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Development and evaluation of an "optimal" perturbed parameter approach to represent model error in the convective-scale AROME-EPS

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AROME-EPS is the regional ensemble prediction system, operational at Météo-France, consisting of 12 perturbed non-hydrostatic forecasts with a 2.5km horizontal resolution. Model errors are currently represented with the Stochastic Perturbed Parametrization Tendency (SPPT) scheme. However, this method presents some disadvantages such as a difficult physical interpretation of its results. In order to overcome this drawback, a more physically-based approach of model error representation is considered, based on the perturbation of parameters from physical parametrization schemes. A two-step procedure is adopted to implement such a technique: a sensitivity analysis of the AROME model to some parameters is first performed, then an optimisation of perturbed parameters values is determined.

Following advice of parametrization experts, 21 parameters from 6 different physical and dynamical parametrizations, with uncertain values, have been selected. Sensitivity analyses, conducted on different seasons and using the Morris screening as well as Sobol' sensitivity indices, have led to reduce this list to a subset of eight parameters with a high influence on different weather-related variables forecasts.

Several perturbed parameters techniques have then been set up and evaluated over long periods. They largely improve AROME-EPS performances for most near-surface variables including wind speed and accumulated precipitation. Different optimizations improving the statistical CRPS score have also been tested. Thus, a set of parameter values has been identified for each AROME-EPS member. This optimal perturbation parameter method is shown to significantly outperform the current SPPT scheme for several near-surface variables, with improvements of probabilistic scores up to 10%. Furthermore, restricting the perturbation to the eight most influential parameters has shown similar results as the version perturbing the full set of 21 parameters, suggesting a possible cheaper setting of weather prediction models.