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Simulating permafrost evolution in Eurasia during the last deglaciation

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Dated periglacial features such as ice wedge casts in Northwest Europe along with discoveries of relict permafrost zones such as in Western Siberia indicate the expanse of permafrost through Eurasia during the Last Glacial (Huijzer & Vandenberghe, 1998; Van Vliet-Lanoë, 1989; Ananjeva et al., 2003; Szewczyk & Nawrocki, 2011). These zones then degraded and mostly disappeared in response to late glacial and Holocene warming. It is unknown how significant a role permafrost played during this last deglaciation since perennially frozen ground provides a number of feedbacks during its decay. Most notable are increased atmospheric carbon emissions, an altered hydrological landscape, and decrease in thermal buffering between the land surface and atmosphere.

To simulate permafrost evolution beginning from 21 ka BP to present, we use the Vrije University Amsterdam Permafrost (VAMPER) model at selected locations in Eurasia. The model is forced with annual surface temperatures produced from prior low-resolution coupled climate model simulations by LOVECLIM (Roche et al., 2011). As a response to the surface forcing along with assumed basal heat flow and other parameters, the VAMPER model calculates in 1-D the subsurface temperatures down to 1000 meters.

Verifying and analyzing these stand-alone experiments is the beginning step of a wider project which plans to couple the VAMPER model with LOVECLIM, where permafrost will play a more interactive part in the earth system via certain feedback effects. We present a series of depth-temperature profiles exhibiting the progression of the subsurface thermal regime as Eurasia transitioned from the Last Glacial Maximum into the Holocene. These results are compared with geological evidence of where and how permafrost is believed to have existed around this time.