitive to environmental changes.
The Holocene vegetation and climate reconstructions are based on palaeoecological data from the large peat bog Staroselsky moch (617 ha), which is located in the southeast part of the Central Forest Biosphere Reserve. The mean annual temperature and precipitation during the Holocene were reconstructed with pollen data using the Modern Analogue Technique (MAT). Peatland surface moisture was reconstructed as depth to the water table (WTD) using a testate amoeba-based transfer function. The temporal patterns of moistening conditions within the study area were described using the climate moisture index (CMI) calculated from the rates of annual precipitation and potential evapotranspiration. The annual potential evaporation was calculated using the Priestley-Taylor equation. This numerical algorithm uses the reconstructed annual air temperature, the forest cover and pollen proportion of coniferous and deciduous tree species as input parameters.
The reconstructions of the mean annual temperature and precipitation, the CMI, peatland surface moisture, and fire activity showed that changes of climate conditions in the past epochs have a significant impact on the boreal forests of European Russia. Temperature growth and decreased moistening during the warmest phases of the Holocene Thermal Maximum in 7.0-6.2 ka BP and 6.0-5.5 ka BP and in the relatively warm phase in 3.4-2.5 ka BP led to structural changes in plant communities, specifically an increase in the abundance of broadleaf tree species in forest stands and the suppression of Picea. The frequency of forest fires was higher in this period, and it resulted in the replacement of spruce forests by secondary stands with Betula and Pinus.
To predict possible forest vegetation changes during the 21st century, the RCP2.6 scenario (IPCC 2013) was used. For vegetation projections, we can use the warm phases observed during the Holocene Thermal Maximum 7.0–6.2 ka BP and 6.0–5.5 ka BP, as well as the climate warming between 3.4 and 2.5 ka BP. Results showed that despite significant changes in the climatic parameters projected for the 21st century using even the optimistic climate change scenario, the time lag between climate changes and vegetation responses makes any catastrophic vegetation disturbances (due to natural reasons) in the area in the 21st century unlikely.
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