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Natural methane cycle from the LGM to the present

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The time between the last glacial maximum (LGM) and the present is a highly interesting time with regard to atmospheric methane concentrations. Between the LGM and 10 ka BP atmospheric CH_4, as reconstructed from ice cores, nearly doubled, with very rapid concentration changes of about 200 ppb occurring during the Younger Dryas and Bølling Allerød transitions. Although atmospheric CH_4 is nearly identical for 10 ka BP and PI, CH_4 decreased by 15% between 10 ka and 5 ka BP, with a subsequent increase back to the PI concentration, followed by a strong increase to the present.

We use a methane-enabled version of MPI-ESM, the Max Planck Institute Earth System Model, to investigate changes in methane cycling in a transient ESM experiment from the LGM to the present. The model is driven by prescribed orbit, greenhouse gases and ice sheets, with all other changes to the climate system determined internally. Methane cycling is modelled by modules representing the atmospheric transport and sink of methane, as well as terrestrial sources and sinks from soils, termites, and fires. Thus, the full natural methane cycle – with the exception of geological and animal emissions – is represented in the model.

Model results are compared to methane concentrations from ice cores, and key periods in climate/methane evolution are highlighted by detailed analyses. Preliminary analysis indicates that methane concentrations can mainly be explained by emission changes, with LGM emissions substantially reduced in comparison to the early Holocene and preindustrial states.