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Ocean carbon cycle during the last deglaciation in the Max Planck Institute Earth System Model

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The deglacial atmospheric CO2 increase has been attributed to a combination of mechanisms, many of which relate to the ocean outgassing triggered by changing marine physical and biogeochemical states. To quantify the impact of proposed processes and feedback on the deglacial CO2 rise, previous modelling studies mostly conducted time-slice sensitivity experiments. Here, we present results from a transient deglaciation simulation (24 kB.P. - 1850) using the comprehensive Max Planck Institute Earth System Model (MPI-ESM). We force the model with the deglacial atmospheric greenhouse gases (CO2, CH4, N2O) concentrations, obital parameters, ice sheet reconstruction and transient dust deposition. The ocean biogeochemical component of MPI-ESM is using the same automatical adjustment of bathymetry and land-sea mask in response to deglacial continental runoff and melt water discharge. In and around the areas of changing land-sea mask, we redistribute the marine biogeochemical tracers in accord with the simulated salinity. Terrestrial organic matter is transferred from flooded land areas to the ocean, which guarantees mass conservation with respect to carbon. We also include 13C tracers in the ocean biogeochemical component to evaluate the simulated ocean state against proxy data. The initial marine nutrients and carbon inventories are set the same as those in the present-day ocean.
During the first 3 kyr, the climate and ocean state show, as expected, only modest variations. Some flooding events of coastal areas bring terrestrial organic matter to the ocean and lead locally to CO2 outgassing for several decades. Terrestrial organic matter has a higher carbon to nutrient stoichiometry as compared to marine organic matter, thus its remineralization favours CO2 outgassing. Additionally, the accumulation of terrestrial organic matter in the top layers of the marine sediment reduces the replenishment of the water-column nutrients by the re-flux of remineralization products from marine sediment. Consequently, the strength of the local biological pump decreases. Further results will be presented and discussed.