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A Grand (Ensemble) Design For Ice Sheet Projections

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For projections of the probability of sea level rise from the ice sheets to be considered robust, they ought to be founded in both glaciological theory (represented by dynamical ice sheet models) and statistical inference (formal uncertainty quantification, UQ). No such studies yet exist for either the Greenland or Antarctic ice sheet. Ice sheet projections are therefore at risk of being physically implausible, difficult to interpret, or both.

But ice sheet models have many advantages over climate models for UQ. They are computationally cheaper, simpler to understand, have fewer input parameters and output variables, and it is often straightforward to switch between different model structures. Just as importantly, the ice sheet modelling community is not yet constrained methodologically or culturally by the legacy - and pitfalls - of the CMIP multi-model "ensemble of opportunity".

These advantages present us with a golden opportunity for policy relevant sea level projections: we can design a "grand ensemble" that quantifies multiple modelling uncertainties in a statistically rigorous and efficient way. Such an ensemble would systematically sample model parameters and structures, initial and boundary conditions, in the most informative way (given available computational resources), and would also allow statistical inference i.e. probabilistic estimates.

I will present a design that draws on useful UQ techniques that have recently applied in ice sheet modelling (and others that have not). Such a design has the potential not only to generate more robust and meaningful sea level projections but also to provide thorough sensitivity analyses for prioritising model development and observational campaigns.