Ship-lidar systems for wake measurements

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RAVE Offshore Wind R&D Conference 2015, Bremerhaven

Research Alliance Wind Energy

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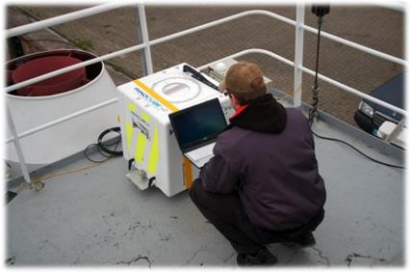


Content

- EERA-DTOC project and measurement campaigns
- Ship-lidar motion correction
- Wake measurements
- Ship-lidar verification
- Résumé and outlook

EERA-DTOC: Project description

- European Energy Research Alliance –

  Design Tool for Offshore Wind Farm Cluster

- EU funded project within Seventh Framework Program (FP7)
- Project duration: 01/2012 – 06/2015

- **„Use and bring together existing models from the partners“**
- Wake and far-wake models should be compared to measurements

=> Scanning lidar measurements and **Ship-lidar measurements**

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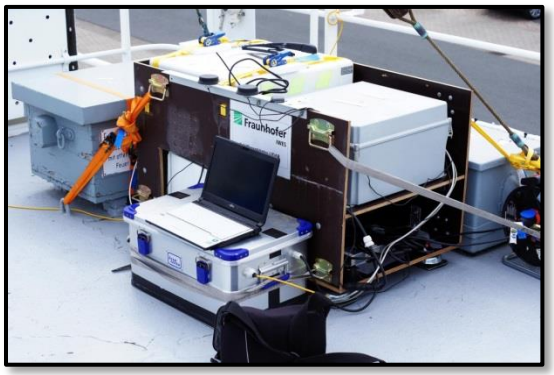
EERA-DTOC: Ship-lidar measurements

Performed measurements:

1. System test, first wake measurements 27-31 Aug 2013
2. Near and far-wake measurements 4-10 Oct 2013
3. Ship lidar and motion correction verification 10-15 Jun 2014



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Ship-lidar development

First **software simulations** of motion correction in 2010

Simulation of motion induced measurements…, Wolken-Möhlmann et. Al., iSARS2010

Onshore motion test in 2012

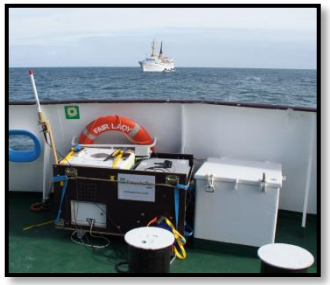
Introduction of a validated and verified floating lidar system, Gottschall, EWEA Offshore 2013

First **ship-based measurement** using a ferry in 2012

Ship based LIDAR measurements, Wolken-Möhlmann, DEWEK 2012

First **ship-based near- and far wake measurements** in 2013

First verification test and wake measurement…, Wolken-Möhlmann, EERA-Deepwind 2014



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Motion correction

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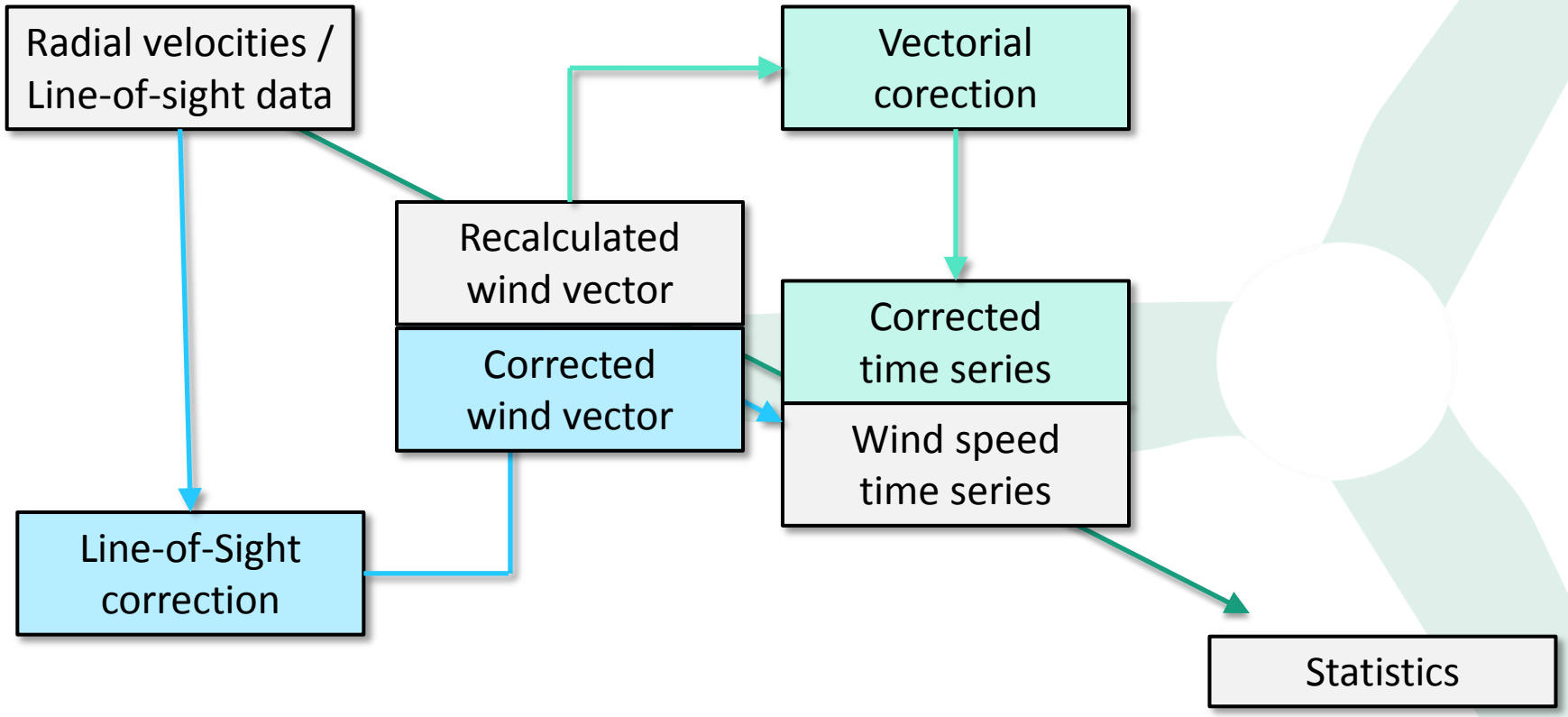
Motion correction



Wolken-Möhlmann et. Al.: First verification test and wake measurement results using a Ship-LIDAR System, Energy Procedia 2014

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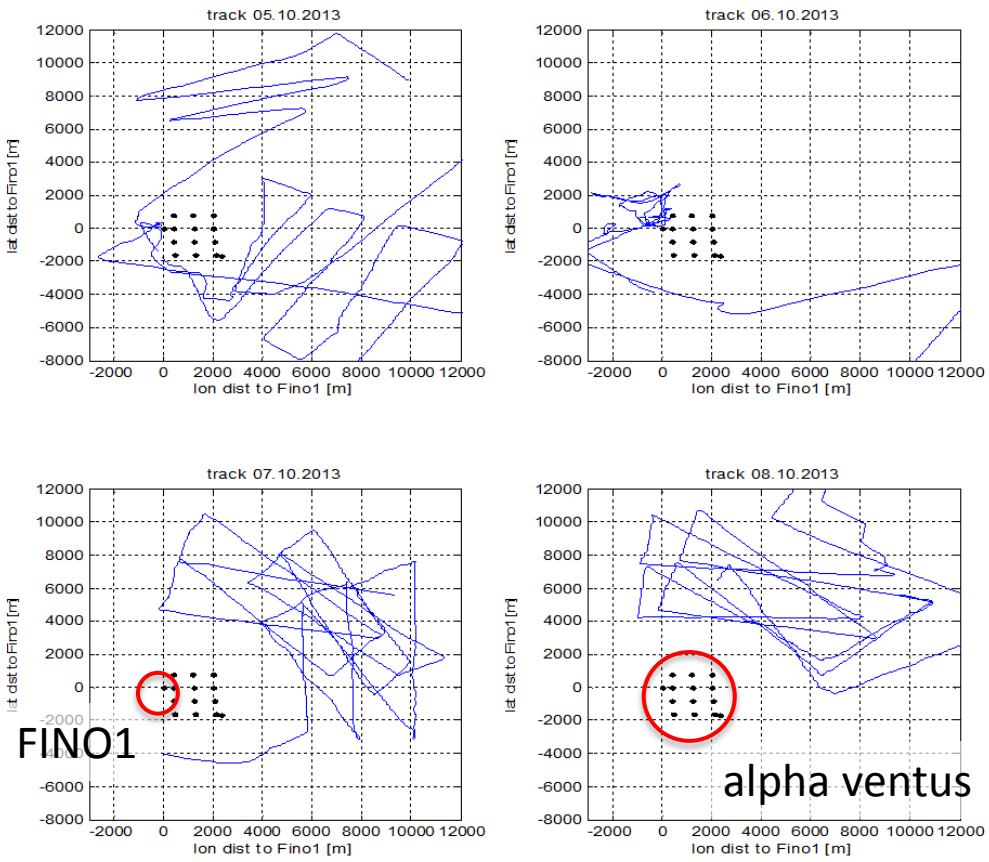
Wake measurements



Different tracks

- Perpendicular to inflow direction
- Different distances to wind turbine

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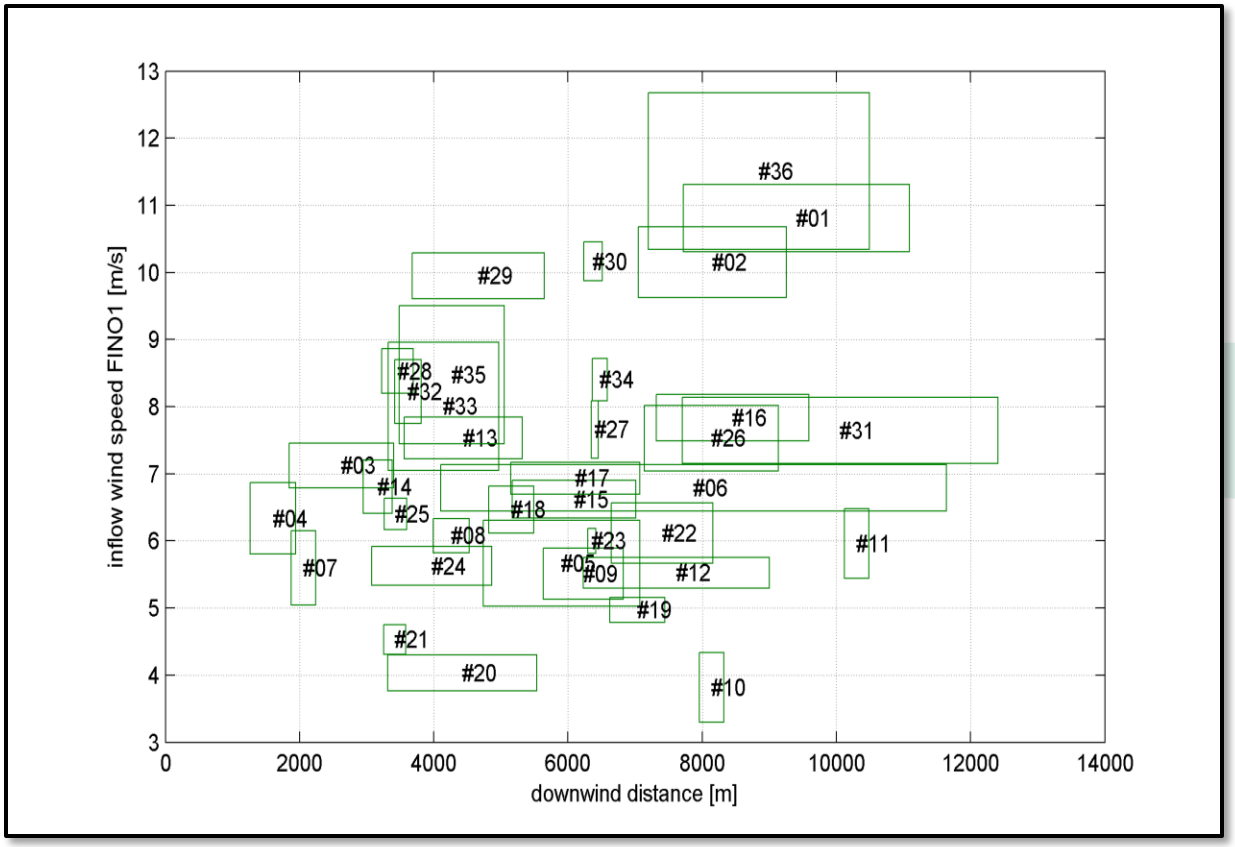
Wake measurements



Different inflow conditions…

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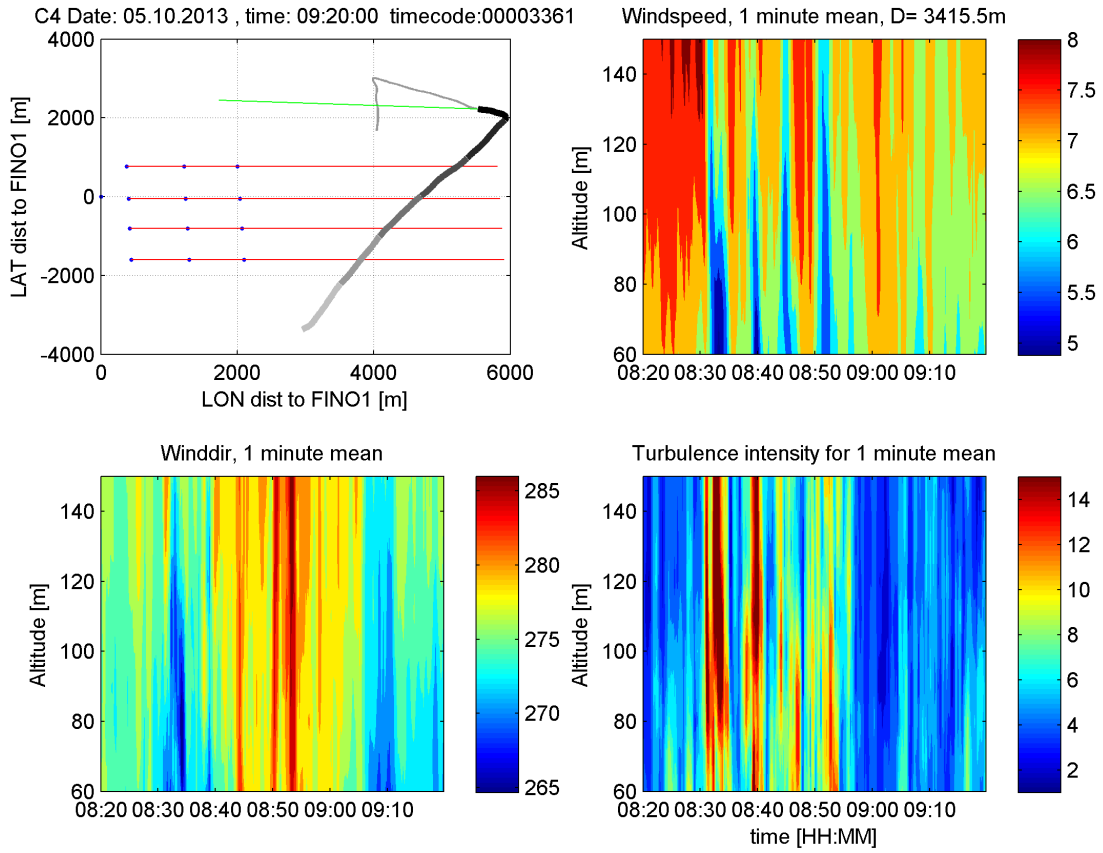
Wake measurements: Results!!!



Measurements without corrections

Measurements with corrections

Keep in mind:
1-min lidar turbulence!

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Wake measurements: Results!!!

- Near-wakes can be detected by wind speed deficit and increased turbulence
- Detection of single and triple wakes
- Far wakes can be detected by turbulence intensity

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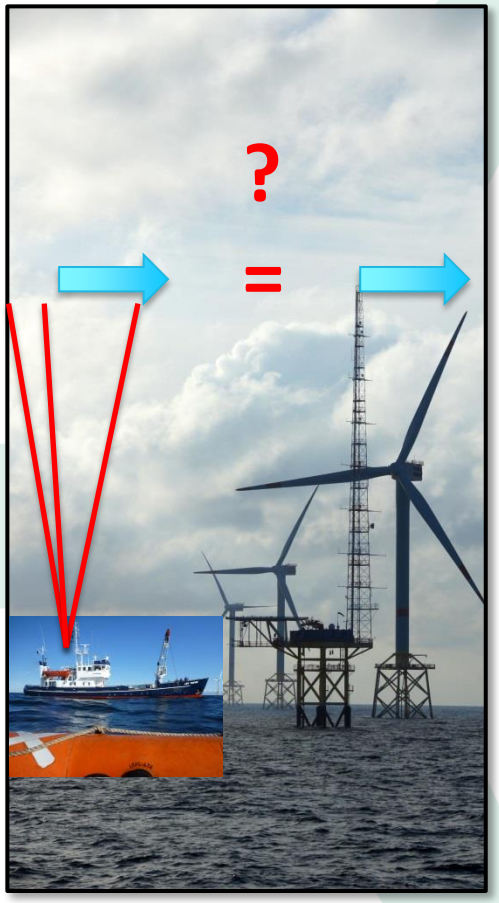
Ship-lidar verification

Can we verify our method?

⇒ Measurement in **proximity to FINO1**

⇒ Using scanning **patterns similar to wake measurements** with similar ship velocities!



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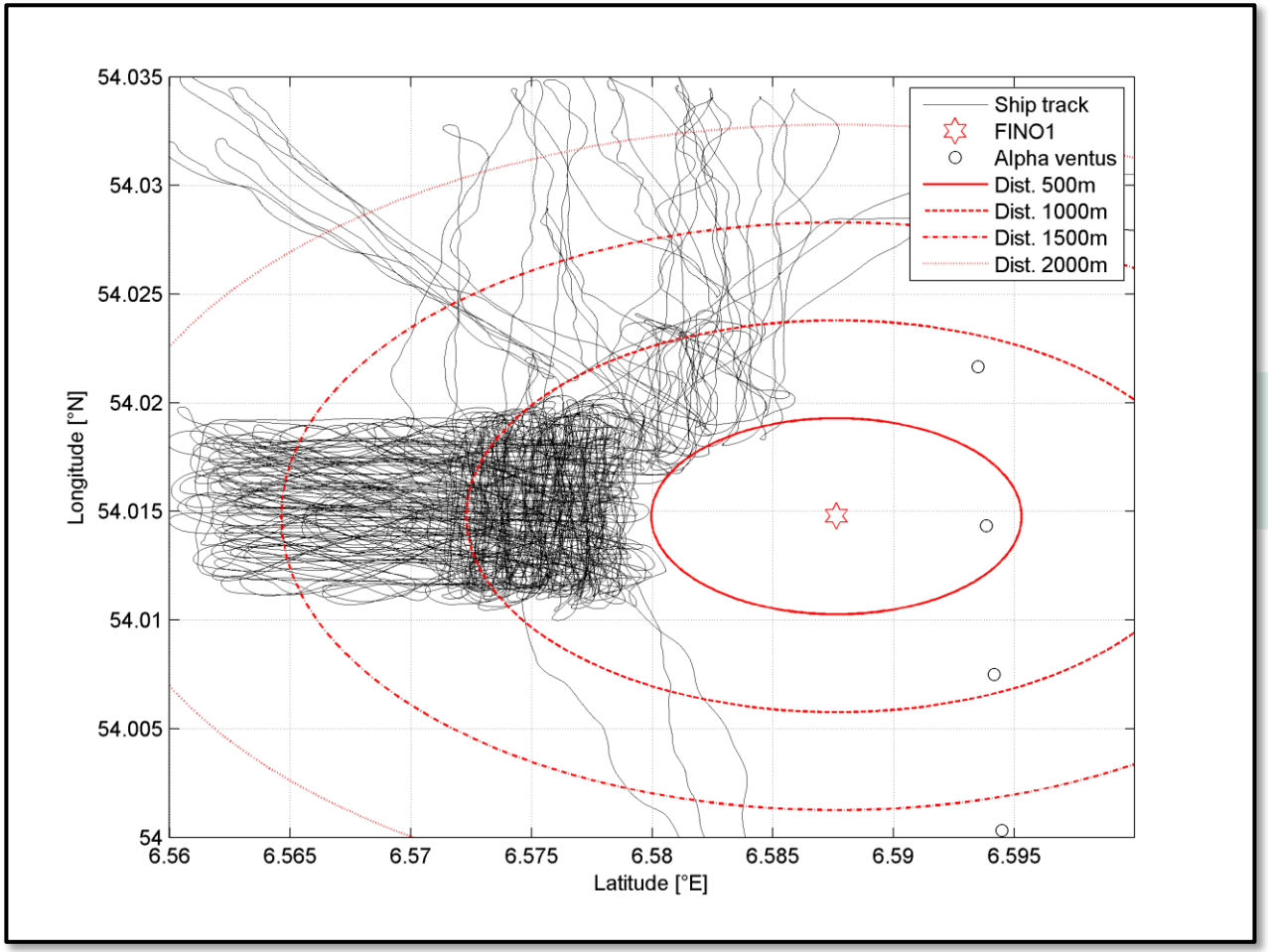
Ship-lidar verification



Overview of performed tracks

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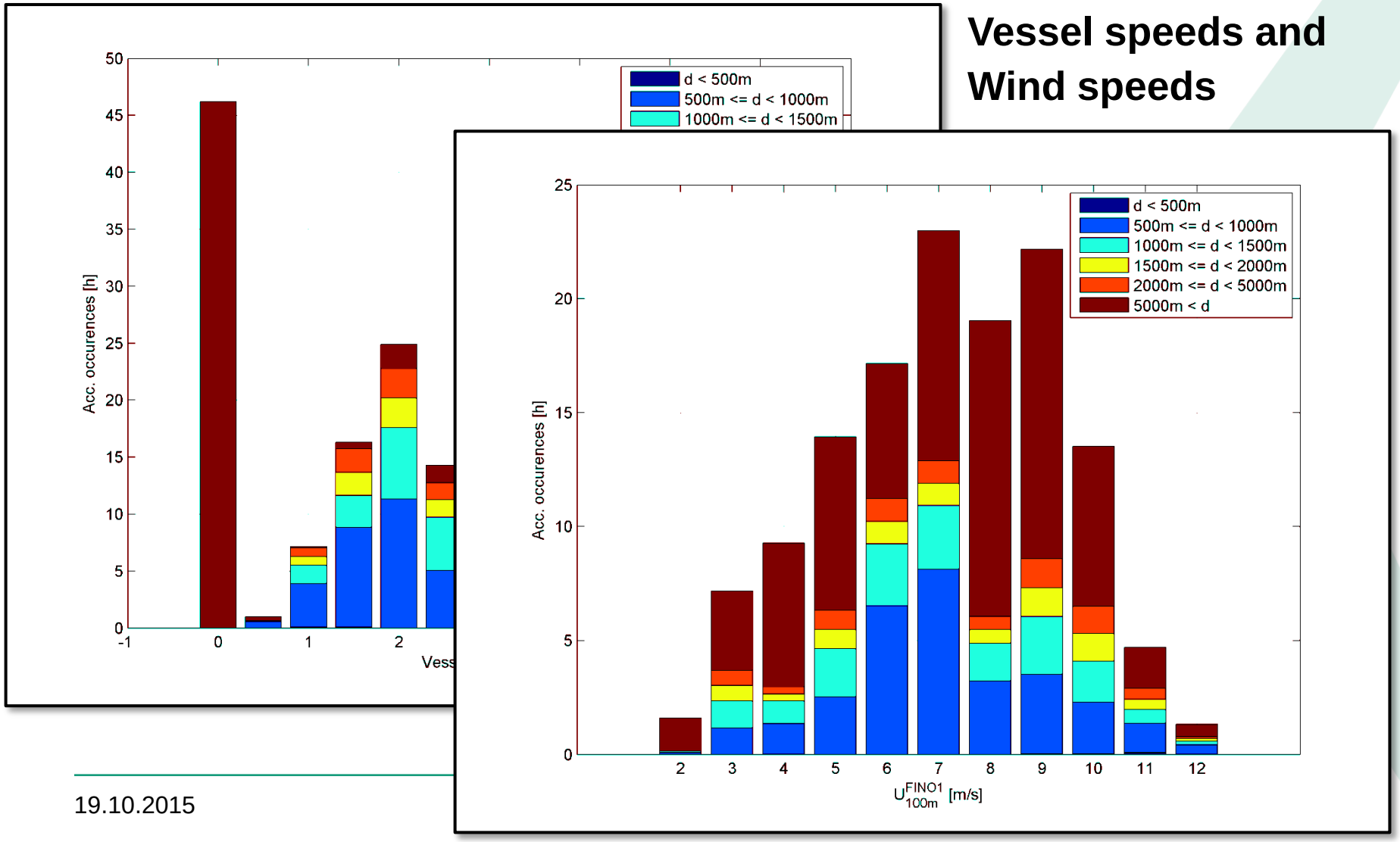
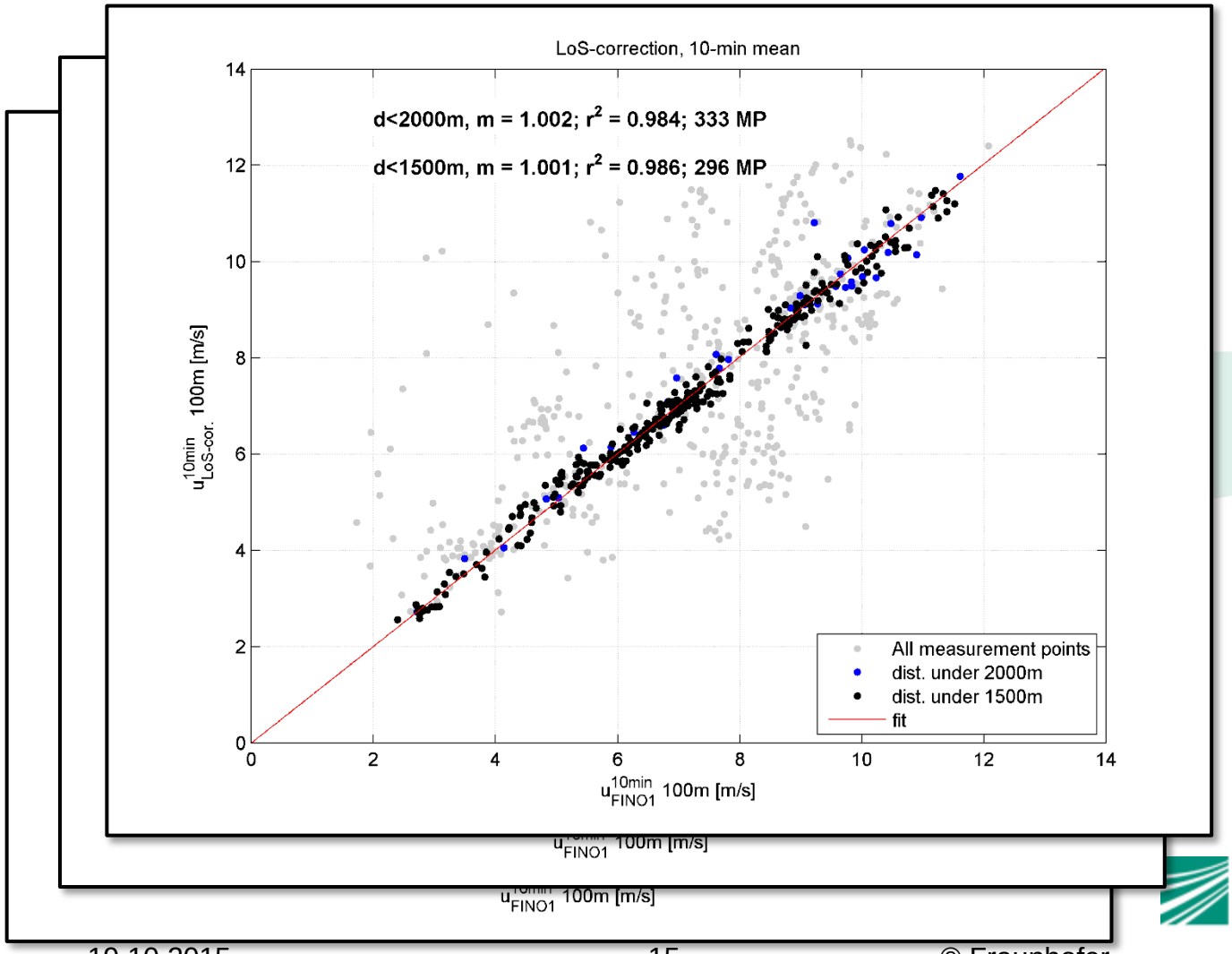
Ship-lidar verification

Vessel speeds and Wind speeds



Ship-lidar verification: Results



Uncorrected

Vectorial correction

LoS-correction

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Ship-lidar verification: Results

- Motion correction is **mandatory for ship-lidar measurements**
- Vectorial correction and LoS-correction show similar results for **10-min-mean speed**
- **Good correlation** to met. mast data!

Résumé and outlook

- **Ship-lidar can detects wakes and far wakes**
- **Comparison for different motion patterns show good correlation!**

Next steps:

- **Using ship-lidar as ferry box**

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THANKS FOR YOUR ATTENTION

Questions?

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