Fourth International Conference on Earth System Modelling
4ICESM-203, 2017

Modelling marine carbon cycle during the last glacial maximum

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There is still little consensus about the mechanisms causing the glacial-interglacial variations in atmospheric CO_2 concentrations of roughly 80-100 ppm. However, it is certain that some of those mechanisms are driven by alterations in ocean biogeochemical cycles. Hence, it is crucial to understand ocean biogeochemistry dynamics during glacial-interglacial transitions. Within the German national climate modeling initiative PalMod, aiming at simulating a full glacial cycle (135k today) in transient mode with a state-of-the-art Earth System Model (ESM), we address the ocean biogeochemical cycles. To simulate marine biogeochemical processes during the last glacial maximum (LGM), we are extending the Hamburg Ocean Carbon Cycle model (HAMOCC), which is coupled to the ocean general circulation model (MPIOM), atmospheric dynamics model (ECHAM6) and terrestrial vegetation model (JSBACH) in the MPI-Earth System Model. First, we include a refined representation of carbon isotopes. The latter are essential for understanding past ocean circulation changes and they will be used, for instance, to constrain the ventilation of the ocean by either northern- or southern-sourced deep water masses. Second extension of HAMOCC is including a module for coral reef growth. The buildup of coral reefs driven by glacial-interglacial changes in the tropical and subtropical oceans affect the rates of shallow $CaCO_3$ deposition and dissolution, which in turn leads to changes in seawater total alkalinity and affects air-sea exchange of CO_2. Our results aim at improving the understanding of glacial interglacial changes in atmospheric CO_2, especially in terms of marine carbon sequestration and release. The presented work contributes to developing comprehensive ESMs, which are capable of simulating the climate evolution and the variability during the last glacial cycle. First results concerning marine carbon cycle during the LGM will be presented.