The implications of climate model evaluation for climate model interpretation

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Abstract

An important metric for the evaluation of global climate and earth system models is their ability to simulate observed changes in global mean surface temperature (GMT), particularly over the last hundred years or so. The InterGovernmental Panel on Climate Change (IPCC) highlights the ability of the most recent generation of such models to reproduce the "general features of the global and annual mean surface temperature changes over the historical period" [1]. Such agreement with observations is often seen as an important element in demonstrating the relevance of these models for climate projections.

The assessments are usually made in terms of GMT anomalies i.e. changes with respect to some period of time such as 1980-2000. Here we present a mathematical interpretation of this aspect of the approach, and also of the focus on "general features". The analysis shows how these features of model evaluation lead to a separation of scales such that the details of the sub-global response (to the extent it differs between models) seems to be unimportant for the GMT response. It also identifies how they imply a degree of linearity in the GMT response. This linearity is only over a limited range when considering one model alone but if we consider a multi-model ensemble then it implies linearity over a much larger range.

The analysis suggests that an important element of model evaluation provides a pressure on model development which limits their value in exploring potentially significant nonlinear responses and feedbacks. The implications for the role of multi-model ensembles in uncertainty assessments, including regional projections, will be discussed.

[1] IPCC, Fifth Assessment Report, Working Group 1, Technical Summary, Stocker et al., 2013.

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