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An assessment of prediction and predictability through the state-of-the-art global ensemble forecast systems

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Ensemble forecasts play a pivotal role in weather prediction, providing valuable insights into the inherent uncertainty of atmospheric processes. Strategies in ensemble construction involve generating multiple simulations by perturbing initial conditions, model parameters, or both. This diverse set of forecasts allows meteorologists to capture a range of possible future scenarios, acknowledging the inherent complexity of the atmosphere. Model resolution is a critical factor, influencing the representation of small-scale features and improving the overall accuracy of ensemble predictions. Additionally, forecast range-related issues address the challenge of extending predictions beyond a few days, where uncertainties tend to grow. Combining advanced statistical techniques with cutting-edge modeling technologies helps refine ensemble forecasts, enhancing our ability to anticipate and mitigate the impacts of weather-related events on society and the environment.

The investigation based operational global ensemble forecast system from NCEP, CMC, ECMWF and CMA to focus on the analyses of ensemble design that combined to the data assimilation for initial condition perturbation and various stochastic physical perturbations. The impact of model resolutions (both horizontal and vertical) will be addressed to the different atmospheric characteristics, such as forecast uncertainty, reliability and resolution. The forecast capability and predictability to the extreme events will be discussed from single model ensemble and multi-model ensemble. Finally, the 1st-moment and 2nd-moment ensemble forecast calibration will be demonstrated from traditional statistical method and machine learning based ensemble reforecasts