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Modelling the marine sediment record - a blueprint for identifying the cause for the glacial-interglacial pCO_2 variation

C. Heinze (1)

(1) University of Bergen, Geophysical Institute and Bjerknes Centre for Climate Research (Contact Email christoph.heinze@gfi.uib.no, Fax +47 55589883)

Glacial-interglacial atmospheric pCO_2 changes can be attributed to a series of simultaneously acting marine processes which could not yet be uniquely determined. A solution provides an exploitation of the marine sediment record for data assimilation in global earth system models. We present here the interface between sediment observations and models through generation of a continuous global synthetic marine sediment core record within a biogeochemical ocean general circulation model (global HAMOCC model, resolution 3.5 by 3.5 degrees, with representations of the carbon and silicon cycles). From this record, individual synthetic sediment cores can be "recovered" at each model grid point for direct comparison with the observations. The approach includes the sediment weight percentages of calcium carbonate, biogenic silica, organic carbon, and clay as well as the sediment accumulation rate. It can be extended to multi-tracer data sets including stable isotopes and radionuclides. One has thus not to rely on proxies for a reconstruction of the carbon cycle parameters, but rather can directly use the variables as rendered by the sediment core measurements. The sediment model further generates a consistent age model to every synthetic sediment core. This enables to even assimilate data from those sediment cores which can only be dated with great uncertainty or not at all. Application of the sediment model to the global ocean with a (preliminary) varying ocean velocity field over the last climatic cycle renders synthetic sediment cores which show features of observed records, but yet a too small amplitude in atmospheric pCO_2. Allowing for changes in the biogeochemical parameters of the ocean model increases this amplitude, while the synthetic sediment core record provides a clear basis for rejecting or accepting the respective parameter change for an accurate reconstruction of the past.