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Towards sub-kilometer resolution probabilistic analysis of surface wind in complex terrain

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Correctly representing surface wind is critical for applications such as renewable energy, snow modelling or warning systems. However, numerical weather prediction models with their limited resolution cannot fully represent the strong variability due to complex topography. Downscaling techniques – functionally equivalent to postprocessing when the ground truth is given by observational data - can achieve remarkable results in reducing systematic biases of raw models and can be calibrated to yield accurate probabilistic information at any point in space.

These techniques can be further improved at analysis time by including real-time measurements, allowing to produce a probabilistic sub-grid resolution analysis of surface wind. Such a product would enable other interesting applications, such as detailed climatologies or nowcasting, and could serve as a ground truth for training deep learning-based postprocessing models with generative approaches, allowing to model spatially and temporally consistent ensembles.

The first important challenge is to integrate measurements in a statistically optimized and efficient way. Here, we share our ongoing work and preliminary results in a comparative analysis of different approaches, from naïve interpolations to geostatistical techniques or novel approaches based on neural networks. The analysis is based on a multi-year archive of hourly wind observations and NWP analyses from the operational COSMO-1E model over Switzerland.