Uncertainty in the Predictions of the Climate Response to Rising Levels of Greenhouse Gases

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Abstract

The range of possibilities for future climate evolution1–3 needs to be taken into account when planning climate change mitigation and adaptation strategies. This requires ensembles of multidecadal simulations to assess both chaotic climate variability and model response uncertainty4–9. Statistical estimates of model response uncertainty, based on observations of recent climate change10–13, admit climate sensitivities—defined as the equilibrium response of global mean temperature to doubling levels of atmospheric carbon dioxide—substantially greater than 5K. But such strong responses are not used in ranges for future climate change14 because they have not been seen in general circulation models. Here we present results from the 'climateprediction.net' experiment, the first multi-thousand-member grand ensemble of simulations using a general circulation model and thereby explicitly resolving regional details15–21. We find model versions as realistic as other state-of-the-art climate models but with climate sensitivities ranging from less than 2K to more than 11 K. Models with such extreme sensitivities are critical for the study of the full range of possible responses of the climate system to rising greenhouse gas levels, and for assessing the risks associated with specific targets for stabilizing these levels.