WESC 2023 Mini-Symposium 1.5 "IEA Wind Task 52: Replacing met masts and Accelerating offshore wind deployment“

https://zenodo.org/record/8007754

Peter Clive

Principal Wind Energy Consultant, Black & Veatch (UK) Ltd

BLACK & VEATCH

"Introducing NEOWIND project: Next Generation of Offshore Wind Lidar Measurements"
- Yiyin Chen, Stuttgart Wind Energy, University of Stuttgart

"Anomalous wind events over the Belgian North Sea at heights relevant to wind energy"
- Gertjan Glabeke, von Karman Institute For Fluid Dynamics

"Quantification of the error induced by floating motions in wind vector and turbulence intensity estimation"
- Maxime Thiébaut, France Energies Marines

"Experimental results of the digitalization of wind flow with LIDAR for different applications: met mast substitution, urban wind & airborne"
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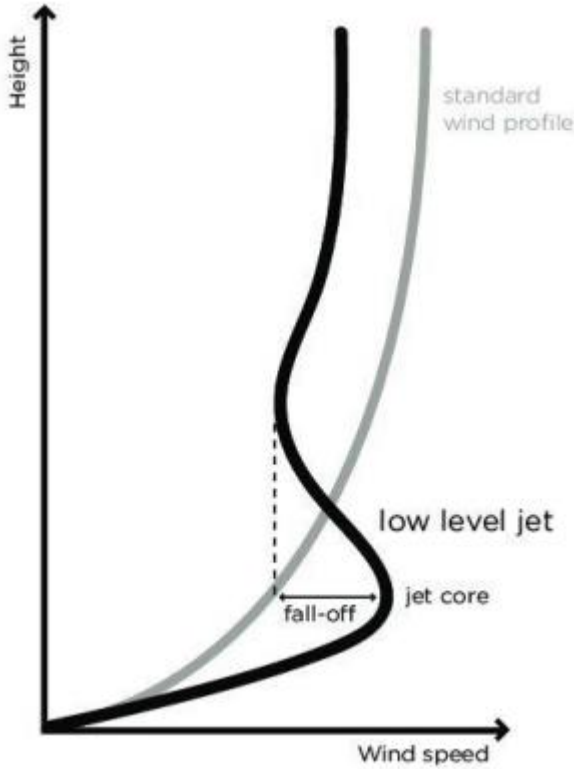

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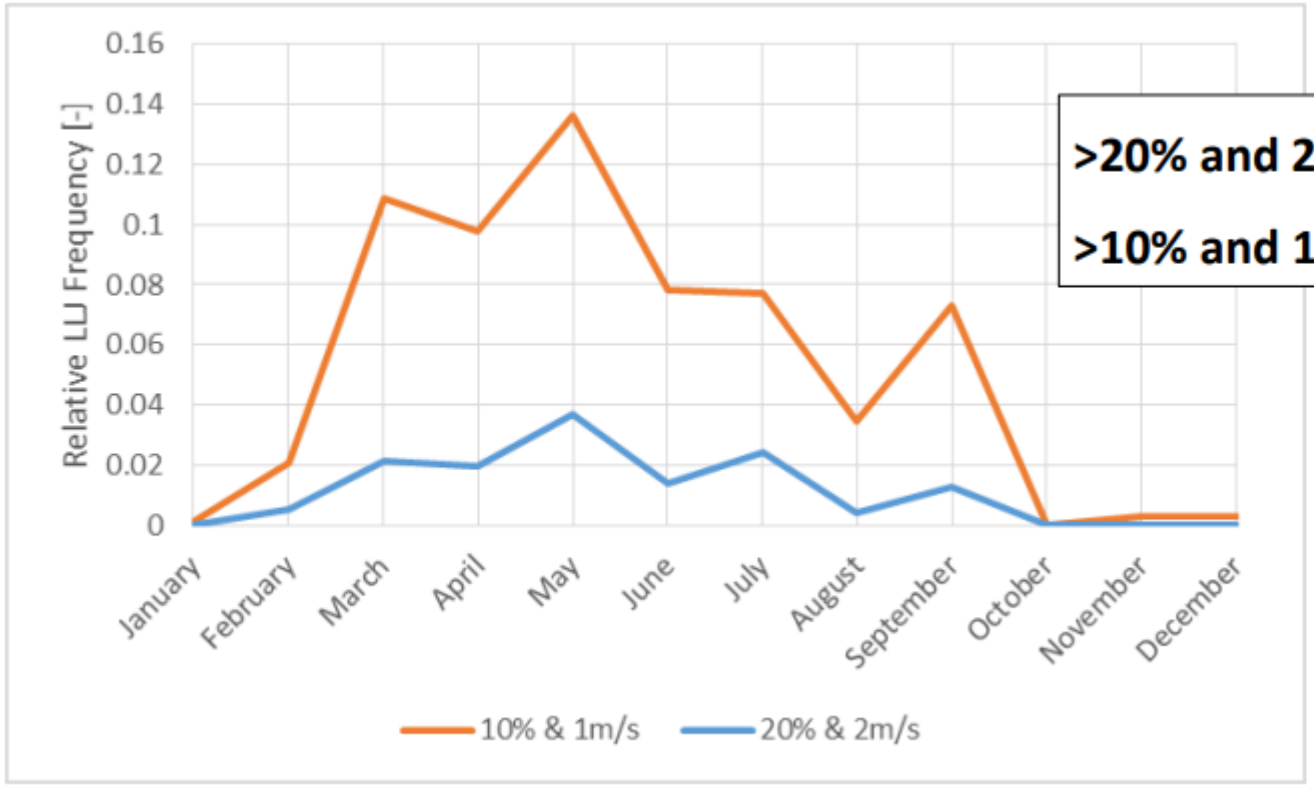

>20% and 2m/s: 1.2% LLJ occurrences

>10% and 1m/s: 5.4% LLJ occurrences

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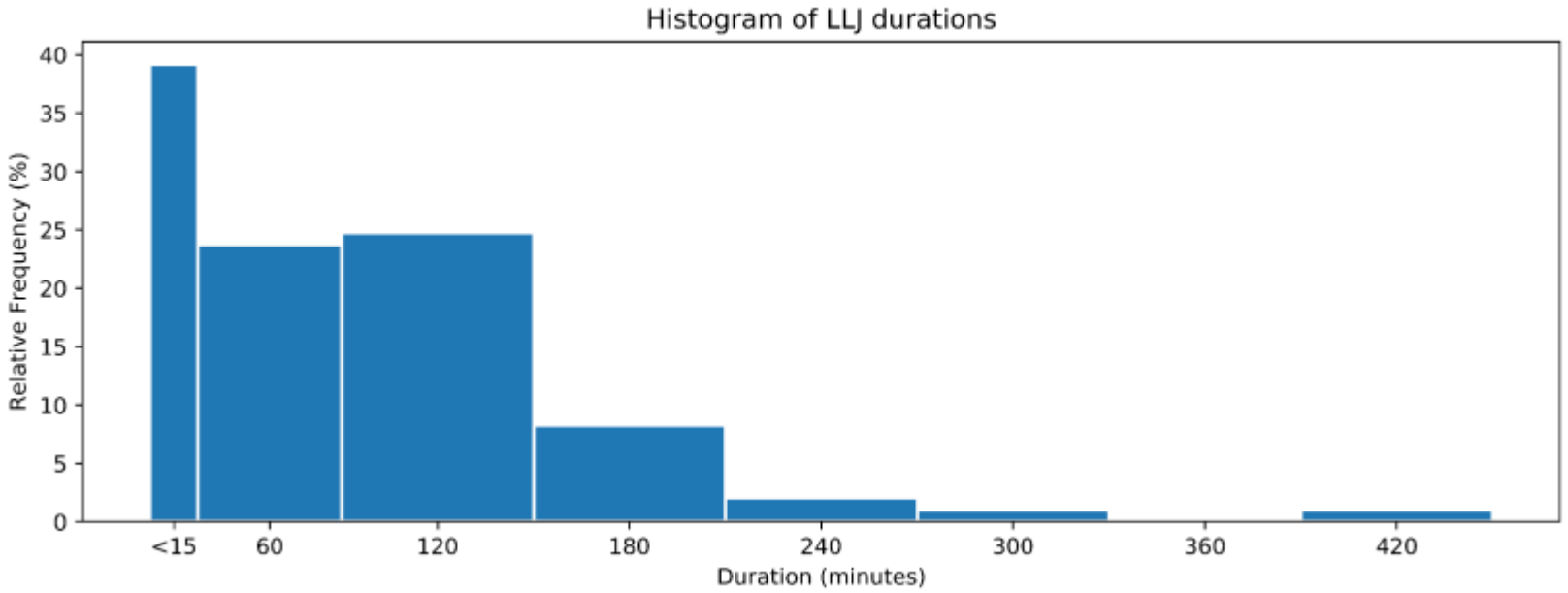

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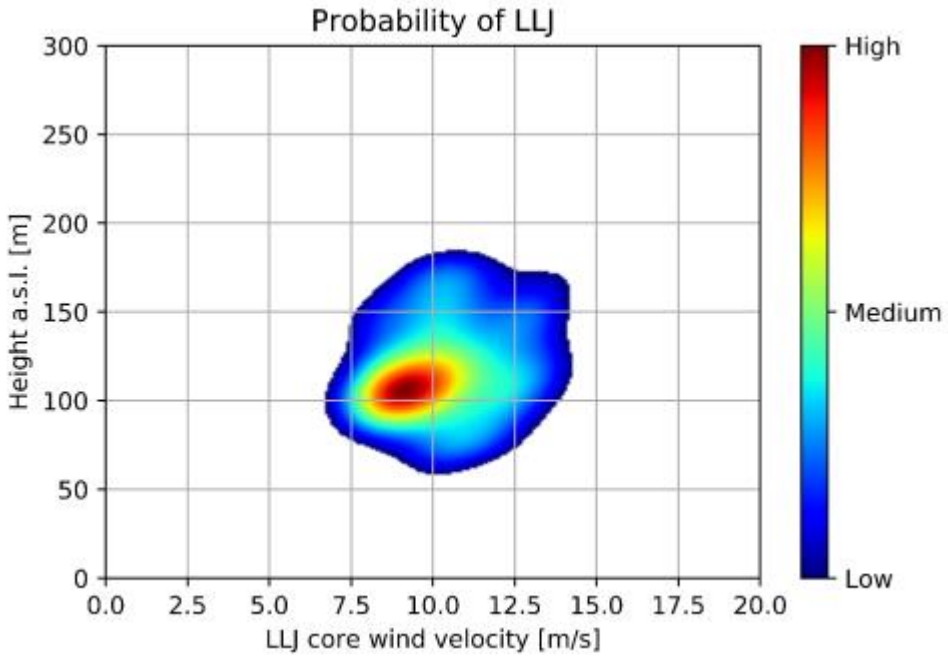
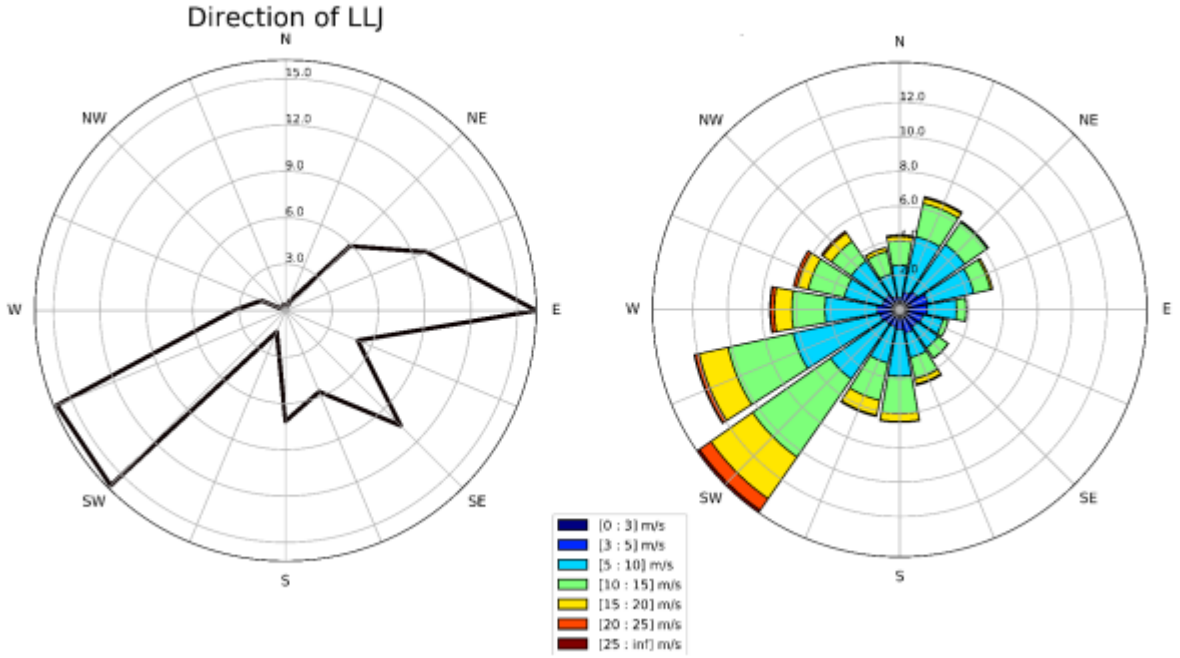
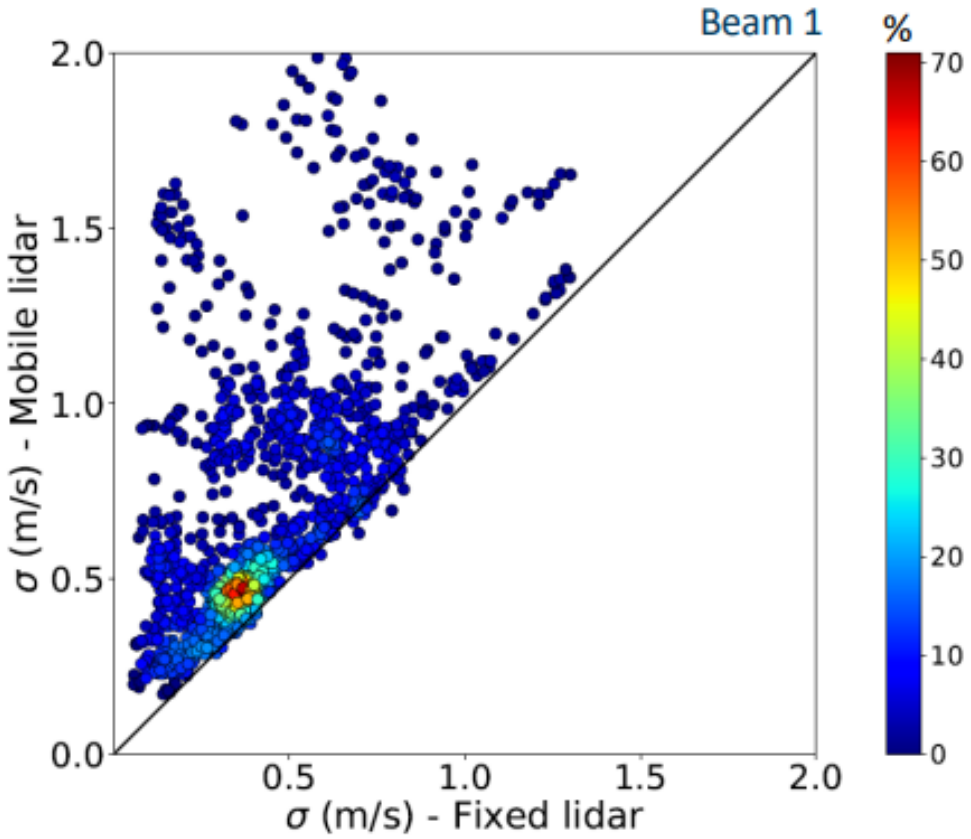




"Quantification of the error induced by floating motions in wind vector and turbulence intensity estimation" - Maxime Thiébaut, France Energies Marines



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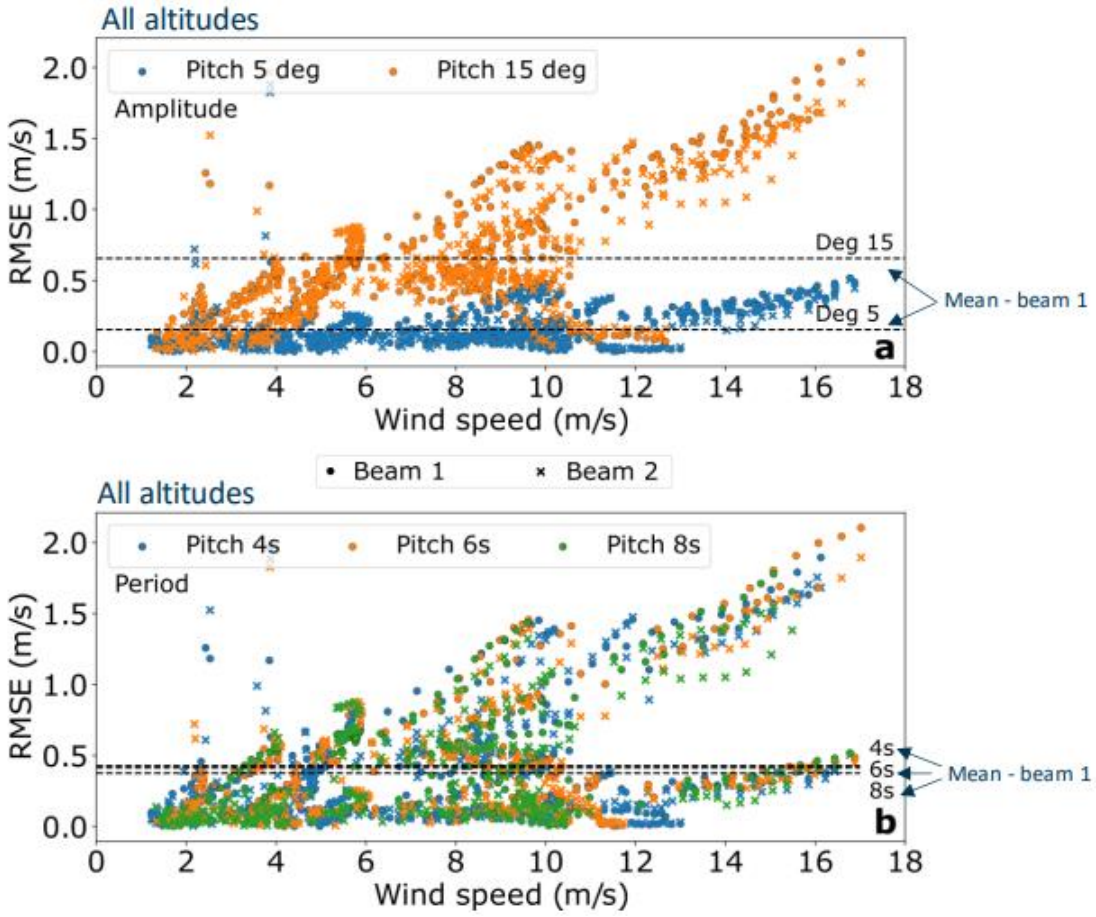

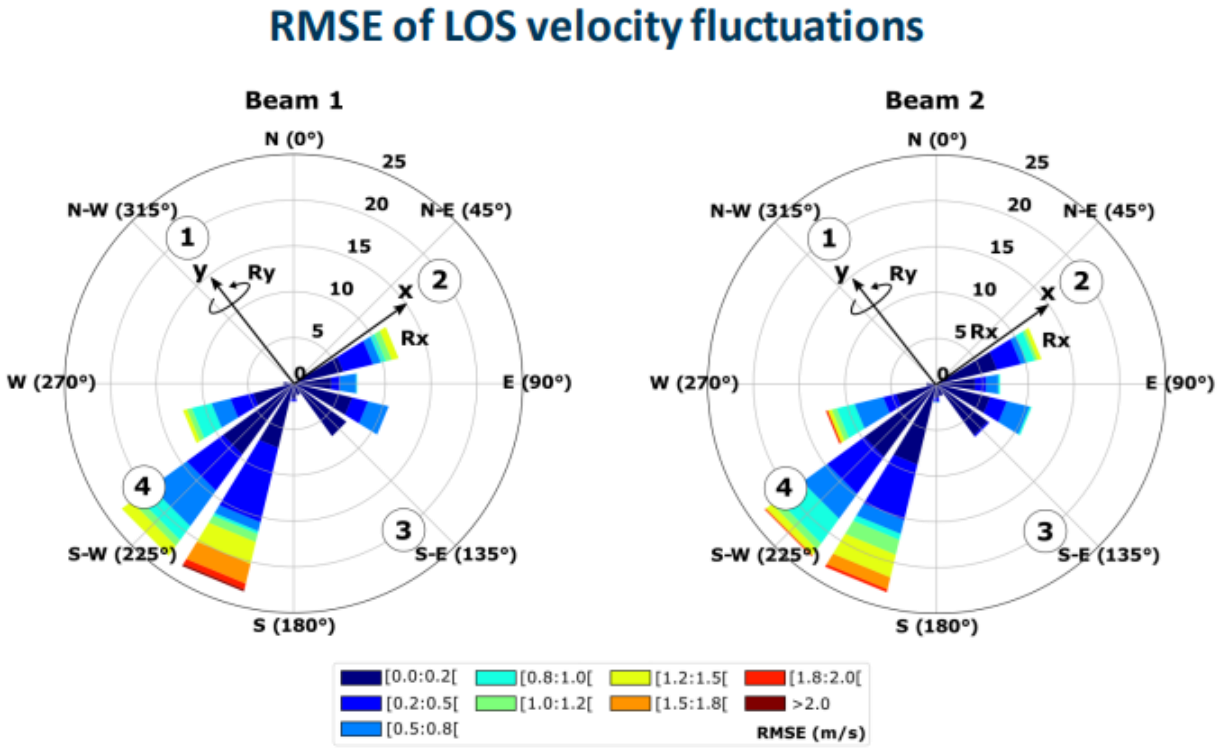

Wind speed **orthogonal** to the axis of rotation gives **higher** RMSE.
Wind speed **aligned** with the axis of rotation gives **lower** RMSE.

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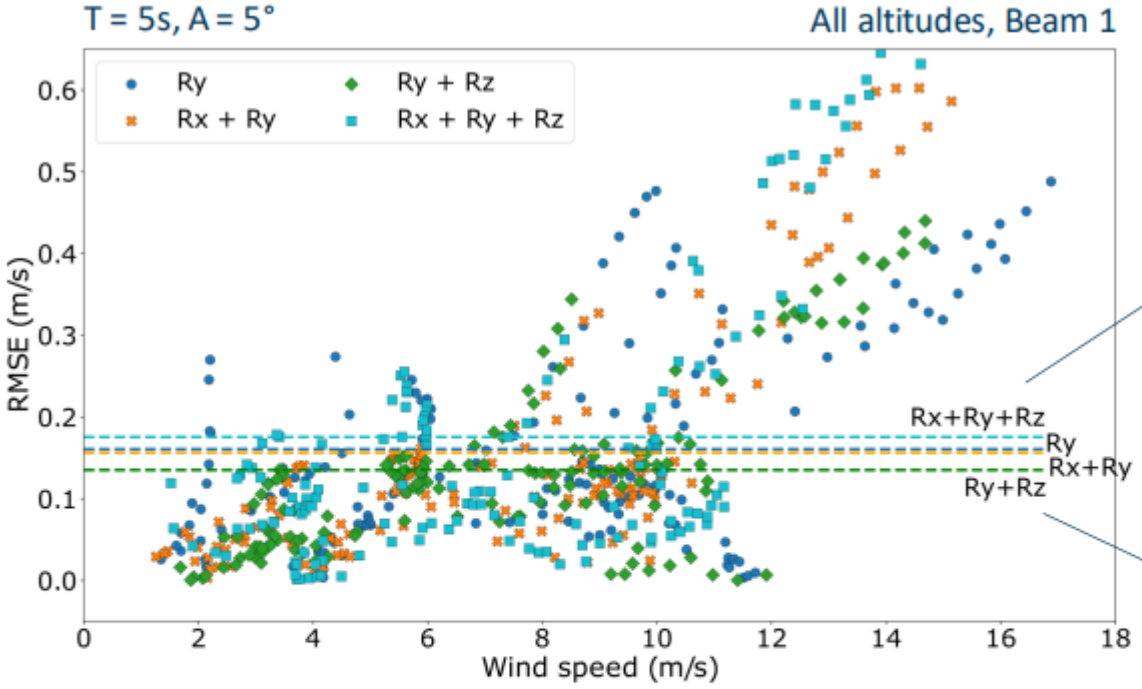
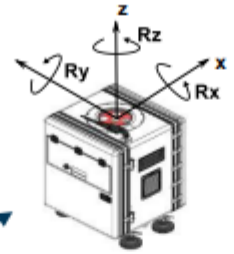
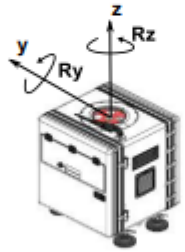




Higher RMSE



Lower RMSE

- For similar wind speed:
- Coupling of Rx/Ry/Rz has the most impact
- Followed by Rx/Ry.
- Followed Ry alone
- Followed by Ry/Rz. Does it mean that a rotation around the z-axis generate low RMSE?

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Conclusions

- High impact
  - Amplitude of the motion
  - Wind speed
  - For rotations around one single axis
    - Wind direction in comparison to the axis of rotation
    - Beam position orthogonal to the axis of rotation
- Low impact
  - Period of the motion.
  - Rotation around the vertical axis?

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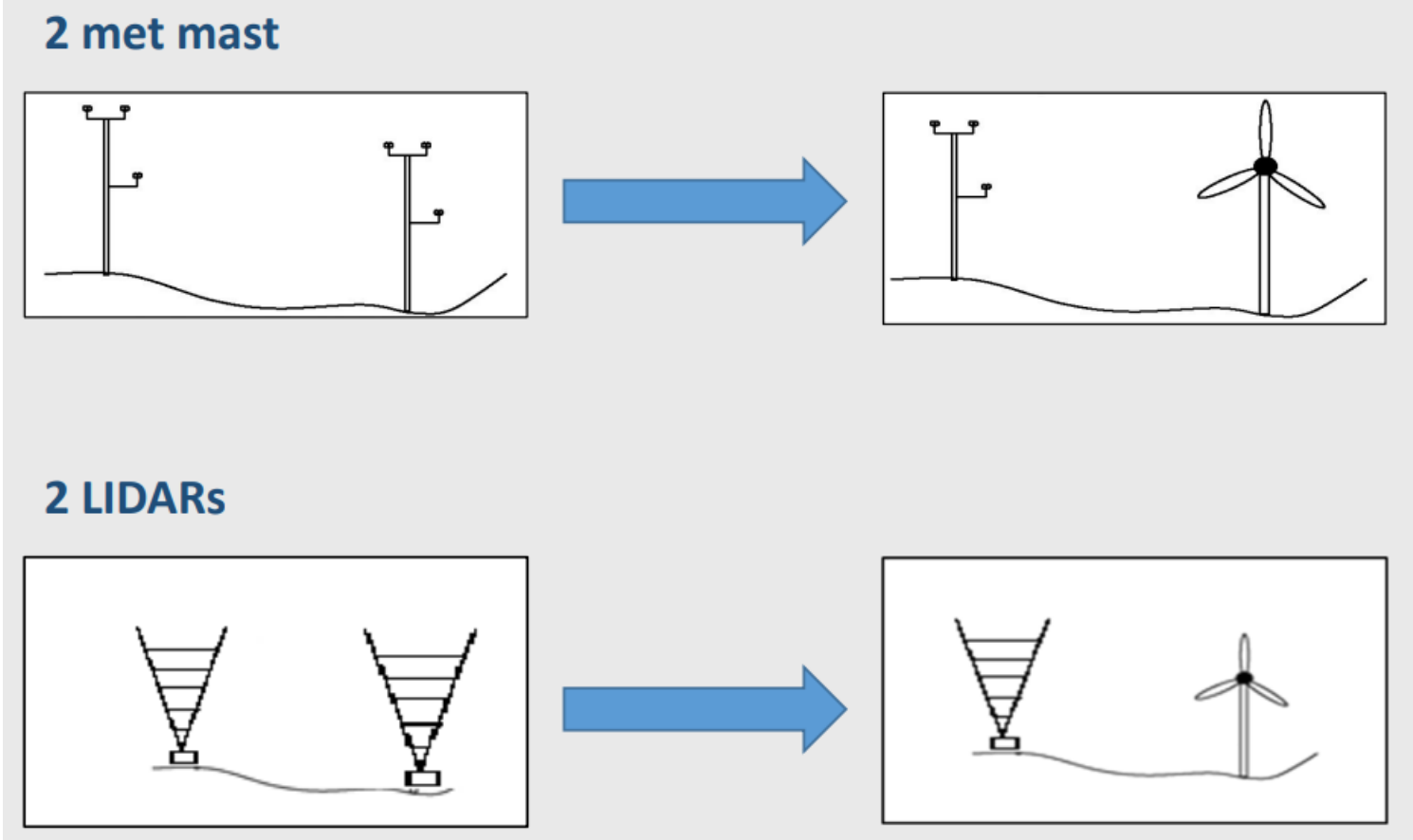

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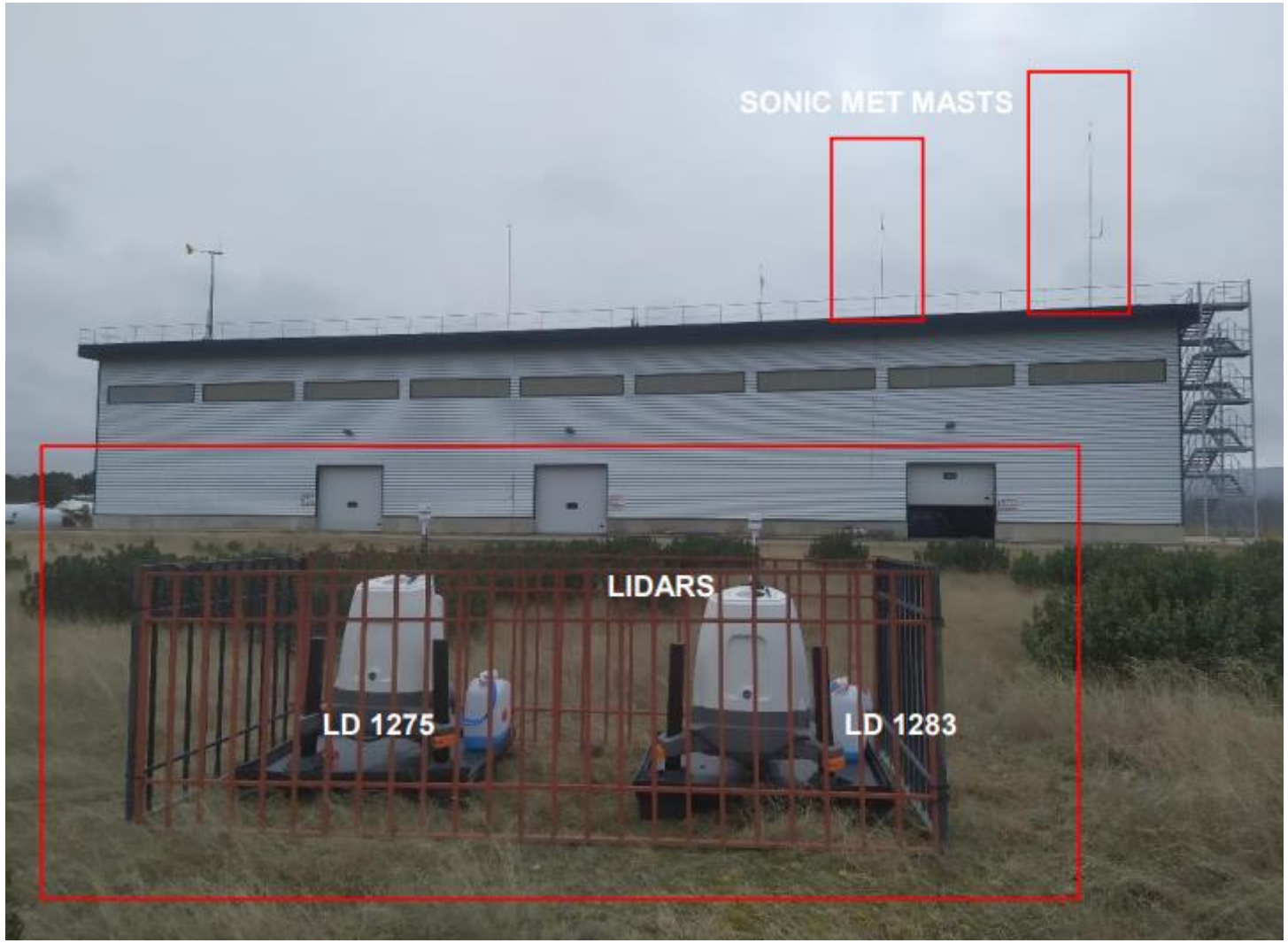

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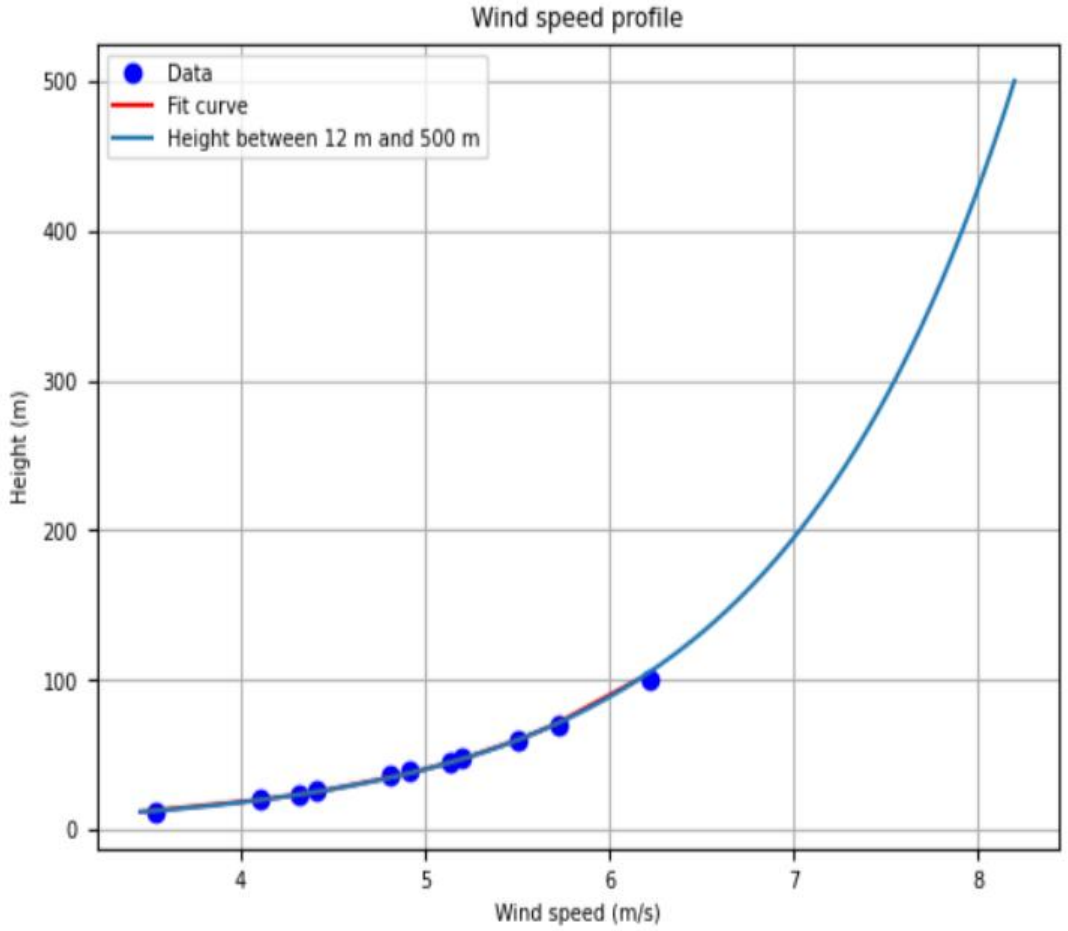


```
Von Karman coeficient:  0.4
Rugosity:  0.7958893027492805
Friction wind speed:  0.5091386318688714
u2 [500 m] m/s: 8.200827387996103
```

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No	Filter Name	Filter Parameters
1	CNR Filter	$-29 \leq cnr \leq 5$
2	CNR + v_{los} Filter	$-29 \leq cnr \leq 5$ $v_{los} - 3\sigma_{Vlos} \leq v_{los} \leq v_{los} + 3\sigma_{vlos}$
3	Interquartile (IQ) Filter	$V_{los,25} - 1.5IQR_{Vlos} \leq v_{los} \leq V_{los,75} + 1.5IQR_{Vlos}$
4	IQ + Despiking Filter	IQ Filter + Despiking Filter
5	Dynamic Density Filter	Data density filter

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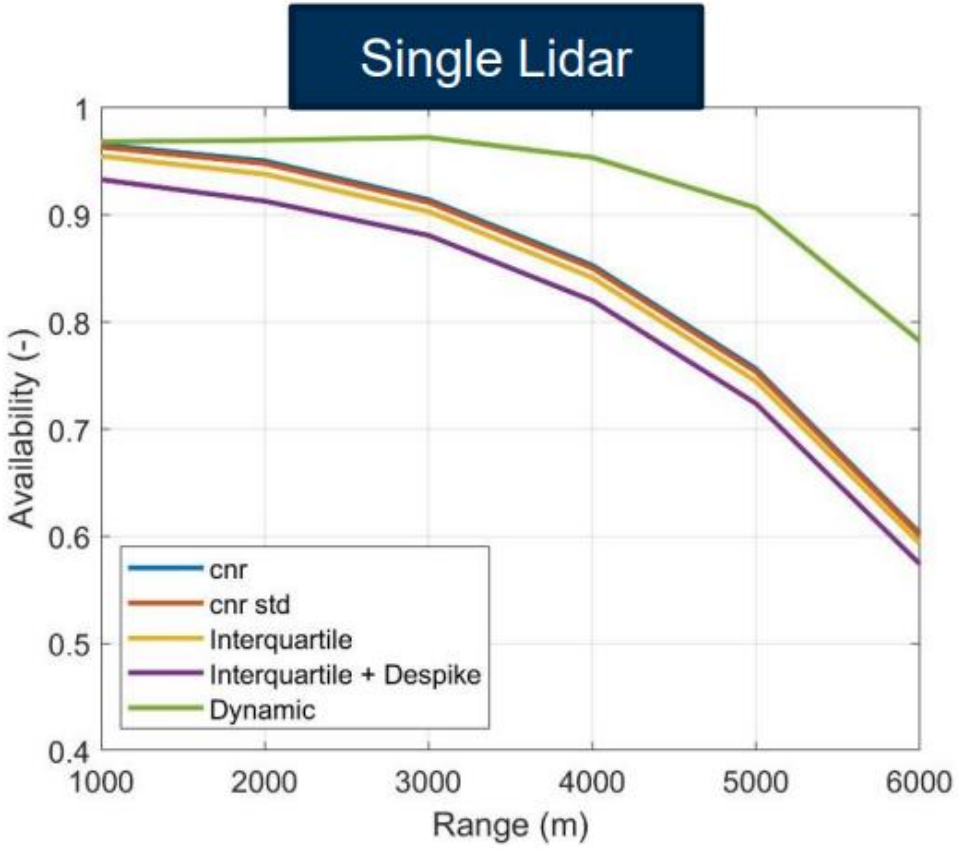
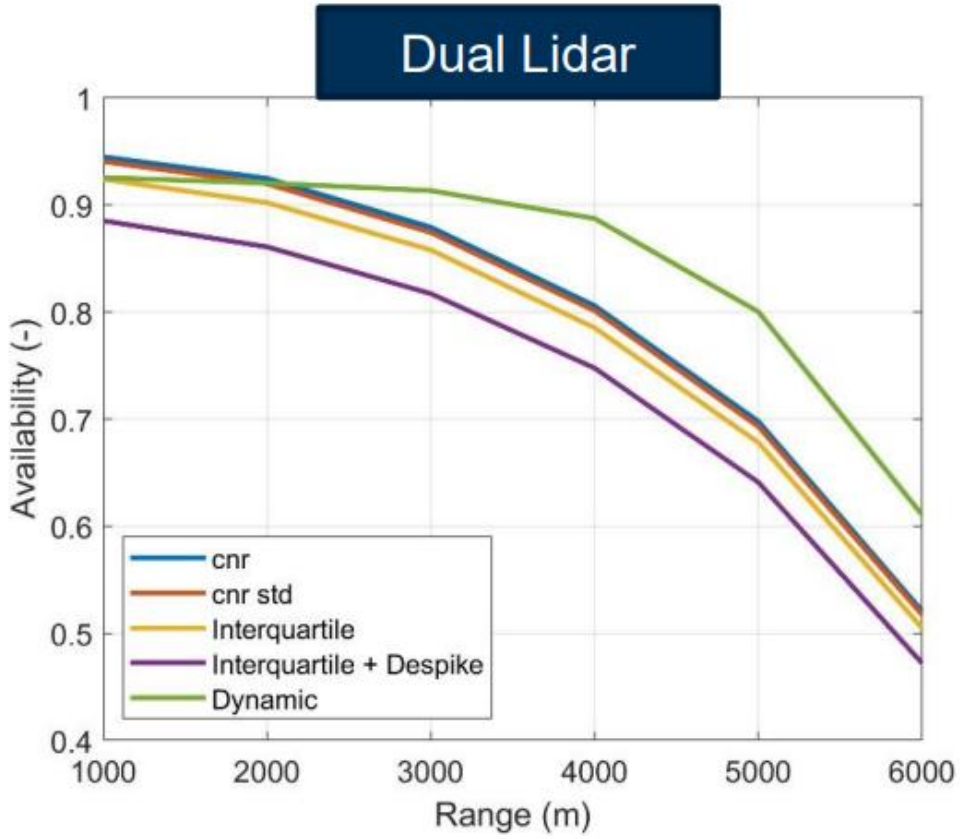
Improvement in data availability

- Single lidar availability up by 20 % at 6 km
- Dual-Doppler availability up by 11 % at 6 km





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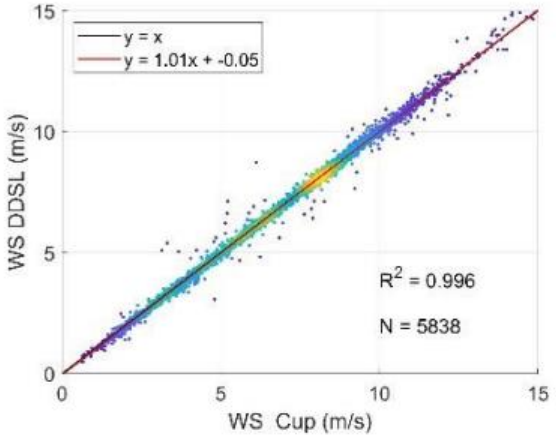
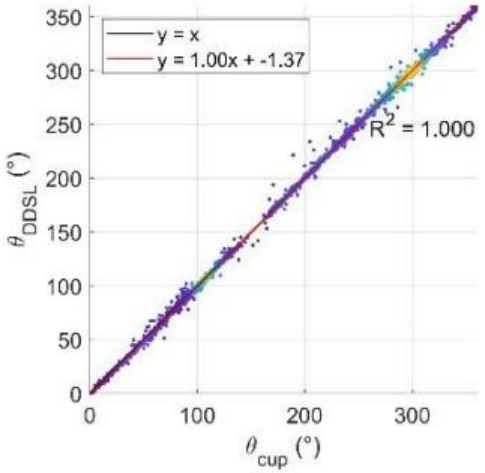
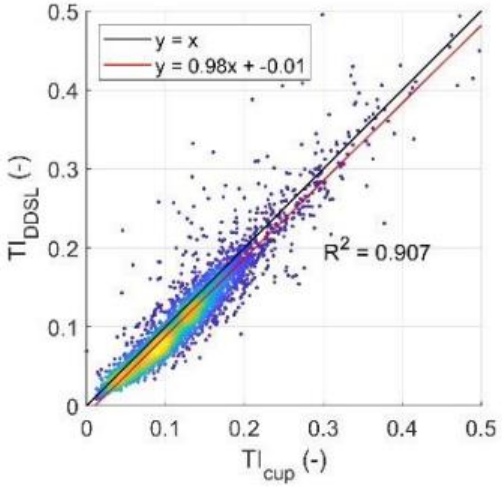
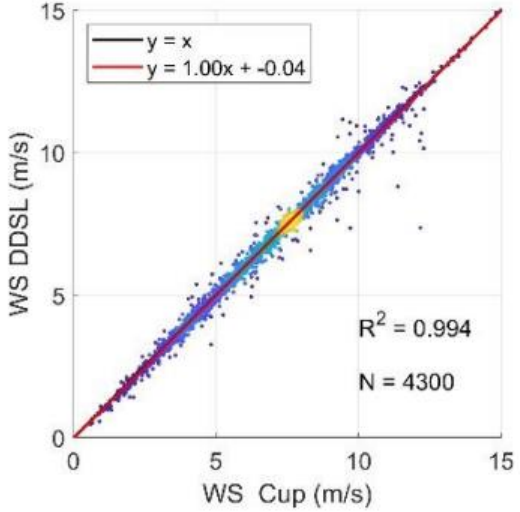
At met mast

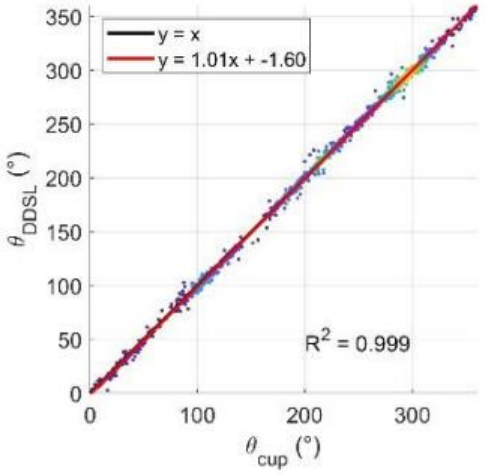


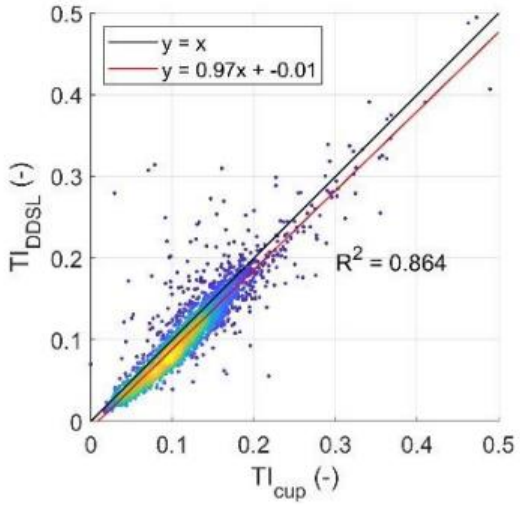




At 6 km (Max range during campaign)







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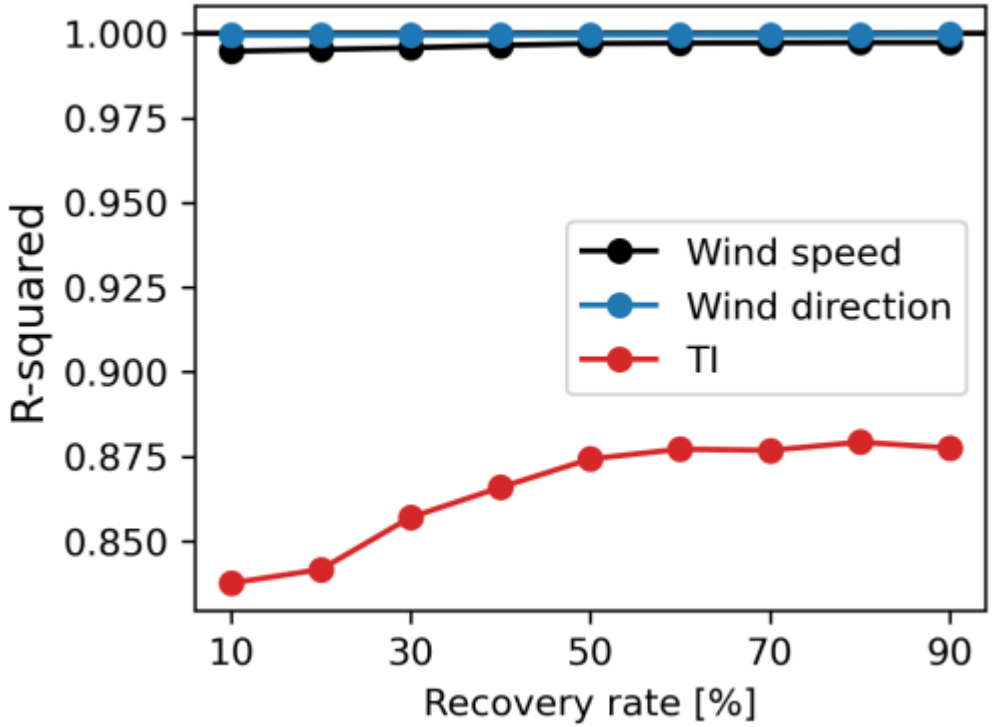

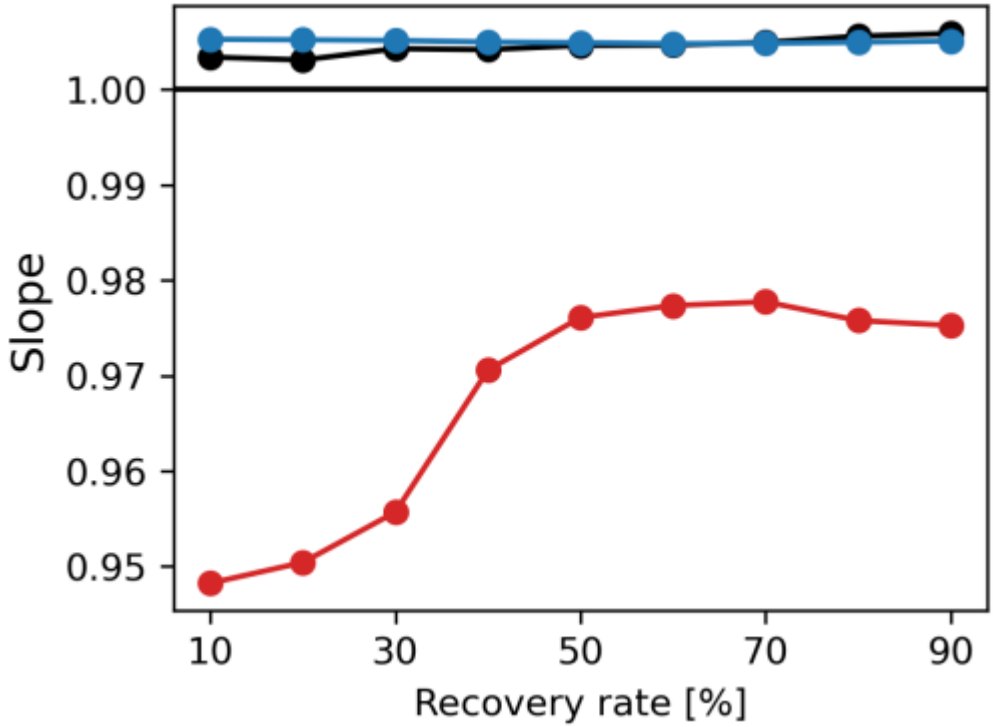

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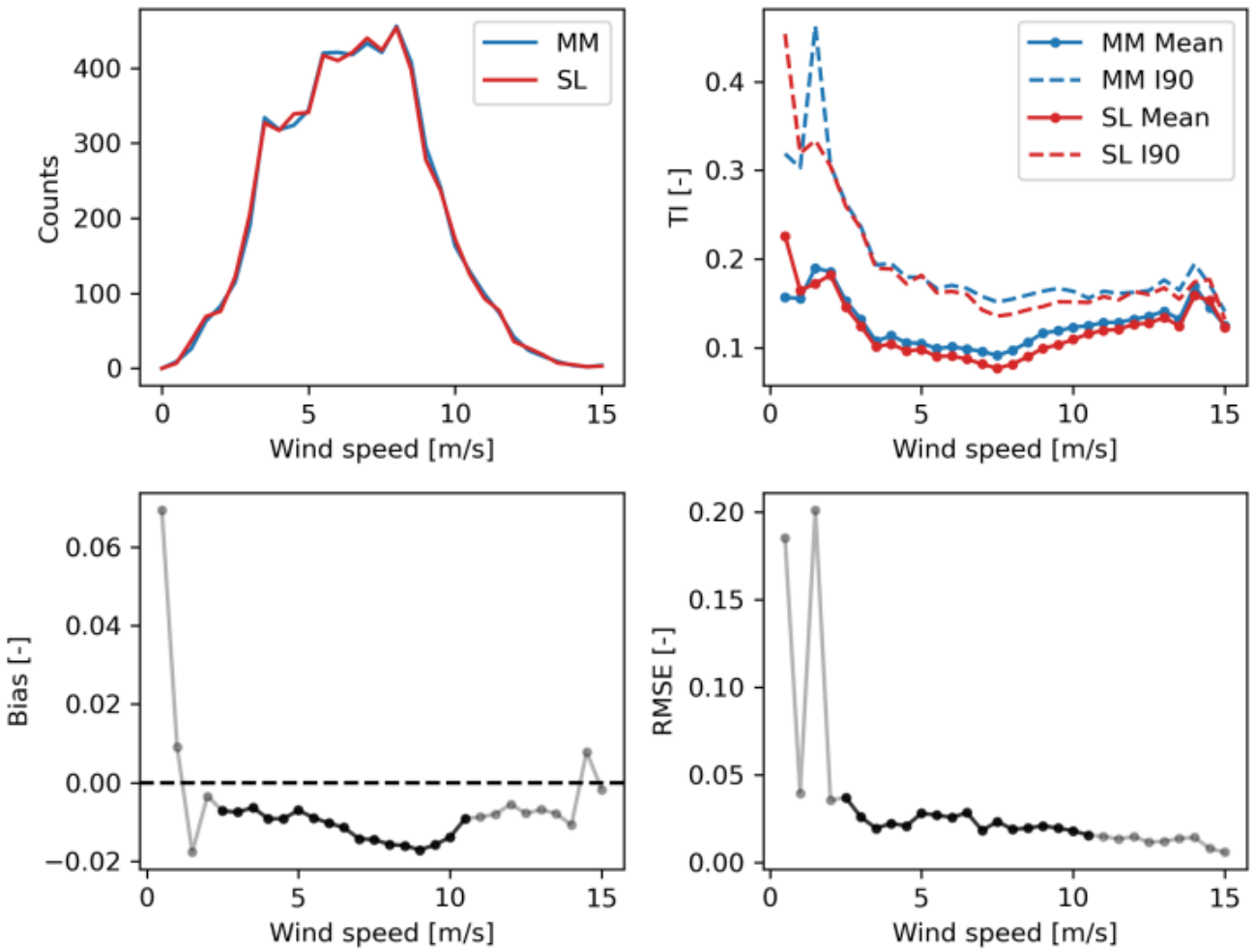

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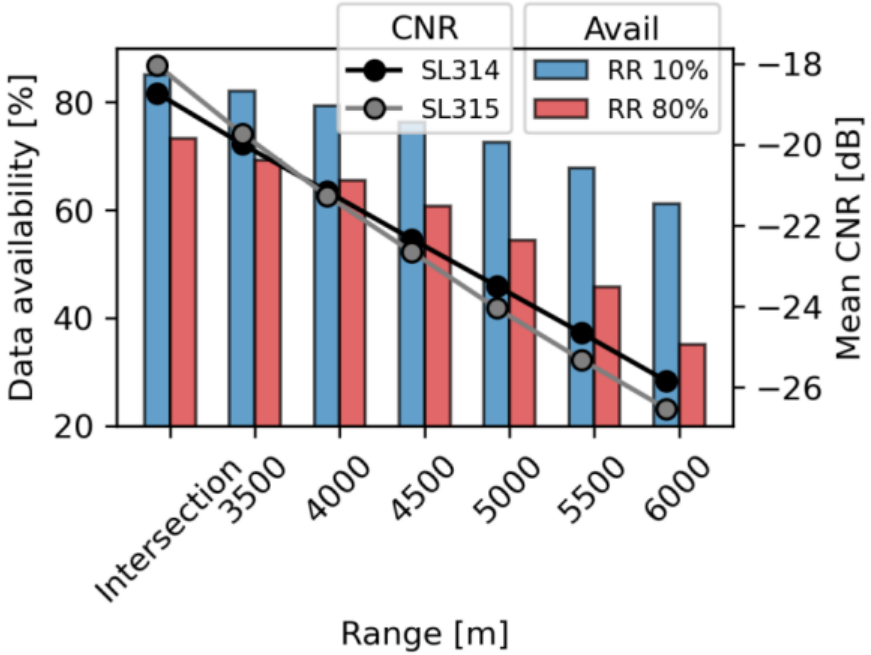
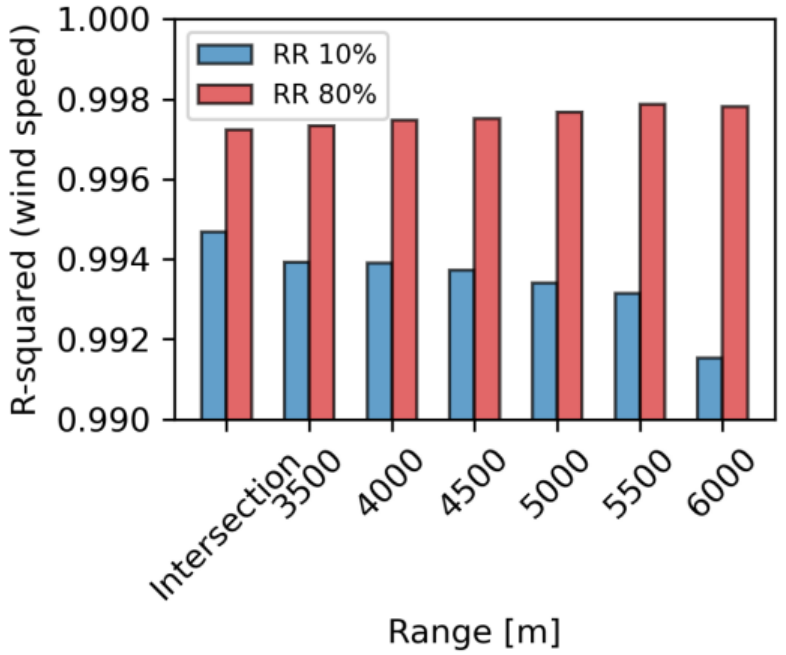
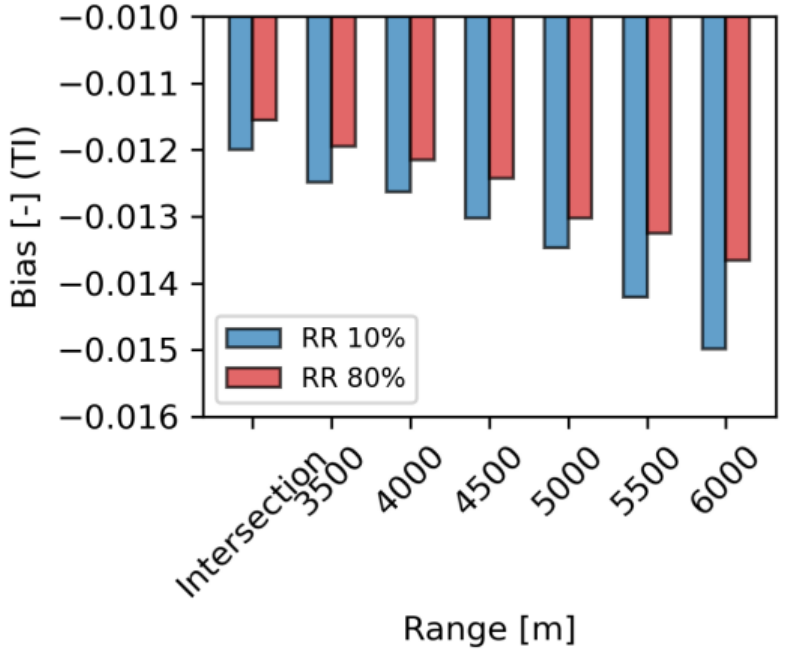
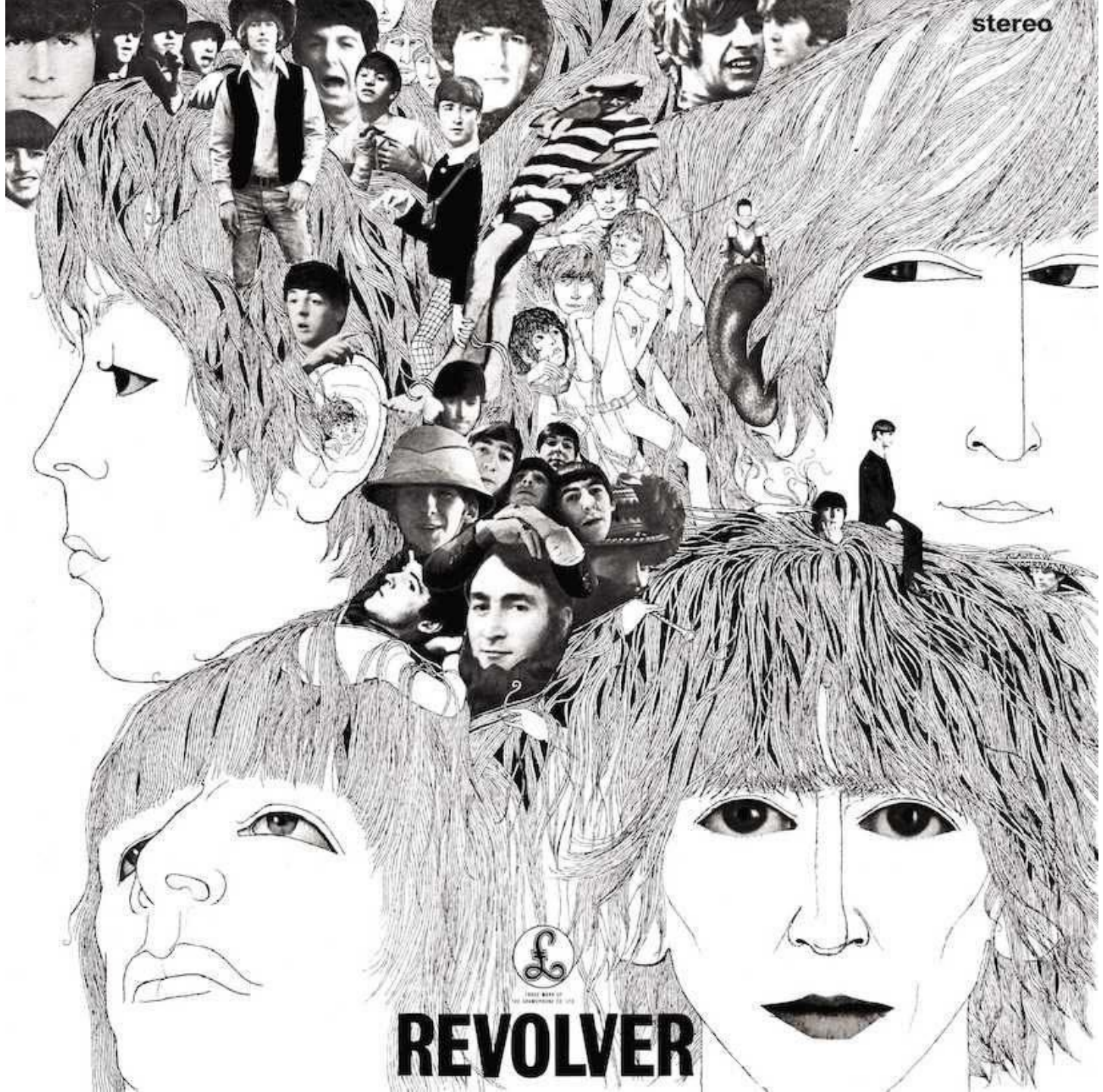






Conclusions


stereo
REVOLVER

Conclusions

- We've moved past the early "lidarmania" stage characterised by a few well known formulaic commercial hits towards a more mature, versatile, varied, curious, exploratory, confident stage of development

- The “studio” is becoming as important or even more important than the “live performance”, with sophisticated analytical techniques, integration of data with models, detailed investigation of influence of operational conditions, etc.

- Application of diverse measurement methods to multiple distinct use cases unlocking the value inherent in the capabilities of lidar that go beyond the limitations of met masts

- A growing, detailed evidence base is supporting confidence in these methods

Discussion.

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