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Verifying dual scanning lidar performance under representative offshore conditions

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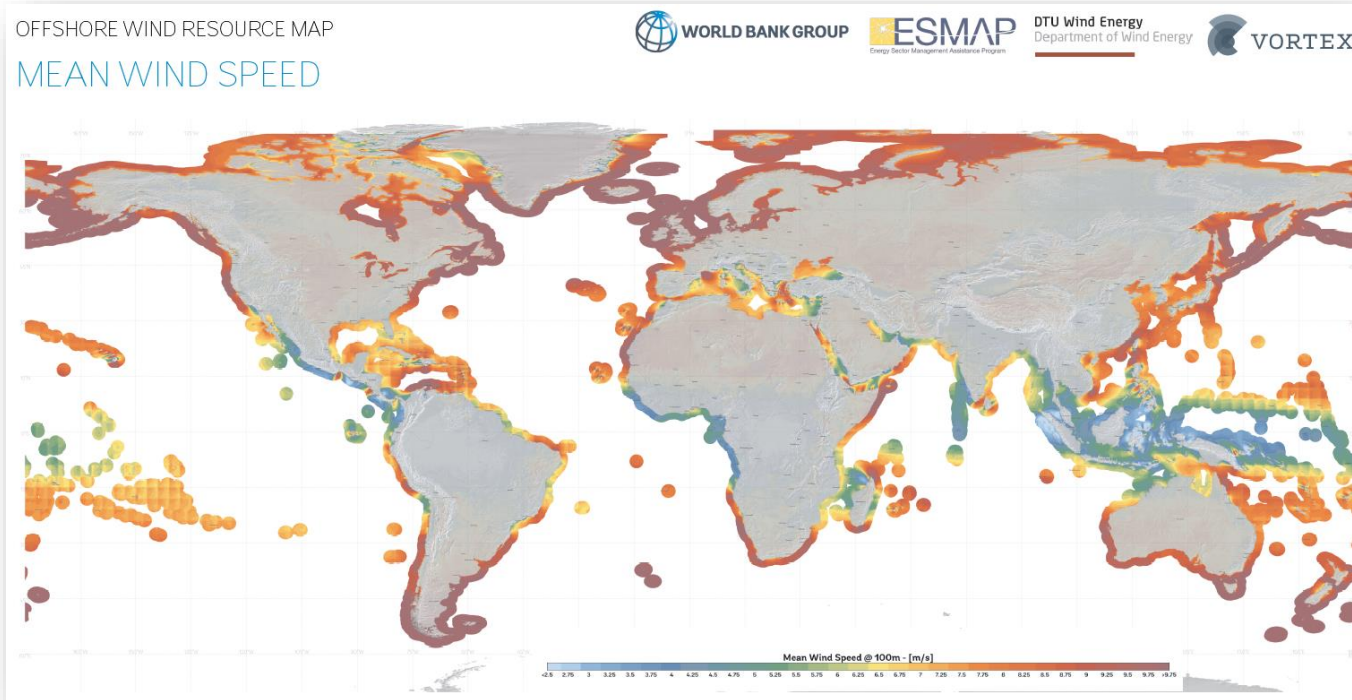
Outline

.. of this presentation

- Introduction / Motivation
- Setup of NEMO measurement campaign
- Overview of collected data
- Evaluation of Dual Scanning Lidar (DSL) performance
- Instrument performance during storm FLORIS
- Conclusions / Outlook

Introduction / Motivation

Measuring and validating offshore wind conditions



[Global Wind Atlas](#)

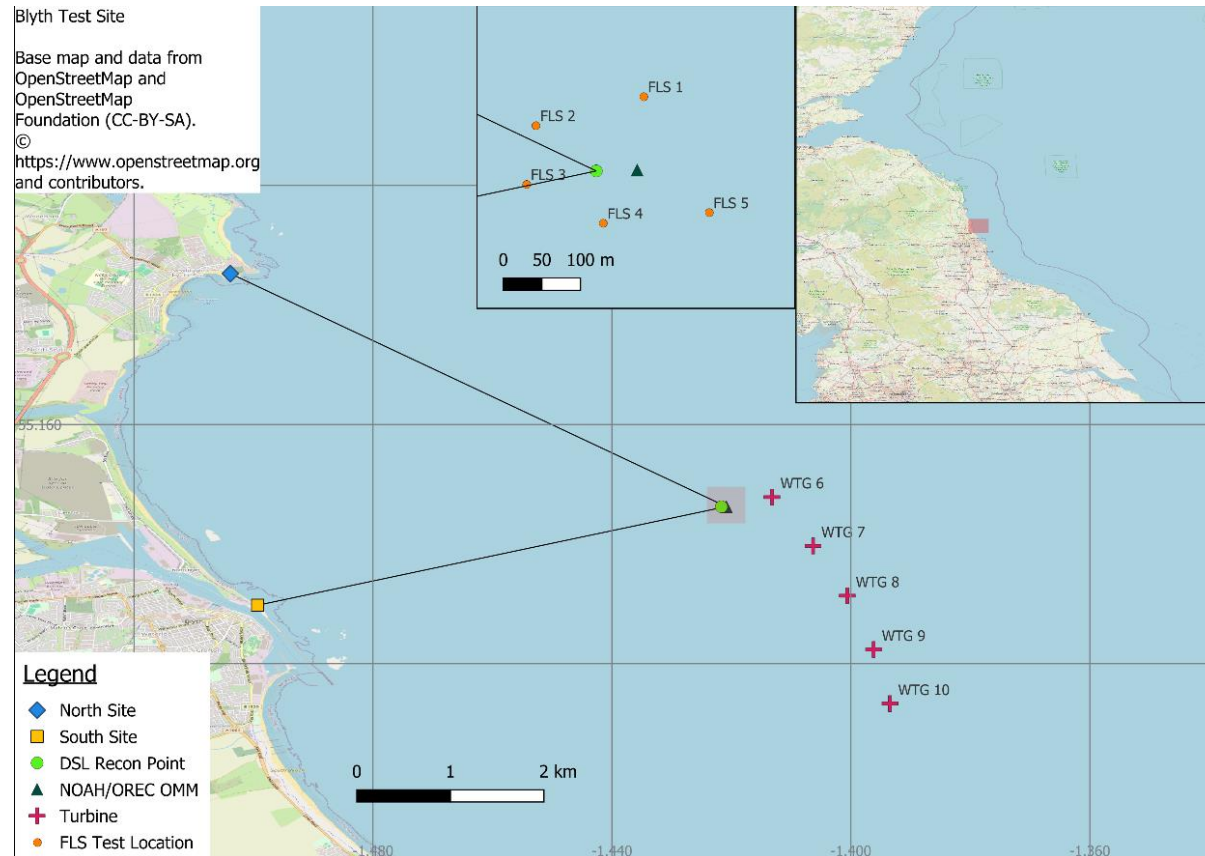


- Floating (top) versus scanning (bottom) lidar ... considering distance to shore, water depth, data availability and accuracy (?)



Setup of NEMO* measurement campaign

Dual Scanning Lidar (DSL)



Scanning lidar in pairs as Dual-Scanning Lidar (DSL) at C-Test (Centre for the Testing of Environmental Sciences Technology), pointing at NOAA

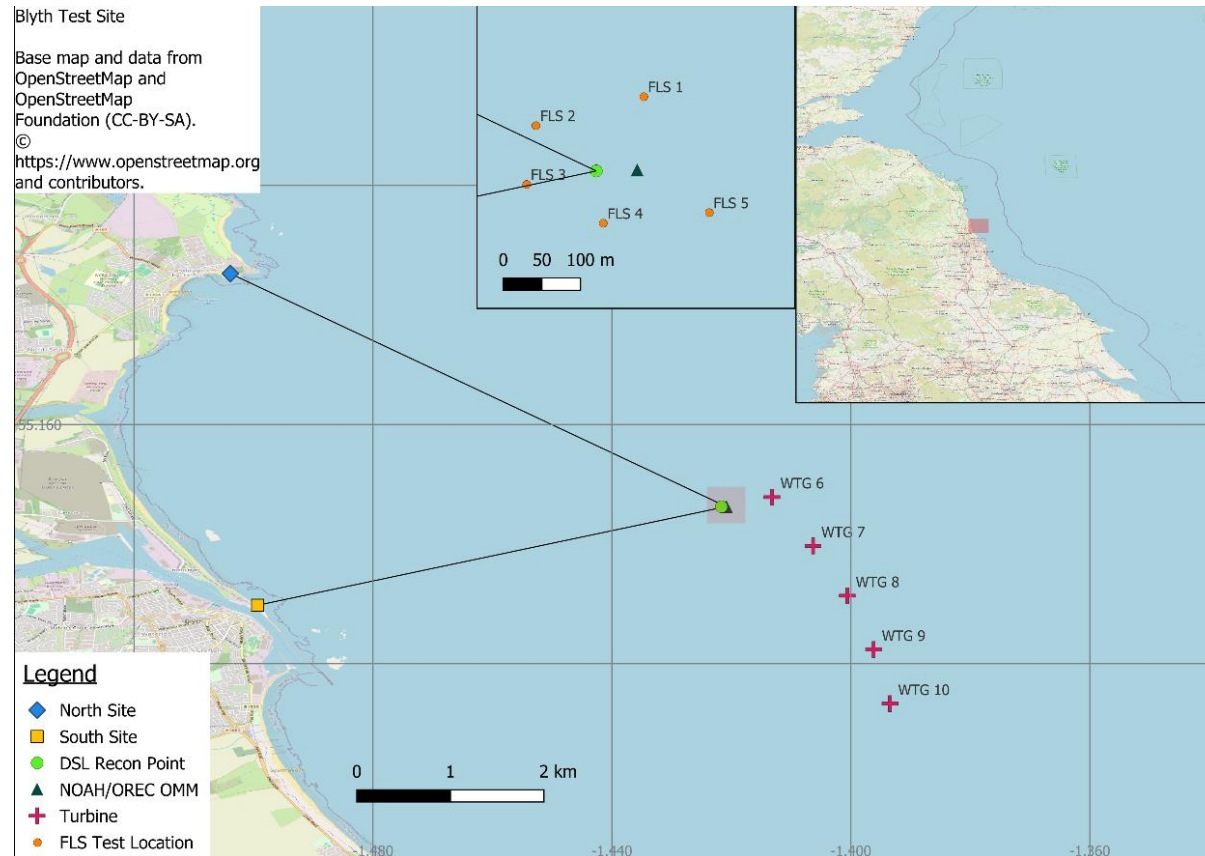
3 Windcube Scan (400S) devices →

- North site: Galerne (#1071), Audra (#319)
- South site: Marin (#1072)



Setup of NEMO measurement campaign

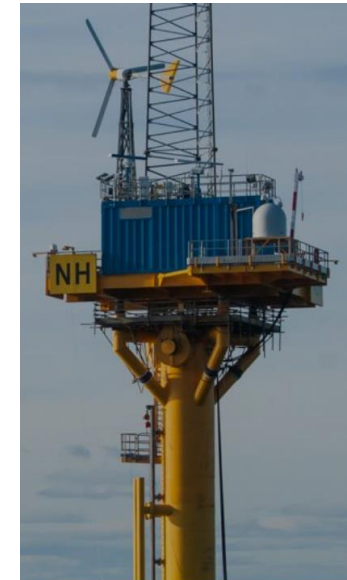
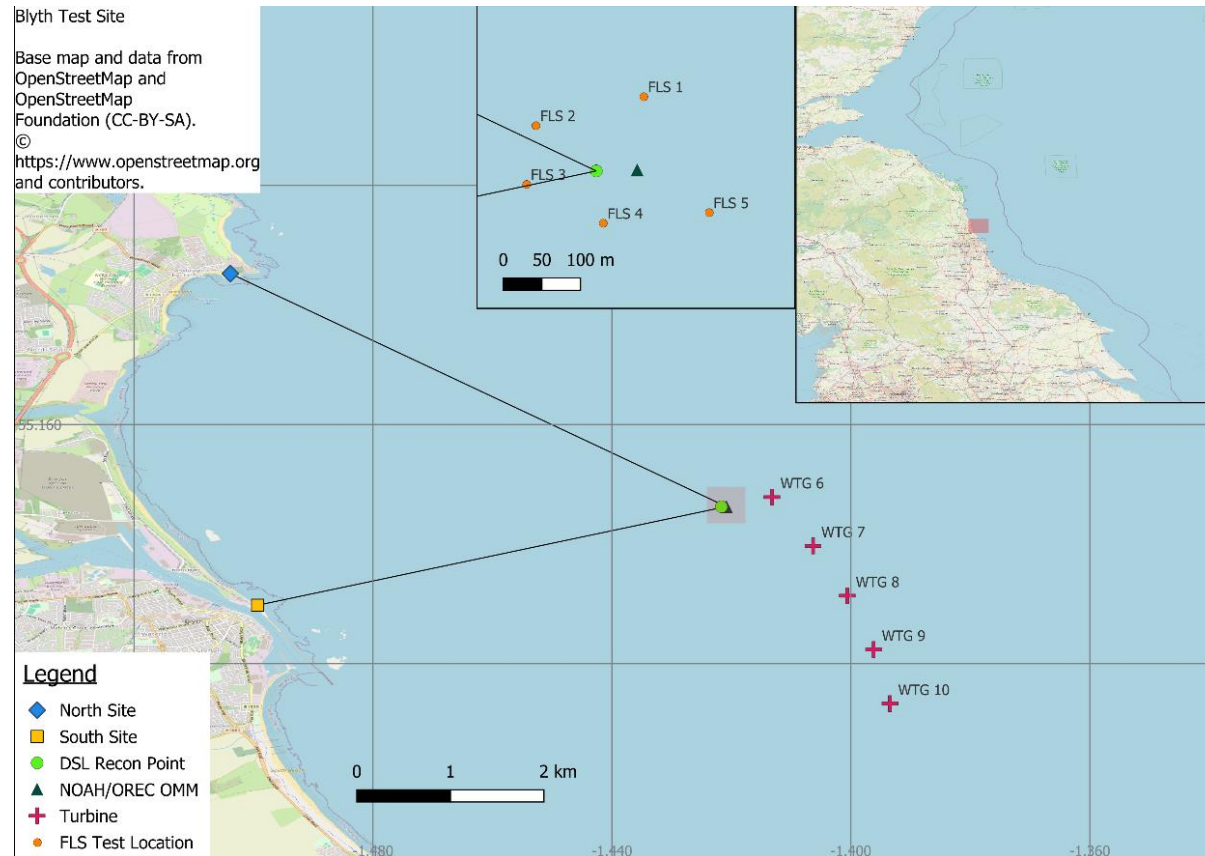
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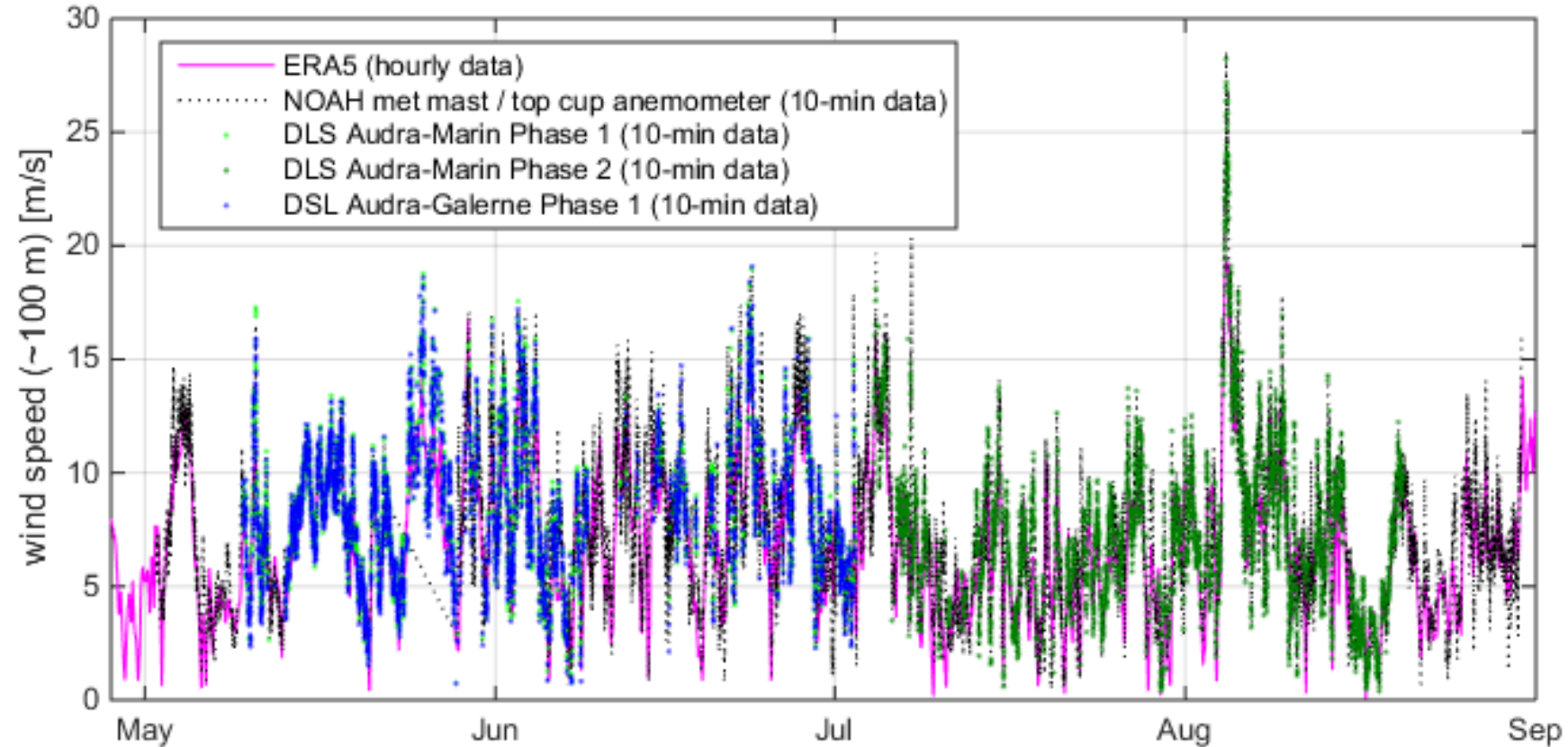
Setup of NEMO measurement campaign

Reference instrumentation at NOAH met mast incl. two Vertical Profiling Lidars (VPL)



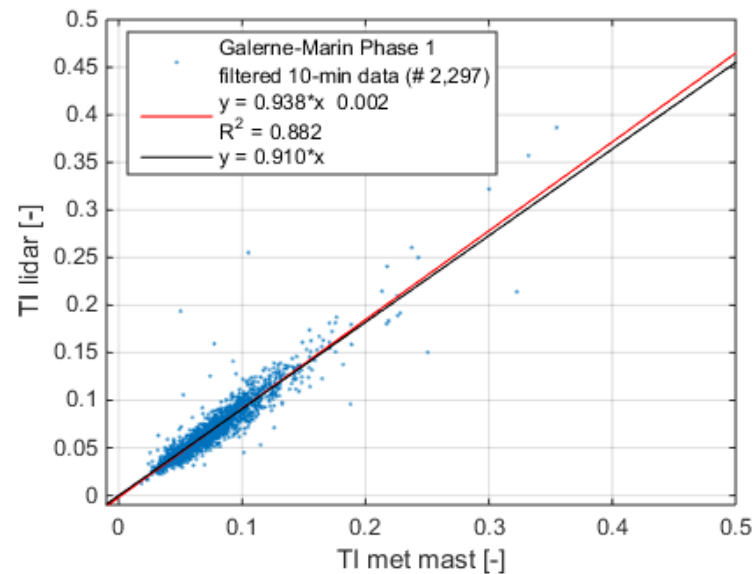
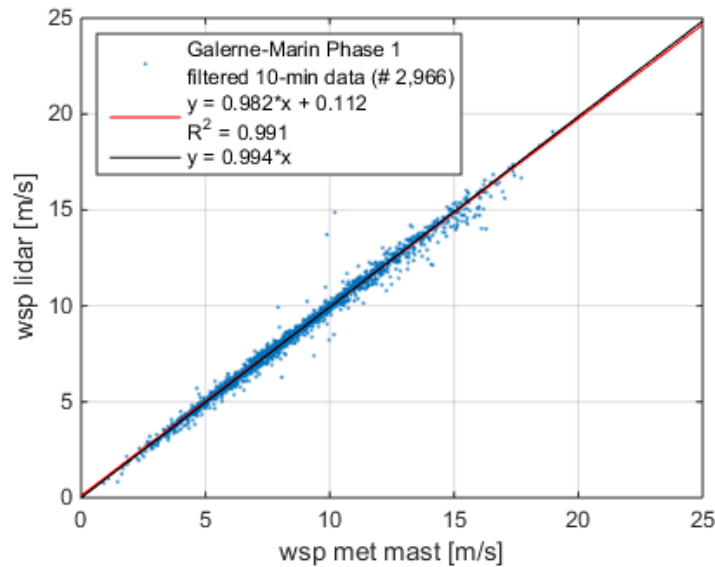
NOAH (National Offshore Anemometry Hub) met mast / test site with two fixed lidars on platform

Overview of collected data



Evaluation of DSL performance (I)

Pair #1, Phase 1

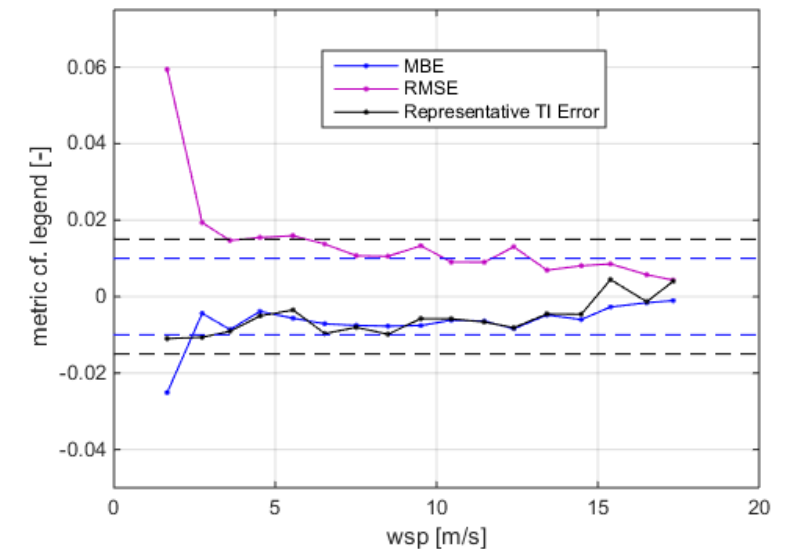


- Very good accuracy performance for both horizontal **wind speed (wsp)** and **turbulence intensity (TI)**

$$MBE_i = \frac{1}{N_i} \sum_{n=1}^{N_i} TI_{n,i} - TI_{ref,n,i}$$

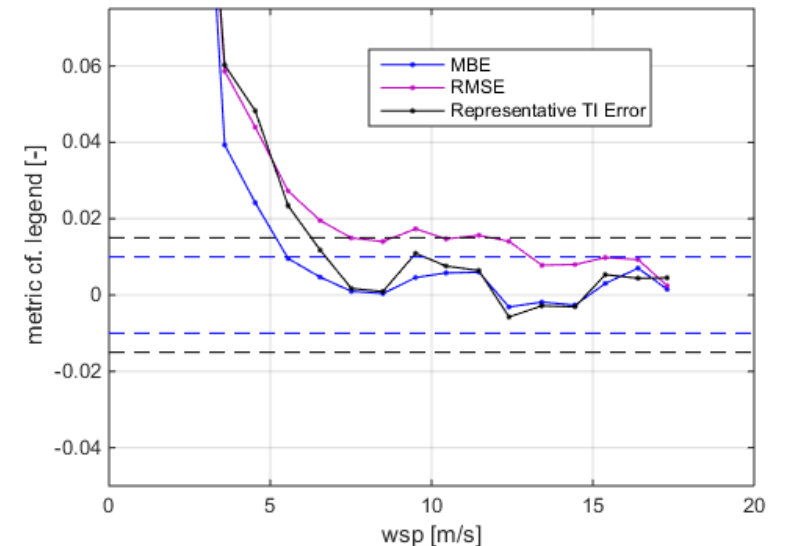
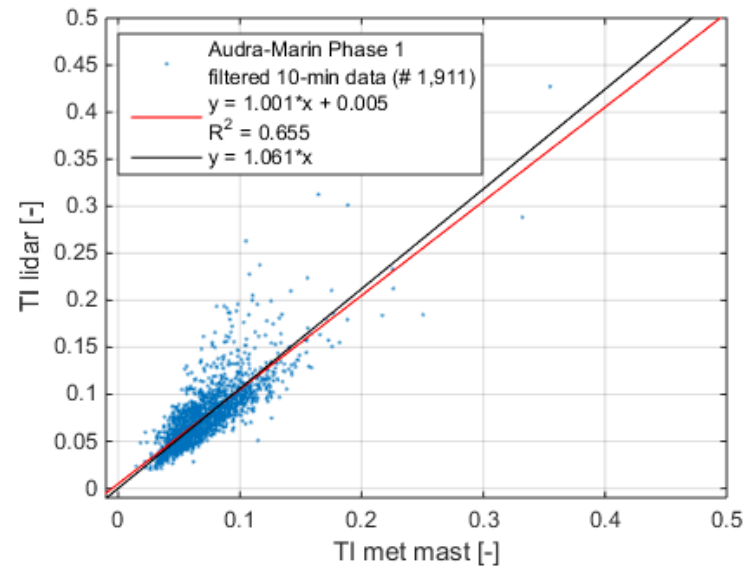
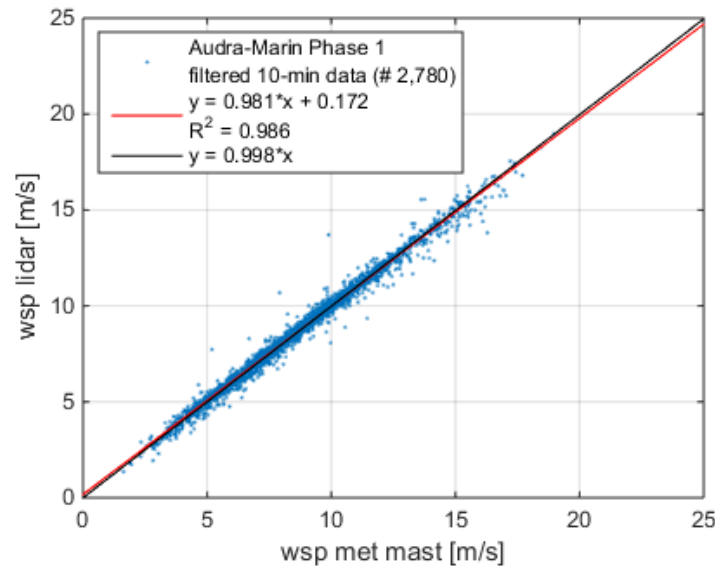
$$RMSE_i = \sqrt{\frac{1}{N_i} (TI_{n,i} - TI_{ref,n,i})^2}$$

$$Representative TI_i = TI_{avg,i} + 1.28 \cdot TI_{std,i}$$



Evaluation of DSL performance (II)

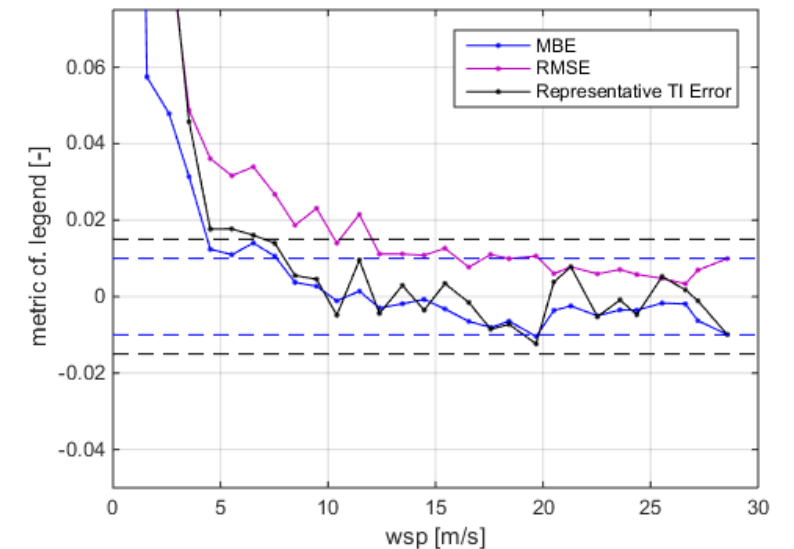
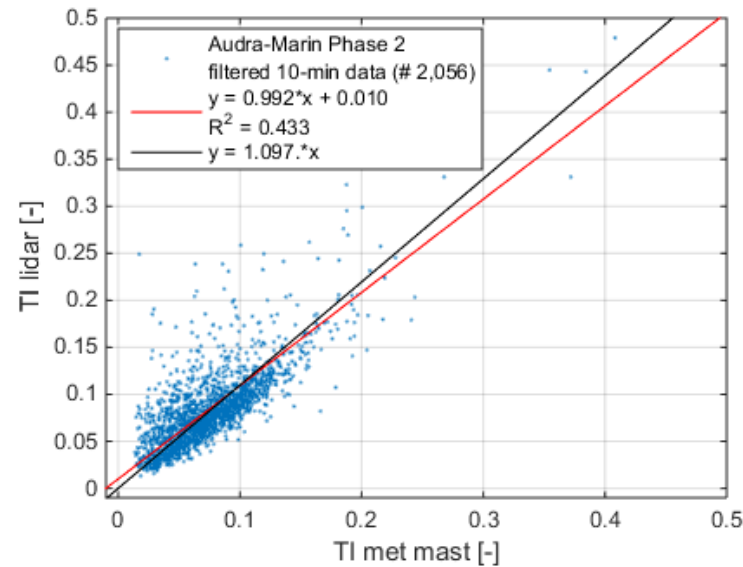
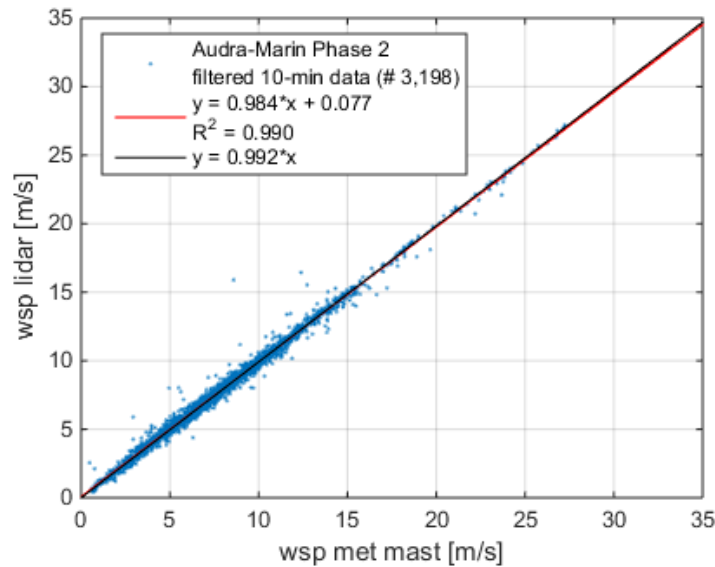
Pair #2, Phase 1



- Very good accuracy performance for both horizontal wind speed (wsp) and turbulence intensity (TI)
- Some dependency on **technology generation** (Audra versus Galerne/Marin)

Evaluation of DSL performance (III)

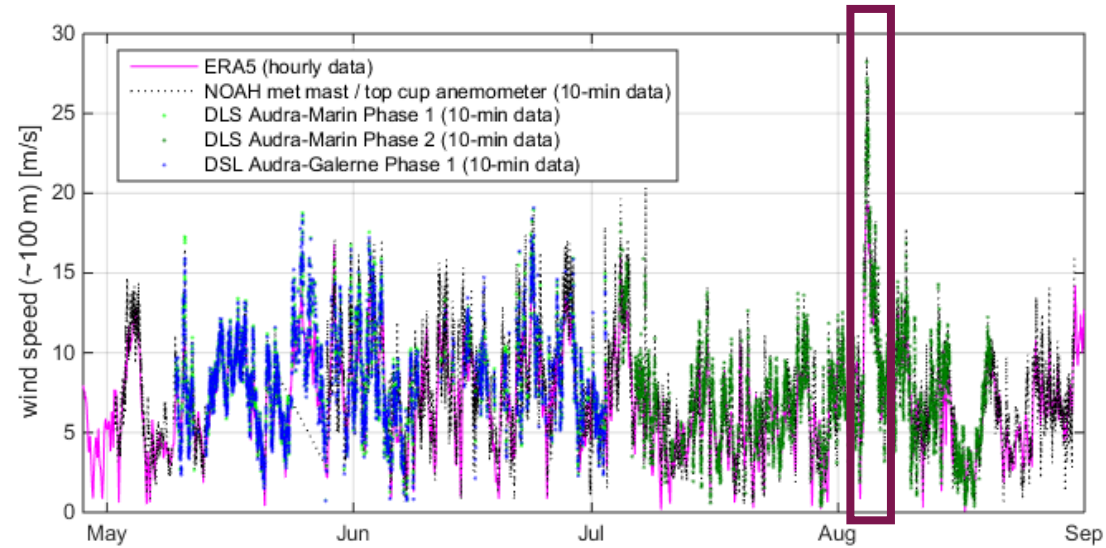
Pair #2, Phase 2



- Very good accuracy performance for both horizontal wind speed (wsp) and turbulence intensity (TI)
- Some dependency on technology generation (Audra versus Galerne/Marin)
- Even **high wind speeds** reproduced very well.

Instrument performance during storm FLORIS

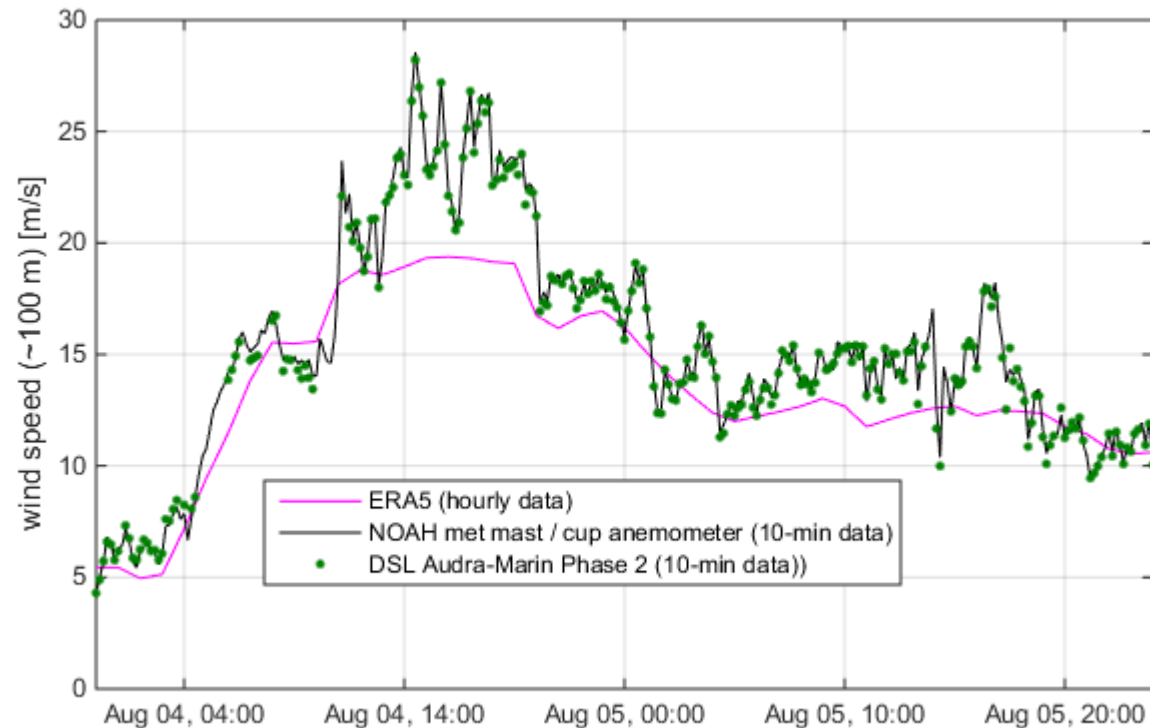
Early August 2025



[storm FLORIS early August 2025]

Instrument performance during storm FLORIS

DSL (Pair #2, Phase 2) – Early August 2025

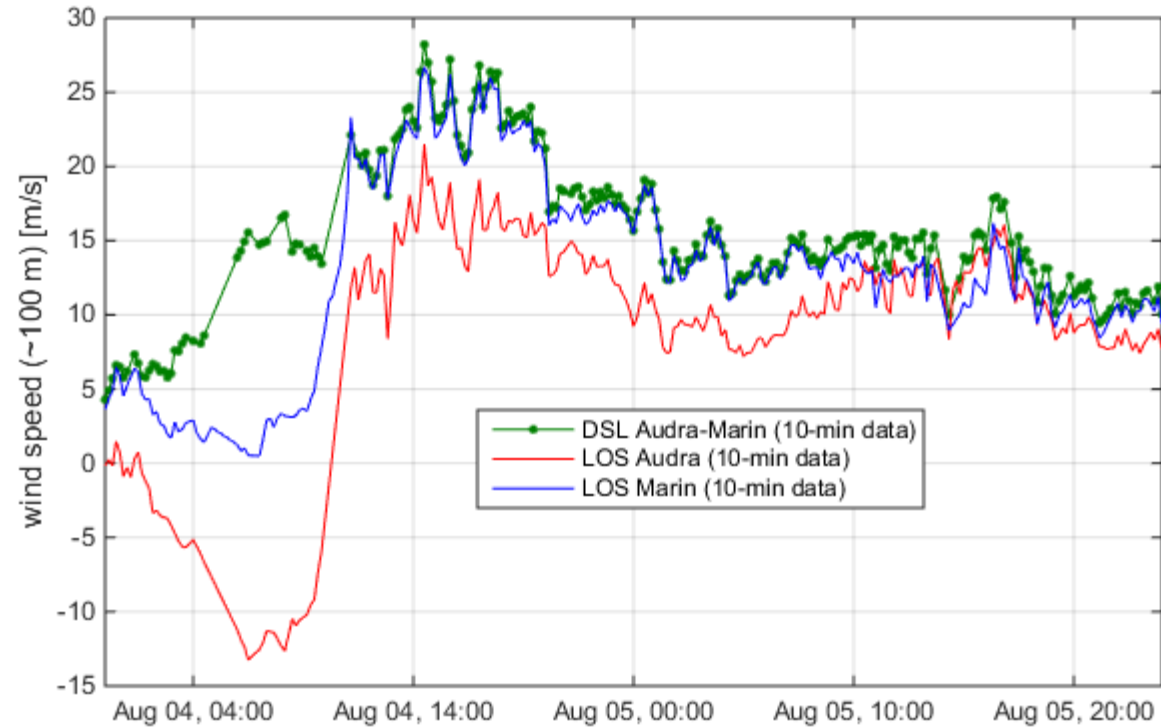


Measured maximum (extreme) wind speeds:

- ERA5 19.38 m/s
- NOAH 28.57 m/s
- **DSL 28.21 m/s**

Instrument performance during storm FLORIS

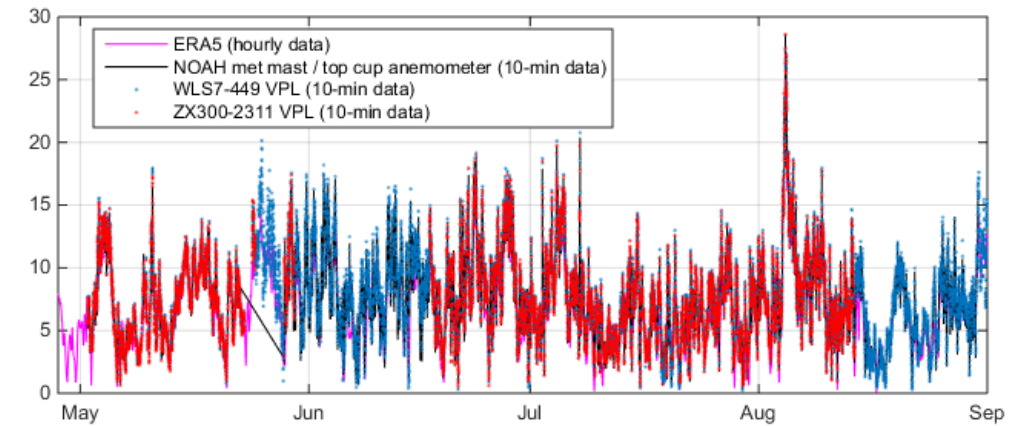
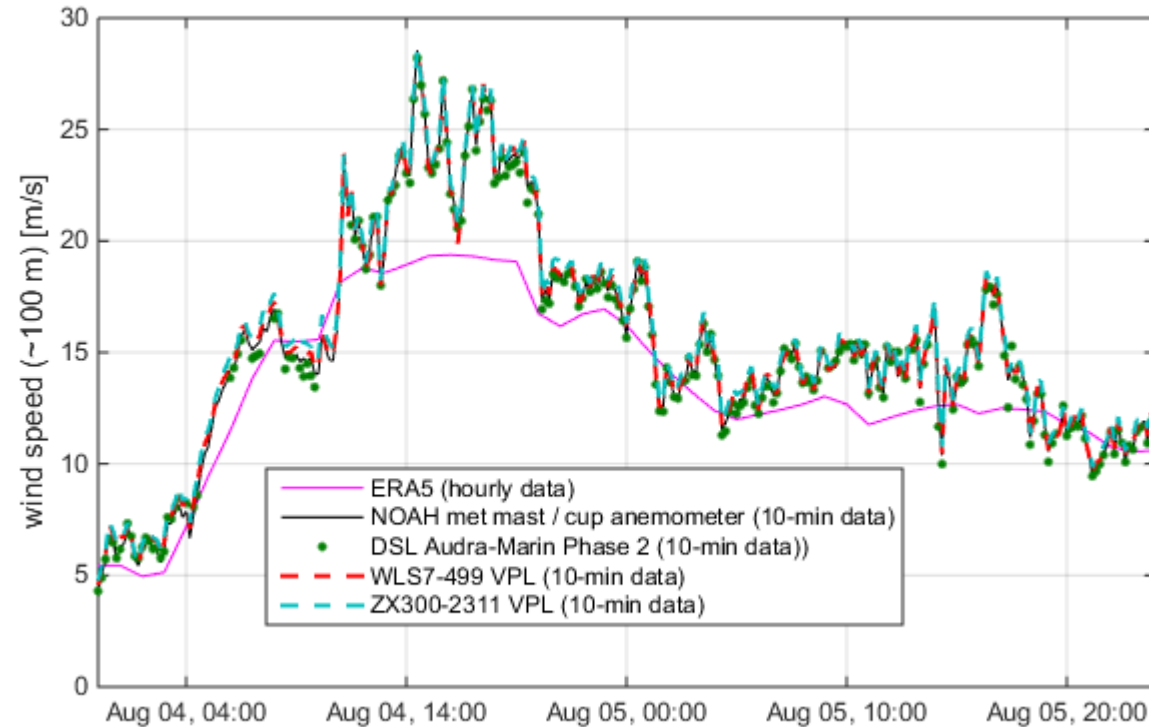
DSL (Pair #2, Phase 2) – Early August 2025



← Extreme wind speed is picked up by both LOS, showing direction alignment with South device (Marin)

Instrument performance during storm FLORIS

Two VPL at NOAH



Measured maximum (extreme) wind speeds:

- ERA5 19.38 m/s
- NOAH 28.57 m/s
- DSL 28.21 m/s
- **VPL #1 28.54 m/s**
- **VPL #2 28.60 m/s**

Conclusions / Outlook

Verifying dual scanning lidar performance under representative offshore conditions

- Two dual scanning lidar (DSL) pairs tested / verified over range of 6-7 km
- Very good performance for both horizontal wind speed and TI → indication for no bias correction required
- Even storm situation is reproduced well in terms of measured extreme wind speed

Conclusions / Outlook

Verifying dual scanning lidar performance under representative offshore conditions

- Two dual scanning lidar (DSL) pairs tested / verified over range of 6-7 km
 - Very good performance for both horizontal wind speed and TI → indication for no bias correction required
 - Even storm situation is reproduced well in terms of measured extreme wind speed
-
- Further sensitivity analysis for test results (incl. differentiation between onshore / offshore winds)
 - Extending evaluation to small-scale fluctuations / gusts
 - Performance benchmark against floating lidar – cf. presentation by Warren Watson in Friday morning session



Acknowledgements to:

- Fraunhofer-internal funding for NEMO within ICON programme
- FEM for valuable discussions in project
- OREC as operator of NOAH
- Oldbaum as operator of C-Test
- Newbiggin-by-the-Sea Maritime Centre for hosting us on their rooftop

Thank you
for your attention!

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