EGU22-1988
https://doi.org/10.5194/egusphere-egu22-1988
EGU General Assembly 2022

Modelling Abrupt Transitions in Past Ocean Circulation to Constrain Future Tipping Points

Guido Vettoretti, Markus Jochum, and Peter Ditlevsen
Kobenhavn University, Physics of Ice, Climate and Earth, Neils Bohr Institute, Copenhagen, Denmark (gvettoretti@nbi.ku.dk)

Recent observationally based studies indicate that the Atlantic Meridional Overturning Circulation (AMOC) and the Greenland Ice Sheet (GIS) may be approaching critical thresholds or tipping points, although the timing is uncertain. The connection between both Greenland meltwater fluxes and anthropogenic greenhouse gas emissions and their impact on the future state of the AMOC is also uncertain. Here we investigate the role of ocean vertical mixing within the interior and surface boundary layer (the K-Profile Parameterization (KPP)) on past millennial scale climate variability in a coupled climate model. Previous studies have demonstrated a sensitivity of the period of millennial scale ice age oscillations to the KPP scheme. Here we show that small changes in the profiles of vertical mixing under ice age boundary conditions can drive the AMOC through a Hopf bifurcation and result in the appearance of millennial-scale AMOC oscillations. This has implications on whether changes in tidal energy dissipation in the coastal and deep ocean are important for modelling past climate variability. More importantly, the same changes in ocean vertical mixing can impact the stability and hysteresis behaviour of the modern AMOC under freshwater input to the North Atlantic as well as leading to abrupt transitions in AMOC strength under a doubling of carbon dioxide concentrations in the atmosphere. We show how understanding the sensitivity of the AMOC to ocean vertical mixing parameterizations used in coupled Earth System models may be important for constraining future climate tipping points.