PO. ID 196

CORRECTION OF LIDAR REMOTE SENSING MEASUREMENTS BY CFD SIMULATIONS

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Abstract

Remote sensing systems measure radial wind speeds which are then transformed by geometrical equations to horizontal wind speed and wind direction.

This calculated horizontal wind speed is used for site assessment.

In the transformation equations the assumption is made that the wind field is homogeneous over the measurement area. This assumption is violated in complex terrain and may lead to measurement errors up to 10 percent in very complex flow situations. Simulations using computational fluid dynamics (CFD) help to overcome this error.

Measurement Error

To determine the horizontal velocity the Windcube LIDAR measures radial velocities along 4 beams (Fig. 1). In complex terrain the wind field over the swept area is highly inhomogeneous. The variability of the vertical wind speed over the volume complicates the calculation of the horizontal velocity.

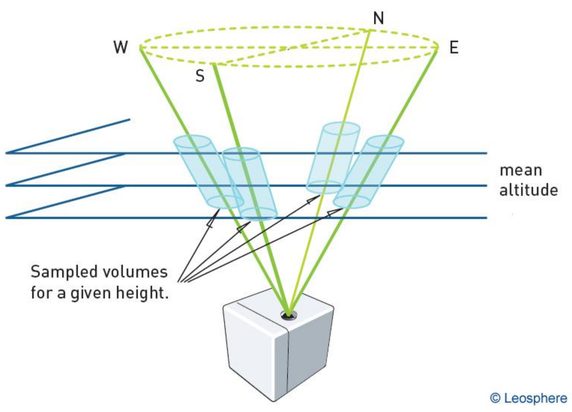

Fig. 1: Measurement technique of the Windcube LIDAR

With the commercial CFD tool WindSim it is possible to simulate the change of the vertical velocity component over the LIDAR swept area.

For the validation site in Greece which is placed on a ridge in moderate terrain (Fig. 2) the vertical wind speeds change by around 1 m/s inside the LIDAR measurement area (Fig. 3).

The site is moderately complex with absolute height differences of 300 m. The simulated area extended over 4x4 km.

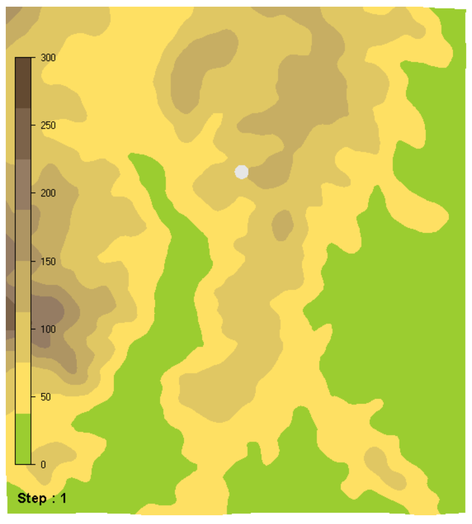

Fig. 2: Topography on the Greece validation site

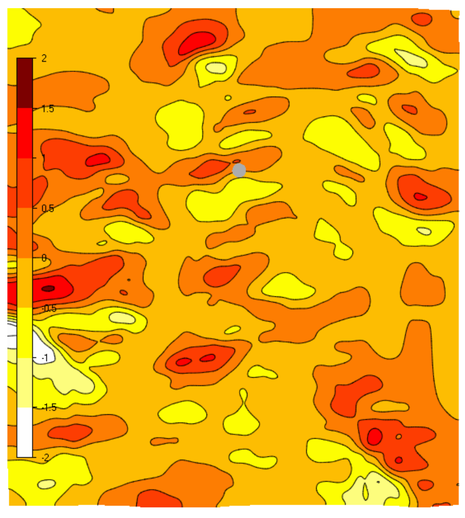

Fig. 3: Simulated vertical wind speed on the Greece validation site

Correction Method

- The inhomogeneity of the vertical component of the wind speed can be simulated by the CFD software WindSim and can be used to correct the LIDAR remote sensing measurements.
- Simulations with a good horizontal and vertical resolution (~10m) resolve the vertical component of the wind flow such that it can be used as an additional term in the geometrical equations.
- After this correction the LIDAR data can be used for site assessment.
- The correction procedure uses the raw data files from the LIDAR.

Validation

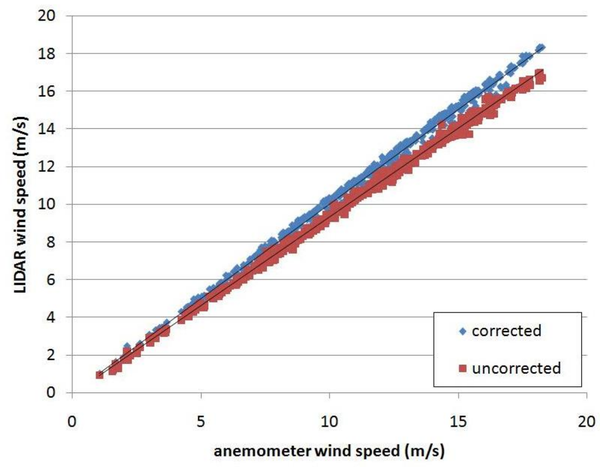

Fig.4: Comparison between original measurement of the LIDAR (red) and CFD corrected measurements (blue).

For the LIDAR measurement height in 74 m a correction was done with the results of the WindSim CFD simulations.

The raw data was corrected and then a ten-minute mean value was calculated and compared to the measured value from a measurement mast placed close to the LIDAR.

For the non-corrected LIDAR measurements the relative error is around 7% compared to the measurements while for the CFD corrected LIDAR measurements the error is reduced to about 1 % (Fig. 4).

Conclusions

The Remote Sensing Correction Tool developed by WindSim has proven that it can reduce the relative error of LIDAR in complex terrain

Further validations are ongoing with more test sites

Through use of a CFD correction LIDAR can be used in complex terrain to carry out an accurate site assessment study

Acknowledgement

The measurements were taken at the CRES Lavrio test facility in Greece. The LIDAR used is the WINDCUBE™ LIDAR developed by LEOSPHERE and owned and operated by CRES