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Quantifying the Agreement Between Observed and Simulated Extratropical Modes of Interannual Variability

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ABSTRACT

Using Historical simulations of the Coupled Model Intercomparison Project-5 (CMIP5) models and multiple observationally-based datasets, we employ skill metrics to analyze the fidelity of the simulated Northern Annular Mode (NAM), the North Atlantic Oscillation (NAO), the Pacific North America pattern (PNA), the Southern Annular Mode (SAM), the Pacific Decadal Oscillation (PDO), the North Pacific Oscillation (NPO), and the North Pacific Gyre Oscillation (NPGO). We assess the benefits of a unified approach to evaluate these modes of variability, which we call the common basis function (CBF) approach, based on projecting model anomalies onto the observed empirical orthogonal function (EOF). The CBF approach circumvents issues with conventional EOF analysis, including the need to correct for arbitrary signs of EOF's, and the need to test if higher-order model modes better compare with the observed modes. Compared to conventional EOF analysis of models, the CBF approach indicates that models compare significantly better with observations in terms of pattern correlation and root-mean-squared-error (RMSE) than heretofore suggested. In many cases, models are doing a credible job at capturing the observationally-based estimates of patterns; however, errors in simulated amplitudes can be large and more egregious than pattern errors.

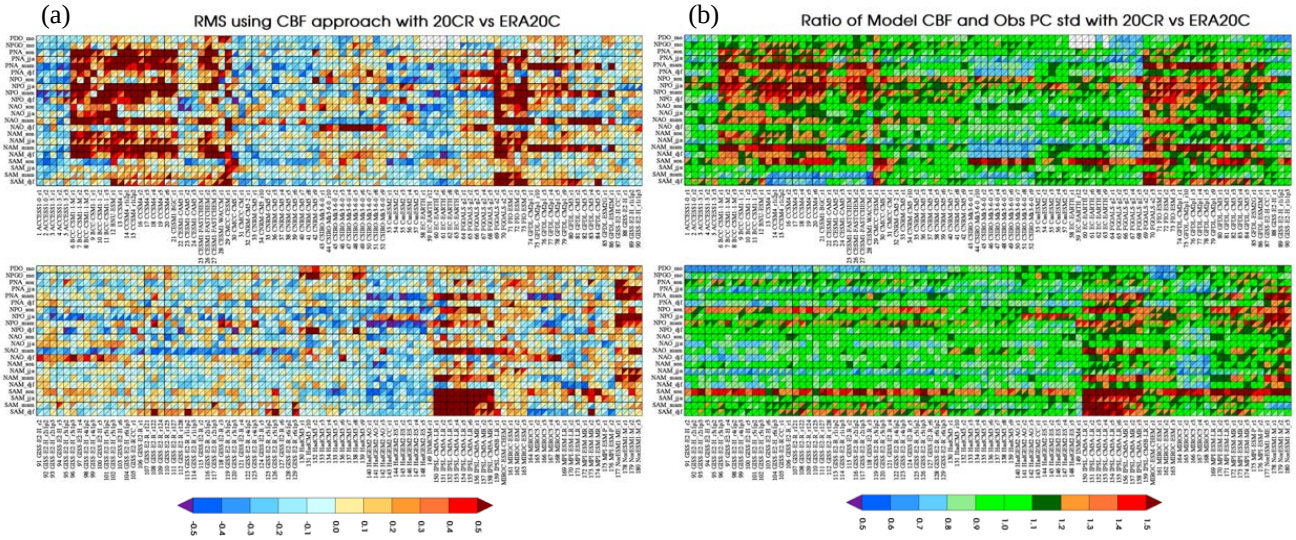

Fig. 1 Portrait plot of (a) the relative RMSE with respect to the median RMSE in each row. For sea-level pressure based modes (PNA, NPO, NAO, NAM, and SAM) in the upper-left hand triangle the model results are shown relative to 20CR whereas in the lower-right triangle the model results are shown relative to the ERA-20C. For SST based modes (PDO and NPGO), results are shown relative to HadISSTv1.1 (upper-left triangle) and HadISSTv2.1 (lower-right triangle). (b) The ratio of simulated to observed temporal variability as estimated by the standard deviations of the PC time series. Missing data is shown in white. The ratios are unitless. (From Lee *et al.* 2018)

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Sensitivity tests demonstrate that the results from our objective tests are relatively insensitive to methodological considerations (CBF vs. conventional approach), observational uncertainties in pattern (as determined by using multiple datasets), and internal variability (when multiple realizations from the same model are compared). The skill metrics proposed in this study can provide a useful summary of the ability of models to reproduce the observed EOF patterns and amplitudes (Fig. 1). Additionally, the skill metrics can be used as a tool to objectively highlight where potential model improvements might be made. We advocate more systematic and objective testing of simulated extratropical variability, especially during the non-dominant seasons of each mode, when many models are performing relatively poorly.

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Reference

Lee, J., K. R. Sperber, P. J. Gleckler, C. J. W. Bonfils, and K. E. Taylor, 2018: Quantifying the agreement between observed and simulated extratropical modes of interannual variability. *Clim. Dyn.*, doi:10.1007/s00382-018-4355-4.