Verification of decadal forecasts: The interpretation and treatment of biases in decadal climate predictions

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GCM-based decadal hindcasts invariably exhibit large drift, which is manifest as a lead-time dependent bias. Understanding the causes of this bias, and how it may be reduced or otherwise handled, is an essential step towards improving forecasts. As an important first stage in this work we consider the case of hindcasts and forecasts initialised from model states. We demonstrate that in this situation there are three different sources of bias, namely: (i) insufficient sampling of the internal variability, (ii) the use of incorrect forcings, and (iii) the true GCM bias. We describe how to separate these different components, and apply the techniques to an operational decadal prediction system based on the HadCM3 GCM. We demonstrate how our approach can be used to identify the patterns of model error growth, and thereby help to identify the processes responsible. In addition, by applying the approach to an ensemble of perturbed physics decadal hindcasts, we demonstrate how our approach can be used to be obtain a new constraint on the Transient Climate Response to greenhouse gas forcing. Lastly, our analysis provides recommendations about the application of bias corrections to decadal forecasts.