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Effect of ocean carbon cycle feedbacks on the air-sea gas exchange of CO_2 in CESM

Daan Boot[1], Anna Von Der Heydt[1,2], and Henk Dijkstra[1,2]
[1]Institute for Marine and Atmospheric research Utrecht, Utrecht University, Utrecht, the Netherlands (d.boot@uu.nl)
[2]Center for Complex Systems Studies, Utrecht University, Utrecht, the Netherlands

To avoid tipping points in the Earth system, it is important to keep warming of our planet to a maximum of 1.5 to 2°C. To be able to make policy for this goal, it is important to know what our carbon budget is for the coming decades. Unfortunately, the Earth system is a complicated system with multiple feedbacks, which make it difficult to assess this budget. One of the feedbacks is between atmospheric CO_2 concentration and the Atlantic Meridional Overturning Circulation (AMOC). The AMOC is an important component of the global ocean circulation and plays a role in regulating the climate of the Northern Hemisphere. Simulations with earth system models project that the AMOC strength will decrease in the future. Changes in the AMOC influence the distribution of tracers such as heat, salt, nutrients and carbon in the ocean. These tracers all affect the marine carbon cycle by, for example, influencing the solubility of CO_2, and biological production in the surface ocean, and thus the air-sea gas exchange of CO_2. Therefore, changes in the AMOC may be relevant for the maximum emission levels. In this presentation, we discuss the relation between the AMOC and the air-sea CO_2 exchange in the Community Earth System Model v2 (CESM2). By using results of CESM2 simulations, accompanied by the results of a box model, the Simple Carbon Project Model v1.0 (SCP-M), we find that the AMOC-CO_2 feedback is positive, i.e. higher atmospheric CO_2 concentrations result in a weaker AMOC, which leads to less CO_2 uptake by the ocean. The mechanisms behind this feedback, related to changes in the solubility, soft tissue pump and phytoplankton composition, will be presented as well as the impact of this feedback on atmospheric CO_2 concentration.