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Pre-Campaign tools for use of lidars in Energy Yield Assessment

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Abstract

Remote Sensing Devices and especially **lidars have gained acceptance as accurate wind measurement sensors** and are now widely used for various Wind Energy applications: Energy Yield Assessment, Site suitability, Power performance test, Permanent mast monitoring…

This paper presents two methods to assess what should be expected from a wind lidar measurement before launching a measurement campaign.

The **final uncertainty of a campaign depends on the quantity and quality of data** generated onsite. The estimation of data availability and wind flow impact on the measure ahead of time will **help the user to size its project** and thus to **reduce the costs and risks** linked to the campaign.

Objectives

To fully benefit from the lidar technology, it is **essential to assess two aspects** on any prospective installation site:

1. The local **aerosol content**
2. The **topography complexity**

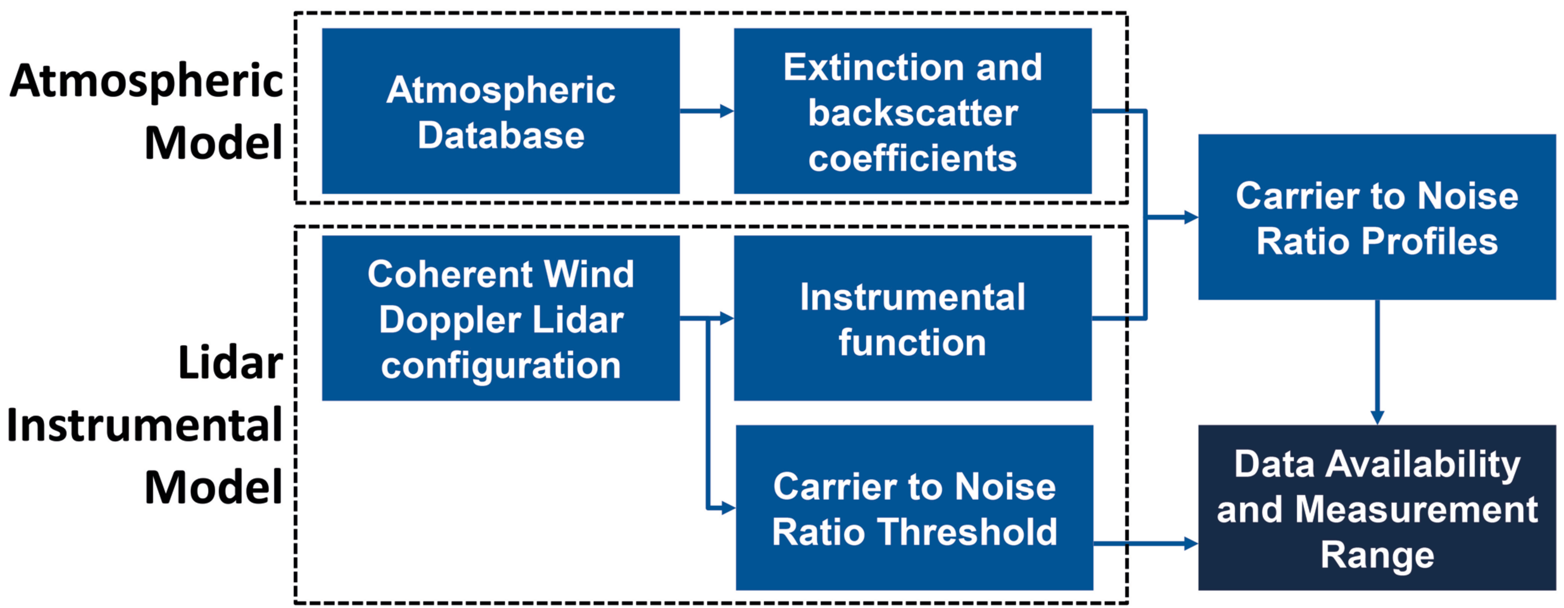
Wind lidar technology essentially relies on the backscatter of the emitted light by the aerosols flowing in the air. A lack of particles in the measurement volume of the lidar will impact the data availability and therefore the campaign success.

In addition, the main assumption in place for wind lidar use is that the wind flow is homogeneous within the measurement volume. However, in complex terrain, the flow cannot be considered as homogeneous and lidar measurements will bring some errors if not corrected.

Methods

Step 1: Will the lidar measure?

The Data Range and Availability Estimator combines the Atmospheric model and the Lidar Instrumental model to simulate the lidar data availability at a given point on earth and for a defined period.



NB: Extinction and backscatter coefficients are computed using raw data from the ECMWF database and calculating the Aerosol Optical Depth, Boundary Layer Height and Lidar ratio parameters.

Step 2: How will the lidar measure?

The Complex Terrain Estimator predicts the error resulting from the lidar measurement due to site complexity. It is built using the local topography data, lidar main measurement parameters (based on Vaisala WindCube v2.1) and the average wind direction history (extracted from Vaisala Energy Wind Prospector).

Neural Network

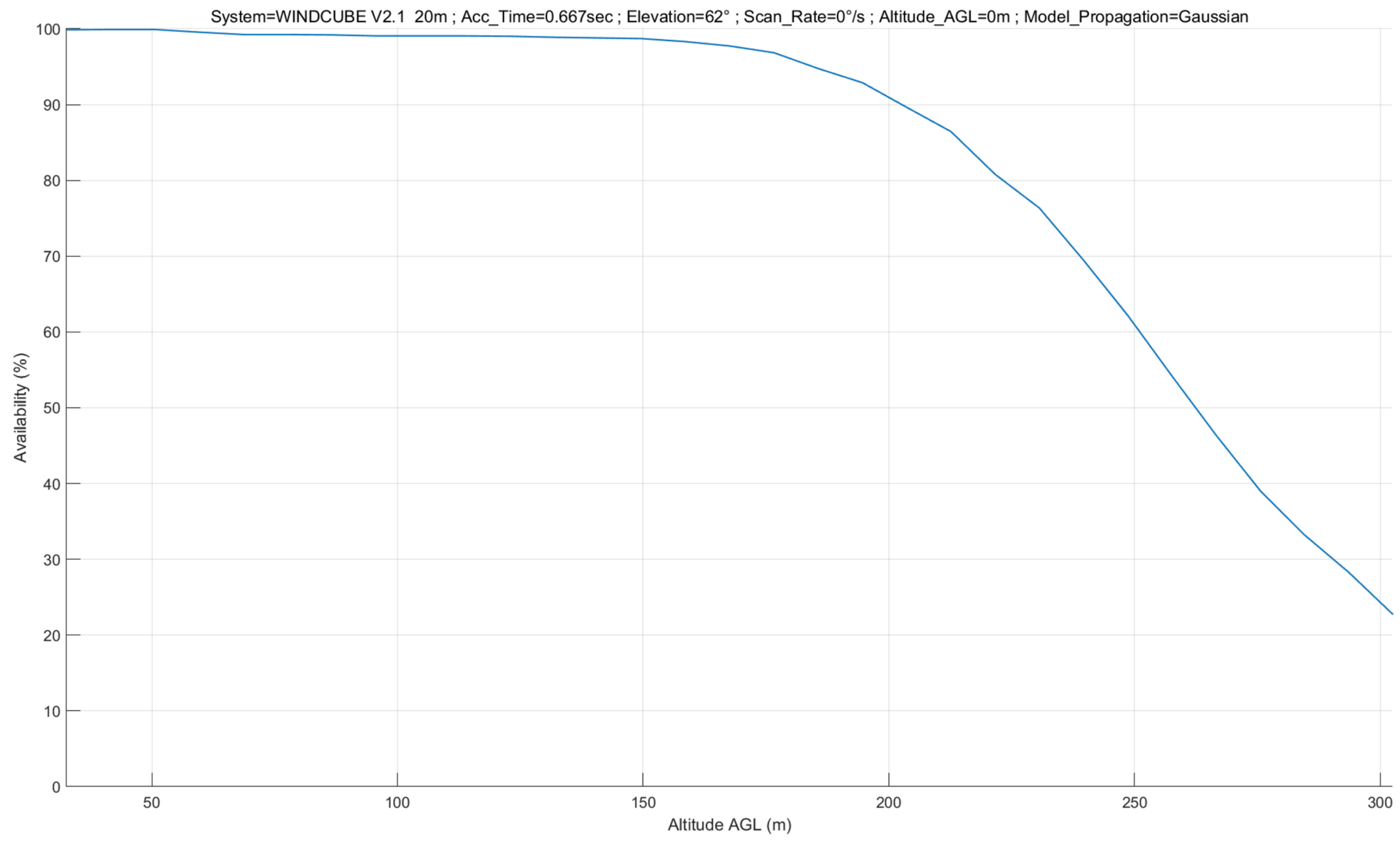
- SRTM radar reconnaissance terrain elevation data
- Label data with prediction of inflow angle resulting from WindCube campaigns

Long Term Wind Roses

- Local averaged wind direction data

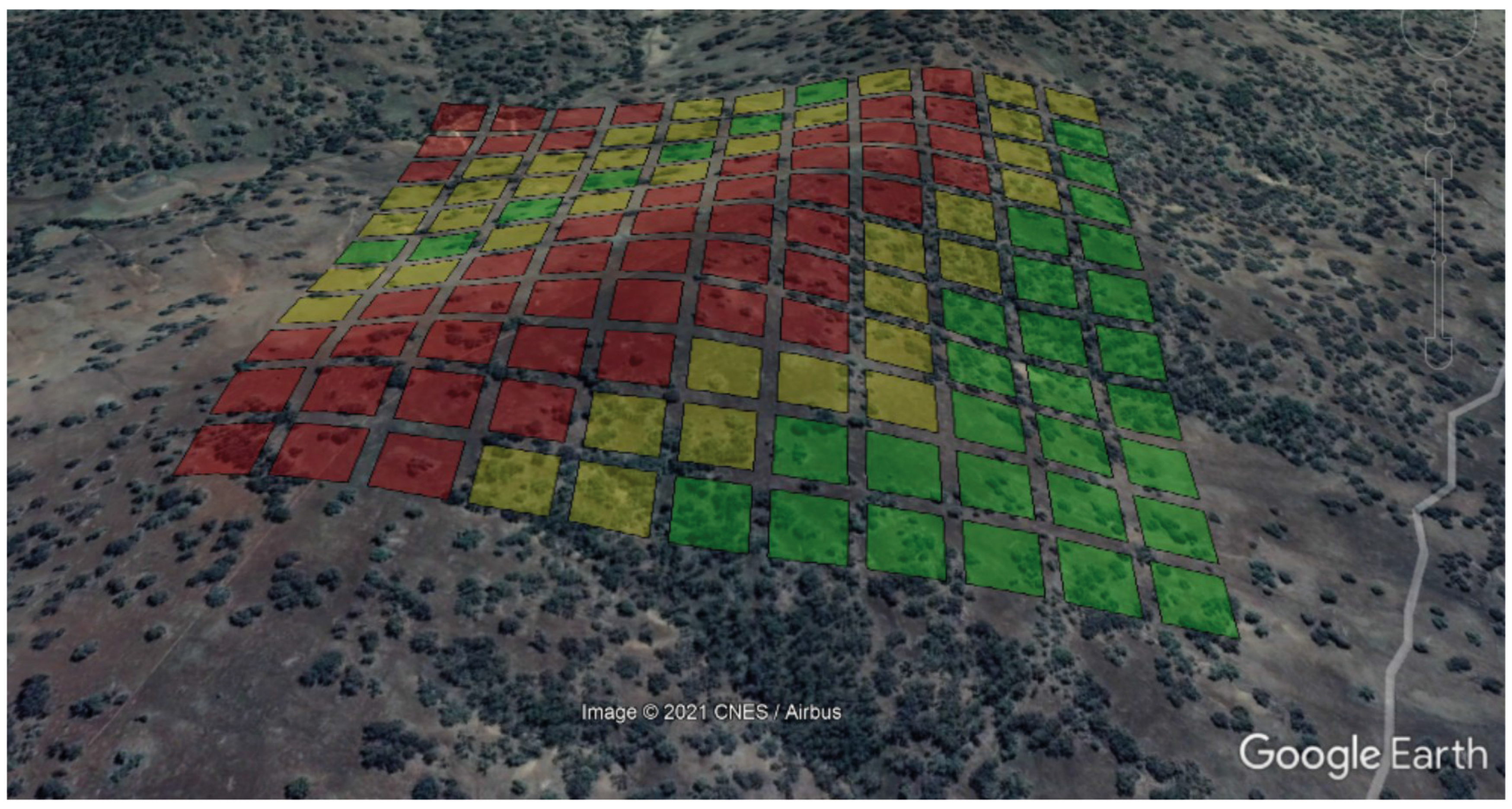
Results

The Data Availability and Range Estimator generates the expected data availability depending on the measurement altitude of the wind lidar.



In cases where lidar data availability is predicted to be poor, the **campaign budget could be updated to include an additional sensor** (met mast, sodar, scanning lidar…) and secure a better data recovery rate.

The Complex Terrain Estimator generates the predicted error mapping of the WindCube® lidar and adds suggestions on how to correct the measurements.



Green locations predict an error below 1% where no correction is suggested to the wind lidar measurements.

Yellow locations predict an error between 1% and 3% where a small correction like the Flow Complexity Recognition (FCR) can be used.

Red locations predict an error above 3% resulting in the need to have data post-corrected by a Computational Flow Dynamics (CFD) software.

For the latter case, the campaign budget could be **updated to include a full CFD correction** and an eventual CFD consulting layer to better understand the site.

Conclusions

It is possible to estimate wind lidar performances for data availability and terrain complexity suitability ahead of time. This helps **refining the campaign's budget.**

The results generated from these methods are **now used across the world** for optimizing the outputs of wind resource assessment campaigns and thus **reducing the final uncertainty of the Energy Yield Assessment.**

References

1. Simulation of Doppler Lidar Measurement Range and Data Availability, *Journal of Atmospheric and Oceanic Technology*

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