The impact of bed elevation resolution on Thwaites Glacier ice dynamics

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Bed elevation is one of the most important datasets in determining the dynamic evolution of the Antarctic ice sheet, being a strong control on ice flow, the evolution of the grounding line, and a predictor for marine ice sheet instability. Concerted efforts through international collaborations such as ICECAP (International Collaboration for Exploration of the Cryosphere through Aerogeophysical Profiling) and NASA's Operation IceBridge have made substantial progress in increasing the resolution of mapped Antarctic bed elevation, particularly on the continental margins. This progress has facilitated improved accuracy in numerical modelling of the Antarctic ice sheet and constrained uncertainty in projections of future ice loss. Nevertheless, fine scale mapping of bed elevation is costly and there is a case for targeting the collection of such observations to get the most out of ice sheet model simulations. Here, we address the question of how much resolution in bed elevation is sufficient to get consistent model simulations of Antarctic ice sheet dynamics and their evolution. We use the Ice Sheet System Model and a synthetic, high resolution (250 m) bed elevation dataset to perform simulations of the Thwaites Glacier basin in West Antarctica. We subsample the bed elevation dataset at 500m, 1km, 2km, 4km, 8km, 16km, and 32km resolutions to investigate the sensitivity of Thwaites Glacier dynamics to the resolution of the underlying bed elevation. The modeled velocities converge for increasing bed elevation resolution and for most of the basin the differences between the 250 m and 500 m simulation velocities are within 5%, which is within the bounds of uncertainty associated with the velocity datasets used to initialize our model simulations. Our results indicate that a bed elevation of 500 m resolution is sufficient in simulating ice dynamics (velocities, basal shear stresses, strain rates) consistent with those using the higher resolution bed elevation data. This result has implications for future fieldwork mapping Thwaites Glacier bed elevations, and has the potential to inform campaigns on other Antarctic glaciers with similar mechanisms controlling ice flow.