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On the relationship between probabilistic and deterministic skills in dynamical seasonal climate prediction

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Despite the gradually increasing emphasis on assessing the skill of dynamical seasonal forecasts from the probabilistic prediction angle, there is a lack of in-depth understanding that an inherent relationship may exist between the probabilistic and deterministic seasonal forecast skills. In this study, we focus on investigating this relationship, through theoretical consideration based on analytical approach and diagnostic analysis of the historical forecasts produced by multiple dynamical models. The probabilistic forecast skill is gauged in terms of its two different attributes: resolution and reliability, while the deterministic forecast skill is measured in terms of anomaly correlation (AC). Through the theoretical consideration under certain simplified assumptions, a nonlinear, monotonic relationship is analytically derived between the resolution and the AC. This relationship does not require the framework of a perfect model that was frequently used in previous studies.Subsequent diagnostic analysis shows that the resolution and AC skills of both the multi-model ensemble and its member single-models indeed appear to be approximately monotonically and nonlinearly related, specifically when they are calculated in a zonally-aggregated manner by which the impact of finite sample size is suppressed. This observed relationship has a specific form that is greatly consistent with what the theory predicts. In one word, the theoretical result is practically well verified by the dynamical model forecasts. Diagnostic analysis also shows that poor relationship exists between the reliability and the AC, once again signifying the difference of reliability and resolution in nature. The potential application of the proven resolution-AC coherence is also discussed.