

# Meteorological conditions at FINO1 in the vicinity of alpha ventus

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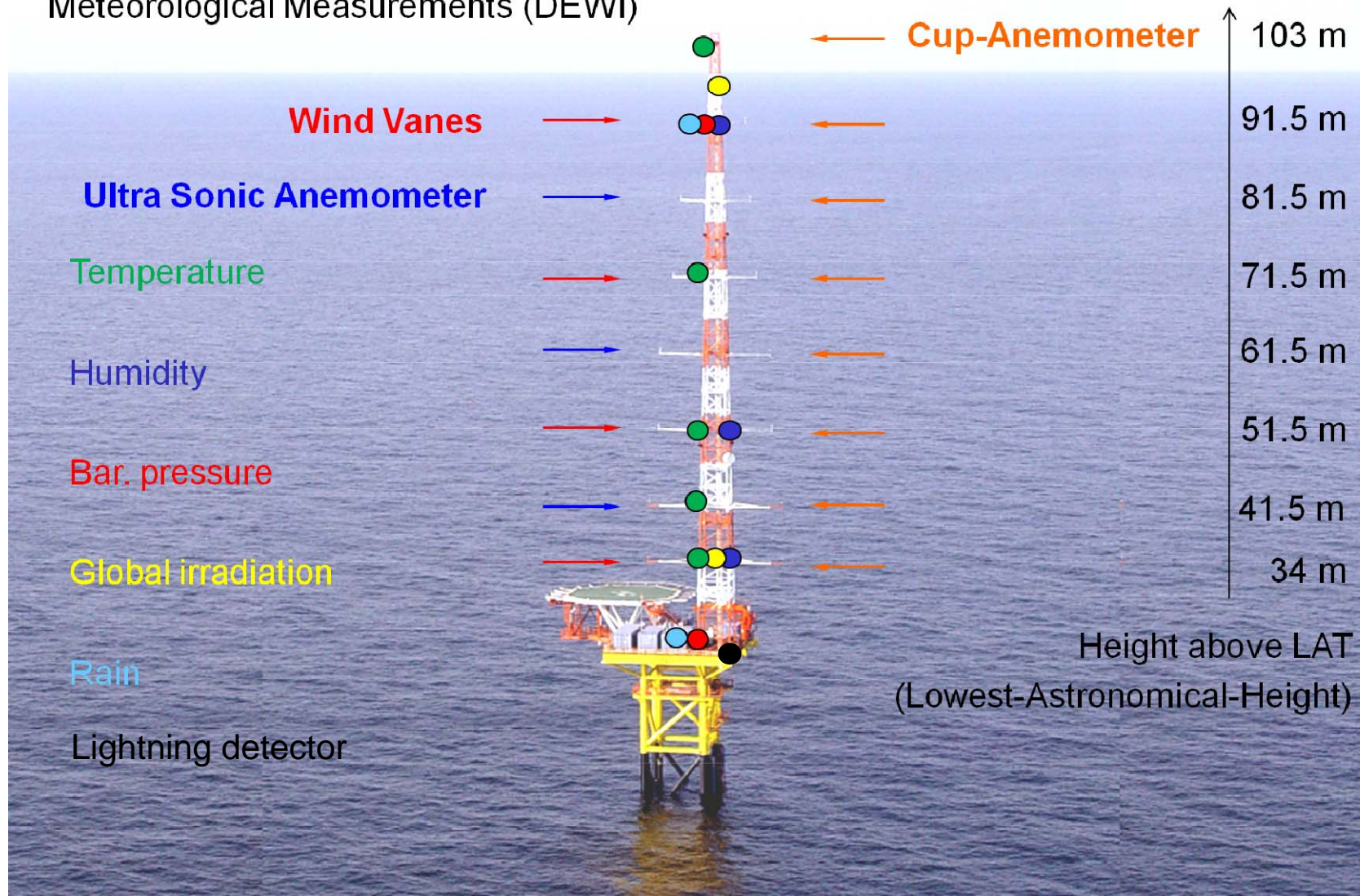
- Measurement system at FINO1 – Meteorological long term measurements
- Latest statistics
- Further measurements and results
  - LiDAR–measurements
  - FINO1 and alpha ventus
  - Park correction
  - Planned measurements
- Summary

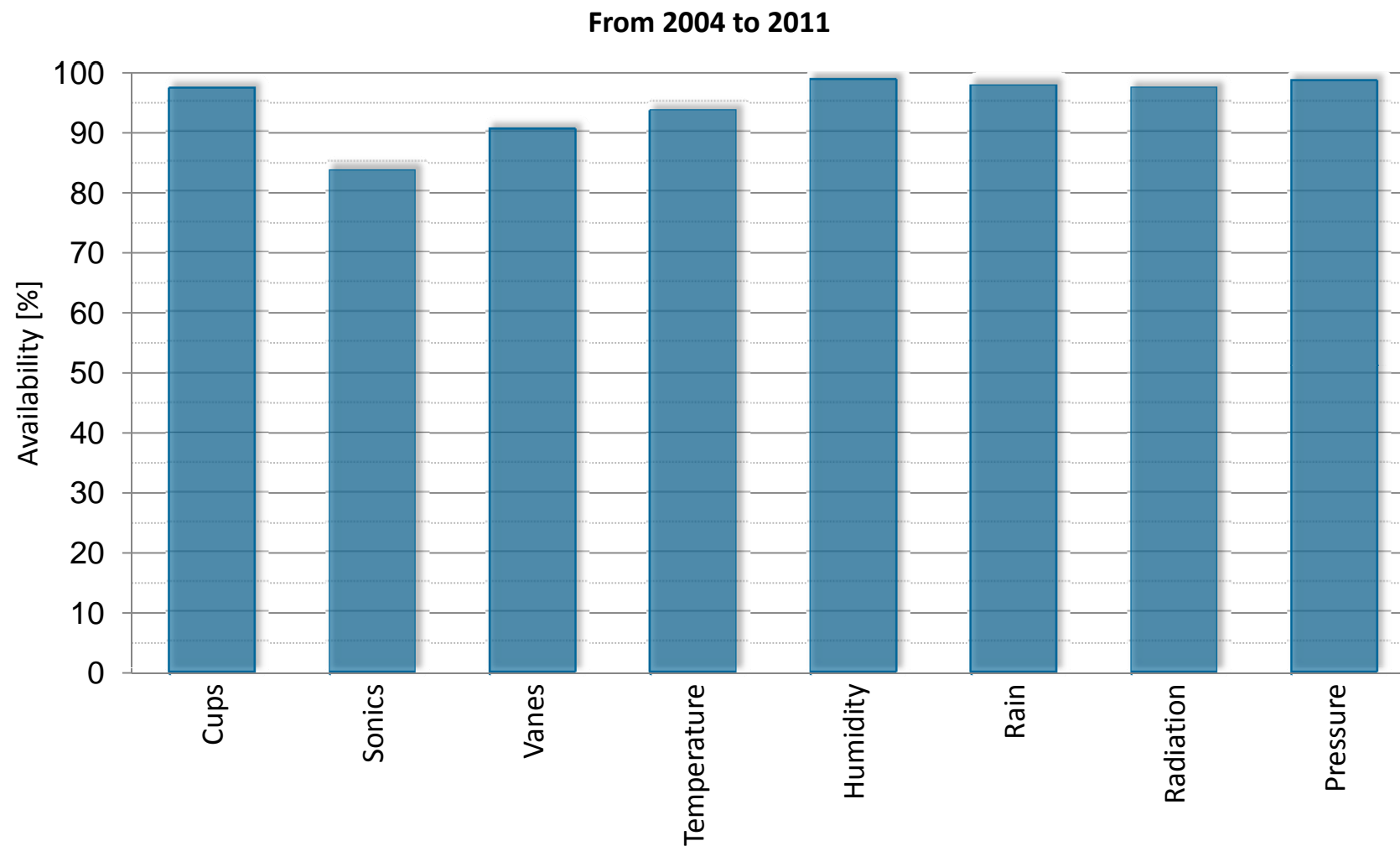


## ▸ Meteorological longterm measurements

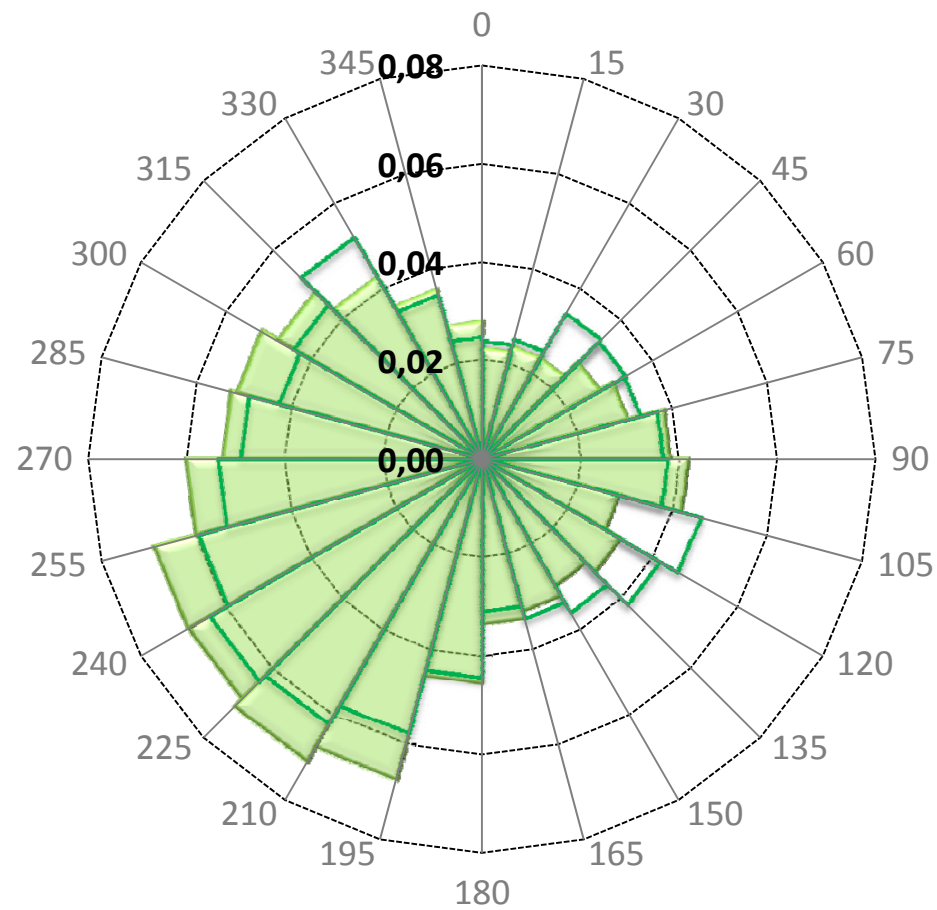
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### Meteorological Measurements (DEWI)



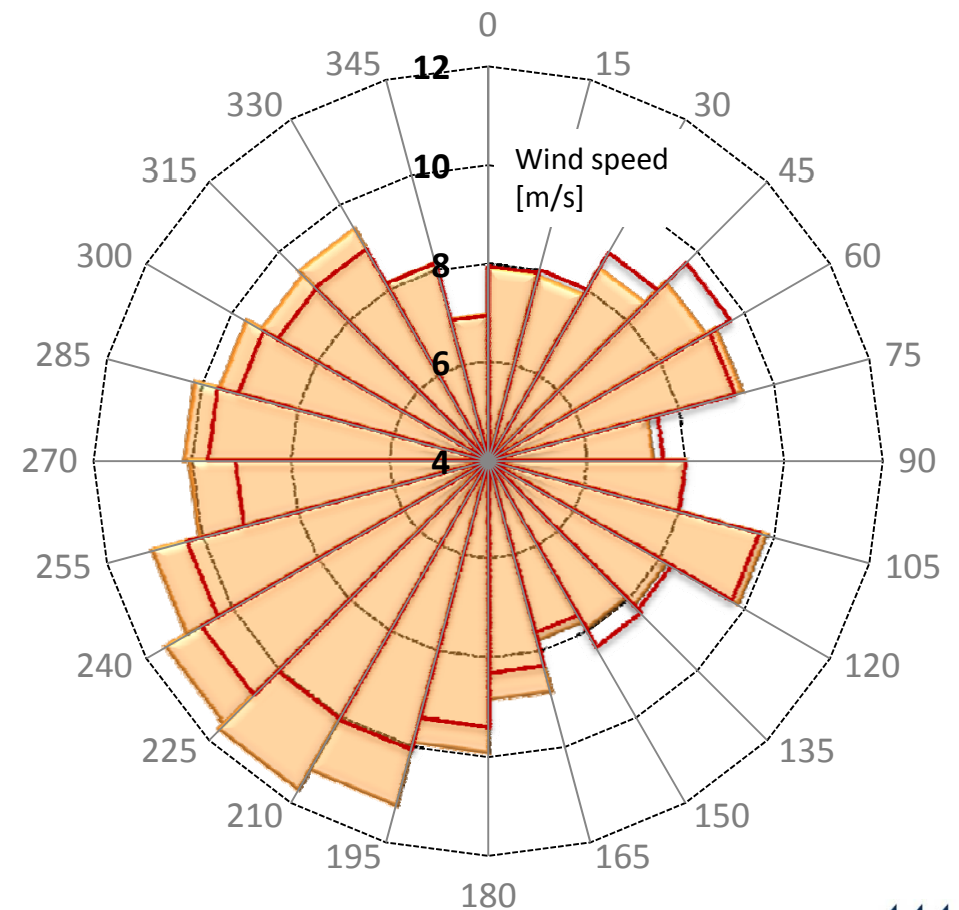


Frequency of wind direction at 91.5 m LAT



■ 2004 - 2009    ■ 2010 - 2011

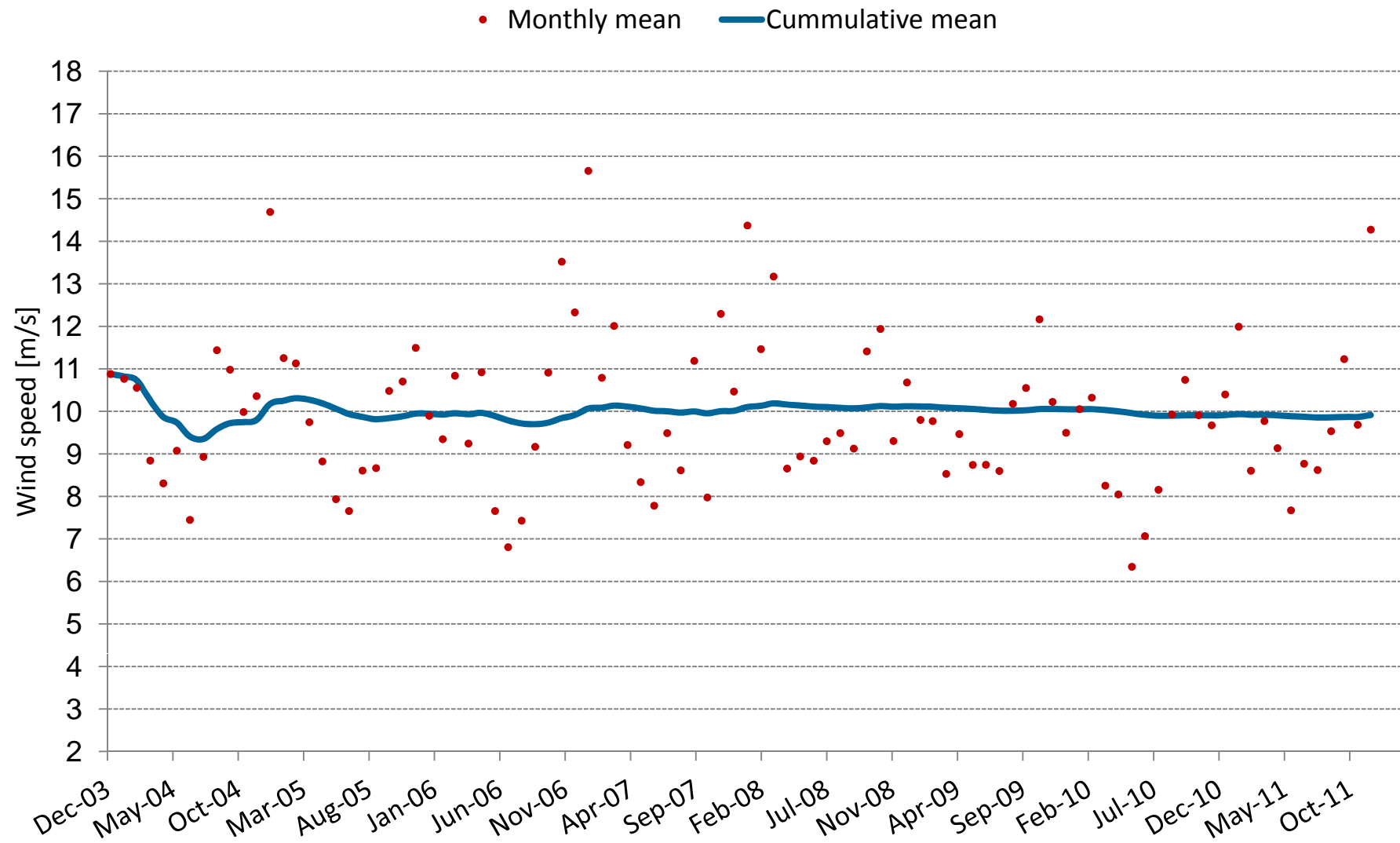
Directional dependency of wind speed at 103.0 m LAT



■ 2004 - 2009    ■ 2010 - 2011

## ▸ Development of mean wind speed at 103.0 m LAT

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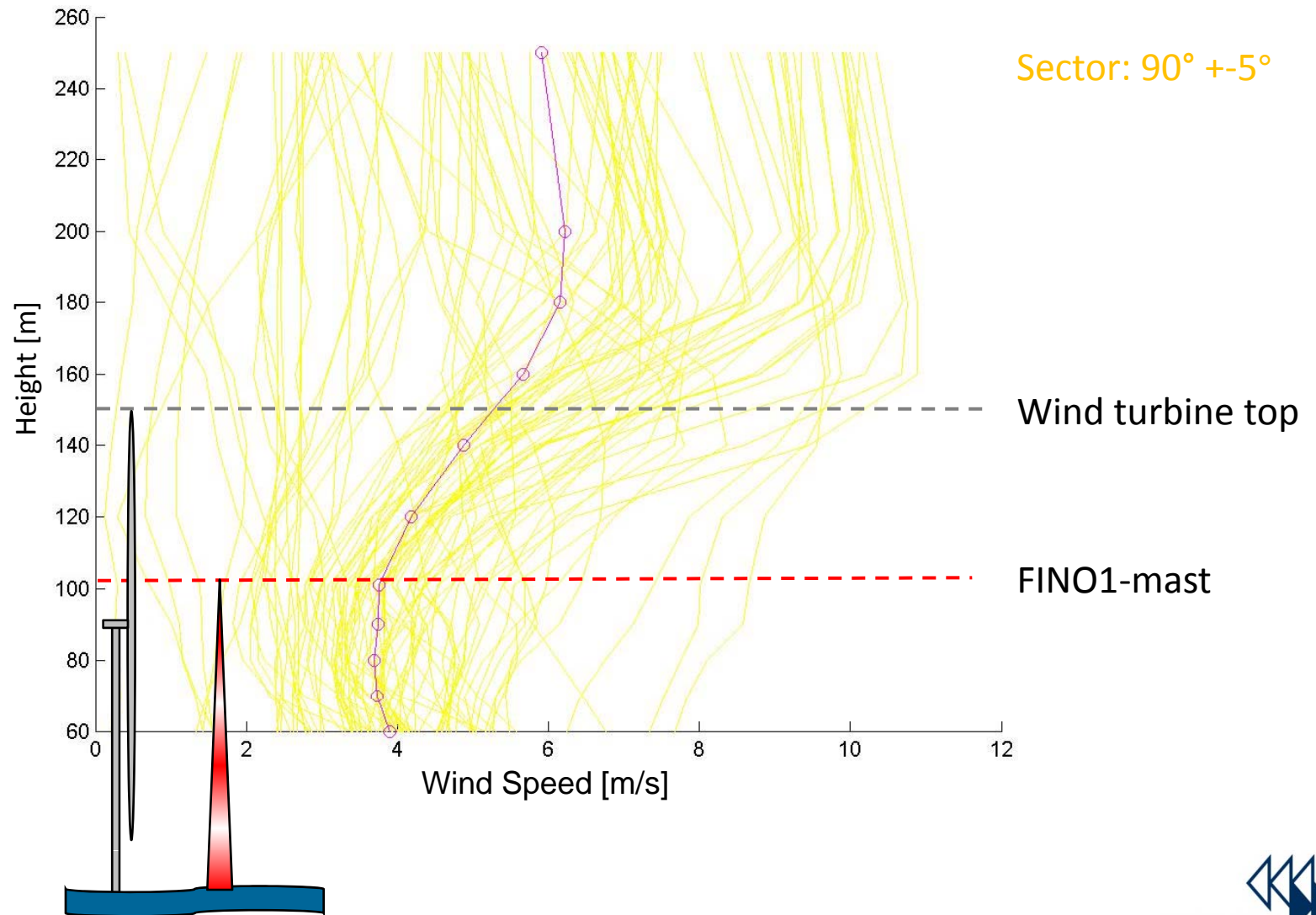




## Wake of alpha ventus (LiDAR)

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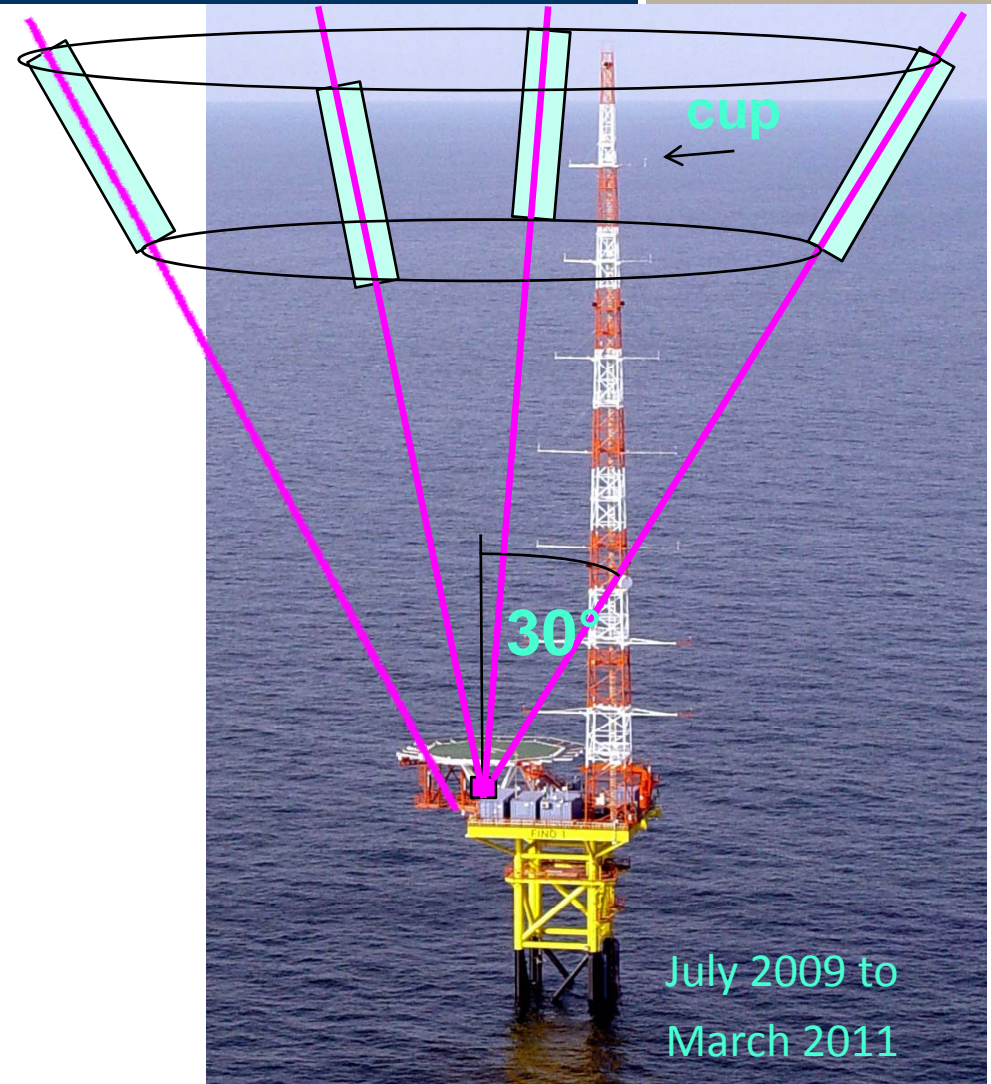
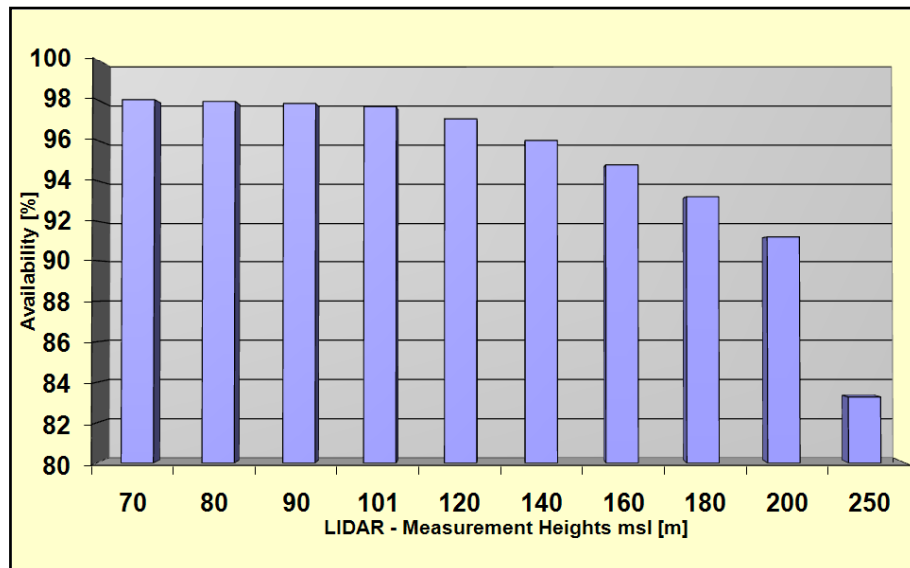
Vertical wind profiles measured with LiDAR in the wake of a wind turbine.



## LiDAR-measurement

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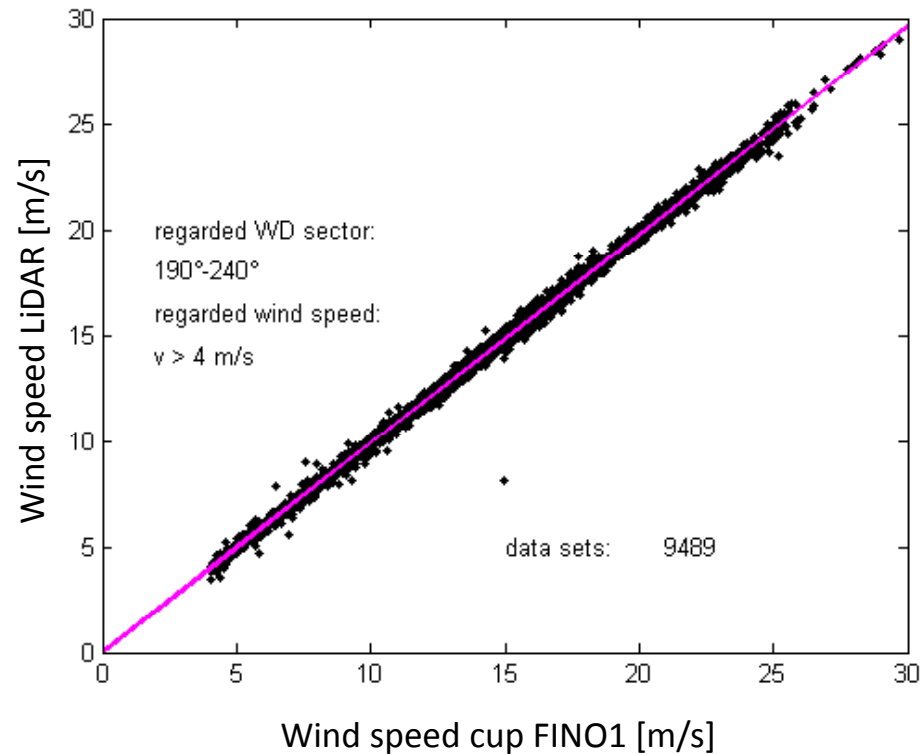
- Leosphere Windcube (pulsed LiDAR with beam in 4 direction)
- 10 heights from 70 m to 250 m
- Measurement in a volume of air
- Highest availability at 70 m: 98% (10-min averages) during 1 year period



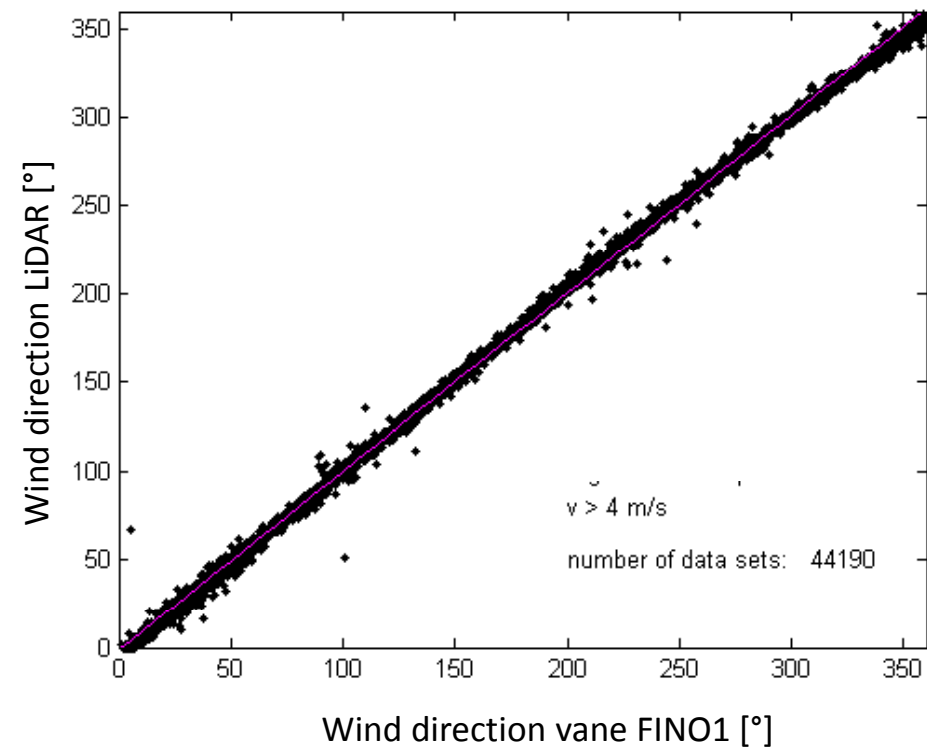


## ▸ Comparison LiDAR – FINO1-mast at 91.5 m LAT

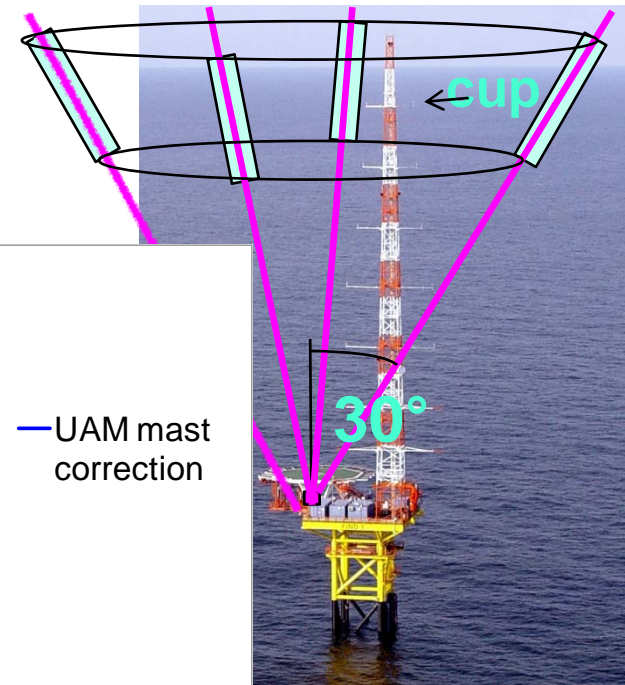
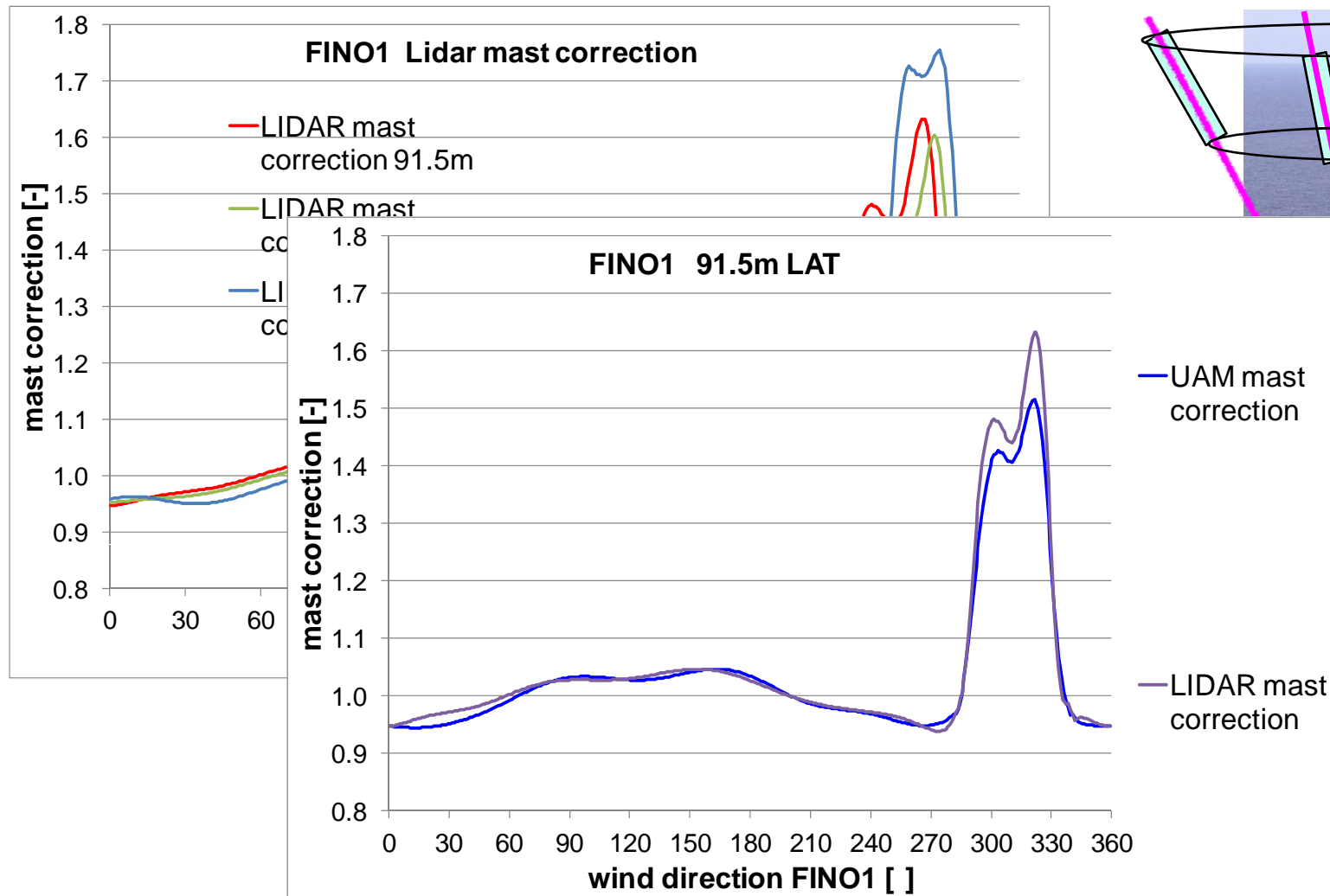
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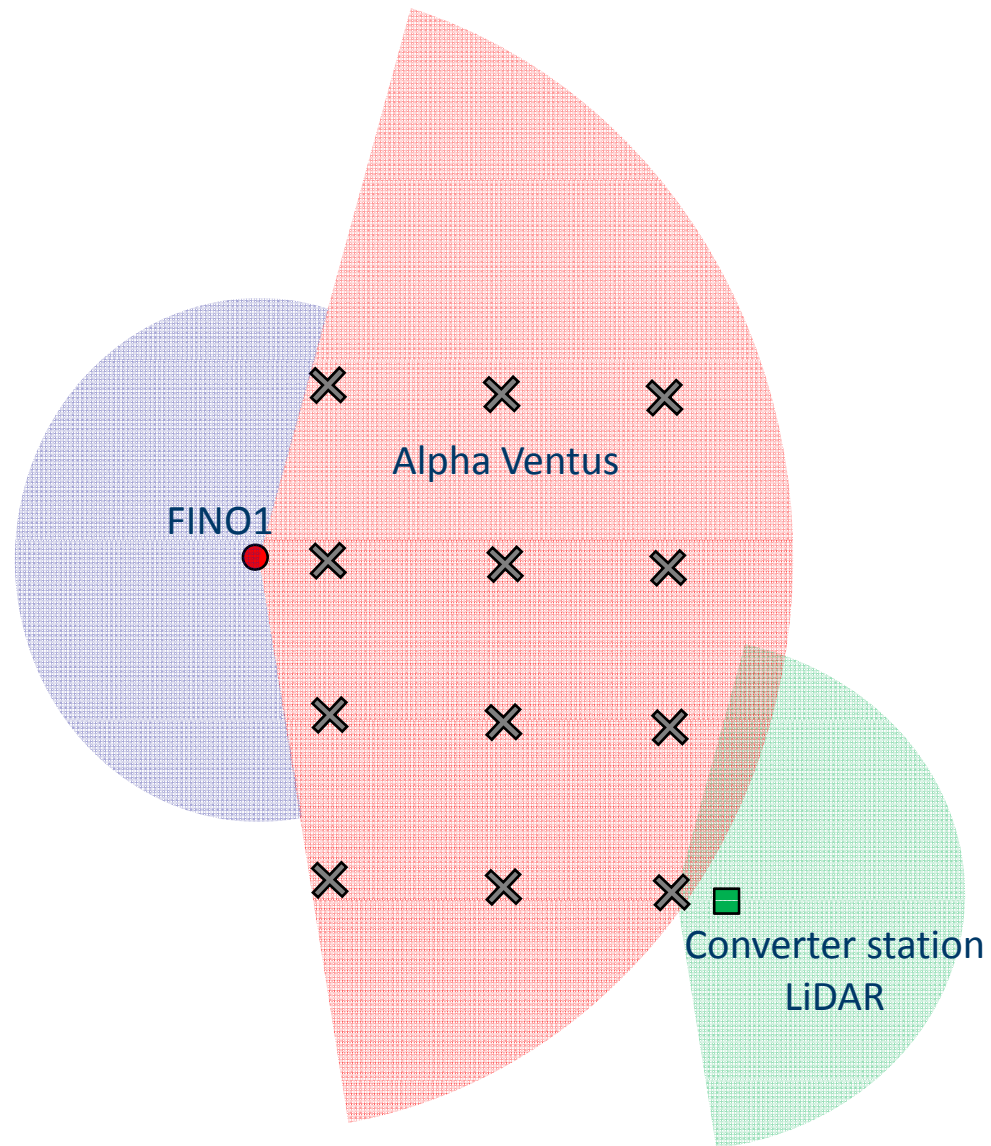


Slope:  $m = 0.988$   
Corr coef:  $R^2 = 0.998$



Corr coef:  $R^2 = 0.999$





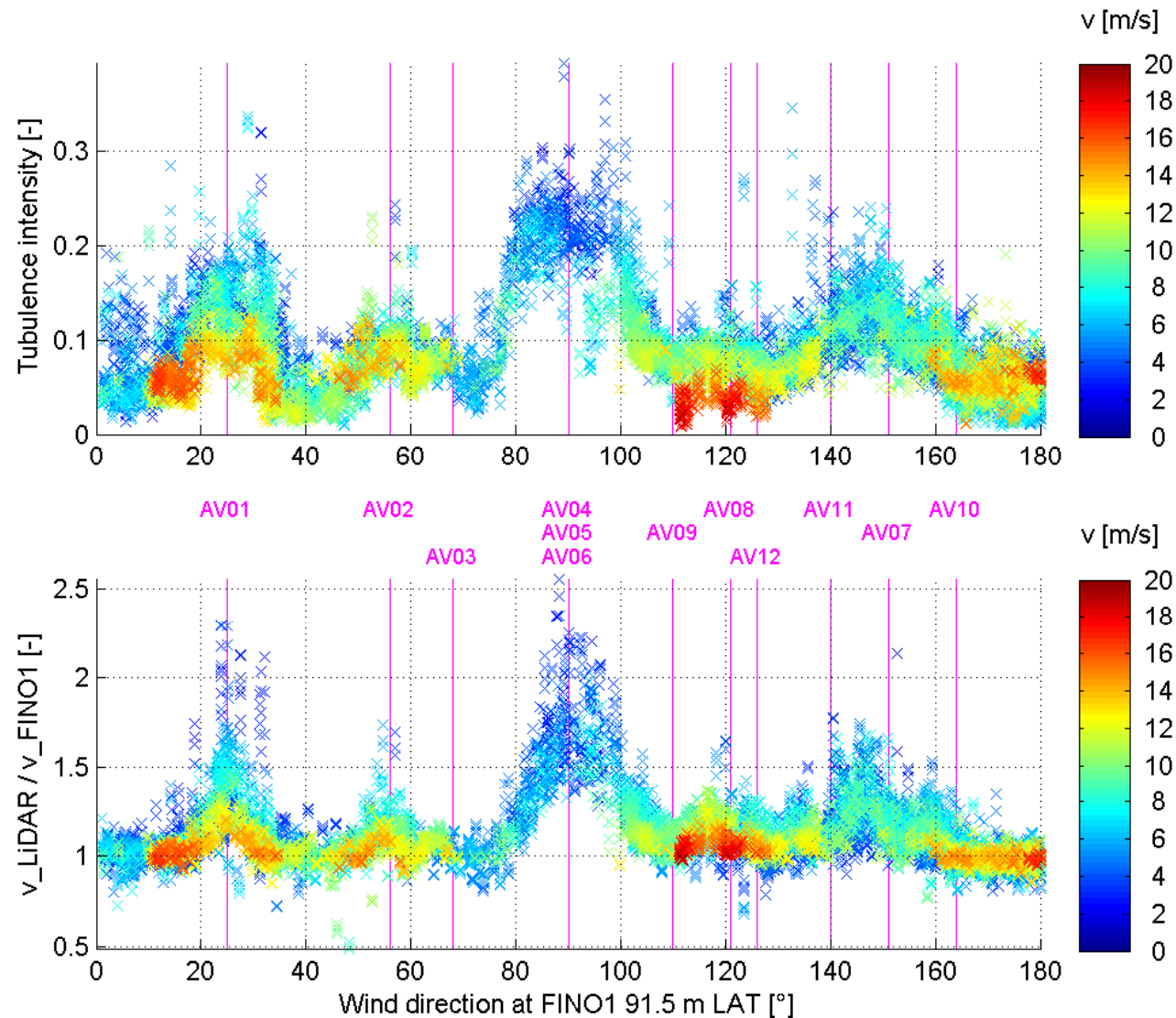
Free flow from West with FINO1

Wind measurements  
influenced by alpha ventus

Free flow from East with LiDAR

## ▸ Turbulence intensity and wind speed reduction

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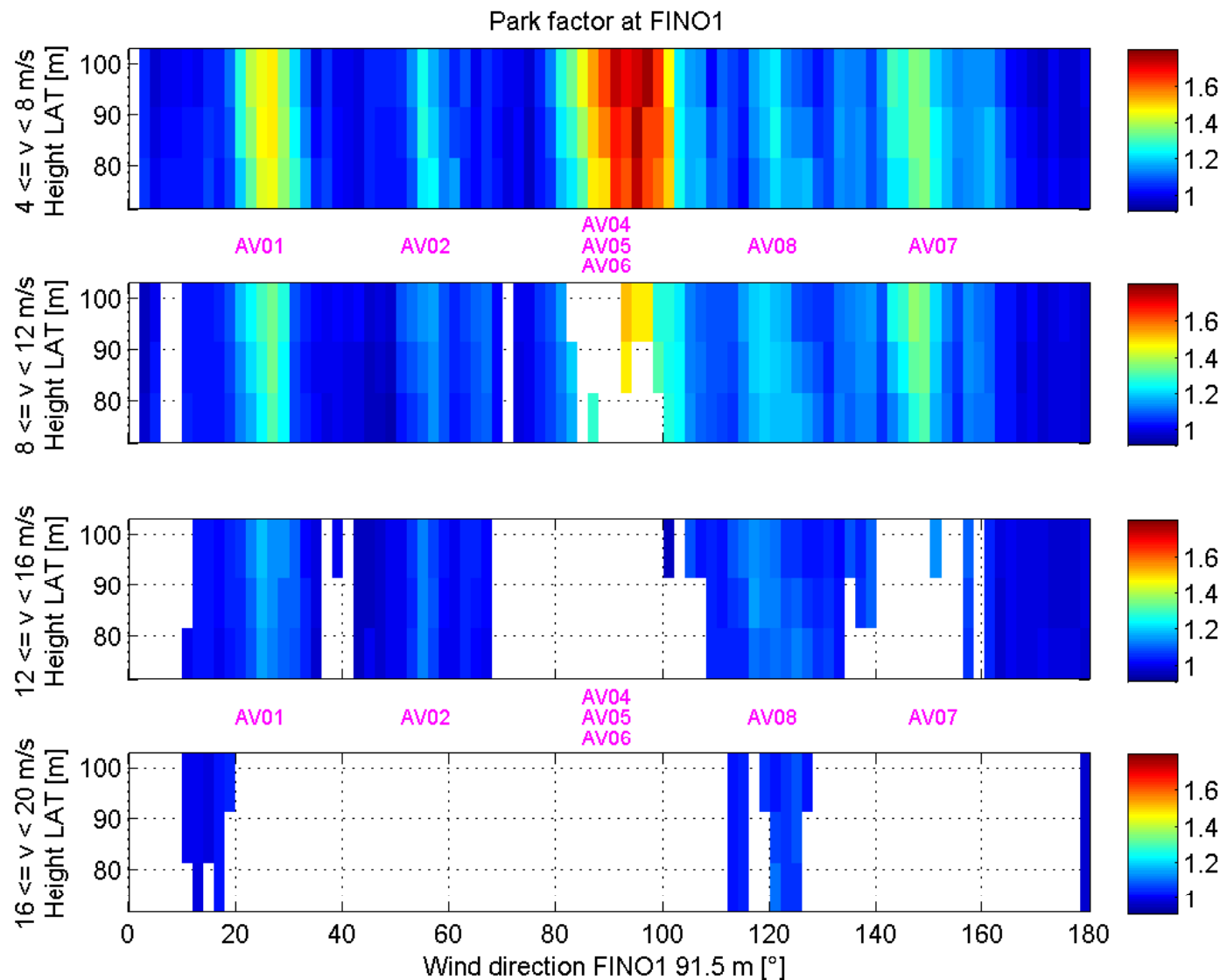


Influence of alpha ventus becomes obvious in turbulence intensity. Local maxima are related to wind turbines. The ratio of free and disturbed wind speed shows a similar pattern.



## ▸ Park factor at FINO1

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Park factor depending on wind direction for different heights and wind speeds.

- Turbulent heat fluxes – Eddy Covariance
  - Precise investigation of atmospheric stability
  - Open-path infrared-hygrometers (Licor) combined with Ultrasonic-Anemometer
  - Installation running
- LiDAR – permanent measurement (heights > 100 m)
  - Wind field above 100 m
  - Over long time
- Ceilometer
  - Measurement of cloud base height

- FINO1-measurements are successful
  - for 8 years
  - with good availability
  - mean wind speed 10 m/s, mean wind direction south west
- LiDAR gives opportunity
  - to derive mast correction
  - for measurement heights above hub height and FINO1-mast
  - for free wind measurements 360 ° around alpha ventus
- Alpha ventus
  - Turbulence intensity increase
  - Wind speed reduction
  - Park correction is derived from combined FINO1 and LiDAR measurements

# Thank you for your attention!

The FINO1 platform is one of three offshore platforms of the FINO Project. The LiDAR measurements were performed within the research project FINO and RAVE. Both projects are funded by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU).

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