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Representation of model error in ICON-EPS: A-priori simulation using a flow-dependent stochastic approach

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In the research project gridcast, the German Meteorological Service (DWD) – in cooperation with the Fraunhofer Institute for Energy Economics and Energy System Technology (IEE) and the German transmission system operators as associated partners – pursues the objective of an improved representation of model uncertainty in its operational ensemble forecasts supporting renewable energy applications. In order to achieve this goal, the DWD aims to characterize and to simulate the inherent model error in the ICON ensemble prediction system.

This is motivated by an insufficient spread-skill reliability of surface variables (e.g. wind gust, wind speed near the surface, or global radiation) as indicated by the ensemble verification. In order to overcome this under-representation of uncertainty, the model error that is caused by the parameterization of sub-grid-scale processes is simulated a-priori at each model iteration step. In particular, the prognostic tendency equations (e.g. wind components or temperature) are extended by an additive tendency error that is approximated by a partial stochastic differential equation (SDE). For the SDE, we use an Ornstein-Uhlenbeck equation that is extended by a diffusion term to ensure spatial correlations. The coefficients of the SDE are estimated off-line based on historical forecast and analysis data. As the SDE-coefficients are assumed to be a function of flow-dependent predictor variables with respect to the weather condition, we investigate the dependencies of the three SDE terms for e.g. different variables, model levels, and regions. Moreover, we present first numerical results along the implementation of the stochastic scheme into the ensemble prediction system ICON-EPS.