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Semi-empirical and process-based global sea level projections

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We review the two main approaches to estimating sea level rise over the coming century: physically plausible models of reduced complexity that exploit statistical relationships between sea level to climate forcing, and more complex physics-based models of the separate elements of the sea level budget. Recent estimates of sea level rise by 2100 have converged, but largely through increased contributions and uncertainty in process based model estimates of contributions from ice sheets. Hence here we focus on ice sheet flow as this has the largest potential to contribute to sea level rise. Recently, progress has been made in ice dynamics, ice stream flow, grounding line migration and integration of ice sheet models with high resolution climate models. Calving physics remains an important and difficult modeling issue. Mountain glaciers, numbering hundreds of thousands, must be modeled by extensive statistical extrapolation from a much smaller calibration dataset. Rugged topography creates problems in process-based mass balance simulations forced by regional climate models with resolutions 10-100 times larger than the glaciers. Semi-empirical models balance increasing numbers of parameters with the choice of noise model for the observations to avoid overfitting the highly autocorrelated sea level data. All models face difficulty in separating out non-climate driven sea level rise (e.g., groundwater extraction) and long term disequilibria in the present day cryosphere-sea level system