



The relationship among probabilistic, deterministic and potential skills in predicting the ENSO for the past 161 years 4

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In this study, we explored in depth the relationship among the deterministic predictability skill, the probabilistic predictability skill and the potential predictability skill. This was achieved by theoretical analyses and, in particular, by an analysis of long-term ensemble ENSO hindcast over 161 years from 1856 to 2016. First, a nonlinear monotonic relationship between the deterministic predictability and the probabilistic predictability, derived by theoretical analysis, was examined and validated using the ensemble hindcast. Further, the covariability between the potential predictability and the deterministic predictability was explored in both perfect model assumption and actual model scenario. On these bases, we investigated the relationship between the potential predictability and probabilistic predictability from both the practice of ENSO forecast and theoretical perspective. The results of the study indicate that there are nonlinear monotonic relationships among these three kinds of predictability measures. The potential predictability is considered to be a good indicator for the actual predictability in terms of both the deterministic measures and the probabilistic framework. The relationships identified here exhibit considerable practical significance for conducting predictability studies, since they provide an inexpensive and robust method for exploring forecast uncertainties without the requirement of costly ensemble runs.