



## Potential for bias in 21st century semi-empirical sea level projections

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We examine the limitations of a semi-empirical model characterized by a sea level projection of 73 cm with RCP4.5 scenario by 2100. Calibrating the model with data to 1990 and then simulating the period 1993-2009 produces sea level in close agreement with acceleration in sea level rise observed by satellite altimetry. Non radiative forcing contributors, such as long term adjustment of Greenland and Antarctica ice sheets since Last Glacial Maximum, abyssal ocean warming and terrestrial water storage, may bias model calibration which, if corrected for, tend to reduce median sea level projections at 2100 by 2-10 cm, though this is within the confidence interval. We apply the semi-empirical approach to simulate individual contributions from thermal expansion and small glacier melting. Steric sea level projections agree within 3 cm of output from process-based climate models. In contrast semi-empirical simulation of melting from glaciers is 26 cm, which is twice large as estimates from some process based models, however all process models lack simulation of calving, which likely accounts for 50% of small glacier mass loss worldwide. Furthermore we suggest that changes in surface mass balance and dynamics of Greenland ice sheet made contributions to the sea level rise in the early 20th century and therefore are included within the semi-empirical model calibration period, and hence are included in semi-empirical sea level projections by 2100. Antarctic response is probably absent from semi-empirical models, which will lead to a underestimate in sea level rise if, as is probable, Antarctica loses mass by 2100.