EGU23-13603, updated on 28 Feb 2023
https://doi.org/10.5194/egusphere-egu23-13603
EGU General Assembly 2023

Simulating wildfire impacts on boreal forest structure over the past 20,000 years since the Last Glacial Maximum in Central Yakutia, Siberia

Ramesh Glückler[1], Josias Gloy[1], Elisabeth Dietze[2], Ulrike Herzschuh[1,3,4], and Stefan Kruse[1]
[1]Polar Terrestrial Environmental Systems, Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, Potsdam, Brandenburg, Germany
[2]Institute of Geography, Georg-August-University Göttingen, Göttingen, Lower Saxony, Germany
[3]Institute for Environmental Science and Geography, University of Potsdam, Potsdam, Brandenburg, Germany
[4]Institute for Biochemistry and Biology, University of Potsdam, Potsdam, Brandenburg, Germany

Even though wildfires are an important ecological component of larch-dominated boreal forests in eastern Siberia, intensifying fire regimes may induce large-scale shifts in forest structure and composition. Recent paleoecological research suggests that such a state change, apart from threatening human livelihoods, may result in a positive feedback on intensifying wildfires and increased permafrost degradation [1]. Common fire-vegetation models mostly do not explicitly include detailed individual-based tree population dynamics. However, setting a focus on patterns of forest structure emerging from interactions among individual trees in the unique forest system of eastern Siberia may provide beneficial perspectives on the impacts of changing fire regimes. LAVESI (*Larix* Vegetation Simulator) has been previously introduced as an individual-based, spatially explicit vegetation model for simulating fine-scale tree population dynamics [2]. It has since been expanded with wind-driven pollen dispersal, landscape topography, and the inclusion of multiple tree species. However, until now, it could not be used to simulate effects of changing fire regimes on those detailed tree population dynamics.

We present simulations of annually computed tree populations during the past c. 20,000 years in LAVESI, while applying a newly implemented fire module. Wildfire ignitions can stochastically occur depending on the monthly fire weather. Within the affected area, fire intensity is mediated by surface moisture. Fire severity depends on the intensity, with scaled impacts on trees, seeds and the litter layer. Each tree has a chance to survive wildfires based on a resistivity estimated from its height and species-specific traits of bark thickness, crown height, and their ability to resprout. The modelled annual fire probability compares well with a local reconstruction of charcoal influx in lake sediments. Simulation results at a study site in Central Yakutia, Siberia, indicate that the inclusion of wildfires leads to a higher number of tree individuals and increased population size variability compared to simulations without fires. In the Late Pleistocene forests establish earlier when wildfires can occur. The new fire component enables LAVESI to serve as a tool to analyze effects of varying fire return intervals and fire intensities on long-term tree population dynamics, improving our understanding of potential state transitions in the Siberian boreal forest.

References:

[1] Glückler R. et al.: Holocene wildfire and vegetation dynamics in Central Yakutia, Siberia, reconstructed from lake-sediment proxies, *Frontiers in Ecology and Evolution* 10, 2022.

[2] Kruse S. et al.: Treeline dynamics in Siberia under changing climates as inferred from an individual-based model for Larix, *Ecological Modelling* 338, 101–121, 2016.