EGU24-19854, updated on 15 Sep 2024
https://doi.org/10.5194/egusphere-egu24-19854
EGU General Assembly 2024

Unfolding responses in the global ocean and land carbon sinks and atmospheric CO_2 to changing emissions with the large ensemble future projections with interactive carbon cycle.

Tatiana Ilyina[1,2,3], Hongmei Li[2,3], Lennart Ramme[3], and Chao Li[3]
[1]Universität Hamburg (tatiana.ilyina@uni-hamburg.de)
[2]Helmholtz-Zentrum Hereon
[3]Max Planck Institute for Meteorology

CO_2 emission-driven simulations are becoming a priority way of running Earth system model simulations of climate change as they directly link Earth system responses to climate policies. Also large ensemble simulations have been identified as a key tool to quantify effects of internal climate variability in the Earth system. We ran a large ensemble of emission-driven climate change projections in MPI-ESM with various CMIP6 emission scenarios. Our simulations produce a realistic temporal and spatial evolution of atmosphric CO_2, as well as ocean and land carbon sinks. An increased seasonal cycle in all carbon cycle compartments is projected in future simulations. Ongoing work focuses on discerning responses of the ocean and land carbon sinks to changing emissions. Thereby, we find that changes in atmospheric carbon are asymmetric to CO_2 emissions across various scenario pathways. Furthermore, temperature continues to increase after CO_2 emission mitigation. In our simulations, under negative emissions, the ocean and land shift from being sink to source after 2100. In particular, for the ocean carbon sink evolution, the regions which acted as a sink for anthropogenic CO_2 in the 20th century, remain sinks also during the 21st century. However, the major carbon uptake shifts from the North Atlantic to the Southern Ocean and much of the additional carbon is then stored in the south-west Pacific. In the 22nd century, it is mostly the North Atlantic that shifts towards less uptake of CO_2 and from which dissolved inorganic carbon is transported away, while the Barents Sea and WeddelSea keep taking up more CO_2 than during pre-industrial times, and parts of the ocean in the southern hemisphere keep accumulating carbon. Air-land CO_2 fluxes overlap among different scenarios emphasizing the substantial role of internal climate variability.