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A framework for prediction of the contribution of collapsing ice sheets to sea-level rise

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The reliability of estimates of each of the major contributions to future sea-level rise need to be improved before we can be confident that sea-level projections are adequate to support coastal impact assessment and adaptation planning, but greater improvements are needed for some contributions than for others. Thermosteric contributions can now be predicted with some degree of confidence, the contribution of mountain glaciers appear to lend itself to a statistical approach, and the contribution of changing terrestrial water storage may require little more than accounting on the grand scale. Predicting future changes in ice-sheets, on the other hand, presents unique difficulties. The brevity of observational records and the lack of well-calibrated geological histories of ice-sheet change, together imply a frustrating paucity of testing data. Ice-sheet variability over decades to centuries is better considered as "weather", rather than "climate", and so the precise specification of initial conditions and rates of change in model projections is essential. Finally, we are still hamstrung by a lack of basic data – the topography Mars is better mapped than the surface of Earth beneath the ice sheets. However, all is not gloom, recent research successes mean that we now know vastly more about ice sheets than we did even a decade ago: detailed monitoring of ice-sheet change is now feasible over continental scale on month-by-month basis; geographically, the areas of greatest concern are now clear; and the weakness of particular portions of the ice sheets to specific environmental drivers is becoming apparent. The speed of these developments call for a rather frequent re-examination of the research framework required to get us closer to a reliable methodology of projection. Here we specifically discuss the relevance of natural and anthropogenic drivers of change, the most relevant time-scales, and assessment and communication of compounding uncertainties.