EGU2020-16536
https://doi.org/10.5194/egusphere-egu2020-16536
EGU General Assembly 2020

Mechanisms affecting equilibrium climate sensitivity in the PlaSim Earth System Model with different ocean model configurations

Michela Angeloni[1,2], Elisa Palazzi[1], and Jost von Hardenberg[1,3]

[1]Istituto di Scienze dell'Atmosfera e del Clima, Consiglio Nazionale delle Ricerche (CNR-ISAC), Torino, Italy
[2]University of Bologna, Bologna, Italy
[3]Politecnico di Torino, Department of Environment, Land and Infrastructure Engineering, Torino, Italy

The equilibrium climate sensitivity (ECS) of a state-of-the-art Earth System Model of intermediate complexity, the Planet Simulator (PlaSim), is determined under three tuned configurations, in which the model is coupled with a simple Mixed Layer (ML) or with the full 3D Large Scale Geostrophic (LSG) ocean model, at two horizontal resolutions, T21 (600 km) and T42 (300 km). Sensitivity experiments with doubled and quadrupled CO_2 were run, using either dynamic or prescribed sea ice. The resulting ECS using dynamic sea ice is 6.3 K for PlaSim-ML T21, 5.4 K for PlaSim-ML T42 and a much smaller 4.2 K for PlaSim-LSG T21. A systematic comparison between simulations with dynamic and prescribed sea ice helps to identify a strong contribution of sea ice to the value of the feedback parameter and of the climate sensitivity. Additionally, Antarctic sea ice is underestimated in PlaSim-LSG leading to a further reduction of ECS when the LSG ocean is used. The ECS of ML experiments is generally large compared with current estimates of equilibrium climate sensitivity in CMIP5 models and other EMICs: a relevant observation is that the choice of the ML horizontal diffusion coefficient, and therefore of the parameterized meridional heat transport and in turn the resulting equator-poles temperature gradient, plays an important role in controlling the ECS of the PlaSim-ML configurations. This observation should be possibly taken into account when evaluating ECS estimates in models with a mixed layer ocean. The configuration of PlaSim with the LSG ocean shows very different AMOC regimes, including 250-year oscillations and a complete shutdown of meridional transport, which depend on the ocean vertical diffusion profile and the CO_2 forcing conditions. These features can be explored in the framework of tipping points: the simplified and parameterized form of the climate system components included in PlaSim makes this model a suitable tool to study the transitions occurring in the Earth system in presence of critical points.