Uncertainty Quantification of the Multi-centennial Response of the Antarctic Ice Sheet to Climate Change

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Uncertainties in ice-sheet models limit the ability to provide accurate sea-level rise projections. Here, we apply probabilistic methods to investigate the influence of several sources of uncertainty (atmospheric forcing, basal sliding, grounding-line flux parameterisation, calving, sub-shelf melting, ice-shelf rheology and bedrock relaxation) on the response of the Antarctic ice sheet to climate change. We provide probabilistic projections of sea-level rise and grounding-line retreat and we carry out stochastic sensitivity analyses to determine the most influential sources of uncertainty. We find that all sources of uncertainty, except perhaps the bedrock relaxation times, contribute to the uncertainty in the projections. We show that the sensitivity of the projections to uncertainties increases and the contribution of the uncertainty in sub-shelf melting to the uncertainty in the projections becomes more and more dominant as the scenario gets warmer. We show that the significance of the contribution to sea-level rise is controlled by instabilities in marine basins, especially in the West Antarctic ice sheet (WAIS). We find that, irrespectively of parametric uncertainty, the RCP 2.6 scenario prevents the collapse of the WAIS, that in both RCP 4.5 and RCP 6.0 scenarios the occurrence of instabilities in marine basins is more sensitive to parametric uncertainty and that, almost irrespectively of parametric uncertainty, RCP 8.5 triggers the collapse of the WAIS.