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Land surface parameterization from new satellite sensors

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Wind resource assessment using microscale modelling relies on descriptions of the land surface roughness and on maps of the terrain height. This presentation demonstrates the potential of new satellite based sensors for providing novel input data layers for wind energy flow modelling. The ultimate goal is to reduce the uncertainty of wind resource assessment on land.

The aerodynamic roughness length is typically estimated from global or regional land cover maps from satellites (e.g. GlobCover, Corine) in combination with a land-cover-to-roughness translation table. This approach does not take any seasonal variability of the land surface properties into account and the spatial resolution of the input data sets is coarse. The Sentinel-2 mission from the European Space Agency (ESA) delivers new imagery every ten days at a high spatial resolution. We present a method for dynamic roughness estimation based on the new satellite observations.

An alternative and more physical approach to land surface roughness parameterization is to observe the vegetation height and density and use these properties directly in flow models. Research based on aerial lidar scans show promising results[1,2] and several new satellite sensors can deliver similar observations with global coverage. We present examples of vegetation properties given by interferometric coherence and multi-temporal change detection based on Synthetic Aperture Radar (SAR) from ESA's Sentinel-1 mission. The sensitivity of wind resource estimates to the use of the different vegetation data layers described here is tested through cross-prediction analyses at two forest sites: Østerild in Denmark and Ryningsnäs in Sweden.

A new generation of Digital Elevation Models (DEM) from satellites provide terrain heights at a very high resolution at the global scale. A systematic comparison of terrain heights given by different DEMs at wind turbine sites with a known elevation shows a significant difference between products. We examine the consequence of choosing a given DEM for wind resource assessment.

Overall, there is a vast potential for reducing uncertainties in wind resource assessment by introducing new satellite based data layers as input to flow modelling. The InnoWind project (www.innowind.dk) works towards achieving the full benefit of new satellite based data layers in connection with flow modelling for wind energy through the development of novel data products and upgrading of flow modelling tools in parallel.

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[2] Floors et al., Wind Energy Science, **3**, 353 (2018).