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Evaluation of a stochastic perturbation scheme

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While ensemble forecast systems are believed to capture well initial value related uncertainty, the representation of uncertainty associated with the use of imperfect models is a more challenging task. Most ensemble forecast systems therefore suffer from being under-dispersive, ie, the ensemble cloud does not capture reality as some model errors are not captured in the ensemble. To address this problem, a Stochastic Perturbation Scheme (SPS) has been developed at the National Centers for Environmental Predictions (NCEP) and tested with the Global Ensemble Forecast System (GEFS). The scheme represents the uncertainty associated with the forecast model itself by adding a stochastic term to the tendencies of all model variables, which is based on stochastic combinations of the conventional perturbation tendencies of all ensemble members. Recently, the scheme has been tested for the first time in a quasi-operational environment with its full version, and this paper evaluates its impact on the forecast, in terms of ensemble mean and ensemble based probabilistic forecasts, for various atmospheric variables.

The experiments are carried out under the Earth System Modeling Framework (ESMF) environment, which allows for simultaneous and synchronized integration of all the ensemble members and information exchange among these members. This makes it possible to implement the full version of the SPS and compare the results with simplified versions. The results suggest that the scheme significantly reduces systematic forecast errors, increases the ensemble spread and improves probabilistic forecast skills. Possible approaches to maximize the positive impact of the scheme on ensemble forecasts are also proposed. Specifically, a rescaling method in which the rescaling factors vary with latitude and season is found helpful to improve the forecast over the southern hemisphere.