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Advances in Antarctic Mantle and Crustal Physics and Implications for Ice Sheet Models and Isostatic Adjustment Measurements

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The problem of improving both solid Earth structure models and assembling an appropriate tectonic framework for Antarctica is challenging for many reasons. The vast ice sheet cover is just one item in a long list of difficult observational challenges faced by solid Earth scientists. The ice sheet has a unique potential for causing relatively rapid global sea-level rise over the next couple of hundred years. This potential provides great impetus for employing extraordinary efforts to improve our knowledge of the thermo-mechanical properties and of the mass and energy transport systems operating in the underlying solid Earth. In this presentation we discuss the role of seismic mapping of the mantle and crust, heat flux inferences, models and measurements as they affect the state of the ice sheet and the predictions of present-day and future solid Earth glacial isostatic adjustment, global and regional sea-level variability. To illustrate the sensitivity to solid Earth parameters for deriving a model temperature at the base of the ice sheet, Tb, we have computed the differences between two models to produce maps of δTb, the differential temperature to the melting point at the base of the ice sheet using the ISSM 3-D Stokes flow model. A 'cold' case (with surface crustal heat flux q_{GHF} = 40 mW/m^2) is compared to a 'hot' geothermal flux case (q_{GHF} = 60mW/m^2). Differences of δT_b = 6 - 10 °C are predicted between the two heat flux assumptions, and these have associated differences in predicted ice velocities of a factor of 1.8-3.6. We also explore the hypothesis of a mantle plume, and its potential compatibility or incompatibility with basal ice sheet conditions in West Antarctica.