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Modelling Holocene peatland and permafrost dynamics with the LPJ-GUESS dynamic vegetation model

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Dynamic global vegetation models (DGVMs) are an important platform to study past, present and future vegetation patterns together with associated biogeochemical cycles and climate feedbacks (e.g. Sitch et al. 2008, Smith et al. 2001). However, very few attempts have been made to simulate peatlands using DGVMs (Kleinen et al. 2012, Tang et al. 2015, Wania et al. 2009a). In the present study, we have improved the peatland dynamics in the state-of-the-art dynamic vegetation model (LPJ-GUESS) in order to understand the long-term evolution of northern peatland ecosystems and to assess the effect of changing climate on peatland carbon balance. We combined a dynamic multi-layer approach (Frolking et al. 2010, Hilbert et al. 2000) with soil freezing-thawing functionality (Ekici et al. 2015, Wania et al. 2009a) in LPJ-GUESS. The new model is named LPJ-GUESS Peatland (LPJ-GUESS-P) (Chaudhary et al. in prep). The model was calibrated and tested at the sub-arctic mire in Stordalen, Sweden, and the model was able to capture the reported long-term vegetation dynamics and peat accumulation patterns in the mire (Kokfelt et al. 2010). For evaluation, the model was run at 13 grid points across a north to south transect in Europe. The modelled peat accumulation values were found to be consistent with the published data for each grid point (Loisel et al. 2014). Finally, a series of additional experiments were carried out to investigate the vulnerability of high-latitude peatlands to climate change. We find that the Stordalen mire will sequester more carbon in the future due to milder and wetter climate conditions, longer growing seasons, and the carbon fertilization effect.

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