On the Application of Science Systems Engineering and Uncertainty Quantification for Ice Sheet Science and Sea Level Projections

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Research and development activities at the Jet Propulsion Laboratory (JPL) currently support the creation of a framework to formally evaluate the observational needs within earth system science. One of the pilot projects of this effort aims to quantify uncertainties in global mean sea level rise projections, due to contributions from the continental ice sheets. Here, we take advantage of established uncertainty quantification tools embedded within the JPL-University of California at Irvine Ice Sheet System Model (ISSM). We conduct sensitivity and Monte-Carlo style sampling experiments on forward simulations of the Greenland and Antarctic ice sheets. By varying internal parameters and boundary conditions of the system over both extreme and credible worst-case ranges, we assess the impact of the different parameter ranges on 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.

Keywords: Ice sheet, Projections, Sea Level, ISSM, Uncertainty Quantification