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Quantifying and reducing uncertainty in deglacial ice sheet evolution

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Complete uncertainty quantification and uncertainty reduction are two necessary goals for reconstructing past ice sheet evolution and quantifying associated present day glacial isostatic adjustment. Through concrete examples of the major ice sheets from the last deglaciation, I will outline the key issues that must be addressed and describe an evolving Bayesian approach to generating posterior probability distributions for deglacial evolution. This rigorously merges observational data and modelling. The ice sheet evolution reconstruction problem must therefore consider uncertainties in ice sheet representation, climate, glacial isostatic adjustment (especially given the reliance on relative sea level and vertical velocity data constraints), and glacial geology.

A focus on uncertainty quantification, aside from being a defining characteristic of science, enables rational choices in how to reduce uncertainty as well as the opportunity to identify the discrepancies that may enable new discoveries. As an example of the former, I consider posterior uncertainty maps for present-day rates of uplift for the major (past and present) ice sheets. These are effectively "treasure maps" offering guidance, for instance, in designing future repeat GPS campaigns as regions of maximum uncertainty offer the strongest potential constraints for past ice sheet evolution. An example of a long-standing discrepancy with the potential for discovery is that of "missing ice". This is the difficulty in getting enough grounded ice at last glacial maximum to satisfy far-field relative sea level constraints. I will describe the key observational and physical constraints that limit continental ice volumes along with some potential resolutions which invariably require consideration of uncertain uncertainties.