Weather Forecasts
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Rating of the suitability of LIDAR for measuring vertical wind speed in complex terrain (D-4.5)

Summary of the WP's main conclusions and their relevance to wind energy utilisation (D-4.6)

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2.1. Characteristics of the vertical wind profile at test sites

The data analysis at the three pilot sites showed, that the vertical wind profile is mainly and strongly driven by the local topography. As the three sites are all located in complex terrain, the vertical profile does not follow the common logarithmic shape. In all cases, the increase of wind speed with height was less strong or even not existent.

Furthermore, it could be seen, that the vertical wind profile is also strongly dependant on the wind direction. Significant differences could be found between the two main wind directions which were present at all sites.

2.2. Temporal evolution of Bora with respect to the vertical wind profile

The analysis of the temporal pattern of Bora was difficult because of the following reasons:

- The Zephir LIDAR was not able to collect data at wind speeds below 4 m/s. Therefore the beginning of Bora event could not be captured in many cases.
- At Maligrad, Bora events were often accompanied by heavy rain and in-cloud situations. These factors also reduced the data availability.
- At Mailgrad, Bora events started so abruptly that the 10 minute averaging interval of the LIDAR was most likely not sufficient to capture the build-up of the wind system.

Tentative results show that at Maligrad, there seems to be not significant pattern during a Bora event. At Rudine, it seems that Bora events start less abruptly. Wind direction changes gradually from South to Northeast while wind speed first increases at higher levels. Only when the wind direction has changed to Northeast, the high wind speeds also reach the lower levels.

It could also be concluded that the vertical profile at Bora sites is still mainly driven by the characteristics of the local topography. On the other hand it is evident that such a strong wind shear as it appeared in the analysed example at Rudine can have a significant effect on a large wind turbine.

A more detailed analysis can be found in deliverable D-4.3.

2.3. Suitability of LIDAR in complex terrain

The use of LIDAR in complex terrain is very attractive for wind site assessments since a grinding installation of a high mast can be avoided. The measurement campaigns in the SEEWIND project showed very promising results.

However, to the present day it is not recommended to use a LIDAR as a stand alone instrument for accurate wind measurements. More validation studies and comparisons are needed and data retrieval algorithms (vertical wind speed, turbulence) have to be improved. Furthermore, the assumption of a homogeneous flow field used by the LIDAR technology has to be considered in the data analyses, especially in complex terrain.

2.4. Relevance to wind energy utilisation

The knowledge on the shape of the vertical wind profile is crucial for energy yield calculations. Especially in complex terrain the vertical profile rarely follows the wind power law relationship. Thus measurements of vertical profile are of utmost importance.

From the technical point of view, strong wind shear appearing within short time has a significant effect on a wind turbine. The rotor of a wind turbine has to withstand a non-uniform wind speed distribution over the swept area.

LIDAR and SODAR are very useful instruments and deliver valuable additional information at reasonable costs where it is not possible to install a high mast.

The LIDAR technology has shown some advantages over SODAR - apart from the price:
- easy handling and installation
- high data availability up to 150 m above ground
- high accuracy of absolute wind speed data
- low power consumption
- no noise

Measurements of the vertical wind profiles at the pilot sites showed in general good wind conditions for wind energy utilisation. However, the special characteristics of the vertical profiles as well as the Bora events have to be considered in the site assessment, energy yield predictions and when choosing a certain wind turbine class.