EGU21-1965
https://doi.org/10.5194/egusphere-egu21-1965
EGU General Assembly 2021

Projecting Global Mean Sea-Level Change Using CMIP6 Models

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The effective climate sensitivity (EffCS) of models in the Coupled Model Intercomparison Project 6 (CMIP6) has increased relative to CMIP5. Consequently, using CMIP6 models tends to lead to larger projections of global mean surface air temperature (GSAT) increase for a given emissions scenario. The effect of increased EffCS on projections of global mean sea-level (GMSL) change however, has so far only been studied using a reduced complexity model. Here, we explore the implications of increased EffCS in CMIP6 models for GMSL change projections in 2100 for three emissions scenarios: SSP5-8.5, SSP2-4.5 and SSP1-2.6.

Whereas CMIP6 projections of GSAT change are substantially higher than in CMIP5, projections of global mean thermal expansion (GTE) are only slightly higher. We use these projections as input to construct projections of GMSL change, using the Monte Carlo approach of IPCC AR5. Isolating the impact of the CMIP6 simulations using consistent methods is an important step to ensure traceability to past IPCC projections of global and regional sea-level change. The resulting 95th percentile of projected GMSL change at 2100 is only 3-7 cm higher for CMIP6 than for CMIP5, depending on the emissions scenario. Projected rates of GMSL rise around 2100 increase more strongly from CMIP5 to CMIP6, though, implying more pronounced differences beyond 2100 and greater committed sea-level rise. GMSL change in 2100 is accurately predicted by time-integrated temperature change and therefore mitigation requires early reduction of emissions.

We also find that the 95th percentile projections based on individual CMIP6 models can differ as much as 51 cm and that the 5-95% range of projected GMSL change for individual CMIP6 models can be substantially outside of the 5-95% range of the CMIP6 multi-model ensemble. Thus, through subsetting the CMIP6 ensemble using EffCS, a choice can be made between characterizing the central part of the probability distribution and more comprehensively sampling the high end of the GMSL projection space, which is relevant to risk-averse stakeholders. Our results show this may substantially alter ensemble projections, underlining the need to constrain EffCS in global climate models in order to reduce uncertainty in sea-level projections.