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Dynamic Response of Antarctic Ice Shelves to Bedrock Uncertainty

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Bedrock geometry is an essential boundary condition in ice sheet modelling. The shape of the bedrock on fine scales can influences ice sheet evolution, for example through the formation of pinning points that alter grounding line dynamics. Here we test the sensitivity of the BISICLES adaptive mesh ice sheet model to small amplitude height fluctuations on different spatial scales in the bed rock topography provided by bedmap2 in the catchments of Pine Island Glacier, the Amery Ice Shelf, and a region of East Antarctica including the Denman and Totten Glaciers. We generate an ensemble of bedrock topographies by adding random noise to the bedmap2 data with amplitude determined by the accompanying estimates of bedrock uncertainty. Lower frequency coherent noise, which generates broad spatial scale (over 10s of km) errors in topography with relatively gently slopes, while higher frequency noise has steeper slopes over smaller spatial scales. We find that the small amplitude fluctuations result in only minor changes in the way these glaciers evolve. However, lower frequency noise is more important than higher frequency noise even when the features have the same height amplitudes and the total noise power is maintained. This provides optimism for credible sea level rise estimates with presently achievable densities of thickness measurements. Pine Island Glacier appears to be the most sensitive to errors in bed topography, while Lambert-Amery is stable under the present day observational data uncertainty. Totten-Denman region may undergo a retreat around Totten ice shelf, where the bedrock is lower than the sea level, especially if basal melt rates increase.