Measuring Wind Profiles in Complex Terrain using Doppler Wind LiDAR Systems with FCR™ and CFD Implementations

Ludwig Wagner (1) , Carolin Schmitt (2)
(1) *GWU-Umwelttechnik GmbH, Bonner Ring 9, 50374 Erftstadt* (2) *juwi Wind GmbH, Energie-Allee 1, 55286 Wörrstadt*

ABSTRACT

- The accurate information on the local wind field and its temporal and spatial variations is a crucial parameter in wind energy business.
- High resolution data of wind velocity, shear, inflow angle and turbulence intensity will influence decisions on micro siting of a wind park as well as its future performance and the final energy yield. This is of special importance with growing hub heights and rotor diameters reaching levels that cannot be easily accessed by standard met towers equipped with MEASNET calibrated wind sensors and other meteorological sensors.
- Very accurate wind speed (0.1 m/s) and wind direction measurements at least to hub heights nearly reaching 150 meter AGL are needed.
- Using the online FCR**™** Flow Complexity Recognition software tool and/or offline implementation and correction of LiDAR data using CFD models leads to significant advancements in data accuracy and thus to fewer uncertainties in planning, wind resource assessment, and site assessment.

WINDCUBE® v2 LiDAR REMOTE SENSOR

Fig.1: WINDCUBE® v2 Lidar Remote Sensor Equipped with FCR™ (Flow Complexity Recognition) Standard and FCR Calculation Methodologies

Specially adapted to wind energy requirements, new independent remote sensing systems as the Doppler Wind Lidar System (WINDCUBE® v2, Leosphere) are capable of measuring the 3D wind profile with high accuracy (~ 1%) and good data availability up to 240m AGL. The standard approach of Lidar measurements generally assumes a homogeneous horizontal wind field for the individual measuring heights, whereas in complex terrain, wind flow is not homogeneous and the errors increase with terrain complexity. Thanks to the WINDCUBE´S 5th beam and resulting direct measurement of w and flow-inclination the manufacturer developed in 2012 the Online FCR™ Flow Complexity Recognition software tool which will be taken into account in this study.

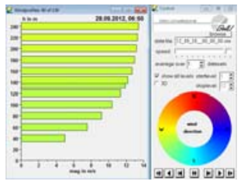


Fig.2: Example 10 min Windprofile

RESULTS: EXPERIMENTAL DATA

STUDY AREA AND METEOROLOGICAL TOWER SETUP

Complex site with coniferous forest and max crop height 30 meter

Quelle : Google Earth

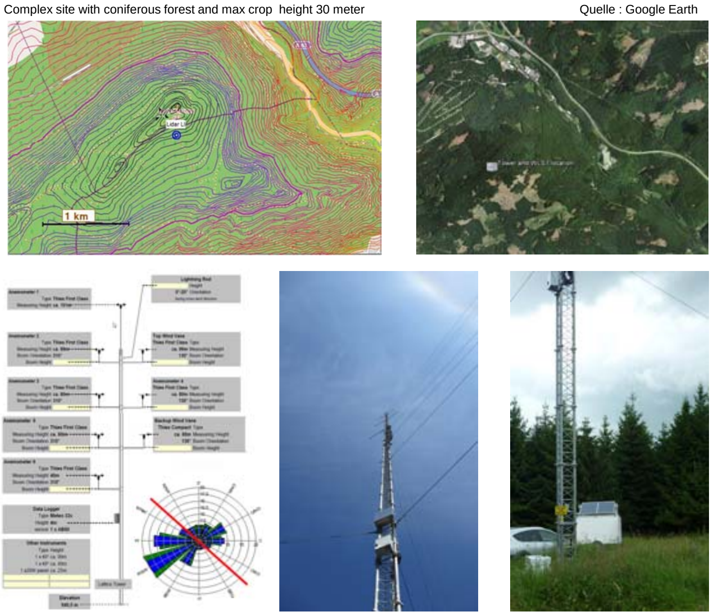
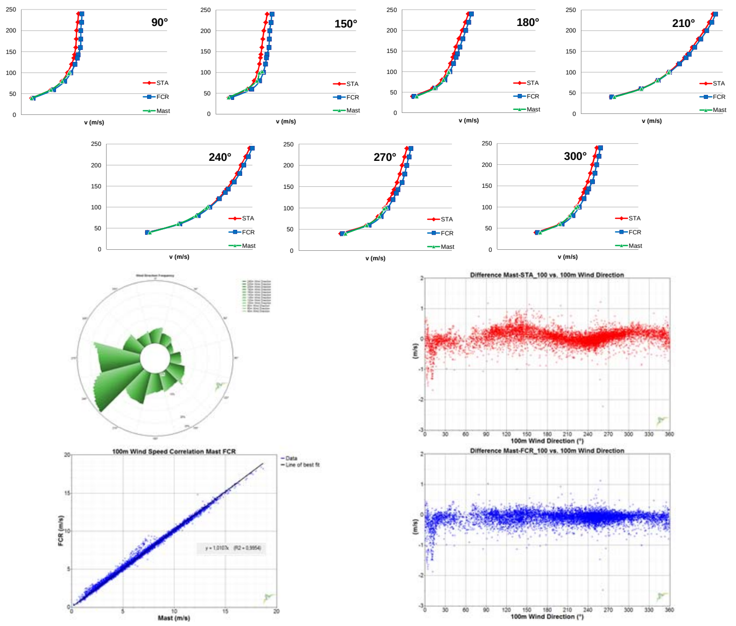


Fig.3: Meteorological Tower & WINDCUBE® v2 Lidar Remote Sensor Location

SECTORWISE COMPARISON : TOWER TO LiDAR WIND PROFILES

Data base : 05.07.2012 to 04.10.2012 (90 days) Data points : 104.064 (10 min average)
Data from Sector 330 to 60 were ignored in this study because of low data availability from this sectors
Only synchronous data for all datasets are used



CONCLUSIONS

- The Doppler Wind Lidar System *WINDCUBE® v2* has become an important tool to measure wind velocity, shear, inflow angle and turbulence intensity at remote, complex, and forested sites.
- All derived data from the *WINDCUBE® v2* in this study correlate very well to the meteorological mast data as shown for the 100 meter level.
- Best results and correlation are shown by using the online FCR™ Flow Complexity Recognition software tool.
- Todays study was concentrated on the online FCR™ software tool and offline implementation and correction of LiDAR data using a CFD model is not yet proofed with these datasets.

REFERENCES

[1] Leosphere, Manual Windcube V2, Version 2012
[2] Parmentier R. et al. Leosphere SAS , An innovative and compact 1.5µm lidar for wind energy, EWEC 2007
[3] D.Foussekis, CRES, Investigating wind flow properties in complex terrain using 3 Lidars and a meteorological mast, EWEC 2009
[4] D.Foussekis, CRES Test Report 546-01B
Operation of the WINDCUBE® v2 lidar at CRES Test Station
[5] Beeken A., Neumann T., DEWI GmbH, FINO1-platform:Operation and Data Analysis of an Offshore based LIDAR device (DEWI Magazin No. 36, Februar 2010)
[6] Bouquet, M. et al., Leosphere SAS , Measurement of Secondary Wind Characteristics by the Windcube V2 LIDAR, EWEC 2011
[7] Bouquet, M. et al., Leosphere SAS, Application of Lidar for Assessment of the Wind Resource in Complex Terrain, DEWEK 2012
[8] Dr. Carolin Schmitt, Catherine Meissner, Non Neutral Wind Profiles Capturing Atmospheric and Orographic Influences, DEWEK 2012

Contact: Dipl. Met. Ludwig Wagner **ludwig.wagner@gwu-group.de www.gwu-group.de**
Dr. Carolin Schmitt **carolin.schmitt@juwi.de www.juwi.de**