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# Ocean biogeochemical cycles and climate sensitivity in an Earth System Model

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The sensitivity of the potential feedbacks between climate and biogeochemical cycles (BGC) is adressed with the help of LOVECLIM, a global three-dimensional Earth system model of intermediate complexity. Key physical or biogeochemical parameters of LOVECLIM are varied within their range of uncertainty in order to provide an ensemble of parameter sets resulting in contrasted climate and global carbon cycle sensitivities.

The selected climate parameter sets lead to a climate sensitivity ranging from 2 to 4$^{o}$C and a reduction of the Atlantic meridional overturning circulation (MOC) ranging from 20 to 60% in response to identical external forcings. The key parameters for the carbon cycle were chosen among those with te largest impact on the marine biogeochemical cycle and on the response of atmospheric $CO_2$ to emission scenario when running the standard version of the climate model. With respect to the oceanic BGC these parameters affect the rain ratio, the vertical flux of particulate organic matter (POM), and the remineralization of silica. The magnitude of the continental vegetation fertilization effect is also considered. The parameters of the ocean carbon cycle allow the export production to vary by 16% and the precipitation of calcium carbonate by nearly 50%. The response of the atmospheric $CO_2$ to the fertilization parametrization is of the order of 10%.

We then perform experiments in which both the climate parameters and the BGC

parameters are modified. Three types of experiments are performed: a control run, an experiment in which the atmospheric CO2 concentration is increased by 1% per year during 70 years from its pre-industrial value and then kept constant at twice the initial value, and, finally, a freshwater hosing experiment in which an additional freshwater flux of 0.0002 Sv is added each year in the North Atlantic Ocean. These experiments allow to examine the impact of change in climate sensitivity and of MOC reduction over the biogeochemical cycles as well as to assess the potential feedback from the carbon cycle onto the climate. The differences in response for the different climate parameter sets are presented and their mechanism examined.