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Statistical adjustment of decadal predictions in a changing climate

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Climate model-based decadal predictions initialized with observational data are subject to systematic errors and drifts that can compromise the forecast information. A common procedure, standard in seasonal forecasting, is to remove mean model bias at each lead time as determined from a set of hindcasts. If, however, the model misrepresents a forced climate trend over the period of the hindcasts then residual drifts will remain. For example, predictions from a model that overrepresents the forced temperature trend will tend to undershoot observed temperatures early in the hindcast period and overshoot observed temperatures late in the hindcast period, increasingly so for future predictions. This occurs both for full-field and anomaly initialized forecasts if the modeled and observed trends differ, and also for so-called "uninitialized forecasts" consisting of freely running historical simulations.

A procedure that corrects for such residual drifts by accounting for errors in modeled trends as well as mean biases is proposed and applied to decadal predictions of annual global mean temperature from the CCCma CanCM4 climate model. These predictions, initialized using full-field observational data at the start of every year from 1961 until present, exhibit systematic residual drifts when only the standard bias correction is applied because CanCM4 (like some other CMIP5 decadal prediction models) tends to warm too rapidly over this period. Application of trend correction largely removes these residual drifts and reduces root mean square error both in initialized and uninitialized hindcasts. Initialized hindcast skill tends to exceed that of uninitialized hindcasts over the 10-year range of the predictions whether or not trend correction is applied, although the differences are statistically significant mainly near the start of the forecast period. Extensions that enable trend correction to be applied to gridscale variables and improve its statistical robustness are described.