Evaluation of modelled methane emissions over high-latitude wetlands

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Atmospheric emissions and concentrations of CH₄ are continuing to increase, making CH₄ the second most important human-influenced greenhouse gas in terms of climate forcing, after CO₂. Previous studies indicated that wetland CH₄ emission is not only the single largest but also the most uncertain natural source in the global CH₄ budget. Furthermore, the strong sensitivity of wetland CH₄ emissions to environmental conditions has raised concerns on potential positive feedbacks to climate change. Therefore, evaluation of the process-based land surface models of earth system models (ESMs) in simulating CH₄ emission over wetlands is needed for more precise future predictions. In this work, a set of high-latitude wetland sites with various nutrient conditions are studied. The wetland CH₄ fluxes are simulated by the land surface model JULES of the UK Earth System model and the Helsinki peatland methane emission model (HIMMELI), which is developed at Finnish Meteorological Institute and Helsinki University. The differences between the modelled and observed CH₄ fluxes are analyzed, complemented with key environmental variables for interpretation (e.g. soil temperature and moisture, vegetation types, snow depth, NPP, soil carbon). In general, the simulated CH₄ fluxes by HIMMELI is closer to the observed CH₄ fluxes in magnitude and seasonality at sites than those by JULES. The inter-annual variability of simulated CH₄ fluxes by HIMMELI depends on the simulated anoxic soil respiration, which serves as the substrate of the CH₄ fluxes in HIMMELI. The anoxic soil respiration is calculated based on the simulated soil respiration and water table depth in JULES. More accurate simulation of soil carbon pool and water table depth in JULES will lead to improvement in the simulated anoxic soil respiration.