Geophysical Research Abstracts
Vol. 20, EGU2018-18698, 2018
EGU General Assembly 2018

Uncertainty Quantification for Ice Sheet Science and Sea Level Projections

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In order to better quantify uncertainties in global mean sea level rise projections and in particular upper bounds, we aim at systematically evaluating the contributions from ice sheets and potential for extreme sea level rise due to sudden ice mass loss. Here, we take advantage of established uncertainty quantification tools embedded within the Ice Sheet System Model (ISSM) as well as sensitivities to ice/ocean interactions using melt rates and melt potential derived from MITgcm/ECCO$_2$. With the use of these tools, we conduct Monte-Carlo style sampling experiments on forward simulations of the Antarctic ice sheet, by varying internal parameters and boundary conditions of the system over both extreme and credible worst-case ranges. Uncertainty bounds for climate forcing are informed by CMIP5 ensemble precipitation and ice melt estimates for year 2100, and uncertainty bounds for ocean melt rates are derived from a suite of regional sensitivity experiments using MITgcm. Resulting statistics allow us to assess how regional uncertainty in various parameters affect model estimates of century-scale sea level rise projections. The results inform efforts to a) isolate the processes and inputs that are most responsible for determining ice sheet contribution to sea level; b) redefine uncertainty brackets for century-scale projections; and c) provide a prioritized list of measurements, along with quantitative information on spatial and temporal resolution, required for reducing uncertainty in future sea level rise projections. Results indicate that ice sheet mass loss is dependent on the spatial resolution of key boundary conditions - such as bedrock topography and melt rates at the ice-ocean interface.

This work is performed at and supported by the California Institute of Technology's Jet Propulsion Laboratory. Supercomputing time is also supported through a contract with the National Aeronautics and Space Administration's Cryosphere program.