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Modeling the ocean carbon cycle in the Paleocene-Eocene Thermal Maximum with an Earth System Model

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During the Paleocene-Eocene Thermal Maximum (PETM; 55 million years ago) the climate underwent significant changes within short geological timescales. The atmosphere, ocean and land system was affected by a massive carbon release which caused an intense global warming, indicated by a negative $\delta^{13}C$-carbon isotope excursion and carbonate dissolution in the ocean. In terms of released carbon and concomitant changes in ocean carbon cycle, the PETM probably serves as the most analogous event in Earth's history for ongoing ocean acidification. However the dimensions of the changes in ocean carbon cycle during the PETM are still uncertain based on the ambiguous amount and time scale of the carbon release. We use the fully coupled Earth System Model of the Max Planck Institute for Meteorology (MPI- ESM) which includes ocean and atmospheric general circulation models (MPI-OM & ECHAM respectively) and models of ocean biogeochemistry (HAMOCC) and land vegetation (JSBACH). Such modeling system enables us to simulate the closed carbon cycle in the oceanic, land and atmospheric compartments. Moreover, by using a three-dimensional ESM we get a more detailed representation of the ocean biogeochemistry and the underlying physical processes. After initializing the ocean biogeochemistry within Late Paleocene (pre-PETM) boundary conditions in an ocean standalone setup, we ran the model into a steady state under 2x pre-industrial atmospheric CO_2 concentrations (560 ppmv). Starting from this climate state we compute different carbon release scenarios for the onset of the PETM. Within these model-runs of several 1000 years duration we prescribe a carbon release of up to 1.5 Gt a^{-1}, which is at the upper limit of estimations for the PETM. We focus on how ocean biogeochemistry is affected, but also highlight the interactions between the different compartments of the carbon cycle. First model results and modifications implemented in HAMOCC for application to the PETM will be presented.