COTUR Estimating coherence and turbulence with LIDARs

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About the campaign

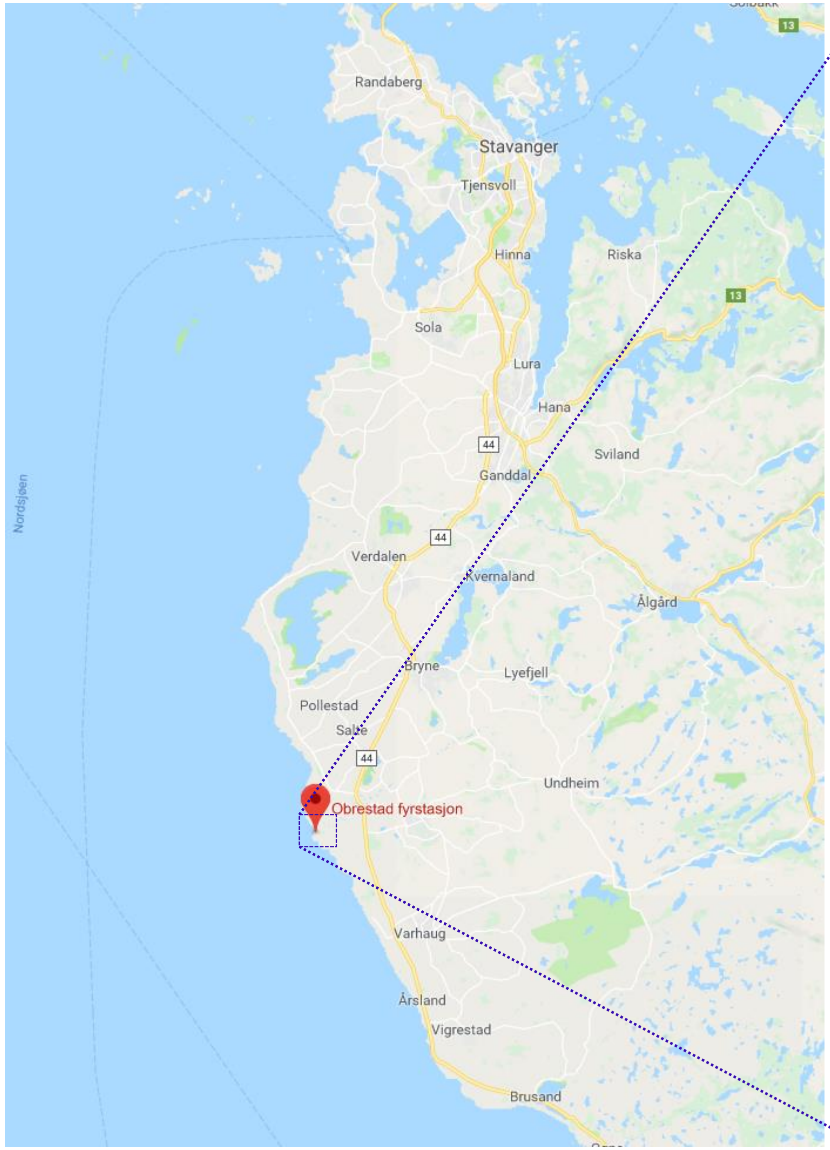
- Participants

equinor NORCE UNIVERSITY OF BERGEN *Geophysical Institute* Universitetet i Stavanger

- Using OBLO infrastructure (UoB)
  - Three 100S scanning LIDARs
  - One vertical LIDAR WindCube V1
  - One passive microwave radiometer

More info about the OBLO infrastructure can be found at https://oblo.uib.no/ and on the OBLO poster in the conference lobby.

Obrestad location



The Obrestad site

- Obrestad Fyr is a light house in Rogaland, opened in 1873
- From 1998, this is a protected area and a cultural heritage site
- The site has an open view of the ocean in a large sector from SW to NW

Some pictures…

Why was Obrestad selected?

NORCE

- In a pre-study in 2017 we identified and analyzed several sites based on the following criteria:
  - Access to suitable power supply and infrastructure
  - Accessibility
  - Free wind inflow conditions (over the ocean)
  - Proximity to meteorological reference measurements, e.g. met-masts, radio soundings, meteorological observation stations
  - Site influence on the wind field (as little as possible)
- Obrestad scored high on all criteria
  - Runner up: Marstein Fyr (more difficult access)

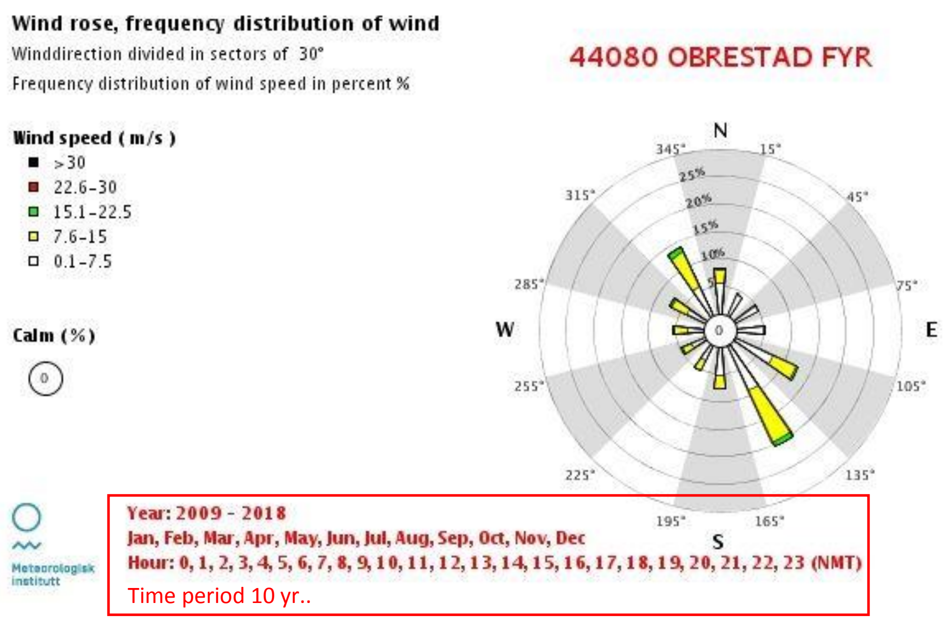
Obrestad

Marsteinen

Obrestad site

- The overview shows the locations of our three WindCube100s LIDAR systems
- A HATPRO-R4 passive microwave radiometer and the WindCube V1 are located together with the WindCube100S at location 1
- The met-station of the Norwegian meteorological institute is located behind location 1

Wind conditions



Main objectives

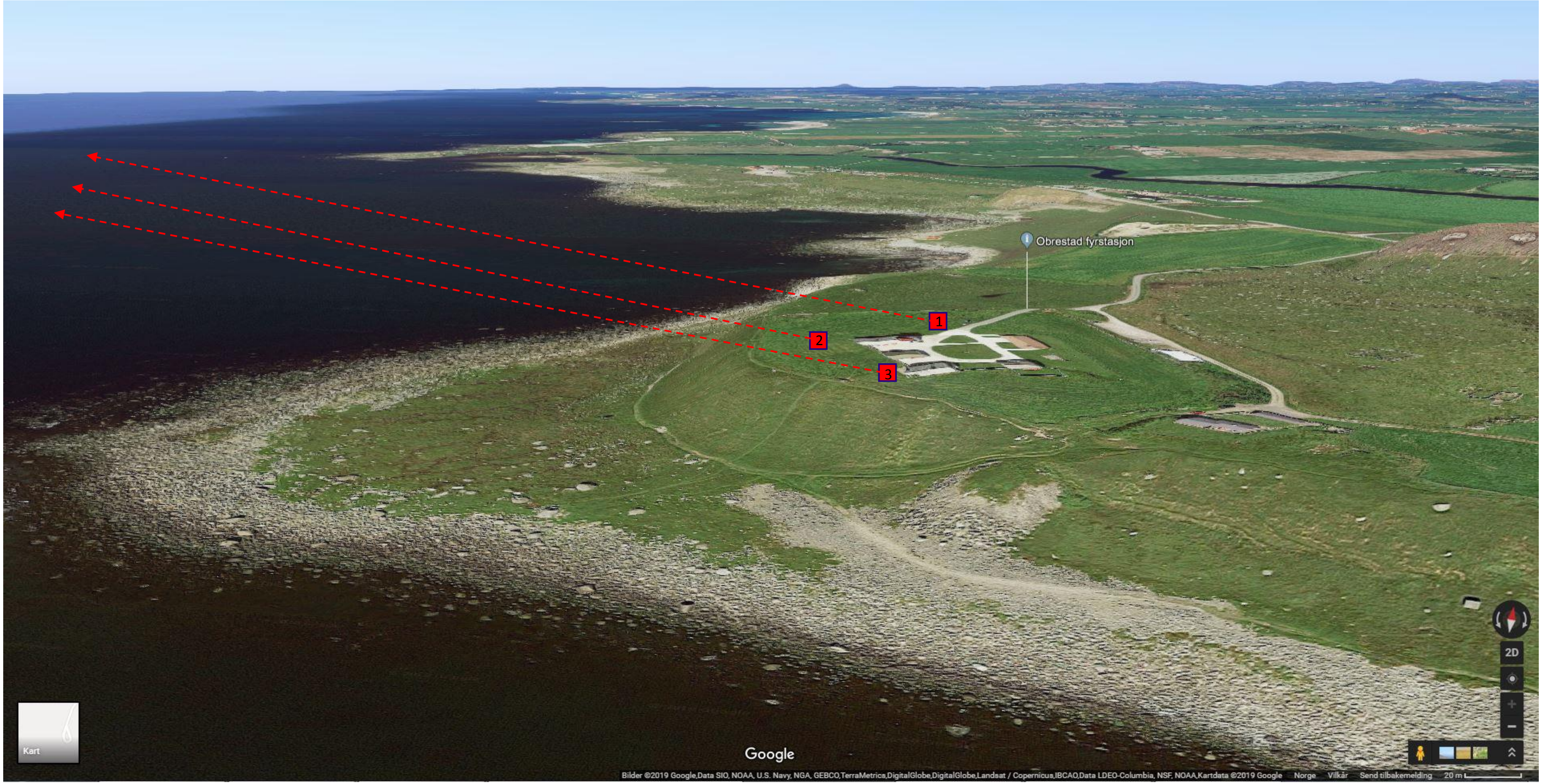
1. Improve our knowledge regarding offshore wind turbulence and horizontal coherence, with respect to offshore wind energy
2. Create a new, unique and highly relevant dataset which is available for future offshore wind energy research
3. Store the collected data and corresponding meta-data in a database for later analysis

The collected data and the performed analysis is highly relevant with respect to load estimations on multi-megawatt offshore wind turbines.

Relevant key research questions

- What is the appropriate averaging time for turbulence analysis under different meteorological conditions when focusing on large offshore wind turbines?
- What are the characteristics of the horizontal coherence offshore?
- How does horizontal coherence relate to different atmospheric conditions offshore?
- How does the observed horizontal coherence compare to the industry standard?
- Is there a feedback from waves on horizontal coherence structures?

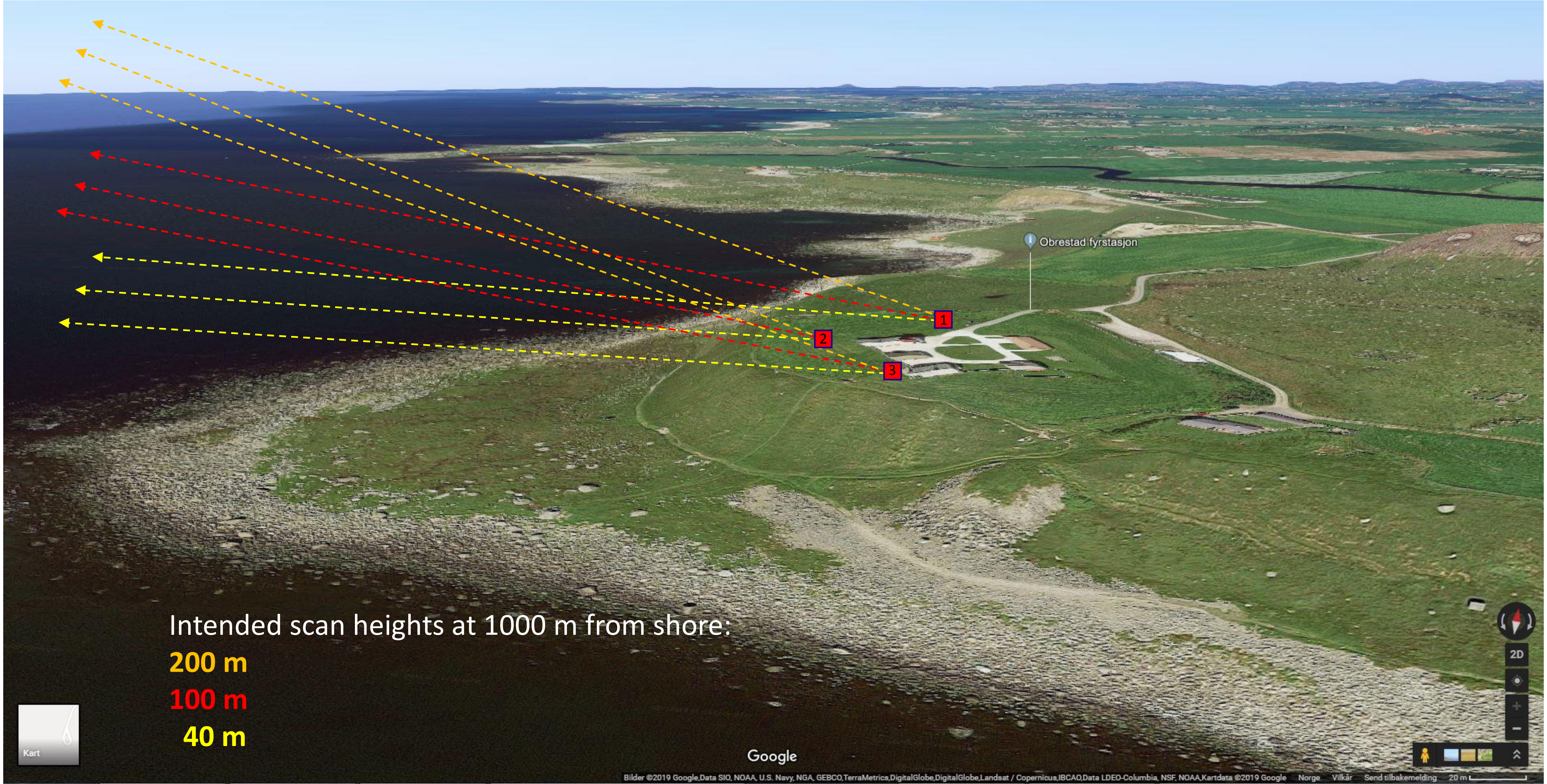
Scanning over horizontal distances



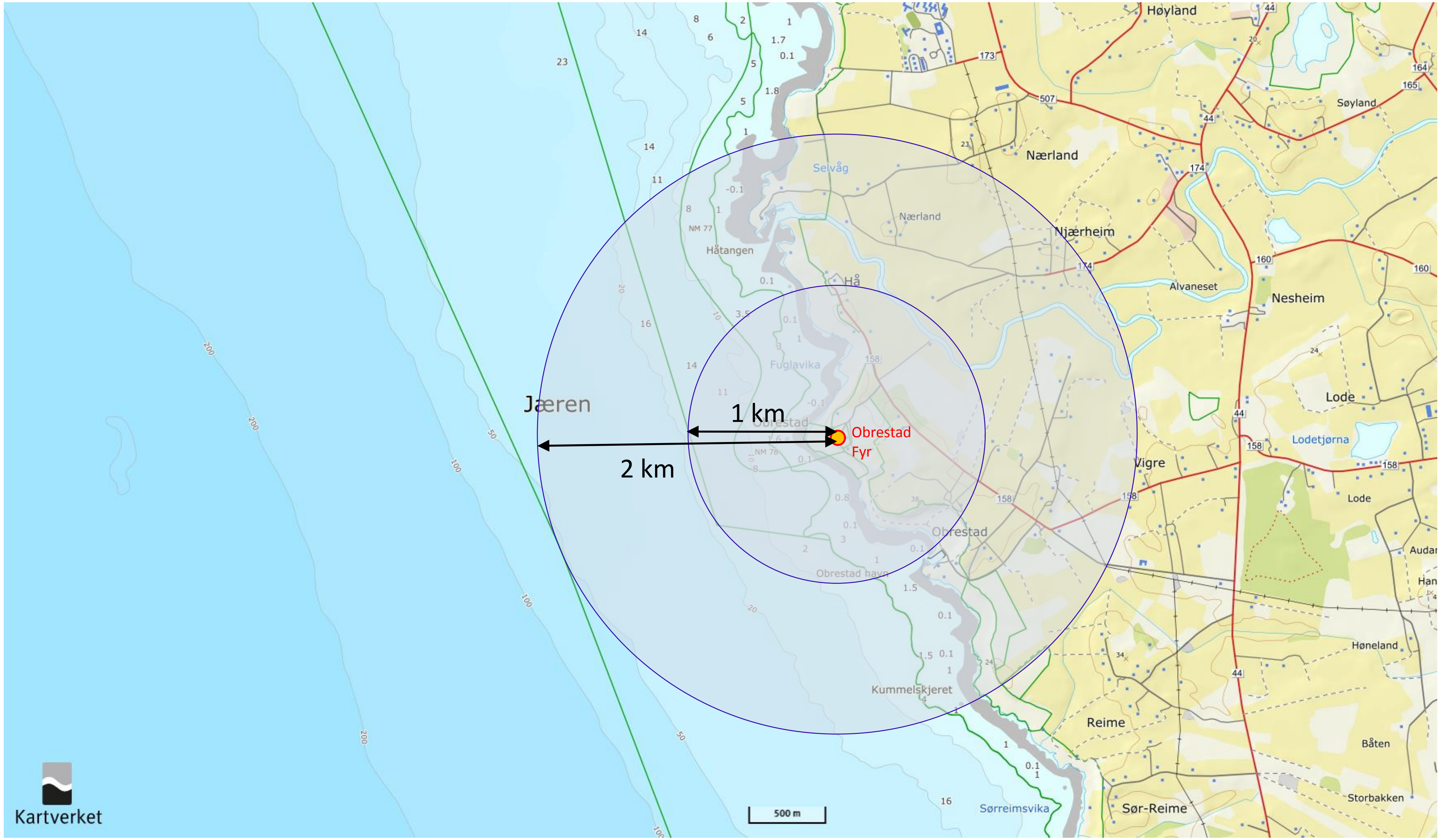
Measuring wind turbulence and coherence with LIDARs

- Horizontal distance between LIDARs: 60-120m
- Parallel scanning beams
  - Enables measurement of horizontal coherence at relevant distances for offshore wind energy
  - We aim to keep the same separation distance at all ranges
  - Enables comparison with results from existing literature

Scanning at different heights

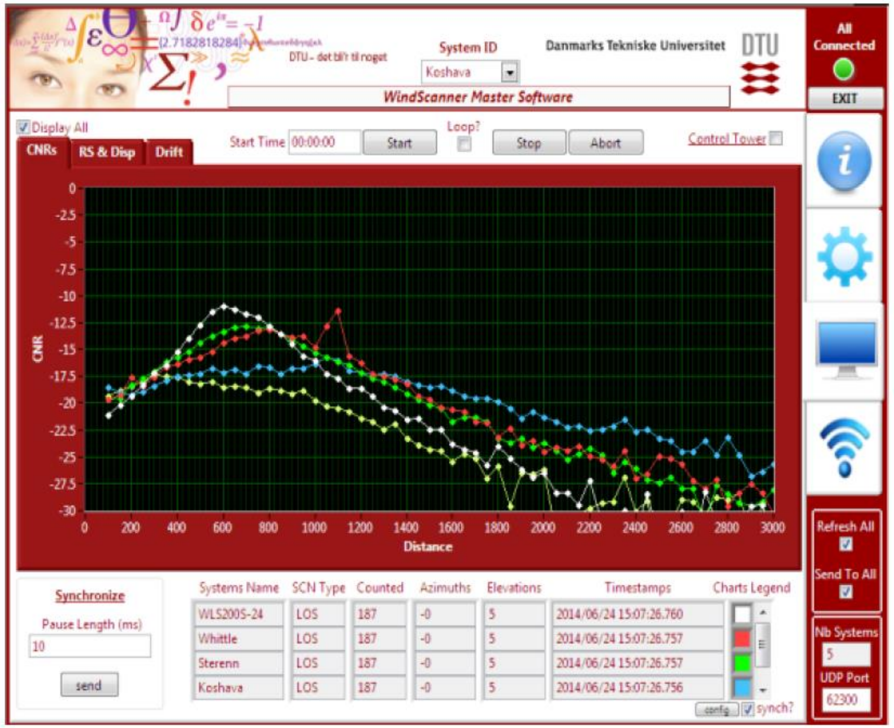


Scanning range



Windscanner software

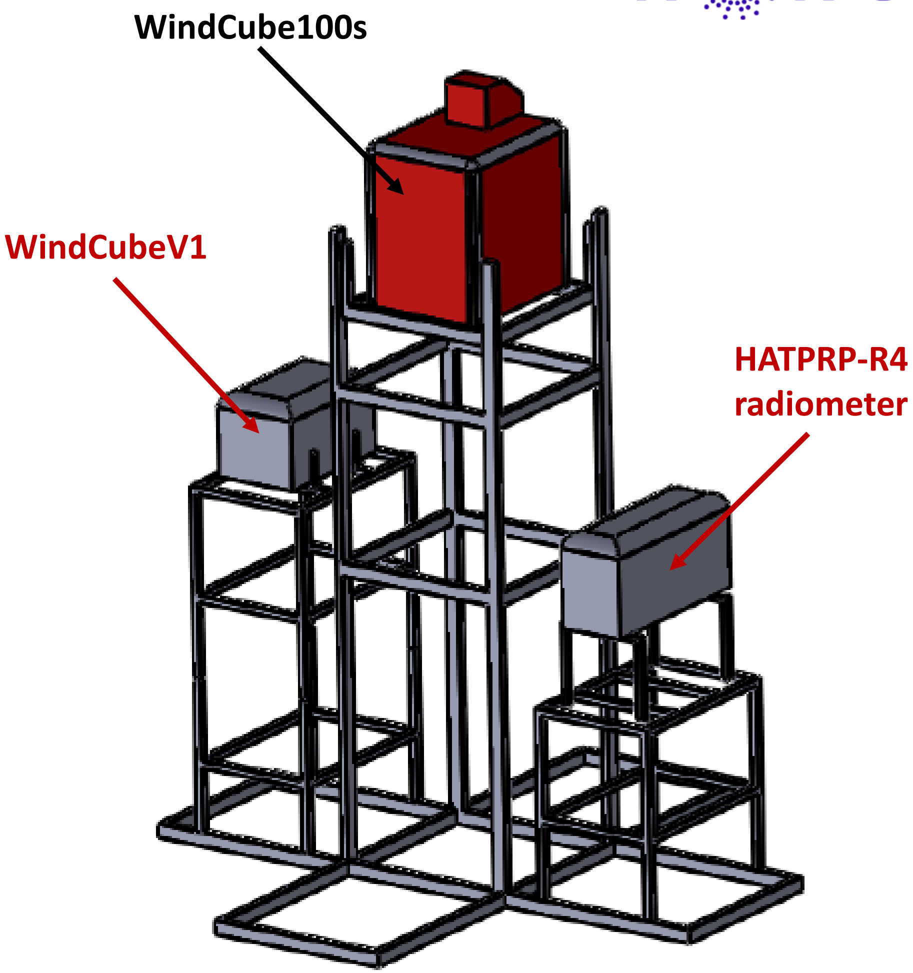
- Developed by DTU
- Enables synchronization of the LIDARs and more advanced scan patterns



Courtesy of DTU

Platforms / frames

- Original plan: place LIDARs on top of containers
  - Had to be changed due to the visual disturbance (popular place for tourists)
- New plan: Build frames in aluminum beams
  - Deformation/strength study performed by third party
  - The instruments have been installed by lifting them inside the frame by using pulleys and winches



NORCE

The measurement campaign will last for 12 months.

All equipment will be removed and we leave “nothing but footprints”.

Permissions:

- Coastal administration – operators of the lighthouse
- County governor in Rogaland – natural conservation laws
- Hå municipality – owners of the property
- Rogaland county municipality – cultural heritage laws

Publication of results

- Results of data analysis will be openly published and will be used for educational purposes
- The data itself is owned by the parties in the project

Thank you for your attention!

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