How do our prior assumptions about basal drag affect ice sheet forecasts?

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Forecasts of changes in the large ice sheets of Greenland and Antarctica often begin with an inversion to select initial values for state variables and parameters in the model, such as basal drag and ice viscosity. These inversions can be ill-posed in the sense that many different choices for the parameter values can match the observational data equally well. To recover a mathematically well-posed problem, assumptions must be made that restrict the possible values of the parameters, either by regularisation or by explicit definition of Bayesian priors. Common assumptions are that parameters vary smoothly in space or lie close to some preferred initial guess, but for glaciological inversions it is often unclear how smoothly the parameters should vary, or how reliable the initial guess should be considered. This is especially true of inversions for the basal drag coefficient that can vary enormously from place to place on length scales set by subglacial hydrology, which is itself extremely poorly constrained by direct observations. Here we use a combination of forward modelling, inversion and a theoretical analysis based on transformation group priors to investigate different ways of introducing prior information about parameters, and to consider the consequences for ice sheet forecasts.