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Quantifying uncertainty in future projections of ice loss from the Filchner-Ronne Ice Shelf System

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Mass loss from the Antarctic Ice Sheet is the main source of uncertainty in projections of future sea-level rise, with important implications for coastal regions worldwide. Enhanced melt beneath ice shelves could destabilise large parts of the ice sheet, and further increase ice loss. Despite advances in our understanding of feedbacks in the ice sheet-ice shelf-ocean system, future projections of ice loss remain poorly constrained in many parts of Antarctica. In particular, there is ongoing debate surrounding the future of the Filchner-Ronne Ice Shelf (FRIS) region. The FRIS has remained relatively unchanged in recent decades, but an increase in air and ocean temperatures in the neighbouring Weddell Sea, could force rapid retreat in the near future. Indeed, previous modelling work has suggested the potential for widespread infiltration of warm water beneath the ice shelf in the second half of the twenty-first century, leading to a drastic increase in basal melting.

Here, we use the ice flow model Úa alongside the ocean box model PICO (Potsdam Ice-shelf Cavity mOdel) to understand the key physical processes and model variability in future projections of sea level rise from the FRIS region. We investigate uncertain model parameters associated with ice dynamics, surface melting and precipitation, ocean temperature forcing, and parameters relating to the strength of basal melt generated by PICO. We optimise the prior distributions of parameters in PICO using observations and a Bayesian approach, leading to improved posterior distributions for use in the following stages of uncertainty quantification. We then run our forward model through the 21st century for various RCP scenarios and extensive random sampling of uncertain parameters to train an emulator. From this, we present probabilistic projections of potential sea level rise from the FRIS region for different future climate change scenarios, together with a sensitivity analysis to identify the most important parameters that contribute to uncertainty in these projections.