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Modelling Methane Emissions from boreal ombrotrophic Peatlands

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Natural wetlands are not only the single largest natural methane source, but also the most uncertain. However, the processes leading to methane emission are reasonably well understood and lend themselves to numerical modelling. Methane emissions depend on the depth of the anaerobic and aerobic soil layers which is determined by the water table, soil temperature, and the availability of substrate for methanogenesis. Climate has direct effects on methane emissions via temperature and precipitation, and indirect effects through vegetation composition and plant productivity. The type of vegetation influences the amount of primary production and the quality of the substrate, and also the escape pathway for methane through the aerenchymatous tissue of vascular plants. We are developing a model, which takes these various processes into account and will allow us to explore the sensitivities of methane emissions to vegetation structure and climate, and to project methane emissions under climate change.

The core modelling approach adopted is that of the Lund-Potsdam-Jena Dynamic Global Vegetation Model (LPJ). Our current focus is on northern ombrotrophic peatlands. We have made the following amendments to LPJ. A distinctive wetland hydrology has been introduced for organic soils. This method predicts water table position and water content in each unsaturated layer of the soil column. A Crank-Nicholson scheme solves the heat diffusion equation and enables us to calculate the temperature in each soil layer. Hence, we can simulate the active layer depth in permafrost regions and the influence of freezing/thawing cycles on the water balance. Four new plant functional types (PFTs) have been added: boreal deciduous and evergreen dwarf shrubs, cold graminoids, and peat mosses. The distributions of these PFTs and the NPP they generate are being evaluated by comparing model results with distribution maps and field measurements. NPP and the temperature and water content in each soil layer

provide input to a methane emissions model, which explicitly simulates the production of methane in anaerobic soils, its partial oxidation in the aerobic layers, and its emission to the atmosphere through the alternative pathways of diffusion, ebullition and transport through aerenchyma. The coupled model system will provide simulations of methane flux time series for comparison with observational data.