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Sources of Uncertainty in Model Based Climate Forecasts

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A fundamental conclusion from basic radiative theory is that significant increases in concentrations of atmospheric greenhouse gases is likely lead to higher global mean surface temperatures and significant changes in many aspects of the climate system. The conclusion is supported by observations of many changes in the earth's climate since the industrial revolution and increasingly over the last 40 years.

Physically based models can provide detailed statements about the impacts of climate change over the next century. For information on regional scales such predictions are commonly based on complex atmosphere/ocean global circulation models. Recent years have seen increasing effort to quantify the uncertainty in such predictions and even to provide results in terms of probabilities.

Here we categorize the different sources of uncertainty in relating model simulations (whether individual or ensembles) to statements about future climate on decadal and longer timescales. We identify five arguably distinct sources: i) forcing uncertainty, ii) microscopic initial condition uncertainty, iii) macroscopic initial condition uncertainty, iv) model uncertainty, and v) model inadequacy. Some aspects of these can potentially be quantified with today's computational resources, some require more observations and a more integrated observational/modeling response, and some require us to reconsider our purpose and approach to the experimental design of decadal timescale climate ensembles.

We discuss the implications of such uncertainty analysis and illustrate the issues using results from the climateprediction.net experiment.