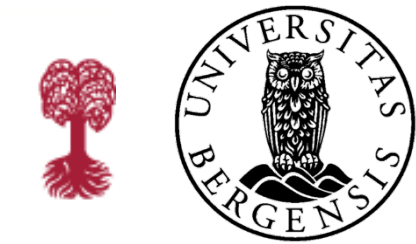


An Overview of the Lollex Experiment

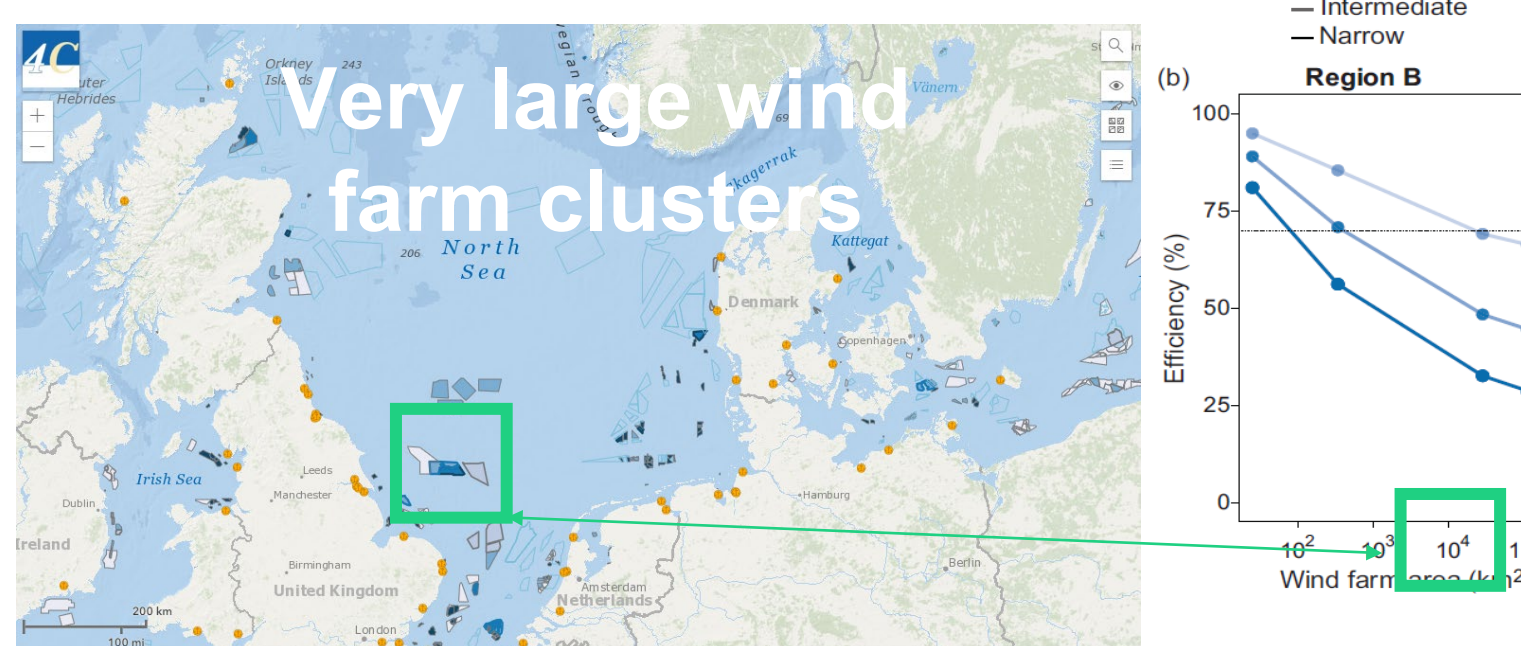
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 O. Garcia Santiago¹, E. Hodgson¹, A. Haseeb Syed¹, A. Owda¹, G. Fraumann², M. Ghirardelli³, S. Malekmohammadi³,
 M. Bramati⁴, G. Miranda-García⁴, M. Sajidi⁴, V. Savvakis⁴, G. Duan⁵, M. Souzaiby⁵

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TRAIN²WIND is a PhD TRAINing school analysing enTRAINment in offshore WIND farms.

Rationale: Very large wind farm clusters influence the boundary layer – where is the momentum coming from?



Volker, P. Hähmann, A.N. Badger, J. & Ejsing Jørgensen, H. 2017, 'Prospects for generating electricity by large onshore and offshore wind farms: Letter', *Environmental Research Letters*, vol. 12, no. 3, 034022. <https://doi.org/10.1088/1748-9326/aa5d86>

We aimed at a measurement campaign at the Rødsand II offshore wind farm in Lolland, Denmark, with a high-intensity measuring period where we deploy UAS, Lidars, and collect information from satellites to establish the transition between the undisturbed air and the atmospheric boundary layer in the presence of the wind farm.

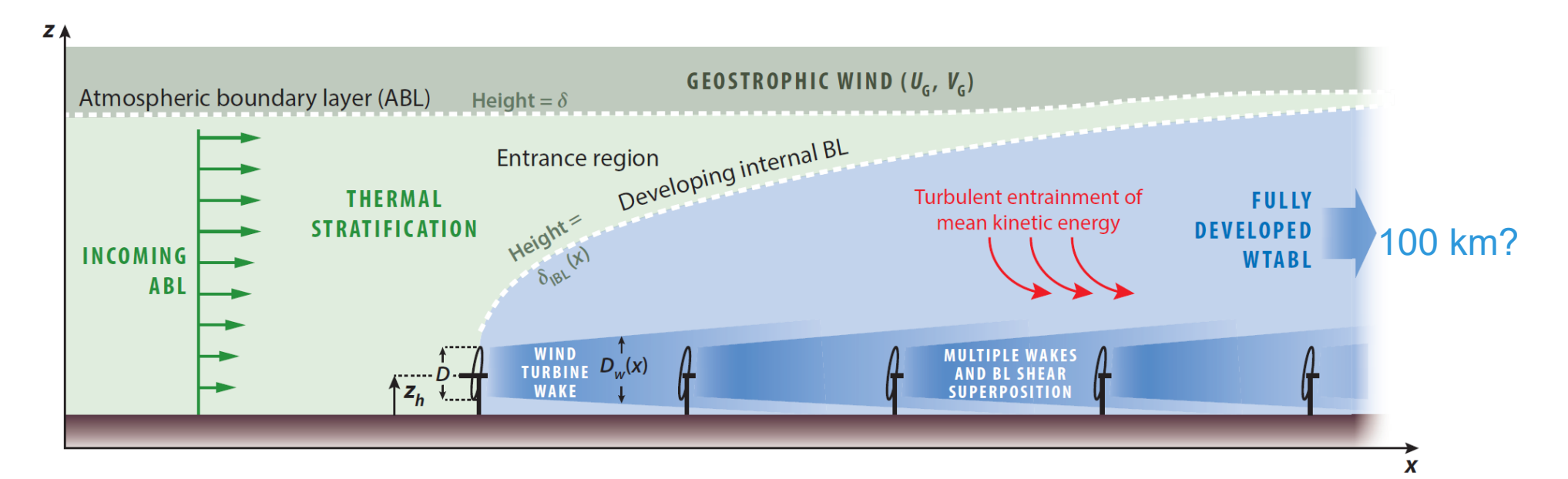
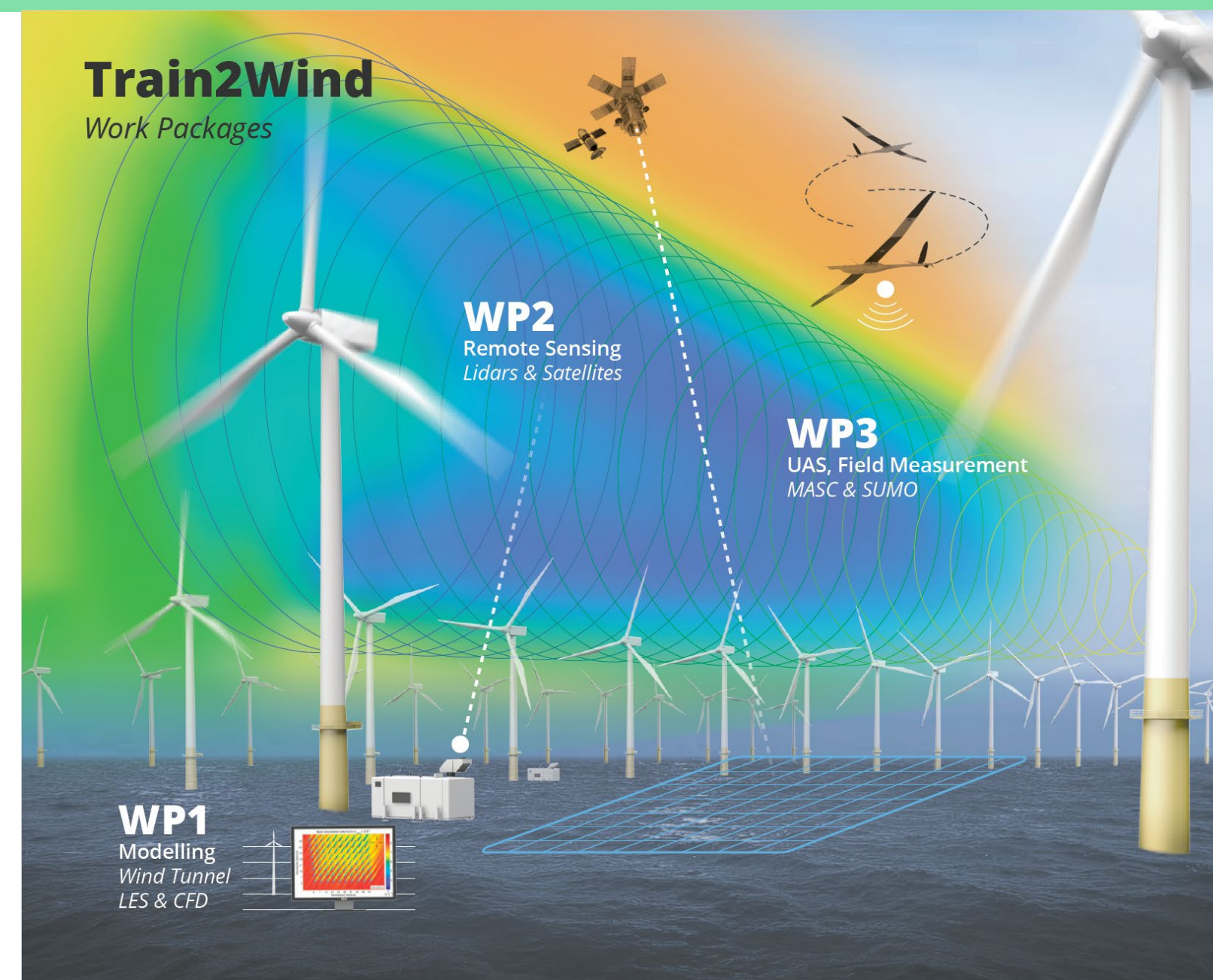


Figure 1. Various fluid mechanical flow phenomena in wind farms, including wakes, their superposition, and interactions with the atmospheric boundary layer (ABL), development of internal boundary layers, and, if a wind farm is large enough, the attainment of a fully developed wind turbine array boundary layer (WTABL) regime. Source: Stevens and Meneveau: *Flow Structure and Turbulence in Wind Farms*. *AnnRevFluidDyn*, 2017

Additionally, one fellow at University of Copenhagen investigates how such a geographically distributed and diverse community of researchers actually collaborates.

Method: A Measurement Campaign in Lolland - Lollex

Initial plan: 3 weeks intense obs in Sept '22



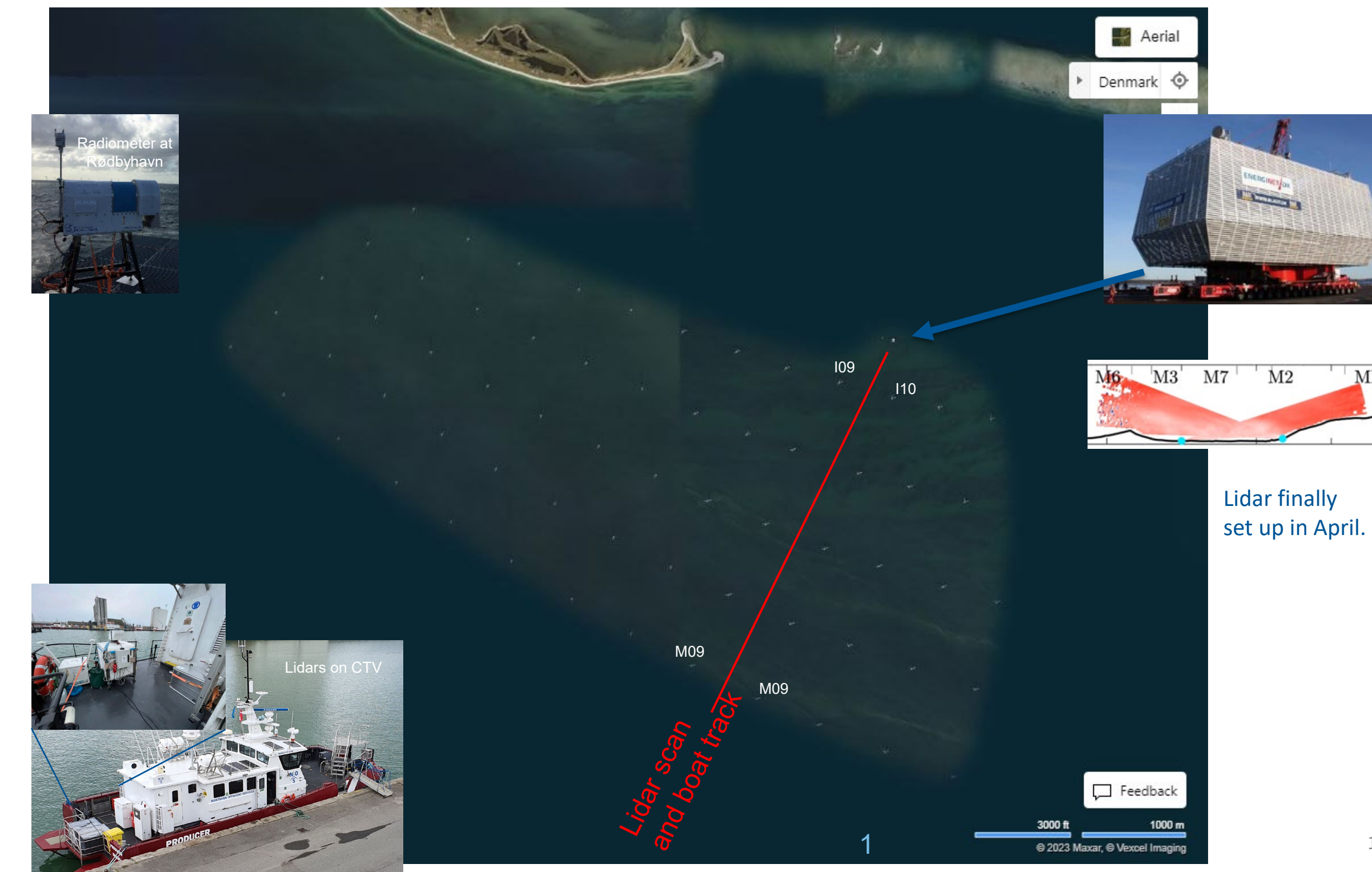
Real life

We started 6 months before the envisaged starting date (Sept 2022) to discuss with flight authorities – too short for the flight permits (we need one for flying profiles up to 600m, and one for flying Beyond Visual Line of Sight). -> Postponed to March 2023. Starting with 2 lidars on the CTV.



Nordstream 2 explosions 27 Sept: no more access to substation to set up lidars. Finally possible from February. Ongoing discussions with flight authorities – 6 months later, still no permit. Therefore, the dedicated boat for the lidar had to be cancelled too.

Actual campaign: April-July '23



Plus: Lidars on CTV since September.

All campaign data will be openly available.

Shokoufeh Malekmohammadi, UiB

Other results by the fellows

Oscar Garcia, DTU

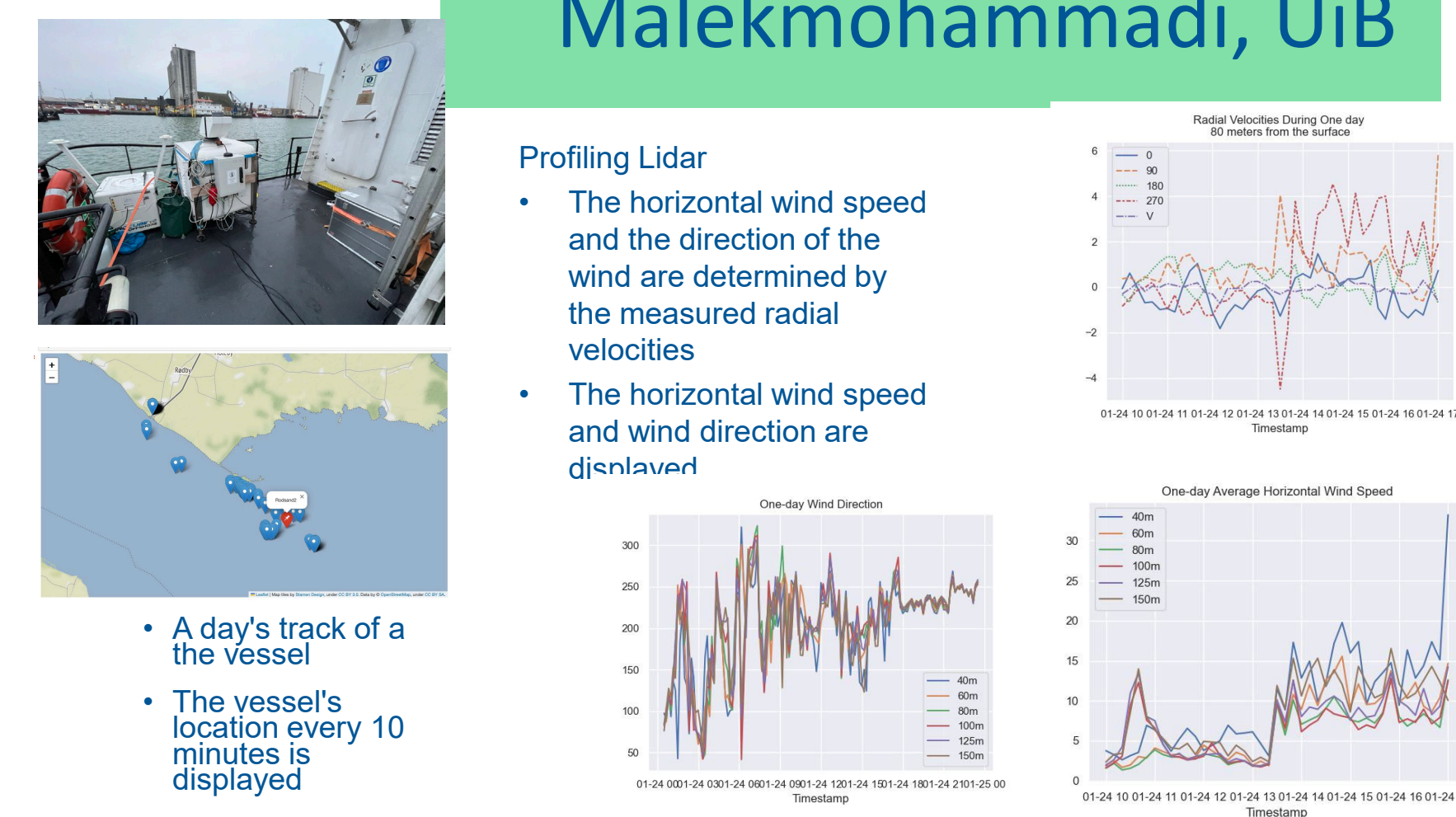
Mesoscale modeling of Nysted and Rødsand II wind farms. We investigate the wake effects using the Weather Research and Forecasting model (WRF) with two wind farm parametrizations (EWP, Fitch) under different atmospheric stability conditions and wind directions. Comparing the "meso" wakes against engineering models. Inflow conditions for every stability case. Wind speed at hub height is 10 m/s for all cases. Mesoscale simulations are done before the campaign to determine atmospheric conditions around the wind farms.

Abdalmenem Owda, DTU

Wind Wakes investigation using Satellite data. We investigate the wind wakes for several offshore wind farms (OWFs) in different regions. Our main focus was to study the hidden relationship between wind wakes and the configuration and capacity of OWFs. Furthermore, quantifying the impact of horizontal coastal wind gradients on wind flow. As far as many OWFs being built close to the coasts, many challenges have appeared and can be studied and investigated using high spatial resolution satellite data, with Synthetic Aperture Radar (SAR) as one main source of data used.

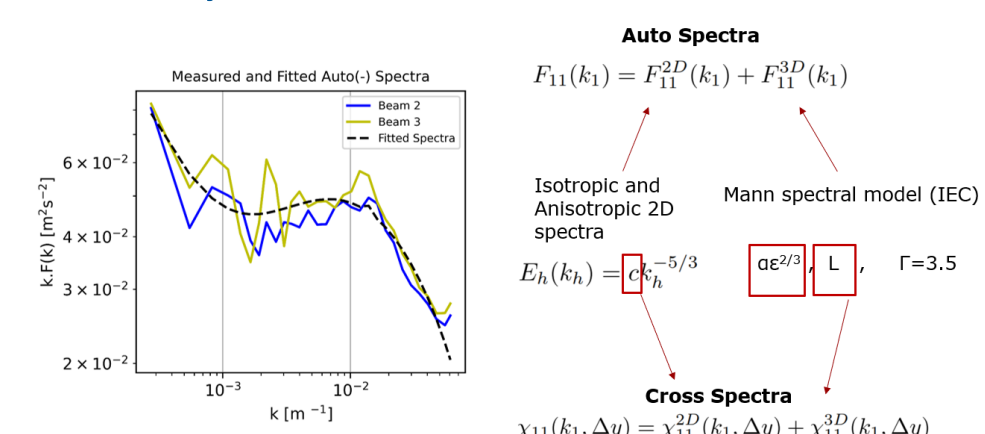
Mauro Ghirardelli, UiB

Sonic Anemometer on a Multirotor UAV. Rotor wings UAV, Motor robotic joint, Sonic Anemometer, Counterweight. How far should the sensor be placed from the main fuselage to reduce the influence of the propellers-induced flow? And in which direction? CFD simulations show that: Horizontal is always better than vertical. Closest distance: 0.63 up to 1.50 D in upwind direction. Attack angle: between 17 and 32° below the horizontal plane.



Abdul Haseeb, DTU

Modeling of the spectra at lower frequencies under different stability conditions.



Accurate prediction of spectra and wind coherence leads to better estimation of loading and turbulence diffusion.

Grischa Fraumann, UCPH

Study of scientific collaboration. Participant observations of preparations for the Lollex experiment, for example, several test flights of UAS and installation of Lidars.

Next steps

- Collect Lollex data, publish the data
- Flight campaigns elsewhere (near Tübingen)
- Finish 13 PhDs
- Studies of wind farm wake control, and vertical axis turbines
- Possibly experiment at floating vertical axis turbine (SeaTwind prototype, Sweden)
- Find financing for Lollex 2, doing the full experiment

V. Savvakis & M. Bramati, EKUT



2 days of test flights in September from the boat, within 120m max altitude regulations – still hoping for the flight permits. The copter also can measure sea spray.

Thanks to RWE / Rødsand site team for continued support!

Train2Wind.eu or @Train2Wind on LinkedIn