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Impact of treeline migration at high latitudes in Siberia – combining modelling and genetics.

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Detailed information of boreal forest dynamics are needed to assess local impacts of current global warming. Strong impacts are expected especially at Arctic treelines, where the temperature has increased dramatically throughout the recent past and is expected to increase further. Simulation models can be used to close this knowledge gap, however, global models do not resolve the important small-scale processes well enough. For this purpose, we designed a new individual-based and spatially explicit model, the *Larix* vegetation simulator LAVESI, and to achieve a most realistic model, each life history stage of larch species are handled explicitly. The model's processes were adapted to observed patterns and calibrated with forest stand data, collected on joint Russian-German field surveys along transects spanning the treeline at the Taymyr Peninsula, Russia.
Recently, we included pollination and coupled this, and seed dispersal, in LAVESI to wind data. The new model allows furthermore to simulate the impacts on the genetics, which might constrain or enhance the responses of the treeline tree stands further.
The dispersal processes were parameterized for larches at the treeline in Siberia. The effective seed dispersal was inferred by a genetic parentage analysis, using eight highly polymorphic nuclear microsatellite loci. We genotyped 612 individuals from an open forest site, at the southern Taymyr Peninsula in north-central Siberia. At this remote site, we sampled all mature trees within an area of one hectare, and furthermore all recruits within the central area of the plot. The results indicated a high on-site recruitment rate of $\sim$53%. The effective seed dispersal follows a Gaussian function with a fat tail. The median dispersal distance of $\sim$10 m is unexpectedly short for a wind-dispersed species in an open forest.
Our simulation results indicate that already the recent temperature rise of c. 4 °C allows the tree stands to densify, but with a time lag of decades. This temperature increase would allow forests to expand farther north by roughly one degree latitude until the end of the 21st century, but seed limitation hinders populations to migrate. The improved model revealed a slowly moving treeline front, advancing only by few meters in each year into tundra. While the observed colonisation of the tundra is assisted by occasional long-distance seed dispersal events beyond the treeline area, we conclude that the treeline advance in north-central Siberia currently lags behind the current strong warming and will continue to lag in the near future.