



Credit: Simo Rissanen / Kjeller Vindteknikk Oy

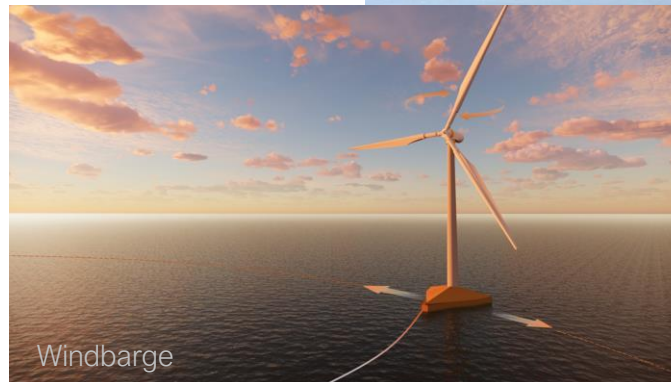


Measuring and simulating offshore wind: Hands-on experience and challenges in the North and Baltic Seas

EERA DeepWind 2025, Christiane Duscha, Hálfván Ágústsson, Martin Sigurd Grønsløth
Trondheim, January 15, 2025

Expertise and Services

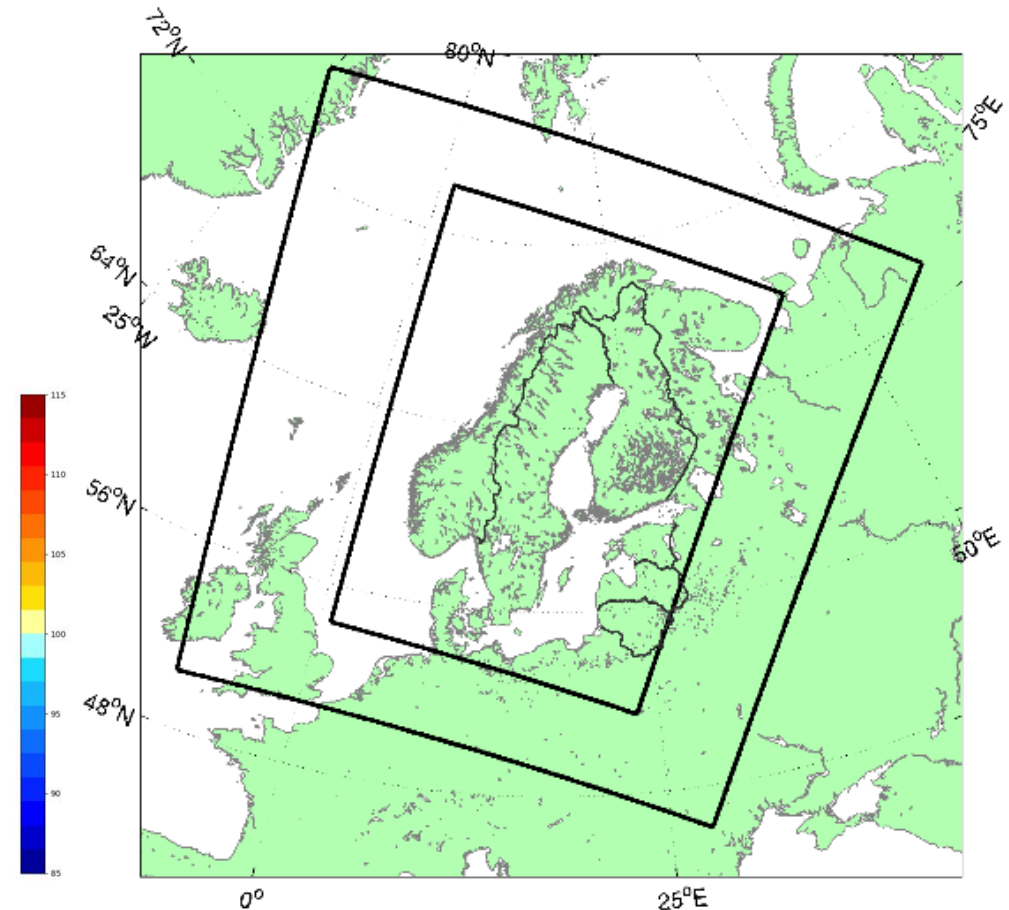
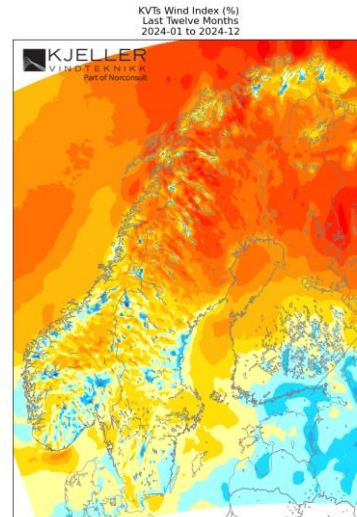
- ▶ Science based consulting in applied meteorology with focus on wind and icing
- ▶ Combination of:
 - ▶ Measurements and instrumentation
 - ▶ Modelling and analysis
- ▶ Metocean measurements and simulations
 - ▶ Offshore wind energy yield assessment
 - ▶ Environmental assessments for sustainable solutions for onshore connection
- ▶ Marine structures
 - ▶ structural engineering
 - ▶ hydrodynamical analysis



Numerical weather prediction

Forecast and hindcast with Weather Research and Forecast model

- ▶ Optimized for wind and icing analysis
- ▶ Continuously updated simulations (since 1979)
- ▶ 3km x 3km horizontal resolution (inner domain)
- ▶ Increased resolution (300m to 1km resolution) for smaller domains and periods
 - ▶ Study area/ measurement site
 - ▶ Validation
- ▶ Product: Norwegian Wind Atlas, validated with data from meteorological masts



Mast measurements

- ▶ Long history of operating large number of tall meteorological masts

Current example for offshore project:

- ▶ 150 meter self-supporting mast (for Wergeland group)
- ▶ Reference data for offshore wind turbine planned to be located at the site (5-years testing period)
- ▶ Challenge: representativeness for offshore conditions



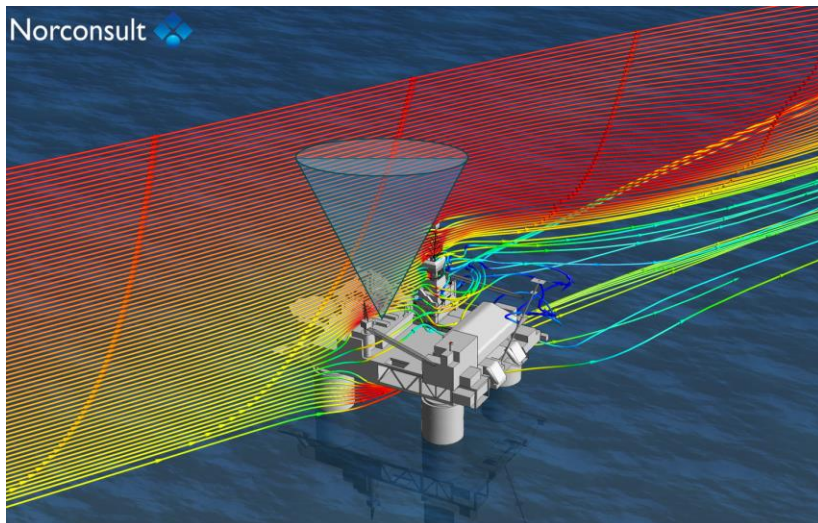
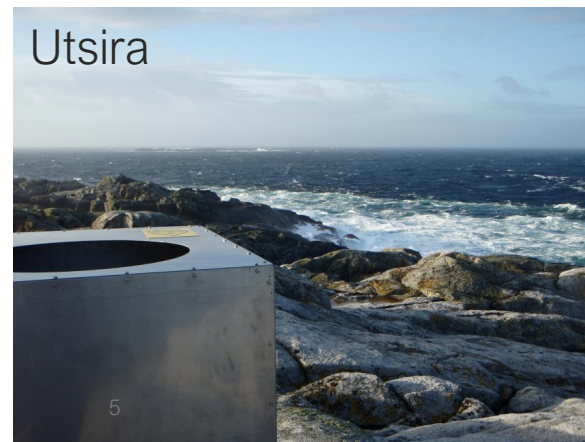
@Bjørn Christian Freitag

See: https://www.linkedin.com/posts/kjeller-vindteknikk_mast-wind-measurement-activity-7201477432019673089-91WL/

Offshore lidar campaigns

Different approaches and platforms

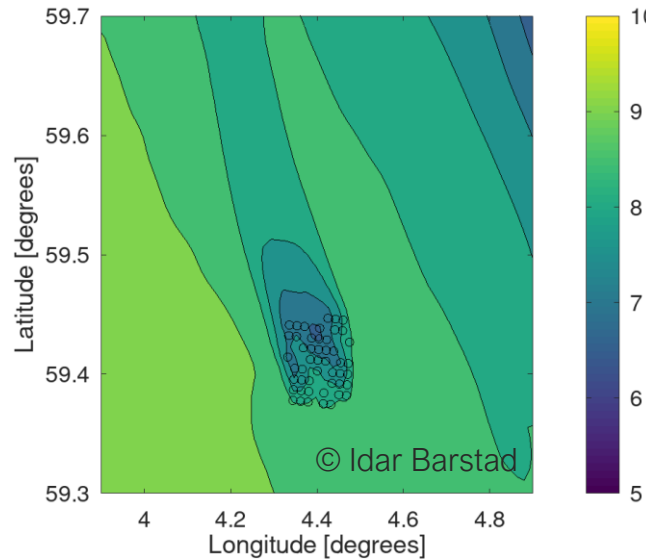
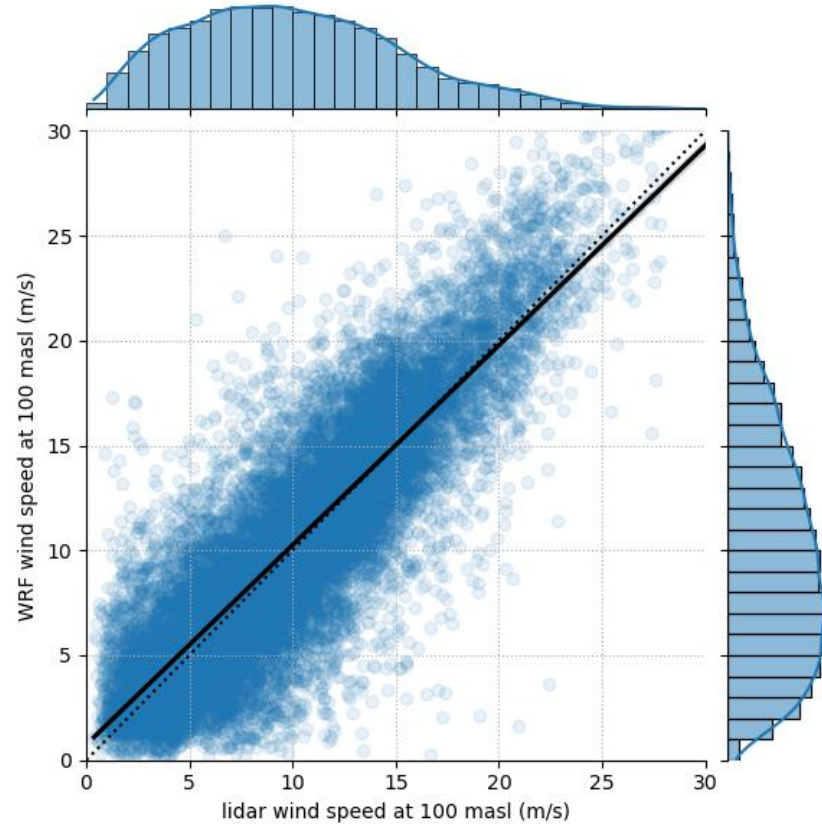
- ▶ Utsira (island): profiling lidar
- ▶ Offshore installation of profiling lidar (on platform):
 - ▶ Oulu lighthouse (fixed)
 - ▶ Goliat platform (floating)
- ▶ Sulafjorden: onshore scanning lidar, masts, floating profiling lidar



Utsira

**Location: Norwegian Island, North Sea
Project for Statoil (now Equinor)**

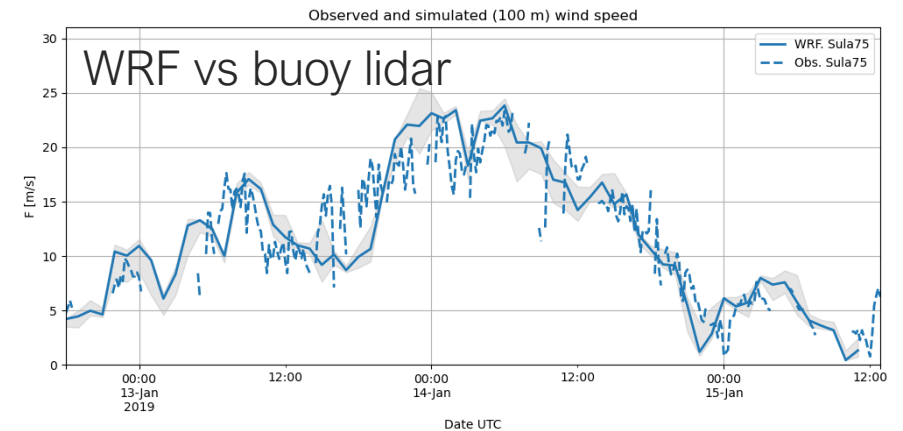
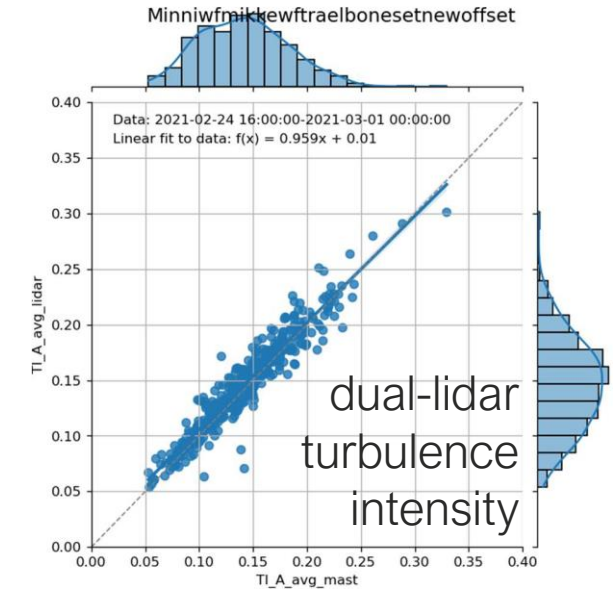
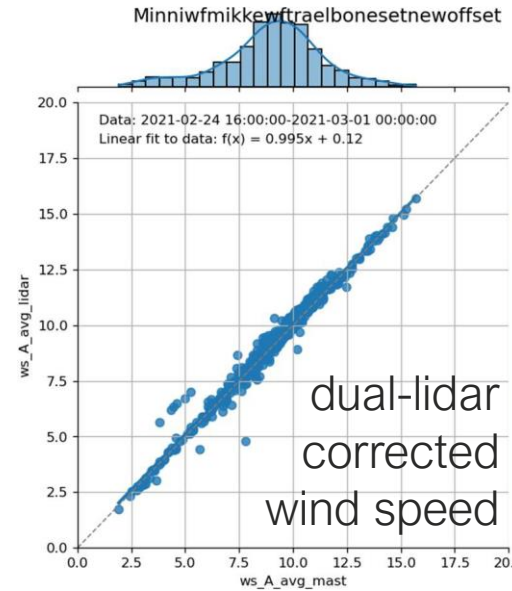
Validation of WRF model (3km x 3km)
with lidar data (Sep 2009 – Feb 2012)



► Simulation of wind park wakes
for the Utsira area using WRF
(for NorthWind FME)

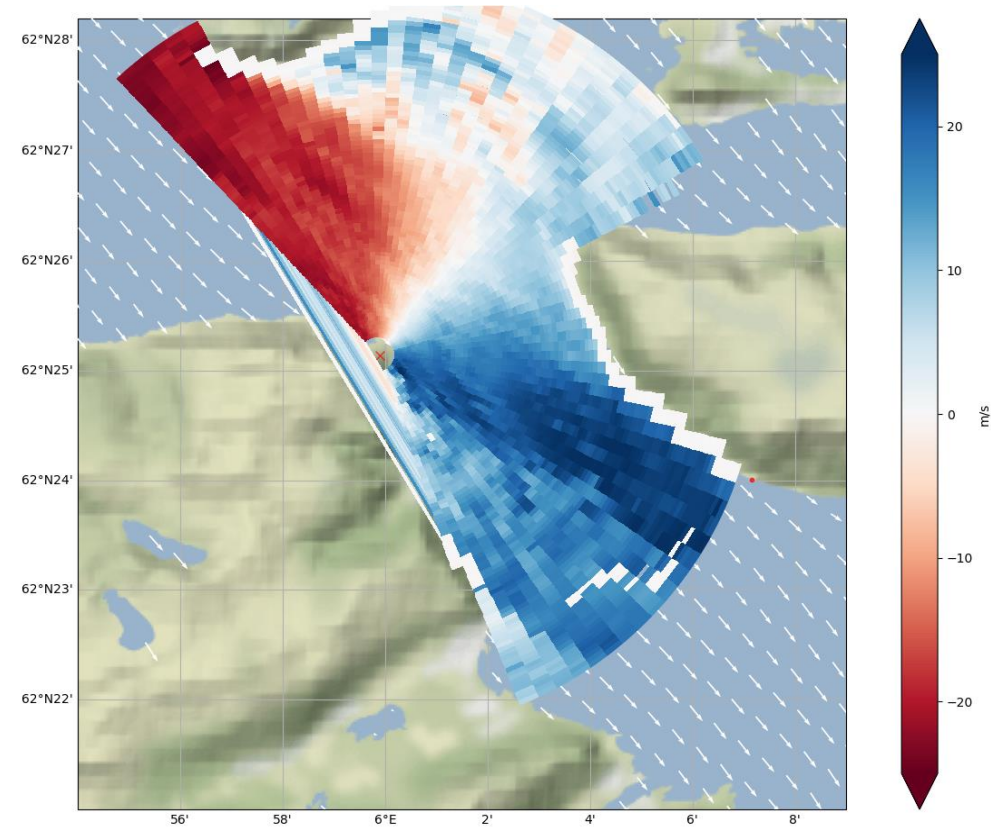
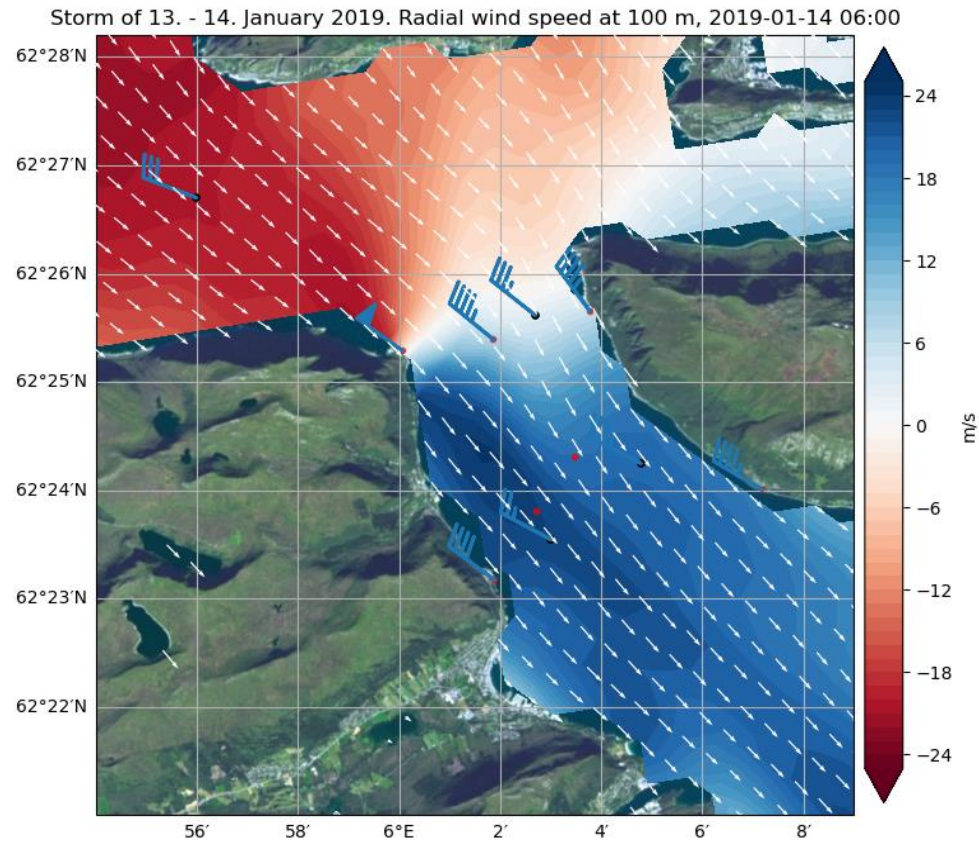
Sulafjorden (lidar + meteorological masts)

For Statens Vegvesen, in cooperation with Met Norway and Fugro



Sulafjorden

WRF simulations vs. scanning Lidar



Summary

Mast	Profiling lidar	Multi-scanning Lidar	Model
<ul style="list-style-type: none"> - Robust and high quality - Validation (simulations and measurements) 	<ul style="list-style-type: none"> - Remote installations - Offshore platforms - High data availability even in extremely cold climates 	<ul style="list-style-type: none"> - High quality retrieval of wind properties - Large spatial coverage - Reveal weaknesses in other measurements and simulations 	<ul style="list-style-type: none"> - Potential to fill gaps in complementing measurements - Simulation of planned offshore wind projects
<ul style="list-style-type: none"> - Representativeness (coast vs. offshore) - In cold climate: freezing of sensors 	<ul style="list-style-type: none"> - Platform movement/draft - Impact on wind field 	<ul style="list-style-type: none"> - Synchronizing lidars at spatially separated locations - Directional offset 	<ul style="list-style-type: none"> - Representative validation (time and spatial resolution)



Every day we improve everyday life