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The nature of ocean heat uptake in a simple conceptual model

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We consider a simple model of ocean heat uptake that accounts for the meridional overturning circulation. This model, based in part on the work of Gnandesikan, 1999 and Marshall and Zanna, 2014, accounts for Southern Ocean Ekman and eddy transports and North Atlantic Deep Water formation in addition to diapycnal mixing. Alongside, we consider another energy balance model of ocean heat uptake that takes an advective-diffusive view of the evolution of temperature anomalies associated with the ongoing global warming. We then confront these models with observational estimates of surface air temperature and ocean heat content in a Bayesian framework to find that neither model is able to effectively capture observational estimates of ocean heat uptake in the depth range of 700 to 2000 m. This is, notwithstanding the parameterized representation of Southern Ocean Ekman and eddy transports in one of the models. It is further shown that a simple parameterization of subduction of surface waters to intermediate depths (e.g., as related to the formation of Sub-Antarctic Mode Water, Sub-Polar Mode Water and Antarctic Intermediate Water) allows either model to capture the warming in the depth range of 700 to 2000 m.