Added value of LiDAR corretion methods from a user's perspective

PO.185

Carolin Schmitt (1), Catherine Meissner (2)
(1) juwi Energieprojekte GmbH, (2) WindSim AS, Norway

Abstract

The application of LiDAR measurements in complex terrain is influenced by volume effects caused by non homogeneous wind flow. This effect on derived wind speeds can be assessed and corrected by different methods:

- **Online methods** like the **FCR** (Flow Complexity Recognition) implemented in the **WindCube v2** software can directly calculate corrected speed values. This method works completely automatic.
- **Offline methods** get correction factors from flow field variables of a **CFD** model like **WindSim** and apply them to the data later on. This method is dependent on the quality and parameter settings of the CFD.

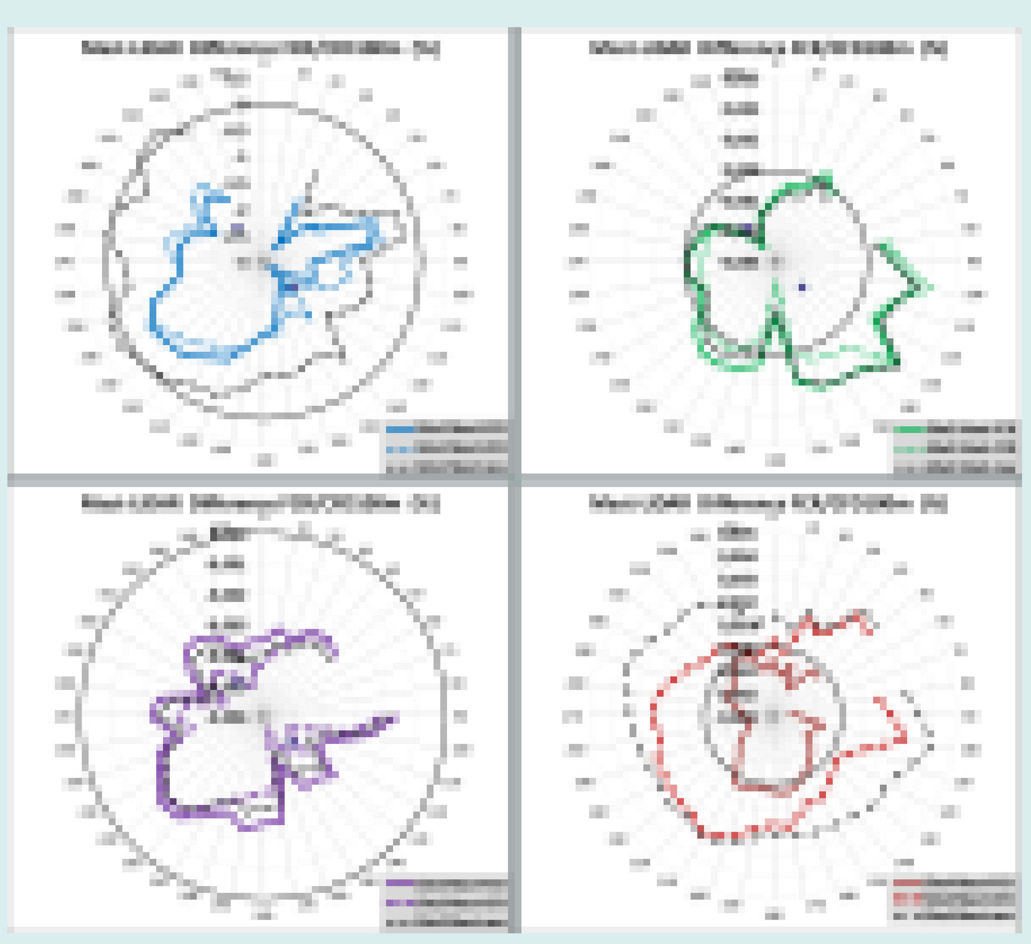
Objectives

The German "Technical Guideline TR6" requires the application of correction methods in complex terrain and the introduction of an additional uncertainty of half of the correction value in an energy yield expertise.

The aim of this study is to test the performance of the standard tools to estimate the magnitude of possible differences, corrections and uncertainties and to understand the mechanisms behind the these effects.

Methods and Results

From a wide range of sites we present examples of four sites with different complexity and direction offset in LiDAR mounting.



Mast-LiDAR Differences

Site 1:

Small mean differences, overestimation from E

Site2:

Small mean differences, underestimations SE, overestimation NW

Site3:

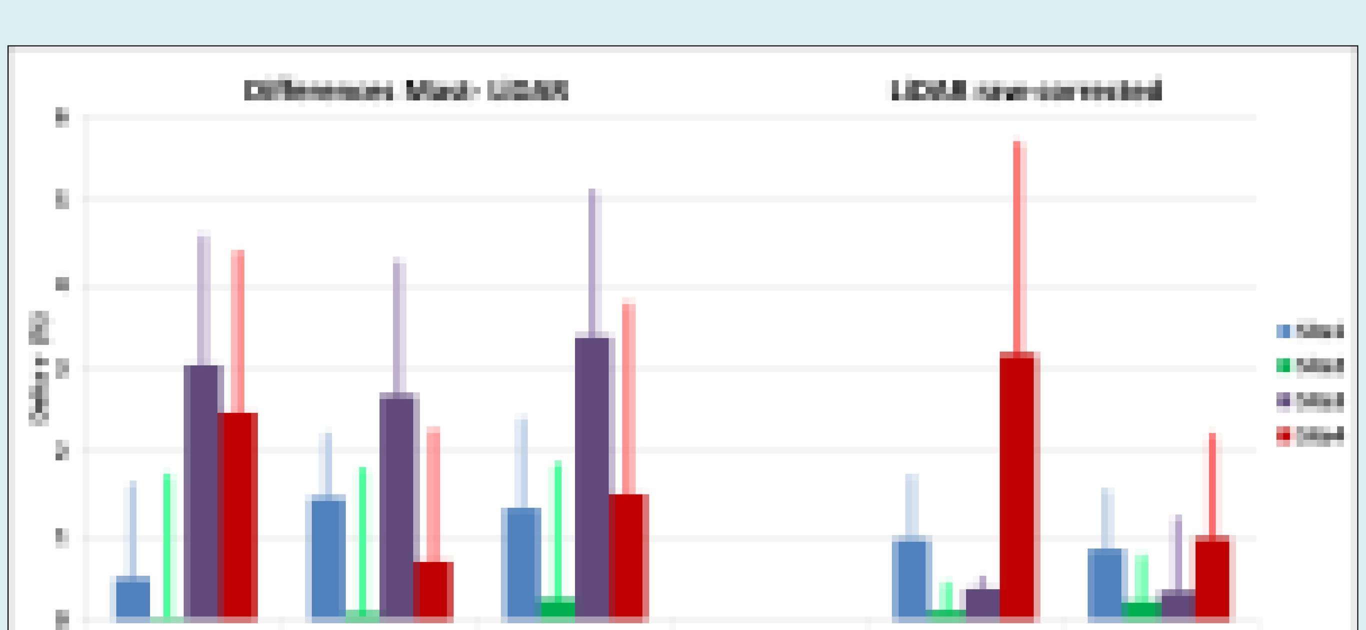
General overestimation strongest SE and NW

Site 4:

Big underestimation from LiDAR, main sectors W and E

Sectorwise Masts-Lidar difference from raw data and after correction with FRC (solid line) and CFD (dashed line)

Comparisons indicate the wide range of possible results, including total over- or underestimation from LiDAR as well as strong sectorwise differences. Influence of both correction methods also differ considerably from site to site.



Comparison of Mast-LiDAR differences (left part) for raw data and correction by FCR and CFD.

Comparison of correction magnitude (right part) for FCR and CFD, which will lead to the value of additional uncertainty according to TR 6.

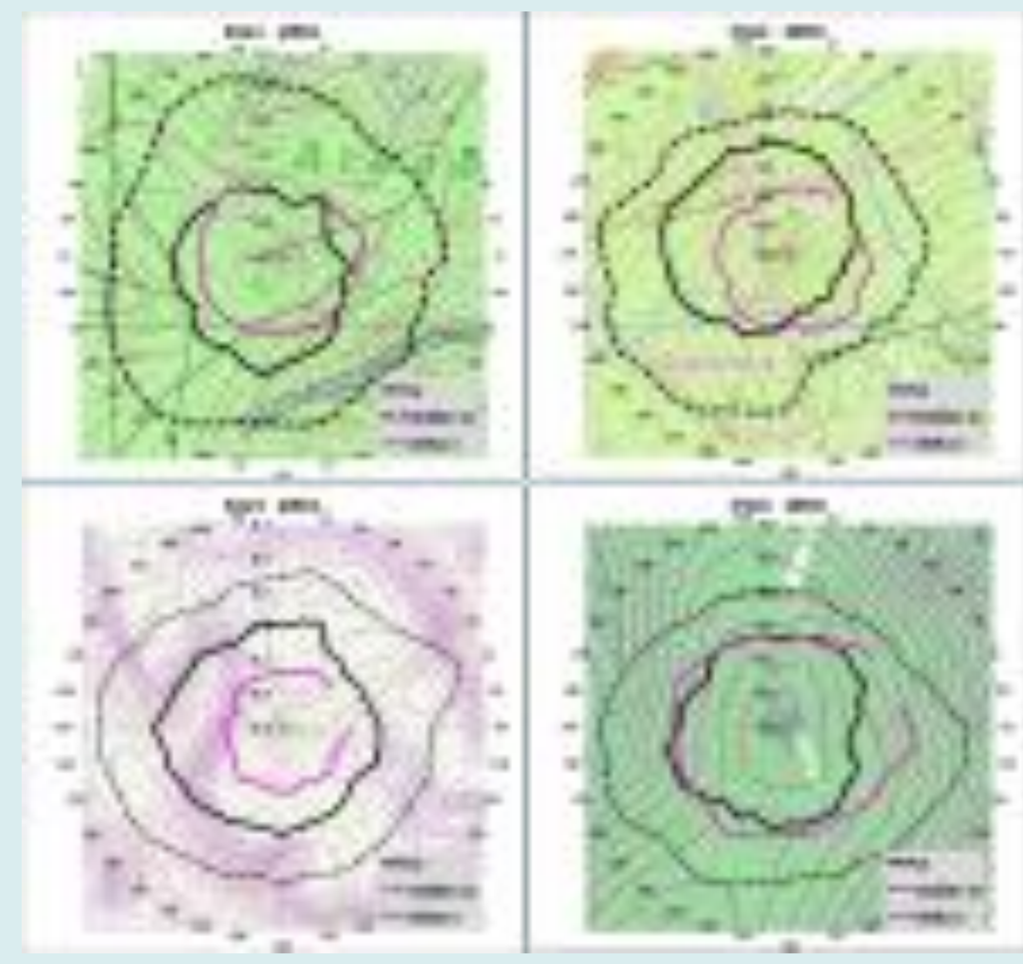
Mean values and peak maxima are plotted.

Mast-LiDAR differences are not automatically minimized by the correction methods. Also sites with small absolute differences (Site 2) can have large sectorwise maxima which are only averaged out. This effect can be misleading. The mean magnitude of corrections of ~1° would lead to uncertainties of ~0.5% according to TR6, but in case of poorer correction (Site 4 CFD) uncertainty also gets smaller, although correction results don't get better, which is also misleading. These effects have to be checked carefully when applying a correction.

Investigation Details

Vertical Speed Component w

The horizontal gradient of vertical wind represents the flow inhomogeneity over the LiDAR cone but is not easy to retrieve from single point measurements. Standard deviation of vertical speed can give an impression of the actual state and flow **modification through orography**.

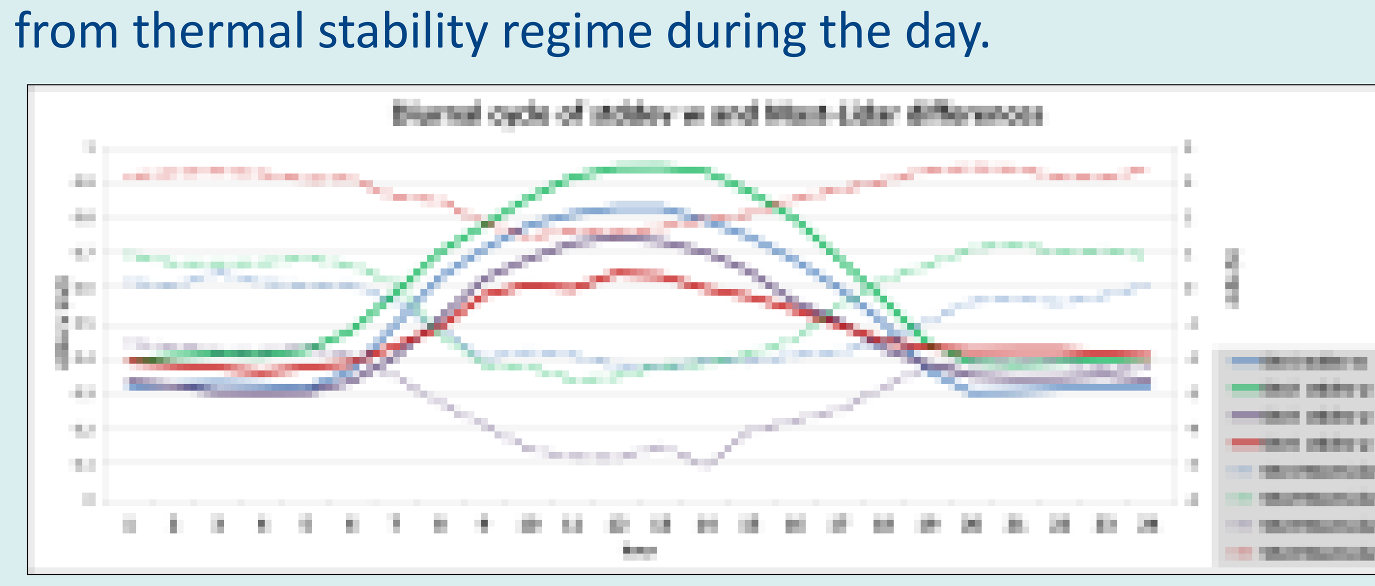


For Site2 (slope) and Site4 (ridge top) the connection between orography, LiDAR derivations and stddev w can be understood from the pictures.

The general overestimation of the LiDAR at Site1 and the failure of both methods here can't be explained from this data.

LiDAR vertical speed (solid), standard deviation (dashed) and Mast-Lidar Differences (pink)

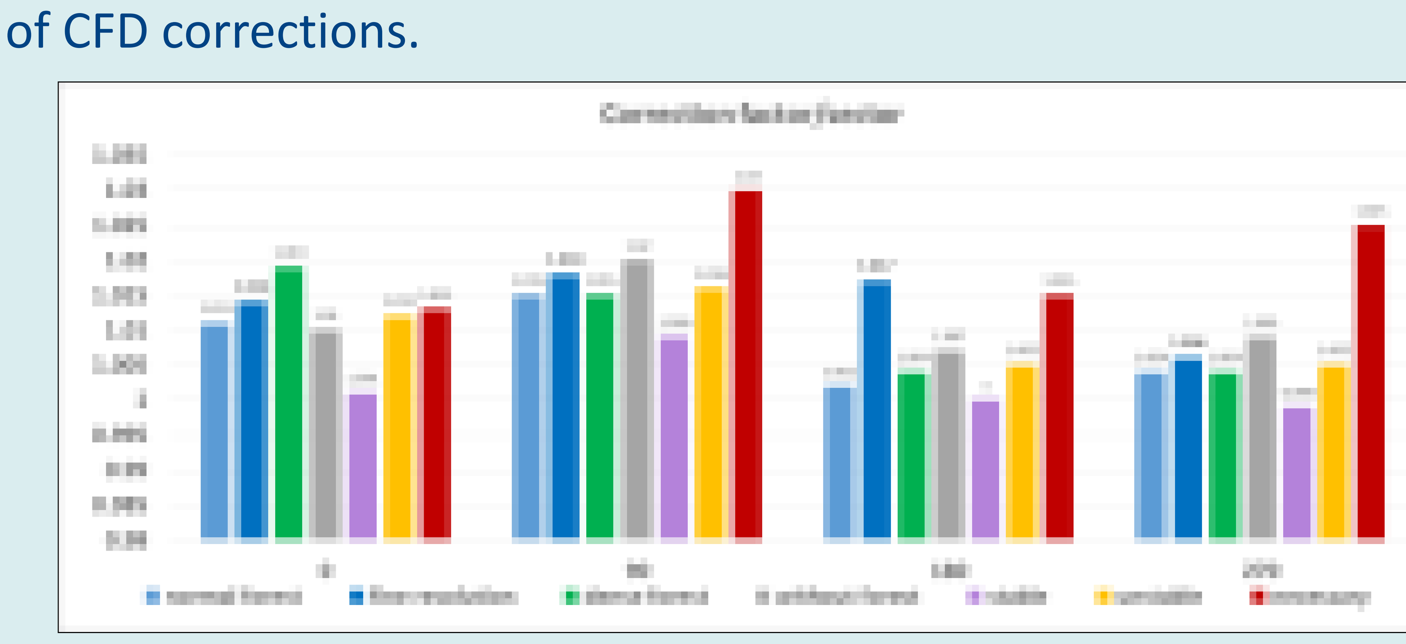
The comparison of diurnal cycles also indicates a strong dependence of LiDAR errors from thermal stability regime during the day.



Diurnal Cycle of Mast-LiDAR difference and standard deviation of w

Model Resolution and Parameters

Good horizontal resolution (normal vs. fine) has more impact on output quality than the increase of modelling sectors. Forest parametrization and stability parameters that reduce vertical motion and were often helpful in improving the models in terms of profile fitting on the other hand seem to decline the quality of CFD corrections.



Sensitivity study of necessary correction parameters (exemplary sectors) and influence of model parameters

Conclusions

- Although doing a good job at some sites, corrections do not improve Mast-LiDAR difference in every case and results differ for the same site and different methods
- For both methods it is not recommended to use them without carefully cross checking the results with mast measurement on their reliability.
- Further studies can help to understand these effects better and improve the correct application.

- Correction of Lidar remote sensing measurements by CFD simulations. Dr. C. Meissner, WindSim AS, M. Boquet, LEOSPHERE SAS, EWEA 2011 poster presentation.
- Cartography of WINDCUBE v2 performances with FCR – A case study in Europe R. Krishnamurthy, M. Boquet, LEOSPHERE SAS, France, EWEA 2015 Poster Presentation