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Quantification of Uncertainty in global Temperature Projections over the twenty-first Century: A Synthesis of multiple Models and Methods

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The quantification of the uncertainties in future climate projections is crucial for the implementation of climate policies. Here I provide projections of global temperature change over the twenty-first century for the six illustrative, non-intervention SRES emission scenarios based on the latest generation of coupled general circulation climate models, and assess uncertainty ranges and probabilistic projections from various published methods and models. Short-term trends in global temperature are comparably well constrained and similar across all scenarios. When considering evidence from different studies, long-term uncertainties are found to be larger than the ranges shown in previous IPCC reports, and also larger than captured in single models or methods. This is due to structural differences in the models, the sources of uncertainty taken into account, the type observational constraints used, and the statistical assumptions made. It is shown that assuming a time- and scenario independent relative uncertainty range for the future is a good approximation for the scenarios considered. The deviations from a constant relative uncertainty can be explained by the assumptions made in different methods, which all consider a subset of uncertainties in climate feedbacks, observed surface warming and observed ocean heat uptake, uncertainties in forcing, contributions of natural unforced internal variability, and natural forced variability by solar and volcanic forcing. Inclusion of uncertainties in carbon cycle feedbacks extends the upper bound of the uncertainty range by more than the lower bound.