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The importance of domain choices and resolution for obtaining credible high-resolution surface mass balance on ice sheets in regional climate model simulations

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In simulations of the evolution of ice sheets, it is vital to calculate the snowfall and snow melt accurately. However, the amount and location of precipitation is strongly dependent on orography; additionally, the location of precipitation can influence whether it falls as rain or snow. Snow melt is also temperature-dependent, and thus varies with elevation. A reliable calculation of snowfall and snow melt therefore requires a detailed representation of the orography, which varies on a fine scale. In the case of Greenland, the orography near the coast is very steep, and cannot be represented sufficiently at the resolutions normally used in general circulation models (GCMs). A high-resolution regional climate model (RCM) is therefore needed for accurate calculation of surface mass balance (SMB).

The choice of domain for the regional model is critical. If the domain used is too small, the finer details of the regional synoptic flow may not be included. If the domain is too large, the simulations will be needlessly computationally expensive. Additionally, the SMB calculated by the model has been found to depend strongly on the source of the input lateral boundary conditions (LBCs). For example, very different results may be obtained with LBCs taken from re-analysis data than with LBCs taken from a global model that has not been adjusted to agree with observations. The resolution of the model is also important. A higher-resolution model will have a more-detailed representation of orography, and should therefore simulate the SMB more accurately.

We discuss new results from the ice2sea project (www.ice2sea.eu) in which we have used PRECIS, the regional version of the HadCM3 GCM, to study these sensitivities systematically. We will present results for temperature, precipitation, runoff and SMB. Additionally, we will validate the model output with surface observations of temperature and precipitation, temperature profiles from radiosondes, and observational estimates of SMB. The validation will allow the identification of an optimum model configuration for use in RCM simulations in the ice2sea project, which will inform future sea-level projections and ultimately provide input to IPCC AR5.