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How can model error characteristics be utilised to improve climate projections?

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The discussion on how to improve climate projections of a multi-model ensemble by exploiting information on model errors has a long tradition. Most studies follow the strategy to weight simulations according to their error characteristics or in a Bayesian framework. However, the potential to find optimal weights is currently very limited and none of the weighting approaches gained widespread acceptance so far.

In this study, an alternative strategy is pursued: The systematic effect of a particular type of model error („intensity-dependent error“) on the expected climate change signal of a multi-model ensemble and its spread is utilised. A theory of the influence of intensity-dependent model errors on the climate change signal is developed and it is investigated, whether expected climate change is biased and uncertainty is inflated due to such errors. In addition, empirical correction methods are analysed in order to mitigate potential biases in expected climate change and to constrain uncertainty.

The theory is applied to the ENSEMBLES regional multi-model ensemble. The results indicate that expected temperature change at the end of the 21st century from the ENSEMBLES ensemble is regionally biased with an over-estimation of up to +0.5 K in Eastern Europe and France in summer and an underestimation of about -0.4 K in Scandinavia. In addition, it is shown that intensity-dependent errors tend to increase the spread of a multi-model ensemble, which indicates the potential to reduce uncertainty in climate projections by a suitable correction.