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Impacts of peatland and permafrost changes on the terrestrial carbon storage over the last 21 ka

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Paleoclimate records and global climate-carbon cycle models suggest a net increase in land carbon (C) storage between 300 and 700 Pg C (1 Pg C = 10^{15} g C) during the transition from the last glacial maximum (LGM), the Holocene up to the preindustrial period. Peat accumulation rate records imply an increase in peatland C of $\sim$600 Pg C over the course of the Holocene. In high northern latitudes mineral and organic soils are subject to permafrost formation, which is believed to have been more extensive during glacial compared to interglacial periods. Soil C in permafrost regions represents the largest inert C pool on land at present. The spatio-temporal evolution, however, of C stocks in soils and vegetation remains poorly quantified and is uncertain. Here, the Land surface Processes and eXchanges (LPX-Bern) Dynamic Global Vegetation Model is applied in transient simulations to explore the evolution of permafrost, peatland and vegetation C over the last 21'000 years. The model is forced with temperature and precipitation output from the Trace-21ka climate simulation, and dynamically simulates the formation and disappearance of peatlands and permafrost soils, vegetation distribution and C stocks. Results indicate that peatlands and permfrost areas existed further south in the LGM, in agreement with available proxy information, and that their associated C was lost during the transition into the Holocene. The simulated loss of inert C is over-compensated by vegetation regrowth. The timing of the C relocation on land is compared to observational evidence from paleoclimate archives and estimates from ocean C inventory changes.