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A "stochastic dynamics" method for ensemble seasonal forecasts with the CNRM-CM5.1 GCM

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Ensemble seasonal forecasts using coupled global climate models (GCM) often suffer from insufficient spread and systematic errors. A new stochastic method we call stochastic dynamics (Batté and Déqué, 2012) addresses both issues at a time, by including additive stochastic perturbations in the atmospheric component ARPEGE-Climat of the CNRM-CM5.1 GCM, as random corrections of initial tendency error estimates. These estimates are first calculated following Guldberg et al. 2005 by nudging the atmospheric model prognostic variables temperature, specific humidity and streamfunction towards ERA-Interim over a 1979-2010 hindcast period for the November to February season (NDJF) in a coupled run. In seasonal forecast mode, each ensemble member is perturbed initially and during the run with error corrections from an appropriate population derived from the nudged run.

The random method significantly improves deterministic scores for 500-hPa geopotential height forecasts over the Northern Hemisphere extratropics (NH Z500) and increases the ensemble spread with respect to a reference ensemble, whereas the mean bias is reduced. Several re-forecast ensembles were run, using monthly mean perturbations or sequences of initial error estimates from the nudged run. An optimal method (drawing the error corrections within the current month of the hindcast period) reaches correlation scores of over 0.6 with respect to ERA-Interim for NH Z500 anomalies and the North Atlantic Oscillation index. These promising scores are seen as an upper limit to forecast skill using the stochastic dynamics method, since the optimal method cannot be implemented in forecast mode.