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Characterization of the model error in COSMO-D2-EPS using a flow-dependent partial SDE

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The increasing share of renewable energy in power generation requires better power forecasts to enable the transmission system operators (TSOs) to guarantee grid stability. Predicting the renewable power generation requires not only high-quality weather forecasts but also information about forecast uncertainties to prepare stability provisions – especially prior to severe weather events. To this end, the project *gridcast* at the German Meteorological Service (DWD) together with Fraunhofer IEE and the German TSOs aims at improving the weather forecast and the resulting power forecast including its uncertainty quantification using the local ensemble prediction system COSMO-D2-EPS at DWD (operational since May 2018). To appropriately represent the forecast uncertainty in an ensemble NWP system it is important to not only consider the initial error in the analysis but also the inherent model error. Therefore, we present an improved characterization of the model error in COSMO-D2.

We describe the model error using the following ansatz: The tendency equations for a set of relevant variables for power prediction like temperature, zonal and meridional winds, and relative humidity are extended by a tendency error approximated by a partial stochastic differential equation (SDE). This SDE consists of a damping term, a diffusion term that ensures spatial correlations, and a random field. Each of the three terms has a strength parameter that is assumed to be a function of (possibly different) flow dependent predictor variables. Hence the relative importance of the three terms varies in space and time according to the respective weather conditions. The functional form of the parameters can be approximated from past estimates of the model error and can then be implemented into the COSMO model.

We present theoretical properties of the SDE and motivate its choice as representation of the model error. Furthermore, we investigate methods to determine the parameters of the SDE, in particular approaches from optimal control theory. Numerical experiments validating the parameter estimation are shown. Finally, we apply this method to the new operational COSMO-D2-EPS at DWD to determine the parameter functions for the model error of relevant forecast variables.