EGU21-9942
https://doi.org/10.5194/egusphere-egu21-9942
EGU General Assembly 2021

Ocean model formulation influences climate sensitivity

Tido Semmler[1], Johann Jungclaus[2], Christopher Danek[3], Helge F Goessling[1], Nikolay Koldunov[1], Thomas Rackow[1], and Dmitry Sidorenko[1]

[1]Alfred Wegener Institute, Climate Dynamics, Bremerhaven, Germany (tido.semmler@awi.de)
[2]Max Planck Institute for Meteorology, The Ocean in the Earth System, Hamburg, Germany
[3]Alfred Wegener Institute, Paleoclimate Dynamics, Bremerhaven, Germany (christopher.danek@awi.de)

The climate sensitivity is known to be mainly determined by the atmosphere model but here we discover that the ocean model can change a given transient climate response (TCR) by as much as 20% while the equilibrium climate sensitivity (ECS) change is limited to 10%. In our study, two different coupled CMIP6 models (MPI-ESM and AWI-CM) in two different resolutions each are compared. The coupled models share the same atmosphere-land component ECHAM6.3, which has been developed at the Max-Planck-Institute for Meteorology (MPI-M). However, as part of MPI-ESM and AWI-CM, ECHAM6.3 is coupled to two different ocean models, namely the MPIOM sea ice-ocean model developed at MPI-M and the FESOM sea ice-ocean model developed at the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI). A reason for the different TCR is different ocean heat uptake through greenhouse gas forcing in AWI simulations compared to MPI-M simulations. Specifically, AWI-CM simulations show stronger surface heating than MPI-ESM simulations while the MPI-M model accumulates more heat in the deeper ocean. The vertically integrated ocean heat content is increasing stronger in MPI-M model configurations compared to AWI model configurations in the high latitudes. Strong vertical mixing in MPI-M model configurations compared to AWI model configurations seems to be key for these differences. The strongest difference in vertical ocean mixing occurs inside the Weddell Gyre, but there are also important differences in another key region, the northern North Atlantic. Over the North Atlantic, these differences materialize in a lack of a warming hole in AWI model configurations and the presence of a warming hole in MPI-M model configurations. All these differences occur largely independent of the considered model resolutions.