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# The response of marine biogeochemistry to atmospheric CO2 increase: simulations with a coupled Earth System Model

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Marine ecosystems are major components of the Earth system and their response to increasing atmospheric CO2 levels is an important issue to be faced when analyzing the future evolution of our climate system. The fully coupled CMCC-INGV Earth System Model (ESM) is used to investigate the response of the Earth system to increasing levels of atmospheric CO2, focusing in particular on the impact on marine ecosystems. The CMCC-INGV ESM is composed of coupled atmosphere and ocean general circulation models, the latter including a sea-ice model and a comprehensive marine biogeochemistry model. About 350 years of simulation are produced and analyzed, of which 200 years under current climate conditions (1xCO2 experiment) and 150 years with a doubling of atmospheric carbon dioxide (2xCO2 experiment). The PELAGOS biogeochemistry model, which is the global implementation of the Biogeochemical Flux Model (BFM, http://bfm.cmcc.it), is capable of capturing the main features of the phytoplankton community structure in the global ocean under current climate conditions. Global sea surface temperatures raise of about 2 °C throughout the 2xCO2 experiment, and this increase is associated with a sudden drop in the southern hemisphere sea-ice volume. In the 2xCO2 experiment major changes in ocean stratification are observed during the winter season at middle and high latitudes, where an overall decrease in the mixed layer depth occurs. The relative distribution of plankton functional types (PFTs) reveals a generalized decrease in diatom abundance and a shift towards nano- and picophytoplankton. This result is consistent with the overall increase in stratification which favours the development of microbial food webs and

shows how the marine ecosystem structure might be impacted by a change in mean climate conditions.