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Large-Ensemble modeling of past and future variations of the Antarctic Ice Sheet with a coupled ice-Earth-sea level model

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To date, most modeling of the Antarctic Ice Sheet's response to future warming has been calibrated using recent and modern observations. As an alternate approach, we apply a hybrid 3-D ice sheet-shelf model to the last deglacial retreat of Antarctica, making use of geologic data of the last ~20,000 years to test the model against the large-scale variations during this period. The ice model is coupled to a global Earth-sea level model to improve modeling of the bedrock response and to capture ocean-ice gravitational interactions.

Following several recent ice-sheet studies, we use Large Ensemble (LE) statistical methods, performing sets of 625 runs from 30,000 years to present with systematically varying model parameters. Objective scores for each run are calculated using modern data and past reconstructed grounding lines, relative sea level records, cosmogenic elevation-age data and uplift rates. The LE results are analyzed to calibrate 4 particularly uncertain model parameters that concern marginal ice processes and interaction with the ocean.

LE's are extended into the future with climates following RCP scenarios. An additional scoring criterion tests the model's ability to reproduce estimated sea-level high stands in the warm mid-Pliocene, for which drastic retreat mechanisms of hydrofracturing and ice-cliff failure are needed in the model. The LE analysis provides future sea-level-rise envelopes with well-defined parametric uncertainty bounds. Sensitivities of future LE results to Pliocene sea-level estimates, coupling to the Earth-sea level model, and vertical profiles of Earth properties, will be presented.