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GC12D-05: Statistical Emulation of Ice-Sheet Model Simulations to Estimate Uncertainty in Future Antarctic Sea-Level Contributions

Monday, 10 December 2018
11:20 - 11:35
Walter E Washington Convention Center - 150A

Observational estimates of Antarctic ice loss have accelerated in recent decades, and worst-case scenarios of modeling studies have suggested potentially catastrophic sea level rise (~2 meters) by the end of the century. However, modeled contributions to global mean sea level from the Antarctic ice-sheet (AIS) in the 21st century are highly uncertain, in part because ice-sheet model parameters are poorly constrained. Individual ice-sheet model runs are also deterministic and not computationally efficient enough to generate the continuous probability distributions required for incorporation into a holistic framework of probabilistic sea-level projections. To address these shortfalls, we statistically emulate an ice-sheet model using Gaussian Process (GP) regression. GP modeling is a non-parametric machine-learning technique which maps inputs (e.g. forcing or model parameters) to target outputs (e.g. sea-level contributions from the Antarctic ice-sheet) and has the inherent and important advantage that emulator uncertainty is explicitly quantified. We construct emulators for the last interglacial period and an RCP8.5 scenario, and separately for the western, eastern, and total AIS. Separate emulation of western and eastern AIS is important because their evolutions and physical responses to climate forcing are distinct. The emulators are trained on 196 ensemble members for each scenario, composed by varying the parameters of maximum rate of ice-cliff wastage and the coefficient of hydrofracturing. We condition the emulators on last interglacial proxy sea-level records and modern GRACE measurements and exclude poor-fitting ensemble members. The resulting emulators are sampled to produce probability distributions that fill intermediate gaps between discrete ice-sheet model outcomes. We invert emulated high and low probability sea-level contributions in 2100 to explore 21st century evolution pathways; results highlight the deep uncertainty of ice-sheet model physics and the importance of using observations to narrow the range of parameters. Our approach is designed to be flexible such that other ice-sheet models or parameter spaces may be substituted and explored with the emulator.

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