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Multi-lidar observations of gravity waves, recirculation zones and wind resources over complex terrain

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Perdigão is the largest of a series of field experiments in the on-going NEWA (New European Wind Atlas) Project. The purpose of many of the experiments is validate models for siting of wind turbines, in particular for wind resource estimation. In this presentation we investigate three subjects with a set of eight scanning Doppler lidars: 1) Wind resource variations along the ridges 2) Characterization of the recirculation zones at three cross-wind positions, 3) Internal gravity waves and how they may affect wind turbine siting.

Pairs of synchronously scanning Doppler lidars measure the average wind speed of flows crossing the parallel ridges at Perdigão, Portugal. The variations along the ridges are compared to neutral LES calculations making a good match at the upstream ridge but a significantly worse prediction at the downstream ridge. One reason could be an insufficient representation of the terrain. Another unknown is the influence of the atmospheric stability on the flow which is clearly seen by the scanning lidars.

The flow recirculation can have a significant impact on the success of wind energy projects since it represents one of the main contributors to the turbulence generation. We achieved simultaneous dual-Doppler scans of the recirculation zone at three positions and simultaneous observations of recirculation behind two parallel ridges. Methods are developed to identify and define the extent of recirculation bubbles. Different parameters are defined to characterize the dimensions of the recirculation zone. The impact of atmospheric stability and the changes of the wind field at the position of the downwind ridge are investigated.

The measurements reveal that internal waves are present under nocturnal stable stratified conditions roughly half of the time. Factors determining the internal wave characteristics, such as the wavelength and thickness, are studied.