Geophysical Research Abstracts
Vol. 18, EGU2016-17313, 2016
EGU General Assembly 2016

Ensemble Data Assimilation of Wind and Photovoltaic Power Information in the Convection-permitting High-Resolution Model COSMO-DE

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Determining the amount of weather dependent renewable energy is a demanding task for transmission system operators (TSOs) and wind and photovoltaic (PV) prediction errors require the use of reserve power, which generate costs and can - in extreme cases - endanger the security of supply. In the project EWeLiNE funded by the German government, the German Weather Service and the Fraunhofer Institute on Wind Energy and Energy System Technology develop innovative weather- and power forecasting models and tools for grid integration of weather dependent renewable energy.

The key part in energy prediction process chains is the numerical weather prediction (NWP) system. Wind speed and irradiation forecast from NWP system are however subject to several sources of error. The quality of the wind power prediction is mainly penalized by forecast error of the NWP model in the planetary boundary layer (PBL), which is characterized by high spatial and temporal fluctuations of the wind speed. For PV power prediction, weaknesses of the NWP model to correctly forecast i.e. low stratus, the absorption of condensed water or aerosol optical depth are the main sources of errors. Inaccurate radiation schemes (i.e. the two-stream parametrization) are also known as a deficit of NWP systems with regard to irradiation forecast. To mitigate errors like these, NWP model data can be corrected by post-processing techniques such as model output statistics and calibration using historical observational data. Additionally, latest observations can be used in a pre-processing technique called data assimilation (DA). In DA, not only the initial fields are provided, but the model is also synchronized with reality – the observations – and hence the model error is reduced in the forecast. Besides conventional observation networks like radiosondes, synoptic observations or air reports of wind, pressure and humidity, the number of observations measuring meteorological information indirectly such as satellite radiances, radar reflectivities or GPS slant delays strongly increases.

The numerous wind farm and PV plants installed in Germany potentially represent a dense meteorological network assessing irradiation and wind speed through their power measurements. The accuracy of the NWP data may thus be enhanced by extending the observations in the assimilation by this new source of information. Wind power data can serve as indirect measurements of wind speed at hub height. The impact on the NWP model is potentially interesting since conventional observation network lacks measurements in this part of the PBL. Photovoltaic power plants can provide information on clouds, aerosol optical depth or low stratus in terms of remote sensing: the power output is strongly dependent on perturbations along the slant between sun position and PV panel. Additionally, since the latter kind of data is not limited to the vertical column above or below the detector. It may thus complement satellite data and compensate weaknesses in the radiation scheme.

In this contribution, the DA method (Local Ensemble Transform Kalman Filter, LETKF) is shortly sketched. Furthermore, the computation of the model power equivalents is described and first assimilation results are presented and discussed.