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Slow-down of oceanic CO2 uptake in response to climate change

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The increase of atmospheric CO2 concentration due to anthropogenic emissions is substantially damped by the ocean. However, climate change affects the ocean's efficiency to take up CO2. Here, we investigate the atmosphere/ocean CO2 flux changes in response to climate change. In detail, the CO2 flux determining properties, namely solubility, atmosphere/ocean partial pressure difference and gas transfer velocity are analyzed.

We compare two simulations with a version of the Max Planck Earth System Model (MPI-ESM). This model includes the full feedback loop of CO2 emissions, climate change and terrestrial and oceanic carbon cycle. In both experiments observed anthropogenic CO2 emissions were prescribed until 2000, followed by the emissions according to the IPCC Scenario A2. One simulation completely allows the feedback between climate and carbon cycle, the other artificially suppresses climate change due to greenhouse warming.

The increase of oceanic CO2 uptake weakens due to climate change (about 10% in 2100), representing a positive feedback. This response is dominated by fluxes owing to changes of partial pressure difference. Solubility effects are of secondary importance, however, also contribute to the positive feedback. The positive global feedback is to a large degree compensated by fluxes due to gas transfer velocity changes following the enhancement of wind belts and sea ice melting, the latter even inducing an enhanced oceanic CO2 uptake in the polar regions. All three processes show the main response in the high latitudes. In the North Atlantic, they accumulate, whereas in the Southern Ocean, they partly cancel each other out. Note that our experiment include the terrestrial biosphere, whose response to climate change leads to additional atmospheric CO2, which in turn masks the oceanic response.