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Linkages between ocean circulation, heat uptake and transient warming: a sensitivity study

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Transient global warming due to greenhouse gas radiative forcing is substantially reduced by ocean heat uptake (OHU). However, the fraction of equilibrium warming that is realized in transient climate model simulations differs strongly between models (Frölicher and Paynter 2015). It has been shown that this difference is not only related to the magnitude of OHU, but also to the radiative response the OHU causes, measured by the OHU efficacy (Winton et al., 2010). This efficacy is strongly influenced by the spatial pattern of the OHU and its changes (Rose et al. 2014, Winton et al. 2013), predominantly caused by changes in the Atlantic meridional overturning circulation (AMOC). Even in absence of external greenhouse gas forcing, an AMOC weakening causes a radiative imbalance at the top of the atmosphere (Peltier and Vettoretti, 2014), inducing in a net warming of the Earth System. We investigate linkages between those findings by performing both freshwater and greenhouse gas experiments in an Earth System Model of Intermediate Complexity. To assess the sensitivity of the results to ocean and atmospheric transport as well as climate sensitivity, we use an ensemble of model versions, systematically varying key parameters. We analyze circulation changes and radiative adjustments in conjunction with traditional warming metrics such as the transient climate response and the equilibrium climate sensitivity. This aims to improve the understanding of the influence of ocean circulation and OHU on transient climate change, and of the relevance of different metrics for describing this influence.

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