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How Much Improvement Can Be Made for the Asian Winter Monsoon Prediction?

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Efforts have been made to appreciate the extent to which we can predict dominant modes of the Asian winter monsoon (AWM) variability with the state-of-the-art dynamical models and with the physically based statistical model, the predictable modes forecast model (PMFM). Dynamical prediction was made based on 13 coupled models' multi-model ensemble (MME) with November 1st initial condition for 21 years of 1981/1982-2001/2002. Statistical prediction was made using September-October mean 2m air temperature (TS) as predictor. The attainable potential predictability is obtained from predictable mode analysis (PMA) and compared to the dynamical and statistical forecast. Since the dynamical and statistical predictions are complementary to each other, the simple composite of two predictions is capable of improving the forecast skill of the DJF TS over most of the AWM region. The area-averaged temporal correlation coefficient (TCC) skill for the combined forecast is 0.59 which is larger than that of dynamical (0.53) and statistical skill (0.51). On the other hand, the area-averaged attainable TCC skill for the DJF AWM TS is 0.82.

The first four observed modes are identified as predictable modes because they are not only able to explain 69% of the total observed variability with physical interpretations and statistically separated from other higher modes but also well predicted by the current climate prediction models to some extent. It is demonstrated that the MME skill basically comes from the climate models' ability to capture the first four predictable modes. The MME has better skill for the first (a basin-wise warming trend) and Arctic Oscillation (AO)-related second mode whereas the PMFM better captures the third and fourth modes which are highly related with ENSO variability on interannual and interdecadal timescales, respectively. Independent statistical forecast for the recent 11 years of 1999/2000-2009/2010 further reveals that the first and fourth mode are highly predictable, regardless of forecast period, but two interannual modes of the second and third mode are less predictable along with lower persistency of boundary forcing and less potential predictability for recent years. In particular, the notable decadal change of the monsoon-ENSO relationship likely makes statistical forecast difficult.