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An empirical system for probabilistic seasonal climate prediction

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Preparing for episodes with risks of anomalous weather a month to a year ahead is an important challenge for governments, non-governmental organisations, and private companies and is dependent on the availability of reliable forecasts. The majority of operational seasonal forecasts are made using process-based dynamical models, which are complex, computationally challenging and prone to biases. Empirical forecast approaches built on statistical models to represent physical processes offer an alternative to dynamical systems and can provide either a benchmark for comparison or independent supplementary forecasts. Here, we present a simple empirical system based on multiple linear regression for producing probabilistic forecasts of seasonal surface air temperature and precipitation across the globe. The global CO_2-equivalent concentration is taken as the primary predictor; subsequent predictors, including large-scale modes of variability in the climate system and local-scale information, are selected on the basis of their physical relationship with the predictand. The focus given to the climate change signal as a source of skill and the probabilistic nature of the forecasts produced constitute a novel approach to global empirical prediction.

Hindcasts for the period 1961–2013 are validated against observations using deterministic (correlation of seasonal means) and probabilistic (continuous rank probability skill scores) metrics. Good skill is found in many regions, particularly for surface air temperature and most notably in much of Europe during the spring and summer seasons. For precipitation, skill is generally limited to regions with known El Niño–Southern Oscillation (ENSO) teleconnections. The system is used in a quasi-operational framework to generate empirical seasonal forecasts on a monthly basis.