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Impacts of initialisation of coupled ice sheet-ocean models forecasting.

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In recent years, there have been great advances in coupled ice sheet-ocean modelling, to the point where ice-ocean interactions can be represented in global climate models — with potential to greatly improve forecasting of marine ice-sheet loss and sea level rise in the coming century and beyond. However, initialisation of coupled ice sheet-ocean models has not yet been properly examined; and initialisation approaches applied to ocean and coupled atmosphere-ocean models may not be appropriate due to the long time scales inherent in dynamic ice sheets. Moreover, as ocean melt rates and ice-shelf geometry strongly influence each other, nonphysical transients in incorrectly initialised coupled ice-ocean models may persist for longer than in ice-sheet models alone.

In this work, two approaches to coupled initialisation are considered using a synchronously coupled ice-ocean model. The two approaches are based on two commonly used approaches to ice sheet model initialisation: “snapshot” calibration, where ice-sheet basal and internal parameters are configured to optimise fit with observed surface velocity; and “transient” calibration, where these parameters are configured to jointly optimise fit with velocity and geometry change; however, the transient calibration makes use of the ocean component to ensure the ice model is not subject to “initialisation shock” from ocean melting. The approaches are applied to Smith Glacier, a small but fast-thinning glacier in West Antarctica, and the model is forced under ocean warming scenarios in multidecadal runs. Initially there is much faster retreat seen in the Snapshot-calibrated simulation, but this difference decays over several decades, and ultimately the Transiently-calibrated model sees more retreat.

The experiments further suggest that Smith Glacier is not likely to exhibit Marine Ice Sheet instability in the next century. But the methods discrepancy has strong implications for glaciers which are susceptible to this instability.