Underestimated Decadal Predictability and the Existence of the Signal-to-noise Paradox in CMIP5 Models

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Recent studies suggest increasing evidence for the existence of the signal-to-noise paradox in climate models, where in the ensemble-based climate prediction, model ensemble mean forecast generally shows higher correlations with observations than with individual ensemble members. This seems to lead to a paradox referred to as the signal-to-noise paradox that the model makes better predictions for reality than predicting itself. The signal-to-noise paradox highlights a potentially serious problem with climate model predictions as previous seasonal-to-decadal model predictions may be underestimated due to the existence of the paradox. The main purpose of the study is to determine if decadal climate predictability is underestimated in CMIP5 models, and if so, is the underestimated decadal predictability associated with the existence of the signal-to-noise paradox? Decadal potential predictability of SST in CMIP5 models is first examined and compared with observations. The result suggests that most CMIP5 models underestimate SST decadal predictability especially in part of the North Atlantic, the Indo-western Pacific, and the Southern Ocean. A simple Markov model framework is used to represent the ensemble forecasts and reproduce the signal-to-noise paradox. We argue that the existence of the signal-to-noise paradox is dependent on the relative amplitude of the persistence and noise variance in models and observations. Based on the Markov model framework, we find the widespread existence of the signal-to-noise paradox in CMIP5 models, and the regions with the signal-to-noise paradox are very likely to underestimate SST decadal predictability.

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