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Stochastically Perturbed Parametrizations (SPP) – representing model uncertainties on the process-level

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Ensemble prediction systems rely on representations of the uncertainties in the model itself, in addition to the initial conditions, to produce reliable forecasts. We present a novel approach for representing the model uncertainties through perturbations in the model closure parameters. Spatially and temporally changing perturbations are drawn from prescribed distributions. Unique perturbation patterns are applied to 20 parameters and variables in the ECMWF IFS parametrizations of (a) turbulent diffusion and subgrid orography, (b) convection, (c) clouds and large-scale precipitation, and (d) radiation. Sensitivity of the SPP scheme is studied through altering the spatial and temporal dimensions of the perturbations as well as through changes in the prescribed distributions. The scheme is benchmarked against the ECMWF operational stochastic physics scheme, SPPT. Differences between the schemes are discussed in short-, medium-, and climatological-ranges. In short-range forecasts (less than 24 h), the two schemes display similar skill. However, in the medium-range (up to forecast day 15), the SPPT scheme produces more skilful ensembles for a given set of fixed initial condition perturbations. When comparing long model integrations the SPP scheme displays a better fit to a range of variables. A closer study of the model tendencies in the short ranges indicates that the two schemes represent different aspects of model uncertainty.