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Uncertainty assessment in model-based predictions of surface mass balance

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The main sources of uncertainty in model-based predictions of the surface mass balance (SMB) of an ice mass include structural uncertainty (i.e. choice of processes to include and how to represent them), parametric uncertainty (i.e. uncertainty in values assigned to tuneable parameters), and uncertainty in the forcing data used to drive the model. It is known that, at least for future predictions, uncertainty due to forcing (as determined by climate models) is large, but hitherto the structural and parametric uncertainties in SMB models have not been quantified.

Using techniques from the statistical field of Computer Experiments, we carry out a parametric uncertainty analysis of a state of the art energy balance and snowpack model which is being used to predict the SMB for the Greenland Ice Sheet. We run ensembles of 1D simulations of the model, driven by an idealised forcing representing a typical profile across the ablation zone. The ensembles are generated using an efficient sampling over parameter space, which is constrained as far as possible by relevant observations for each tuneable parameter. We also perform a regression based sensitivity analysis on these ensembles, to identify the parameters causing greatest uncertainty. Here, we discuss the implications of our results for the uncertainty in model based predictions of the current and future SMB of, specifically, the Greenland Ice Sheet and more generally.