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Data-Driven Topographic Feature Selection for Mean Wind Speed Mapping

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Accurate spatial mapping of long term mean wind speeds is of great importance for renewable resources evaluation and wind farm location planning. This task is conventionally approached with a physical model further corrected with some geostatistical or semi-empirical method to take into account local topography and land cover effects. In mountainous regions of complex topographies, however, the evaluation of mean wind speed with this procedure is less precise. A variety of small-scale topographic features has to be incorporated into the model to take into account the factors affecting the wind speed, such as hill and tunnel effects.

Large number of topographic features can be computed from digital elevation models to be integrated into a prediction model. Spatial prediction of the wind speeds by using a large set of input features is a high dimensional and non-linear problem. In conventional scheme, one relies here on many empirical correction coefficients and various topographic indices to take into account the influence of terrain. However, there is an emerging field of machine learning algorithms, which are the data-driven methods well-suited to solve such problems. They are aimed at modelling the non-linear dependencies between the high dimensional input features and a target variable such as the wind speed. There is a noticeable interest for using these methods for wind mapping.

The presented research provides an application of machine learning methods (neural networks and support vector methods) for spatial prediction of mean wind speeds with a particular attention paid to the problem of feature selection. The number of features which can be generated from digital elevation model is countless as the features can be computed at various spatial scales. For example, a difference of terrains smoothed at different spatial scales enables to highlight the ridges and valleys. Feature selection methods allow finding the features and correspondingly the spatial scales that provide best prediction abilities.

The knowledge of relevant features is not only important for increasing prediction accuracy and for reducing computational complexity, but also enhances the interpretability and provides better understanding of the derived data-driven wind speed model.

The real case study is devoted to the mean wind speed mapping over Switzerland. A digital elevation model with a resolution of 250 m is used for the analysis.