Statistical Prediction of Wintertime Subseasonal CONUS Precipitation Based on ENSO and the MJO: Improvements by Training with Large Ensemble Climate Simulations

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Previous studies have highlighted the significant impacts of El Niño–Southern Oscillation (ENSO) and the Madden–Julian Oscillation (MJO) on wintertime precipitation over the contiguous United States (CONUS). Here, we demonstrate skillful statistical prediction of subseasonal precipitation over the CONUS using information from ENSO and the MJO. Simple statistical tools, such as multiple linear regression, exhibit significant improvement in prediction when trained with large ensemble climate simulations, surpassing those trained solely on observational data. Despite biases in climate model simulations, particularly in the MJO-teleconnections, the abundance of data in large ensemble climate simulations allows for the establishment of more robust statistical relationships, leading to such improvement. Our results indicate that prediction skill increases with increasing amount of training data, with about 2000 years of training data required to saturate the prediction skill. In addition, the scarcity of observational data could lead to significant uncertainties when evaluating prediction skills. Similar analysis suggests that approximately 1500 years of validation data are necessary to achieve a robust estimation of the prediction skill. The utilization of machine learning tools yields additional gains in prediction skill beyond multiple linear regression. ENSO emerges as the dominant contributor to prediction skill, surpassing the influence of the MJO, whose impact diminishes with increasing forecast lead time.

Our results suggest that using large ensemble climate model simulations can significantly improve the performance of subseasonal statistical prediction tools compared to those trained only with observational data. Such improved statistical tools could be beneficial for operational subseasonal predictions.