Do we need to classify nacelle lidars?

Ginka G. Yankova, Michael S. Courtney

DTU Wind Energy, Denmark.

1. General summary

Nacelle-mounted lidars are becoming an accepted and attractive method for performing power performance verification, especially at offshore sites where an otherwise hugely expensive mast is avoided. A calibration procedure for nacelle lidars is established and available as a commercial service. An initiative for a new IEC standard (61400-50-3) to cover nacelle-mounted lidars has been taken and work will commence in the autumn of 2017. One of the open questions is to what extent the wind speeds reported by nacelle-lidars are sensitive to environmental parameters such as temperature and turbulence intensity. If such sensitivities are significant, a classification scheme similar to that applied to cup anemometers and ground-based lidars will need to be developed. Based on a large body of data acquired from many nacelle-lidar calibrations, we have attempted to identify any such sensitivities in order to provide a scientific basis for answering the nacelle lidar classification question.

2. Method

Our analysis has been based on the 10 minute mean values of lidar radial speed and projected reference cup anemometer speed collected in the calibration of 9 individual 2-beam nacelle lidars (18 lines of sight). This dataset comprises many thousands of observations spread over a wide range of atmospheric conditions. Observations of atmospheric parameters (temperature, humidity, pressure, rain, turbulence intensity) come from sensors on a nearby meteorological mast. Differences between the lidar radial speed and the projected reference speed have been analysed to identify possible correlations with the environmental parameters using both single and multi-variate regression techniques. In addition, using the Accuwind model, we have attempted to quantify the likely sensitivities of the reference cup anemometer.

3. Results

No significant sensitivity to any of the atmospheric parameters has been identified. A minor sensitivity to wind direction has been observed but this is attributed to a slight in-homogeneity of the measuring site. This could be mitigated by a small reduction in the width of the measuring sector.

4. Conclusions

From our findings, we can conclude that for the lidar type tested, no classification test is required to characterise the accuracy of the line-of-sight speed in operational conditions. Alternatively, should a classification test in any case be performed, we would not anticipate identifying sensitivities greater than those of the available reference instruments. Our recommendation would be rather to concentrate on the physics of how the horizontal wind speed are reconstructed in order to identify sources that can introduce unknown errors.

5. Learning Objectives

From the presentation, the delegates will

- Receive a quick introduction to how nacelle lidars are calibrated
- Learn about how classification is used for other instrument types to quantify operational uncertainty
- Learn about how we have tested for sensitivity to temperature, humidity, pressure and turbulence intensity
- Understand how the value of testing of this type is limited by reference instrument sensitivity
- Understand what the implications of our results are for a future nacelle lidar international standard.