The Impact of Internal Atmospheric Dynamics on Decadal Climate Predictability

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Decadal climate variability and predictability have received considerable scientific interest in recent decades. Yet the mechanisms and limits of decadal predictability are currently not well known. The purpose of this study is to use the newly developed interactive ensemble coupling strategy to quantify how internal atmospheric dynamics at the air-sea interface limits decadal predictability. The interactive ensemble technique couples multiple realizations of the atmospheric model to a single realization of the ocean model, with the intention of reducing atmospheric noise while retaining the deterministic signal of the coupled air-sea feedbacks. The interactive ensemble has proven useful in quantifying how internal atmospheric dynamics limits interannual predictability. Here we focus on decadal timescales and apply the Nonlinear Local Lyapunov Exponent method to the NCAR Community Climate System Model comparing control simulations with interactive ensemble simulations. A generally larger limit of decadal predictability of sea surface temperature (SST) is found with the interactive ensemble compared control, which can simply be explained as the reduction of internal atmospheric noise in the interactive ensembles. The increased predictability in the interactive ensembles is more consistent with observations, indicating that since atmospheric noise is highly coherent in space in the control simulations, it masks the potential predictability. The specifics of how internal atmospheric noise limits the predictability are diagnosed in terms of regional phenomena, teleconnection pattern and the relationship between decadal variations of SST and convective precipitation.

Keywords: Decadal Predictability, Interactive Ensemble, Internal Atmospheric Noise, Nonlinear Local Lyapunov Exponent

