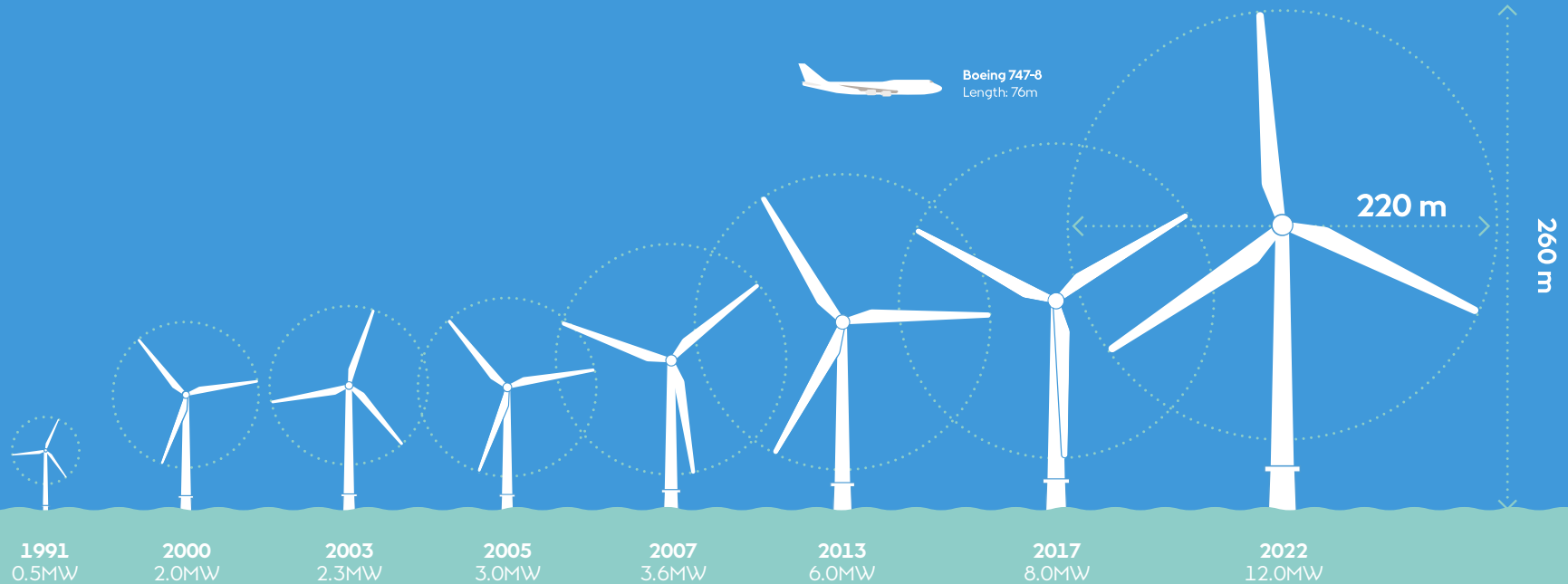


# Assessing the performance of eight commercial lidars

# Wind turbines have been getting taller



# Methods



MeteoLaser LM21901, Pulsed



Leice WP350M, Pulsed



(1<sup>st</sup> prototype 2021) WindPro-6B\*, Pulsed



Molas B300M, Pulsed



Windcube v2.0 – SN328, Pulsed  
Windcube v2.1\*\* – SN1015, Pulsed



ZX300M SN957 – FW 2.2034, Continuous  
ZP300M SN632\*\*\* – FW 1.3238, Continuous

\* Measured for 2 months

\*\* Measured for 3 months

\*\*\* Measured for 6 months in a different period to other lidars.

# Methods

Procedure

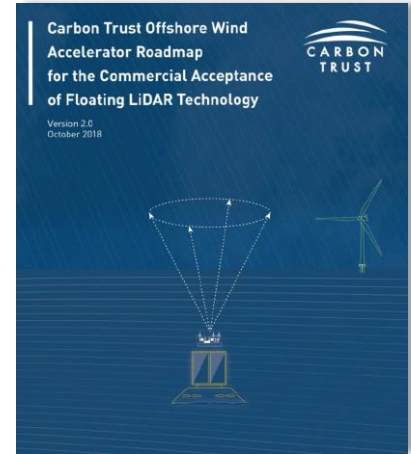
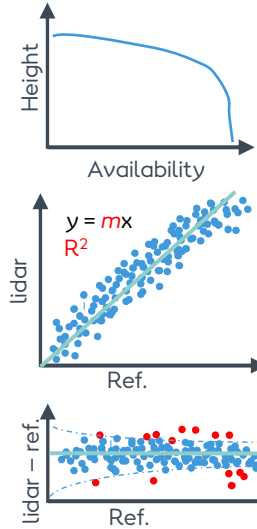
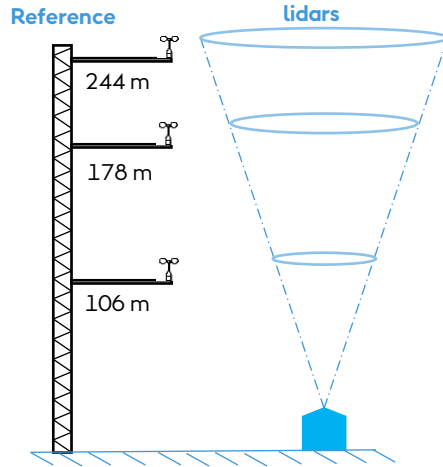
Verification setup

Statistical analysis

Performance KPIs

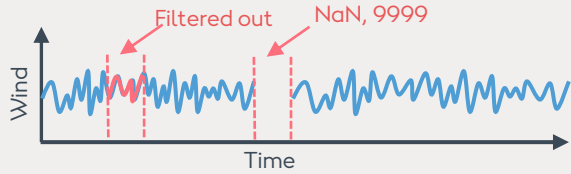


IEC 61400-50-2



OWA Roadmap

# Data Availability

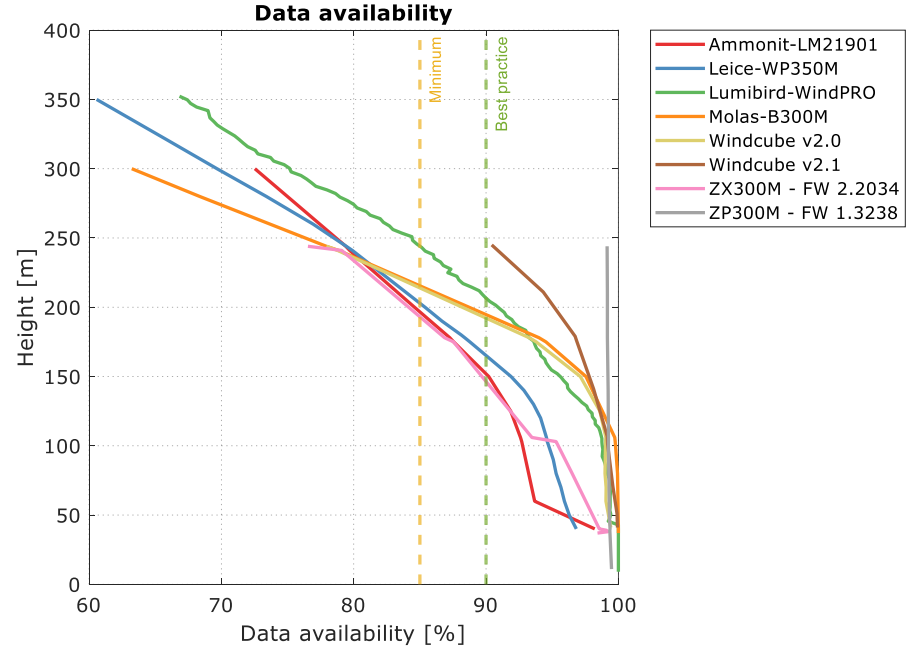


$$D.A. = 1 - \frac{(\text{Filtered out} + \text{NaNs})}{\text{Max. number of data points}} \times 100$$

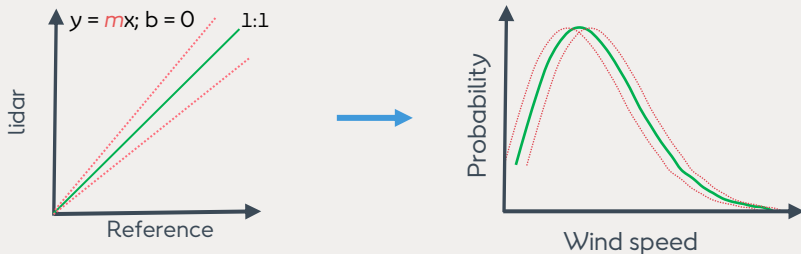
Tested lidars allow configuration of measurement height up to at least 300m.

Pulsed lidars availability varied significantly between different products. ZX lidars data availability varied between old (ZP300) and new model (ZX300).

Best practice criterion failed above 150 - 245 m. Minimum criterion failed above 195 - 245 m.



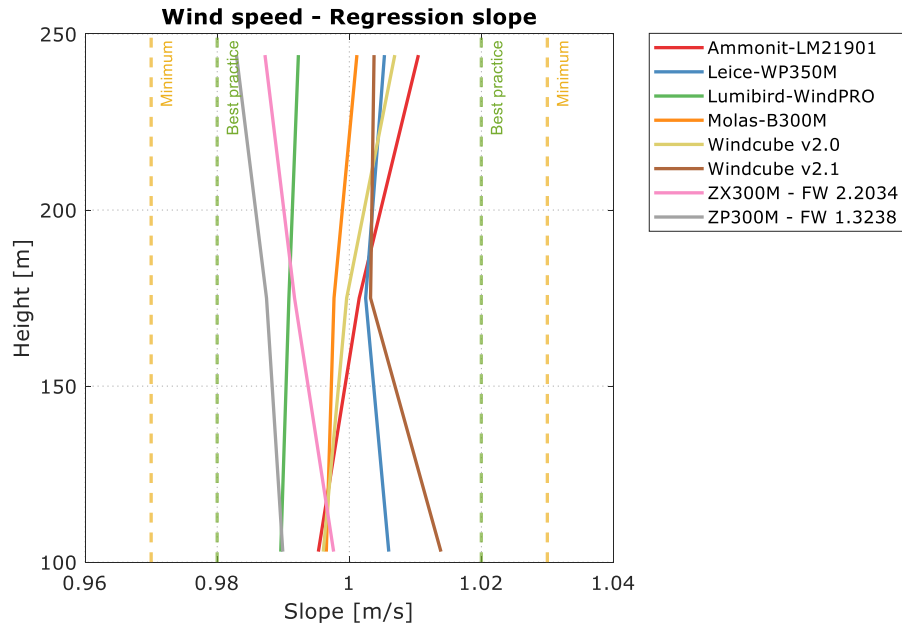
# Wind speed – Regression Slope



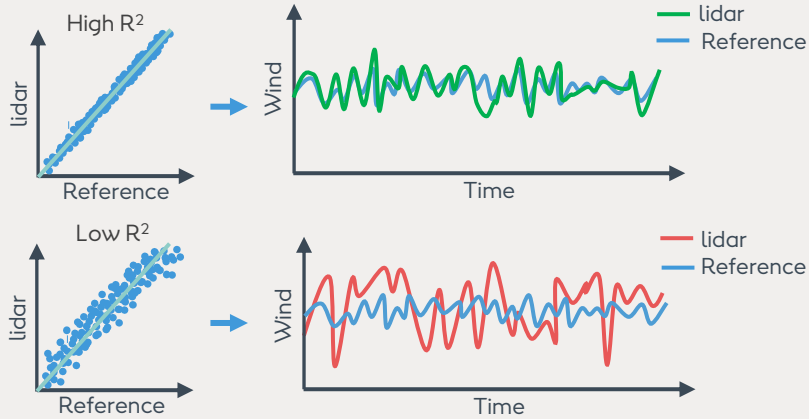
Best practice criterion was met by all lidars at all assessed heights.

ZX lidars and pulsed lidars show diverging slope behavior with increasing height. Although the statistical significance of this trend may be limited.

Lumibird-WindPro doesn't show sign of slope sensitivity with increasing height.

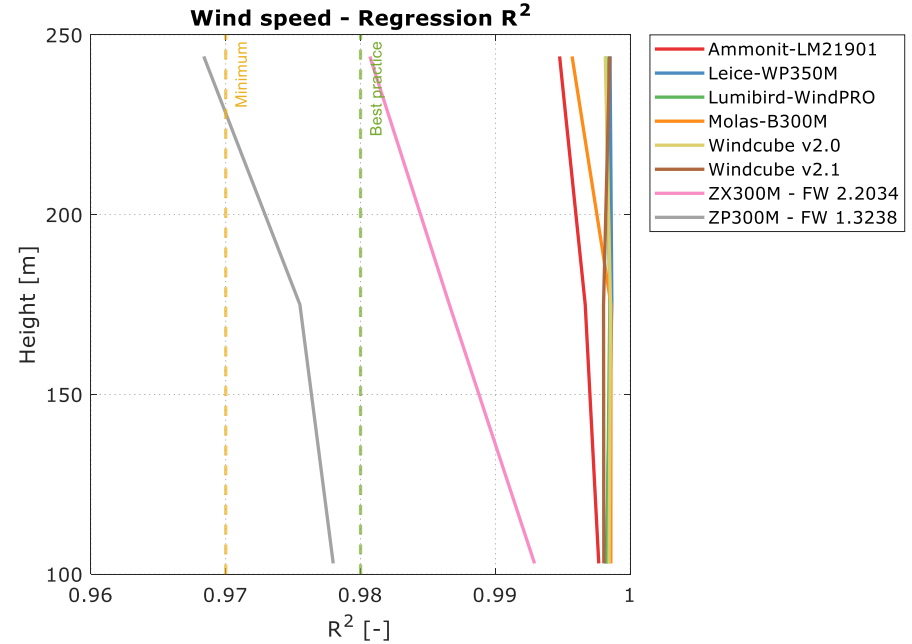


# Wind speed – Regression $R^2$

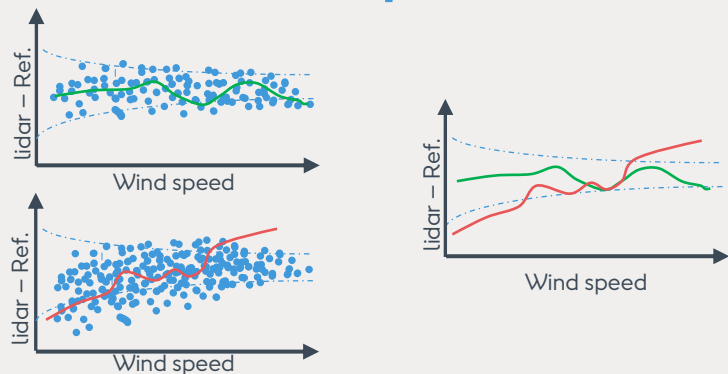


Pulsed lidars yielded high  $R^2$ , much higher than the best practice threshold.

ZX lidars  $R^2$  performance improved notably with the latest type/firmware release.



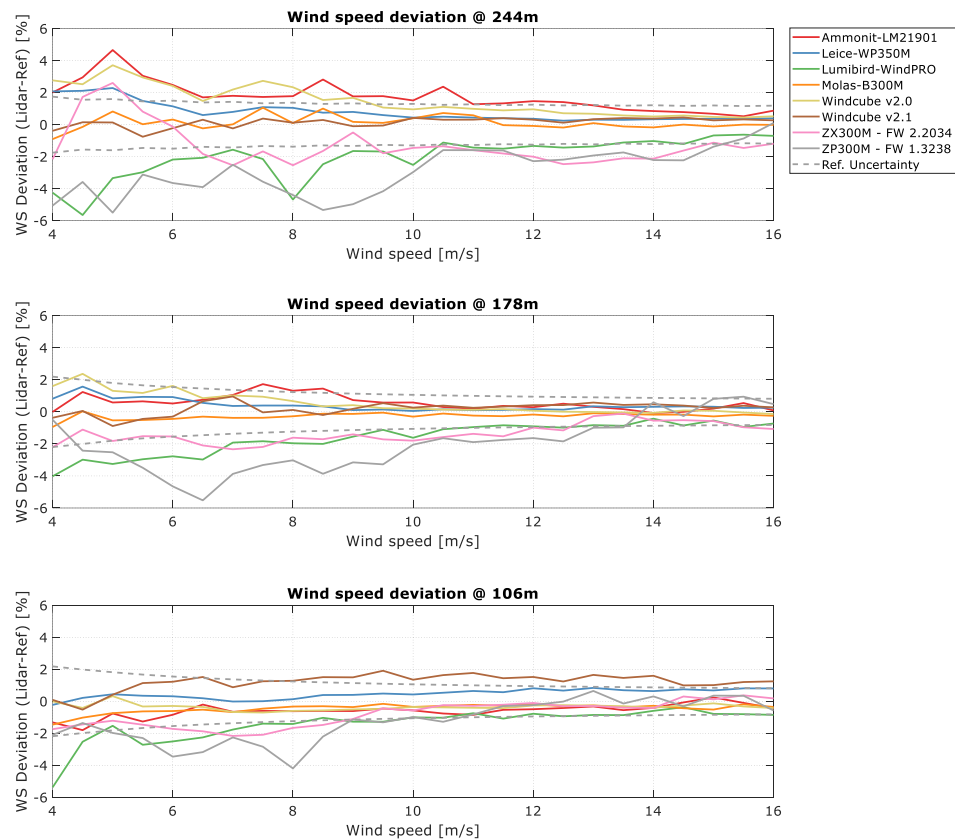
# Binned wind speed deviation



Most lidars showed pattern of larger absolute deviation with increasing height – specially for lower wind speeds.

Most lidars demonstrated binned wind speed deviation within the reference uncertainty for most bins up to 178 m

Leice-WP350M, Molas-B300M, Windcube v2.1 and ZX300M kept consistent performance within most reference uncertainty bins at 244 m.





# Conclusions

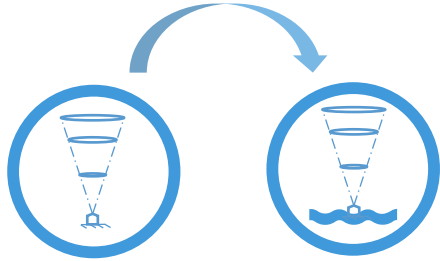
**Lidar performance** is a multifaceted term that entails a non-trivial relationship between data availability and accuracy driven by firmware, hardware and atmospheric condition.

**Data availability** seems to be an issue for most lidars even above 150 m. Although other performance metrics were mostly not impaired.

New versions of Windcube and ZX **improved** their product performance. New entrants to the lidar market showed **matured** performance.



# Outlook



We want to assess the applicability of the conclusions of this trial to an offshore environment.



We're keen in supporting innovation in the wind lidar technology aimed at

1. increased data availability,
2. increased overall lidar performance at heights exceeding 200 m,
3. reduction of verification uncertainty,
4. turbulence measurements.



We want to understand the mechanics and implications of lidar performance variation driven by different firmware / QC filtering threshold.

# Thank you

## Contacts

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