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Projecting Antarctic ice discharge using response functions from SeaRISE ice-sheet models

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The largest uncertainty in projections of future sea-level change still results from the potentially changing dynamical ice discharge from Antarctica. While ice discharge can alter through a number of processes, basal ice-shelf melting induced by a warming ocean has been identified as a major if not the major cause for possible additional ice flow across the grounding line. Here we derive dynamic ice-sheet response functions for basal ice-shelf melting using experiments carried out within the Sea-level Response to Ice Sheet Evolution (SeaRISE) intercomparison project with five different Antarctic ice-sheet models. As used here these response functions provide separate contributions for four different Antarctic drainage regions.

Under the assumptions of linear-response theory we project future ice-discharge for each model, each region and each of the four Representative Concentration Pathways (RCP) using oceanic temperatures from 19 comprehensive climate models of the Coupled Model Intercomparison Project, CMIP-5, and two ocean models from the EU-project Ice2Sea. Uncertainty in the climatic forcing, the oceanic response and the ice-model differences is combined into an uncertainty range of future Antarctic ice-discharge induced from basal ice-shelf melt. The modelled uncertainty range for the Antarctic contribution to the global sea-level rise for the period 1992 to 2011 is in full agreement with the observed contribution for this period. The additional ice-loss for the 21st century is clearly scenario-dependent and results in a median of 0.07m (90%-range: -0.01-0.26m) of global sea-level equivalent for the low-emission RCP-2.6 scenario and yields 0.1m (90%-range: -0.01-0.45m) for the strongest RCP-8.5. If only models with an explicit representation of ice-shelves are taken into account the scenario dependence remains and the values change to: 0.05m for RCP-2.6 and 0.07m for RCP-8.5. These results were obtained using a time delay between the surface warming signal and the subsurface oceanic warming as observed in the CMIP-5 models. Without this time delay the ranges for all ice-models changes to 0.10m (90%-range: 0.01-0.28m) for RCP-2.6 and 0.15m (90%-range: 0.02-0.53m) for RCP-8.5. All probability distributions are highly skewed towards high values.