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Sensitivity of the Atlantic Thermohaline Circulation to extreme CO2 forcing

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In order to study the sensitivity of the Atlantic Thermohaline Circulation (ATHC) to extreme external forcing, a set of experiments has been performed with high CO2 concentration (4, 8, 16 times the present day mean value) and compared with a long control simulation (CO2 present day mean value). All the experiments have been performed with SINTEXG, a state of the art coupled general circulation model with atmospheric and oceanic active components where the ocean model is coupled to a sea-ice model. ECHAM4.6 and OPA8.2 (plus LIM for sea-ice) represent the atmospheric and oceanic SINTEXG components, respectively.
The response of the system to increased CO2 forcing is analyzed focusing on the condition at the equilibrium and during transient episodes. The analysis of the climate mean state at equilibrium reveals significantly different horizontal and vertical density structures as the CO2 concentration increases. In particular, in the 16CO2 experiment a density front forms at mid-latitudes, differently from the other experiments . The temporal evolution of the THC strength changes as well depending on the perturbation applied. The density front formation in 16CO2 experiment does not allow the warm and salty tropical waters to reach high latitudes and forces them to sink more southward with respect to what happens in the 4CO2 and 8CO2 experiments. Furthermore, while the Atlantic THC is subjected to an initial weakening and a subsequent recovery in the 4CO2 and 8CO2 experiments , it weakens permanently and becomes shallower in the 16CO2 one. Another experiment has been performed closing the Gibraltar Strait under 16CO2 condition, in order to evaluate the contribution of Mediterranean Outflow Waters (MOW) to the Atlantic THC. The results show that the contribution of the MOW to Atlantic THC variability and intensity is weak, at least under the most extreme external forcing. The processes responsible for different THC responses to the extreme CO2 forcing are further investigated and presented.