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Assessment of 20th century global-mean thermosteric sea level rise from CMIP5 climate models

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More than 93% of the energy excess associated with anthropogenic climate change. The resulting ocean warming and thermal expansion is a leading contributor to global mean sea level (GMSL) rise. Confidence in projections of GMSL rise therefore depends on the ability of climate models to reproduce global mean thermosteric sea level (GMTSL) rise over the 20th century. In this study, we compare the GMTSL of climate models of the Coupled Models Intercomparison Project Phase 5 (CMIP5) to observations over 1961-2005. Although the model-ensemble mean is within the uncertainty of observations, the model ensemble exhibits a large spread. We aim at explaining the departure of CMIP5 climate models 20th century GMTSL from observations. We show that climate models' GMTSL rise linearly depends on the time integrated radiative forcing F (under continuously increasing radiative forcing). The constant of proportionality (nu) expresses the transient thermosteric sea level response of the climate system. nu depends on the fraction of excess heat stored in the ocean, the expansion efficiency of heat, the climate feedback parameter and the ocean heat uptake efficiency. Most models show noticeably the same fraction of excess heat stored in the ocean and the same expansion efficiency of heat that are consistent with observations. This is unlike the climate feedback parameter and the ocean heat uptake efficiency, which are significantly different across climate models. These differences in climate feedback parameter and ocean heat uptake efficiency along with differences in time-integrated F across models explain most of the departure of CMIP5 climate models 20th century GMTSL from observations.