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Evaluation of a wetland methane emission parameterization for present-day and Last Glacial Maximum

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Wetlands are the largest natural source of atmospheric methane and presumably contribute ∼25-40% to its annual budget (∼500 Tg). However, there remain considerable uncertainties in estimation of global wetlands and their methane emissivity, given the large domain of their vegetation and hydrological characteristics. In this study, we describe the development of a wetland methane emission model in conjunction with global wetland parameterization at seasonal resolution. Contrary to most of the other modeling studies, our model is based on a simple parameterization and also readily adaptable to different paleo climatic scenarios, in which the role of methane is still largely unexplored. Wetlands with a strong climatic sensitivity are perceived to be a key factor in past changes of atmospheric methane concentration, e.g. the double fold increase since the Last Glacial Maximum (LGM).

The present parameterization is primarily based on CARAIB, a large scale dynamic vegetation model designed to study the role of vegetation in the global carbon cycle. Its hydrological module is adept at simulating soil water and several associated hydrological fluxes over various biome types. Our model parameterization uses three basic drivers from CARAIB: soil water, soil temperature and soil carbon content along with high resolution terrain slope data. The emission model is included in the chemistry climate model ECHAM5-MOZ for present day and also used in LGM methane simulations. The model results are evaluated in comparison with atmospheric methane observations from the NOAA-CMDL flask network and ice core records for LGM. We obtained the present day wetland methane source to be 153 Tg/year, which lies near the lower edge of model assumptions. We also discuss the uncertainties of the present day simulation and the impact of emission scaling on atmospheric concentration. The latitudinal distribution of other major methane sources, uncertainties in their budget and their potential role in hemispherical distribution of atmospheric methane are also evaluated.