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Carbon cycle and climate sensitivity related uncertainties in projected sea level rise from thermal expansion

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The Bern2.5CC earth system model of intermediate complexity is used to project long-term global sea level rise from thermal expansion and uncertainties from climate sensitivity and carbon cycle processes. Atmospheric CO_2 and radiative forcing are prescribed over the historic period up to year 2000 and projected thereafter from the six IPCC illustrative SRES emission scenarios until 2100. Thermal expansion over the 21^{st} century is projected to range between 0.24 m for the low-CO_2 SRES-B1 scenario and 0.41 m for the high-CO_2 SRES-A1FI scenario in the standard model setup. These Bern2.5CC results are at the upper end of AOGCM-based projections of sea level rise from thermal expansion. The uncertainty of thermal expansion projections due to uncertainties in carbon cycle processes and climate sensitivity was estimated by combining different bounding assumptions for terrestrial CO_2 fertilization, the response of heterotrophic respiration to soil temperature, the turnover time of the ocean, and by varying climate sensitivity between 1.5 to 4.5°C. These uncertainties translate into ranges of thermal expansion projections of 0.13 to 0.35 m for the low-CO_2 SRES-B1 and 0.23 to 0.51 m for the high-CO_2 SRES-A1FI. Maximum differences relative to the standard setup are -47 to +46% by year 2100 across the six illustrative scenarios, largely determined by the climate sensitivity related uncertainty. The lower bound is rather constant across the scenarios (-47 to -44%), whereas the upper bound is more variable (+46 to +27%) as for high forcings only part of the perturbation has already taken place by year 2100. To study the long-term thermal expansion and the post-2100 commitment in response to stabilized greenhouse gases and radiative forcing, we will further expand these projections beyond the 21^{st} century to year 3000 A.D.