# LiDAR for accurate wind resource assessment


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## Background

LiDARs are used in the atmospheric analysis since 30 years and its recent application in wind energy is appreciated well by the industry and researchers. The aim of the study is to derive the effects of tower on the other sensors present on the metmast with the help of two upward scanning LiDARs available at a test site from ECN. The results help understand certain aspects of reliable data analysis and thereby filtering out unnecessary data. Therefore a comparison between the LiDAR and the sensors on the metmast is necessary and hence evaluated here. The analysis will be later used for reliable wind flow modelling using LiDARs for control of wind turbines.

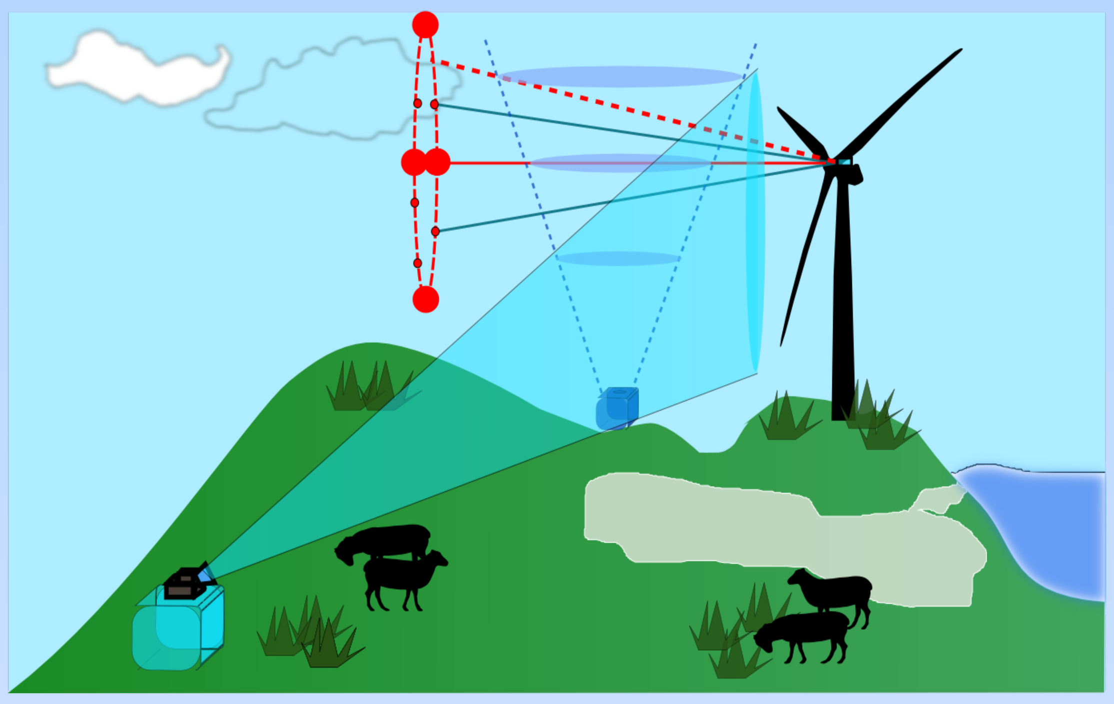

Fig. 1 Test setup for inflow wind modelling

## Test site and Setup

The test site EWTW, Wieringermeer is chosen for the detailed study for the Lawine project. The data from the meteorological mast, MM3 and the two ground LiDARs, namely WindCube from Leosphere are considered for data handling and analysis. The test site is characterized by flat terrain with occasional bushes and trees. The meteorological mast under consideration is MM3 and has a top mounted sonic anemometer at 109m height, two cup anemometers and one sonic anemometer at 80m height and 52m height respectively. The wind vanes are mounted at 79.2m and 51.2m heights respectively [1]. Mounting procedures and met mast erection is done in accordance with the Measnet and IEC standards [2].

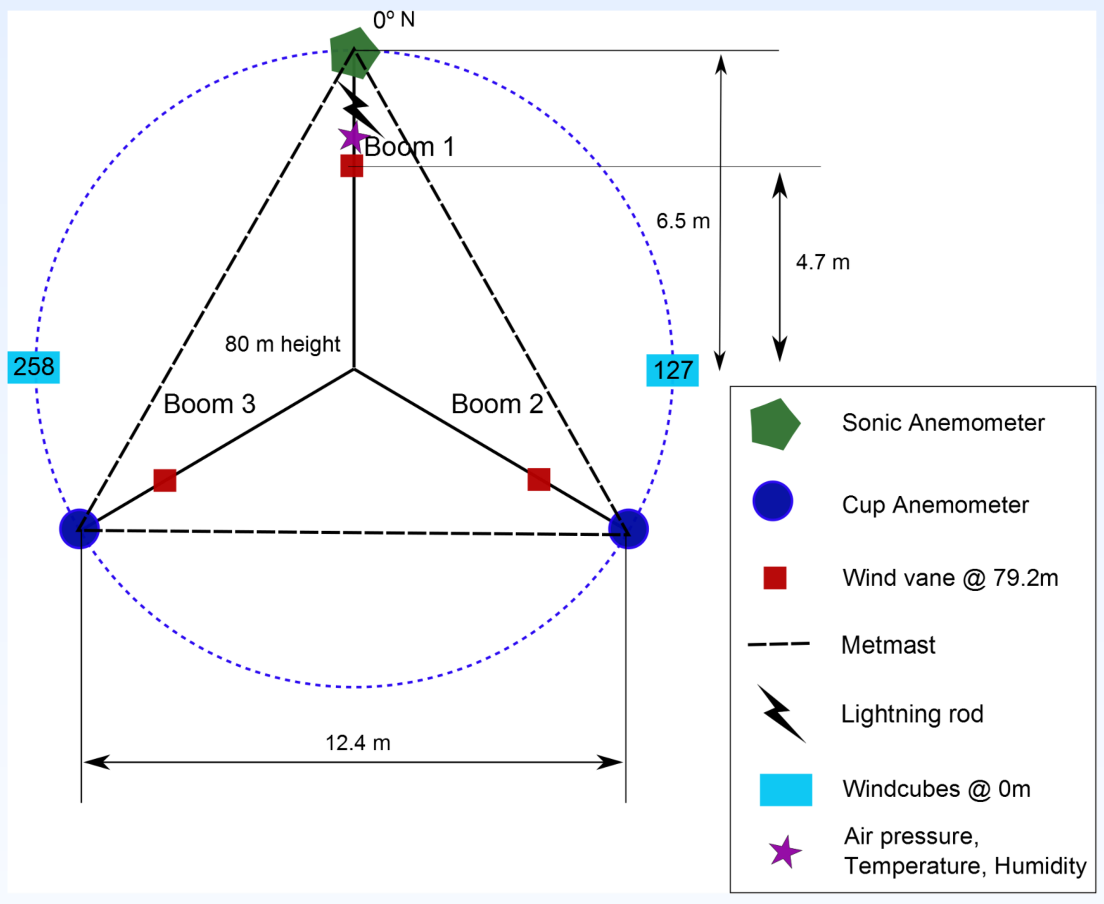


Fig. 2 Metmast 3, (MM3) installation configuration at EWTW

## Histogram Comparisons

The comparison of histogram often reveals the characteristics of the atmosphere and related problems with respect to measurement. In the fig. 3, it could be easily seen that the sonic anemometer had some breakdowns and the measurements data are low in numbers. One might wonder what happened to the second LiDAR instrument in red providing low samples. The sonic anemometer had some problem and was replaced. The LiDAR instrument, however had no problem and was removed from the measurement campaign after the successful tryout. The cup anemometer and the WindCube LiDAR show good resemblance in the data and shall be used as references at 80m height.

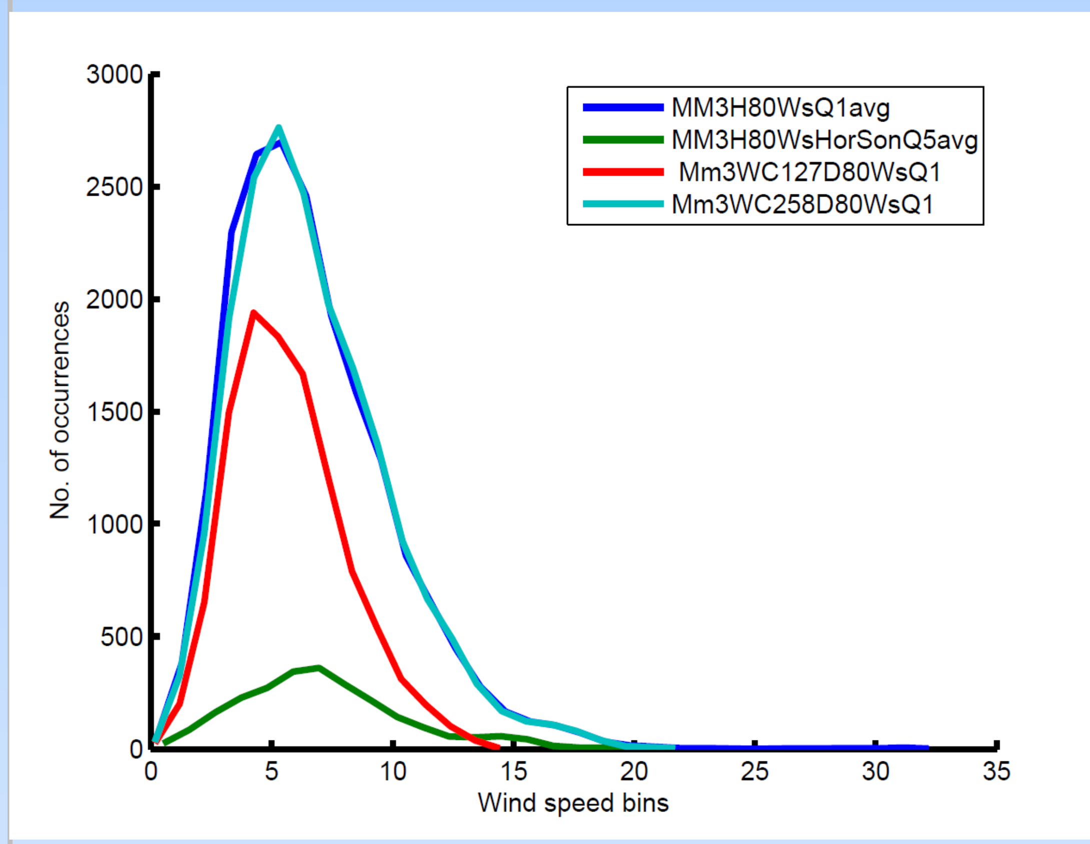


Fig. 3 Histogram of different sensors at 80m height

## Windrose Comparisons

The comparisons of windrose provides information on wake sectors, tower shadow, boom mounting effects and hence are important in the pre-study of any measurement campaign to modify necessary elements which might result in saving time and money. In the fig. 4, the difference in wind direction detected by the WindCube Lidar and the wind vane is visible and the deviations from the tower, boom effects and the wake sectors from the wind turbines are the main causes. The WindCube LiDAR however determines the wind direction with a high uncertainty in cases of wake regime.

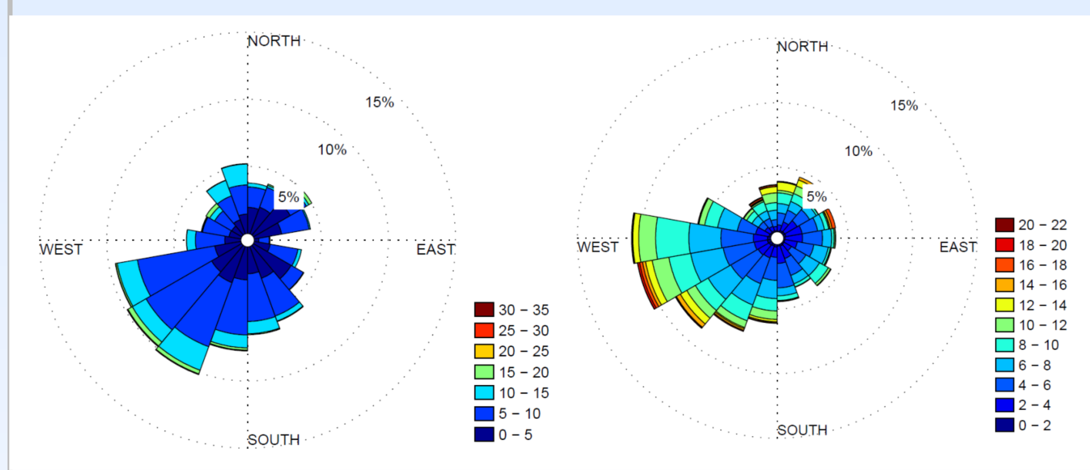

Fig. 4 Windrose from wind vane(left) and LiDAR(right) at 80m height

After comparing the wind directions, clues to deviations and causes to these deviations have to be identified with the help of additional statistics wherein the difference or the ratio of the wind direction with respect to time is plotted to check about special events in environment to influence the deviations. The fig. 5 displays such an event where the LiDAR and the wind vane are having an offset of approximately 5°. There is an additional offset from August onwards of roughly 5°.

A detailed in depth analysis is asked for at ECN who are responsible for the installation and maintenance of the MM3. A similar result was observed when compared to the sonic anemometer and the LiDAR at the height of 108m. However, the offset in this case is around 40°. Hence there seems to be a event linked with WindCube LiDAR.

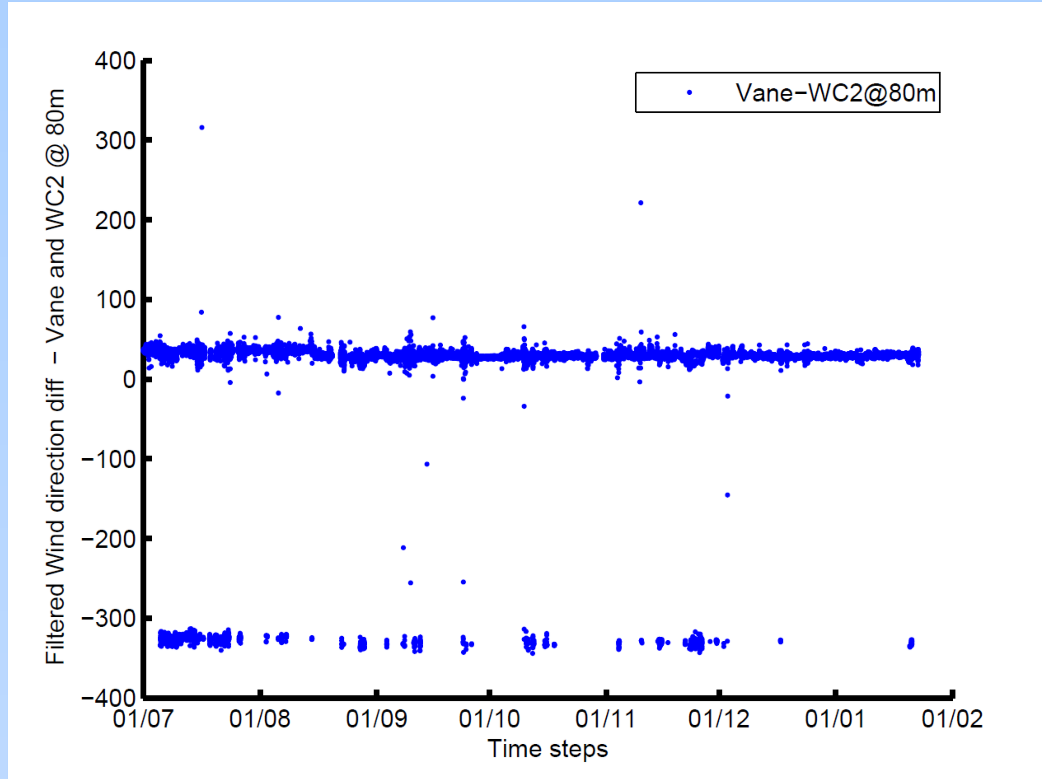


Fig. 5 Diff between the wind vane and LIDAR wind direction wrt reference wind direction

## Wind speed comparisons

The wind speed comparisons between the cup anemometer and LiDAR are used to study the effects of tower shadow, wake effects, boom and mounting effects [3]. In fig. 5, the 0-60°, 290-320° and around 180° are under wake effects from neighbouring wind turbines. The reciprocating ups and downs could be due to turbulence eddies. Such values have to be filtered from the data analysis for further accurate analysis of the inflow conditions on the wind turbines [4].

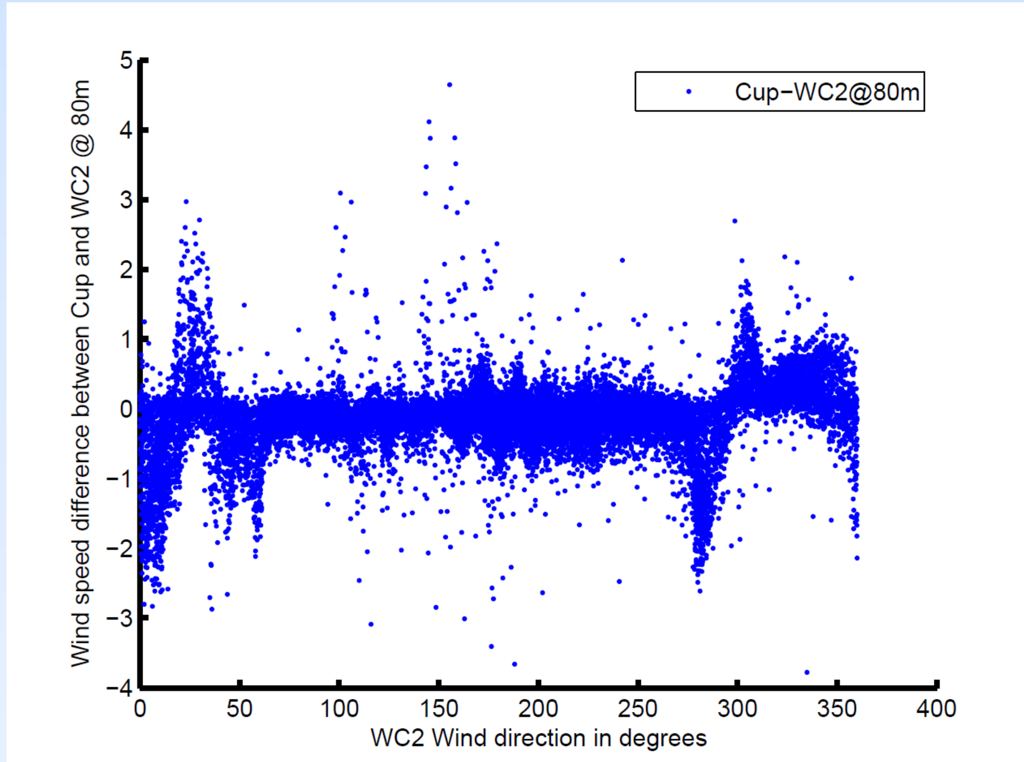


Fig. 5 Diff between the cup anemometer and LIDAR wind speed wrt reference wind direction

## Conclusions and Further Work

The results help to understand the complexities of a good wind resource assessment and allows us to filter out known complex phenomena resulting into inaccurate measurements. The wake of the nearby turbines or tower affect different sensors differently eventually affecting the uncertainty calculation of the site for annual energy prediction. A filter scheme based on the above results is being developed and would be further used for flow modelling of the LiDAR measurements towards the wind turbine. The flow model developed would be used in the development of the transfer model for wind turbine control [5].

## References


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