Benefits of Doppler wind lidars to improve short-term low-level wind forecasts

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Over the last years, climate monitoring and operational weather forecasts have become an important topic for the renewable energy sector. An effective operation of national, and in the case of EU international, power generation aims to find the right balance between the minimization of CO2 emission and reduction of energy costs. In Germany a considerable part of the electricity generation comes from wind. Therefore, an accurate forecast of low-level wind is essential to predict the generation of electrical power produced by wind parks. This enables timely adjustments of the conventional power plants. Currently, short-term low-level wind forecasts have considerable uncertainties. One of the cost-effective solutions to improve low-level wind forecasts is an assimilation of new observations into numerical weather prediction models. Even though in the last decade, the number of remote-sensing sites has been continuously growing, the coverage is far from being optimal to achieve significant improvement of the short-term wind forecast. However, before building new large networks of ground-based instruments it is important to estimate in advance which instruments to install, what effect to expect, and what spatial density of the distributed instruments should be.

One of the ground-based instruments that can provide valuable information for low-level wind forecasts are Doppler lidars. In this study we focus on the estimation of the potential impact of a network of Doppler lidars for short-term low-level wind forecasts essential for sustainable energy applications. The potential impact is analyzed using the ensemble sensitivity analysis (ESA) [1, 3]. ESA is based on the Ensemble Transform Kalman Filter and allows us to investigate how the assimilation of hypothetical Doppler lidars can reduce the wind forecast variance. The impact a Doppler lidar network was analyzed with respect to surface measurements operationally assimilated by national weather services. We investigated the sensitivity of the obtained results to ESA settings such as number of Doppler lidars in the network, number of altitude layers observed by Doppler lidars, and forecast lead time. Our analysis is based on a 1000-member ensemble simulation for the urban and highly populated Rhein-Ruhr area and surrounding regions [2]. The simulation uses a full-physics non-hydrostatic regional model SCALE-RM and covers a two-week time period in May/June 2016.

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