The interpretation of biases in decadal climate predictions

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Understanding the cause of forecast biases in GCM based decadal climate predictions is essential to improve trust in longer term projections. However, there are several different sources of forecast bias, including bias due to GCM errors, insufficient sampling of internal variability, and a lead-time dependent bias caused by using incorrect forcings in the forecast. In this study we use (i) a toy model and (ii) GCM simulations, to demonstrate that it is possible to separate the different sources of bias to extract the underlying true GCM bias. This is achieved by using different sets of forecast verification times and by making a correction for the observed variability. This approach offers a powerful new way to diagnose errors in climate models. We find that the HadCM3 GCM used is mildly positively biased (i.e. warms more rapidly than observations) for predictions of global mean temperature, although this is only marginally statistically significant. We also explore the detailed growth and spatial patterns of the bias and demonstrate that these methods can help very effectively constrain the transient climate response to increasing CO_2.