Using SST for improved mesoscale modelling of the coastal zone

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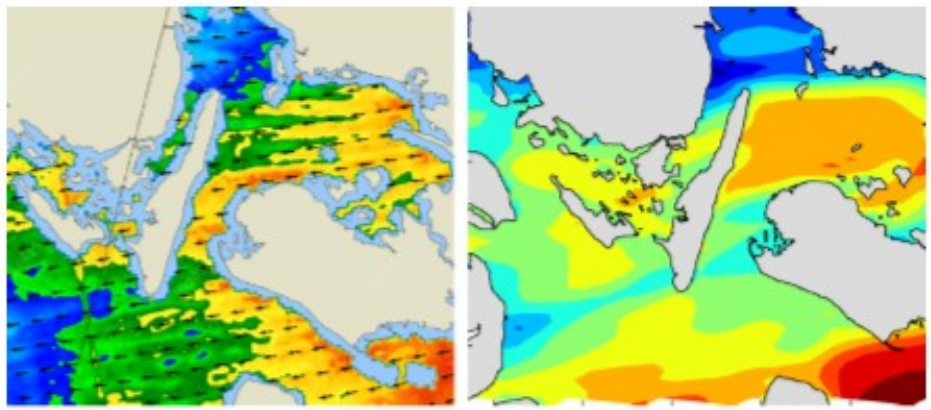
Outline

Motivation

- Many offshore wind farms planned in near-coastal waters:
  - high winds
  - easier connection to the grid
- Model uncertainty of the coastal wind climate is large:
  - roughness changes
  - stability changes
- Is the accuracy of mesoscale models in capturing the coastal flows, accurate?

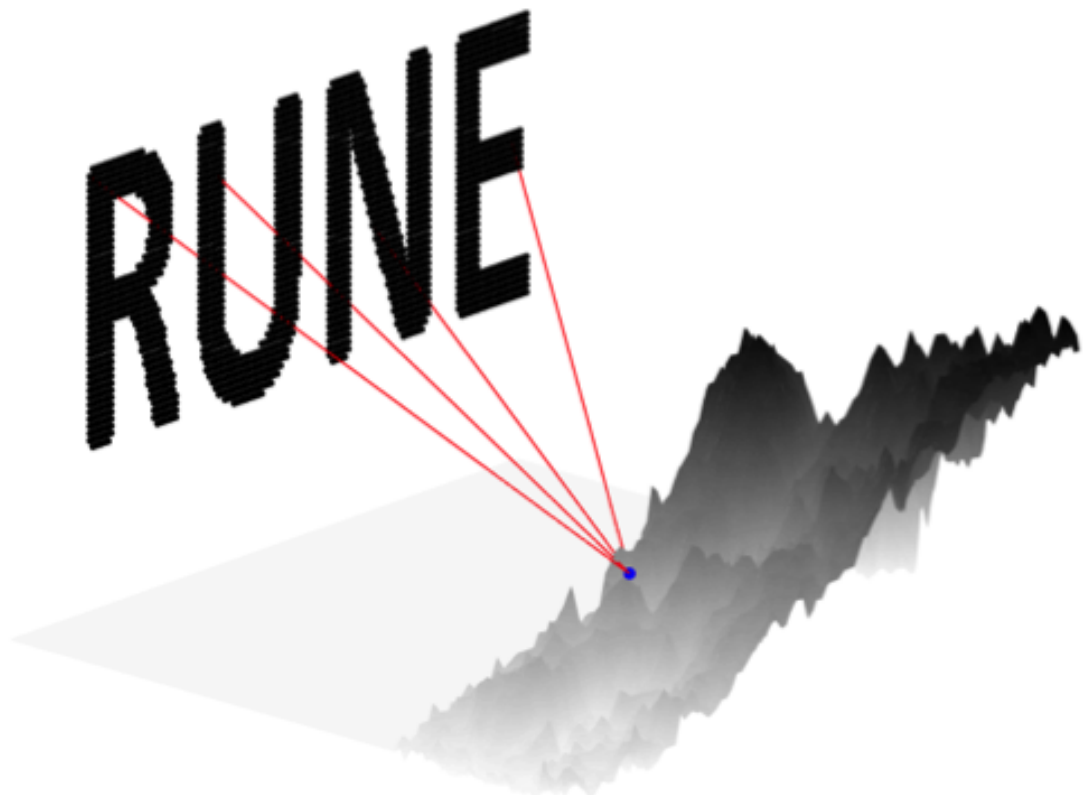


SAR 10-m winds WRF 10-m winds

RUNE

Reducing Uncertainty of Near-shore wind resource Estimates (RUNE)

- How can mesoscale models be enhanced to better predict near-shore wind resources?
- If and how can the uncertainty of modelled near-shore wind ressource estimates be reduced using short-term in situ lidar measurements
- If yes –> By how much?



Campaign duration: November 2015 - February 2016

Measurement Set-up

- 1 dual Doppler system
  - Resolution ∼50 m
  - Scanning for ∼1 s
- 1 sector scanning system
  - Resolution ∼200 m
  - Scanning for ∼45 s at 60°
- 4 profiling LIDARS
  - Resolution ∼20 m

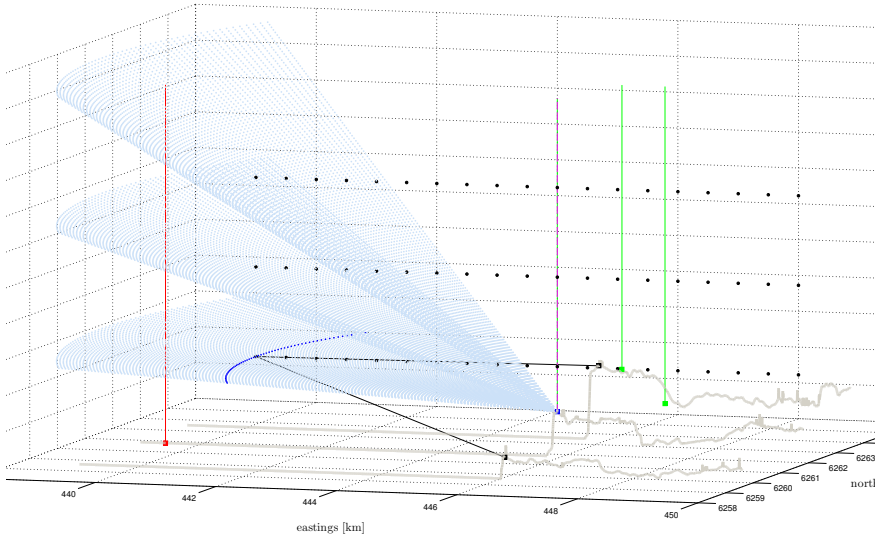


Figure: 3D overview of the measurements. Blue points: range gates from the scanning LIDAR, black points: dual Doppler, vertical lines: profiling LIDARs.

Figure: Loctions of the onshore LIDARs, the floating LIDAR and the wave buoy.

Example of Measurements

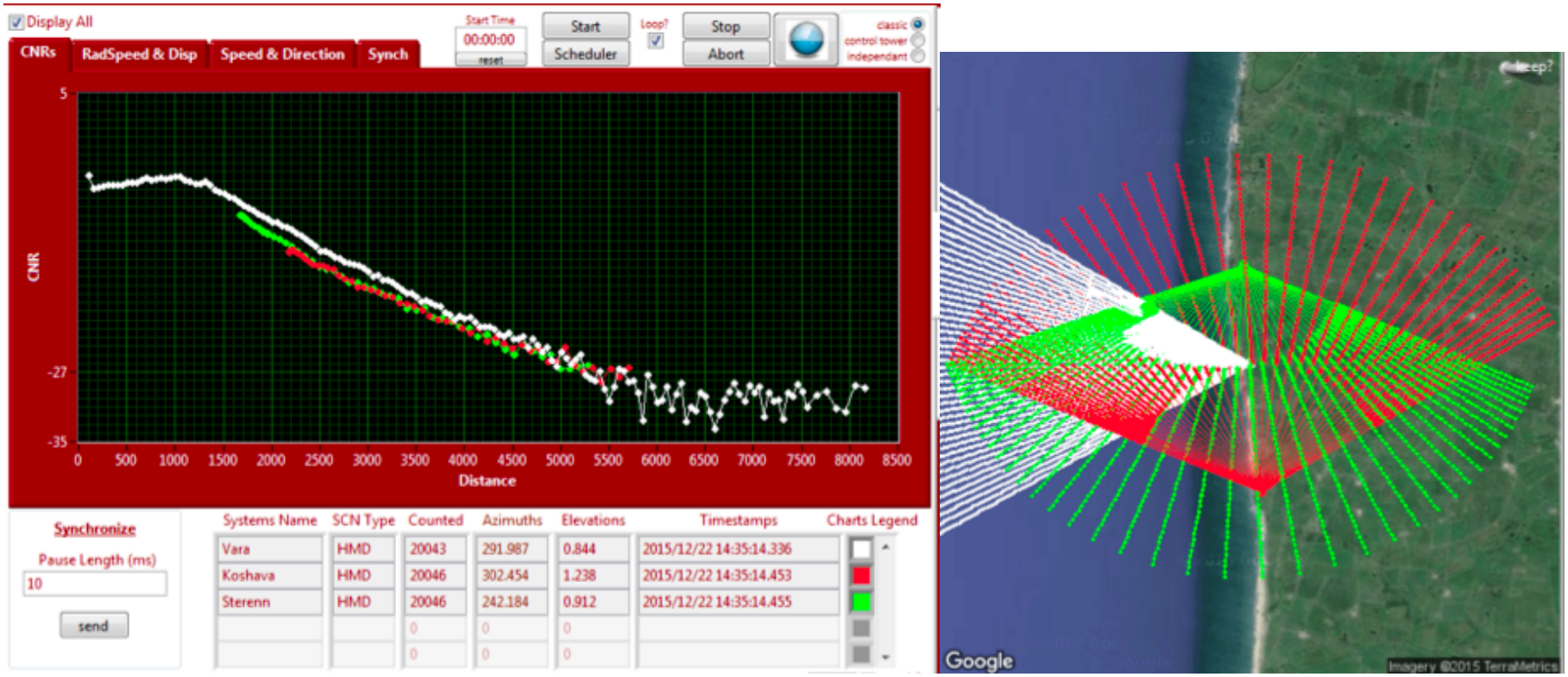


Figure: Carrier to Noise Ratio (CNR) as a function of distance (left) and scanning pattern (right).

WRF

- 2 SST products
  - Daily DMI L4 SST 0.02 deg
  - Daily OI SST v2 0.25 deg
- 2 land use classifications
  - USGS
  - CORINE (250 m)
- 2 PBL schemes
  - MYJ
  - YSU
- 4 spatial resolution set-ups
  - 18, 6, 2 km
  - 12, 4, 1.3 km
  - 9, 3, 1 km
  - 13.5, 4.5, 1.5, 0.5 km

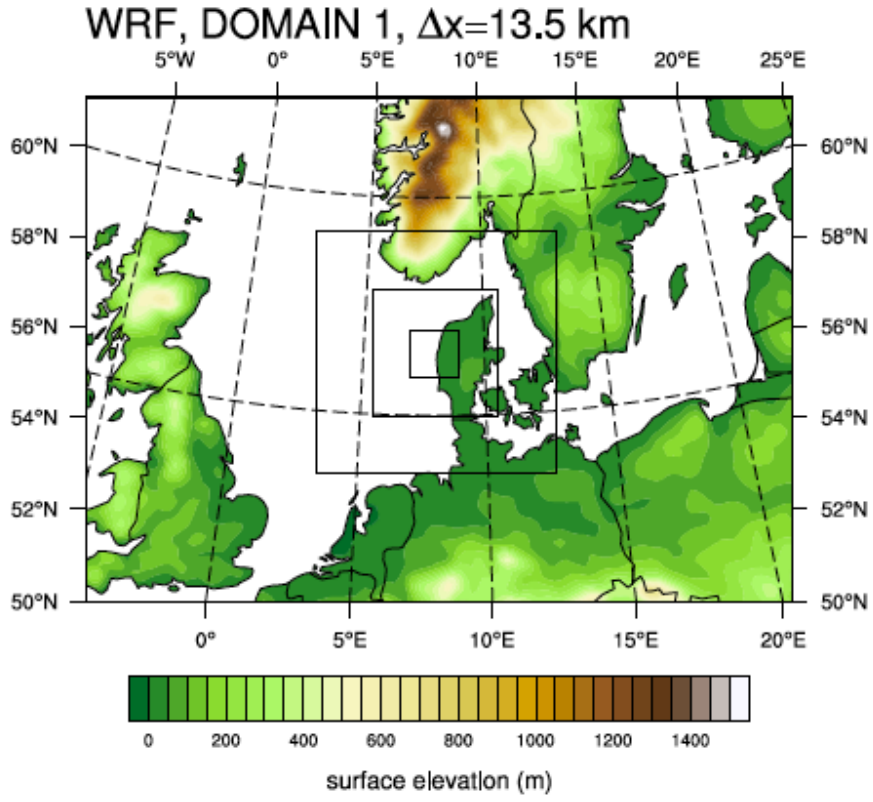


Figure: Domain configuration for the RUNE sensitivity simulations

Example of land uses and resolution

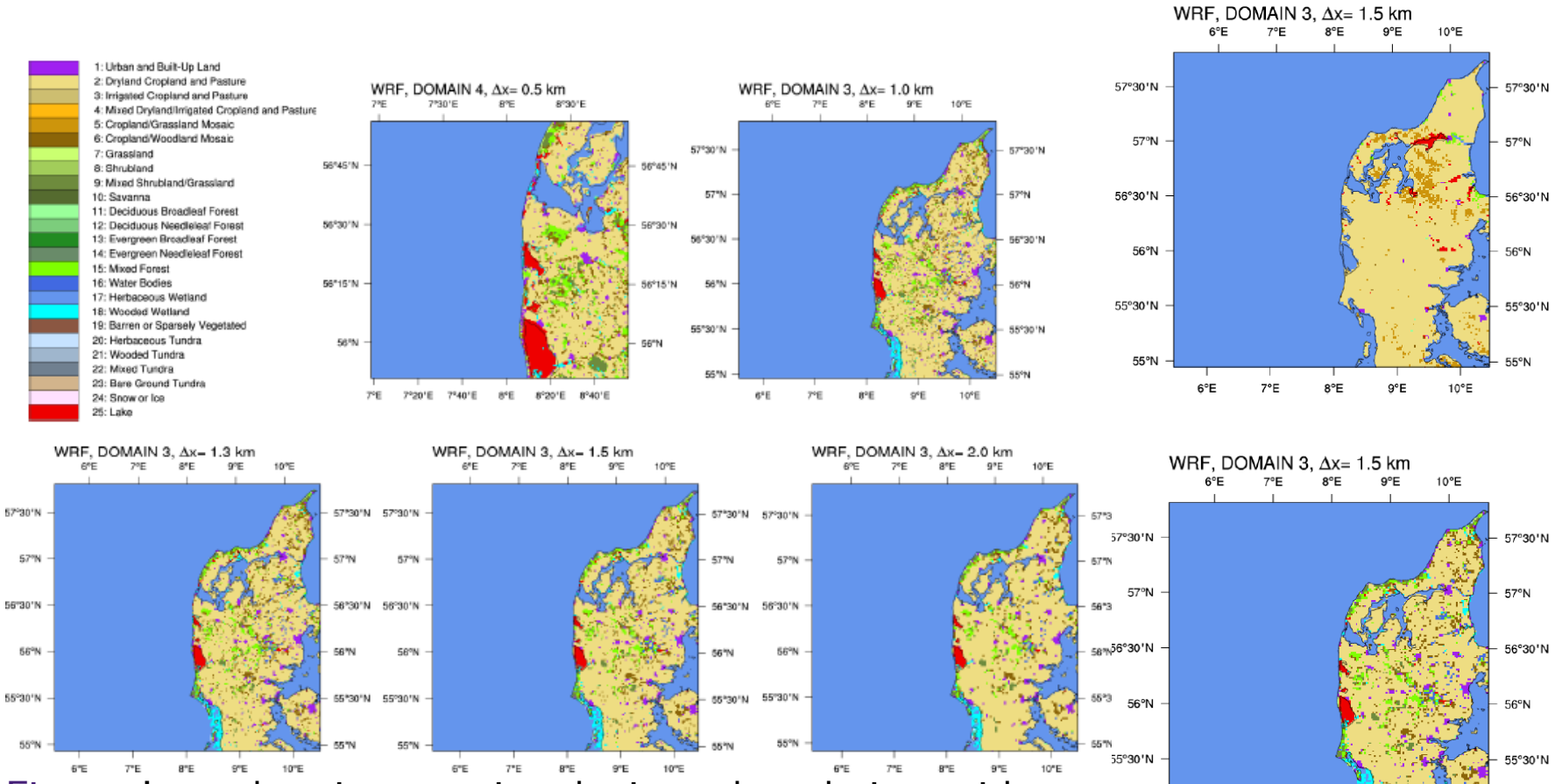


Figure: Inner domains at various horizontal resolutions with the CORINE land use.

Figure: USGS (top) & CORINE.

Sensitivity of the coastal gradient

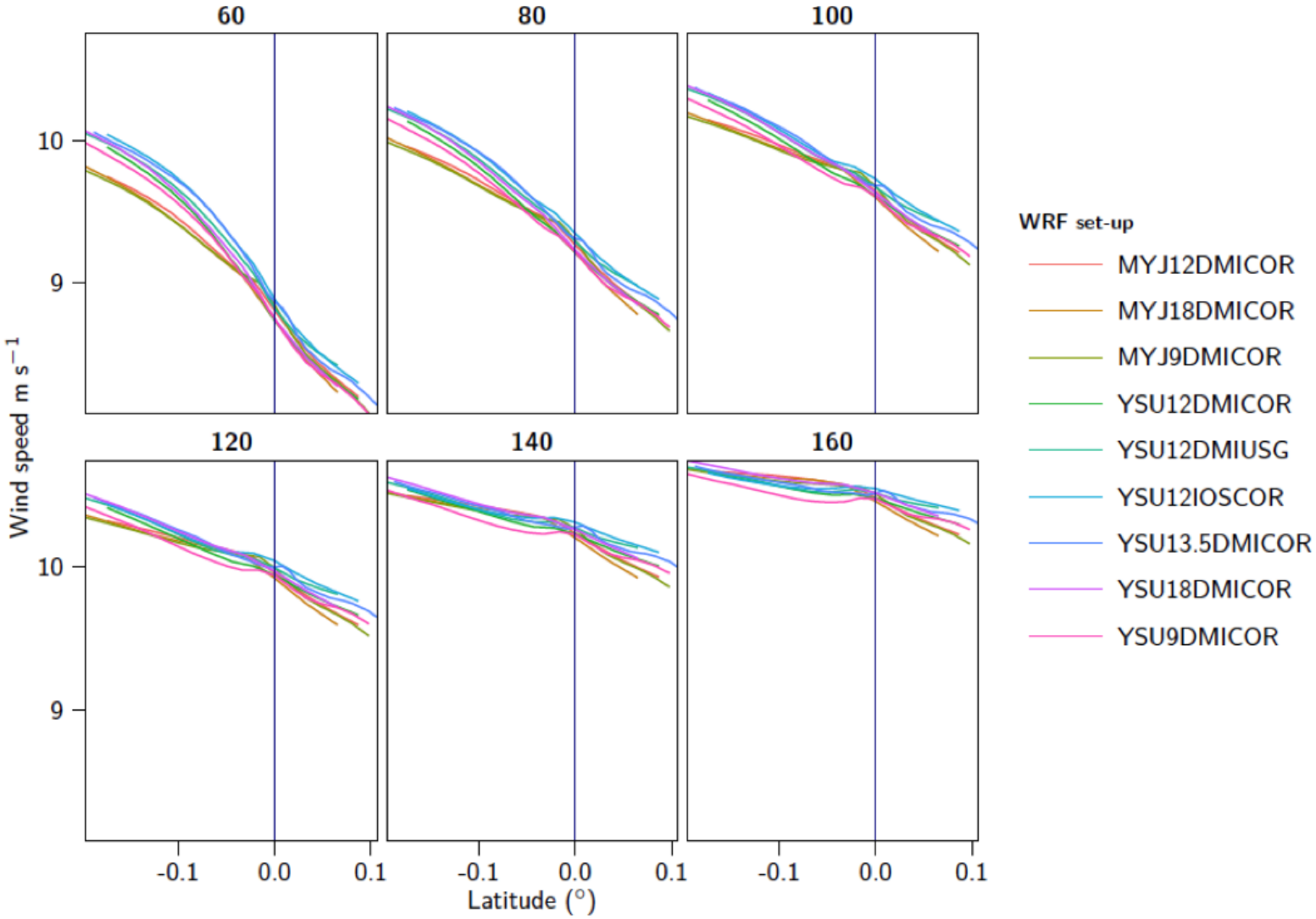


Figure: Wind speed evolution from offshore (left) to onshore (right) for different heights

Sensitivity Tests

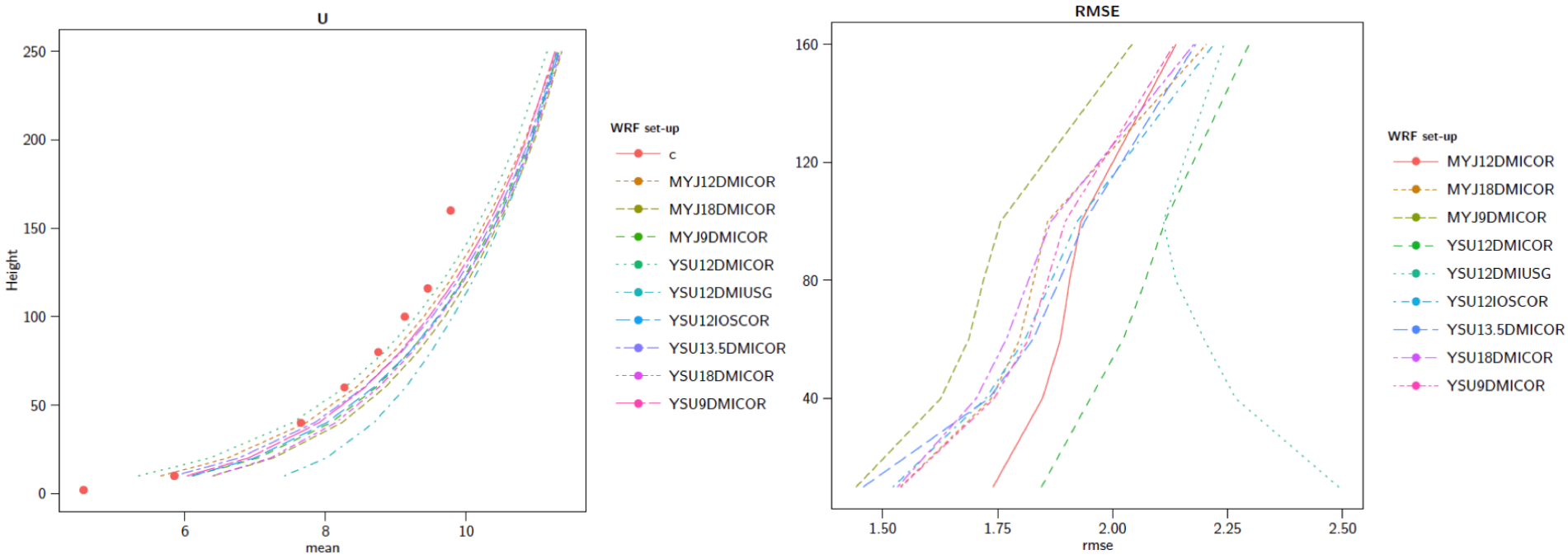


Figure: Mean wind speed profile from the cup anemometers (c) and different WRF set-ups, at Høvsøre. Right: RMSE of the wind speed profile between measurements and WRF simulations.

Combined LIDARs, WRF & TerraSAR-X

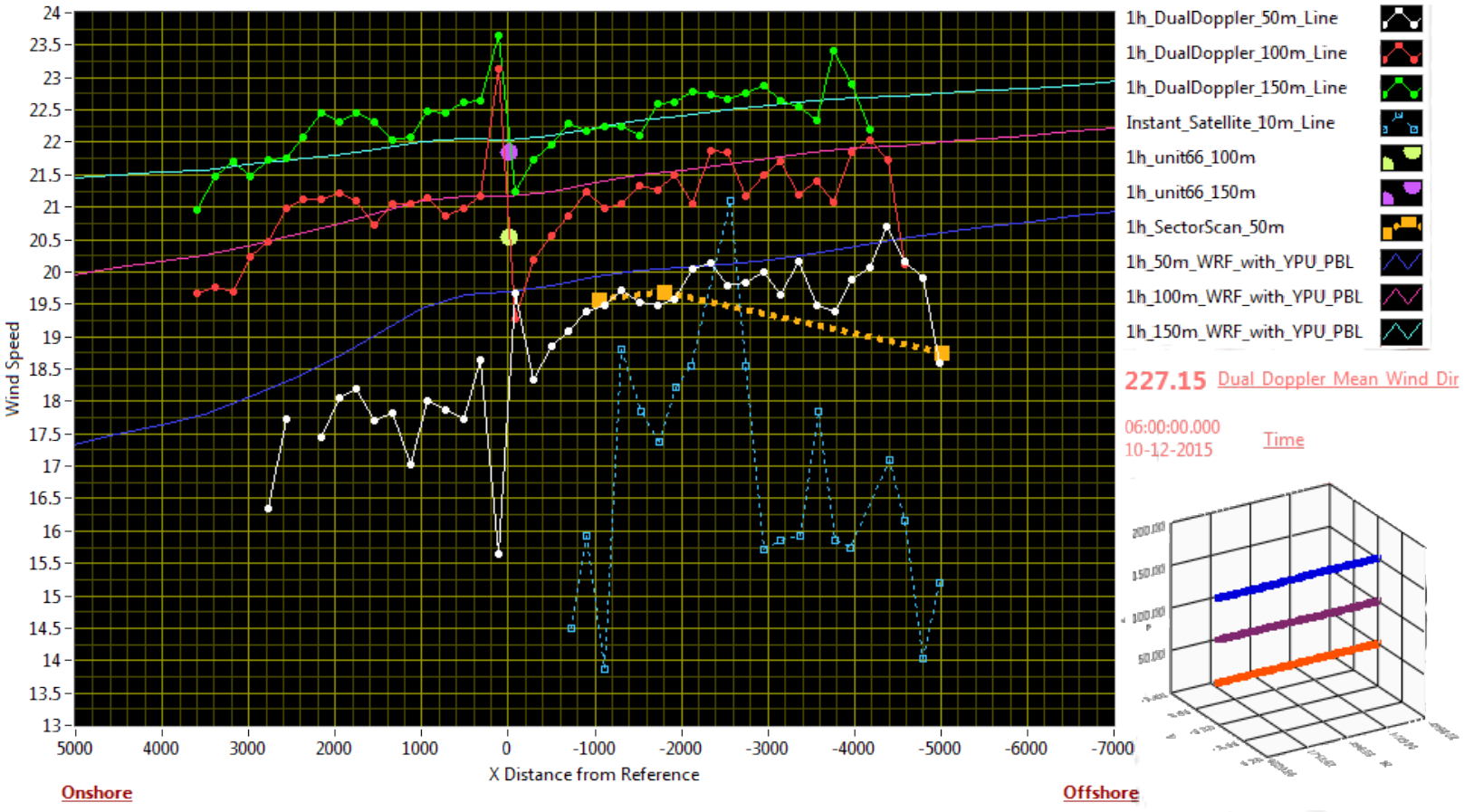


Figure: LIDAR Dual & Sector scans, Profilers, WRF & TerraSAR-X on December 10 2015, 06:00.

WRF vs LIDARs

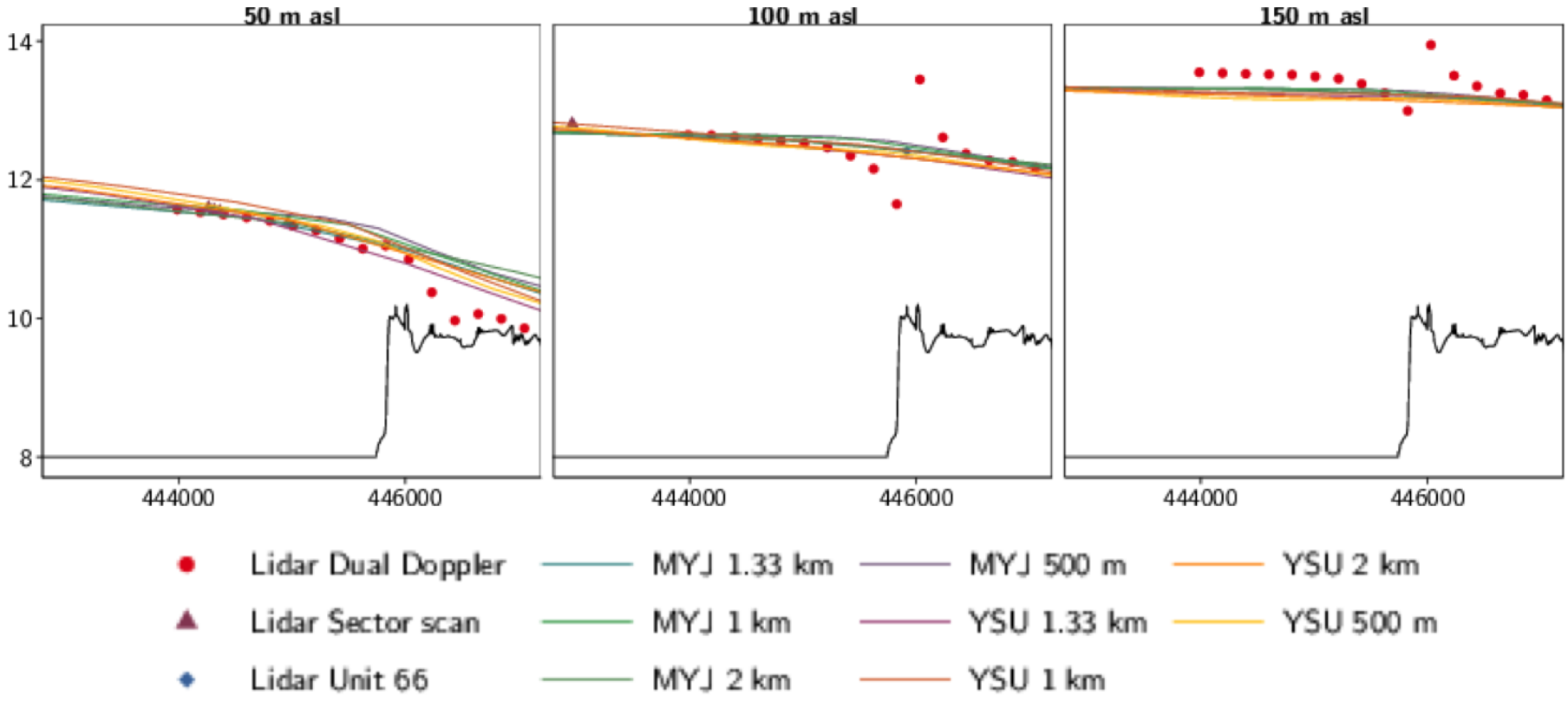


Figure: Mean wind speed using 3368 10-min measurements with 100% availability of the DD up to a distance of 2 km offshore and onshore (total 5 km).

WRF vs LIDARs

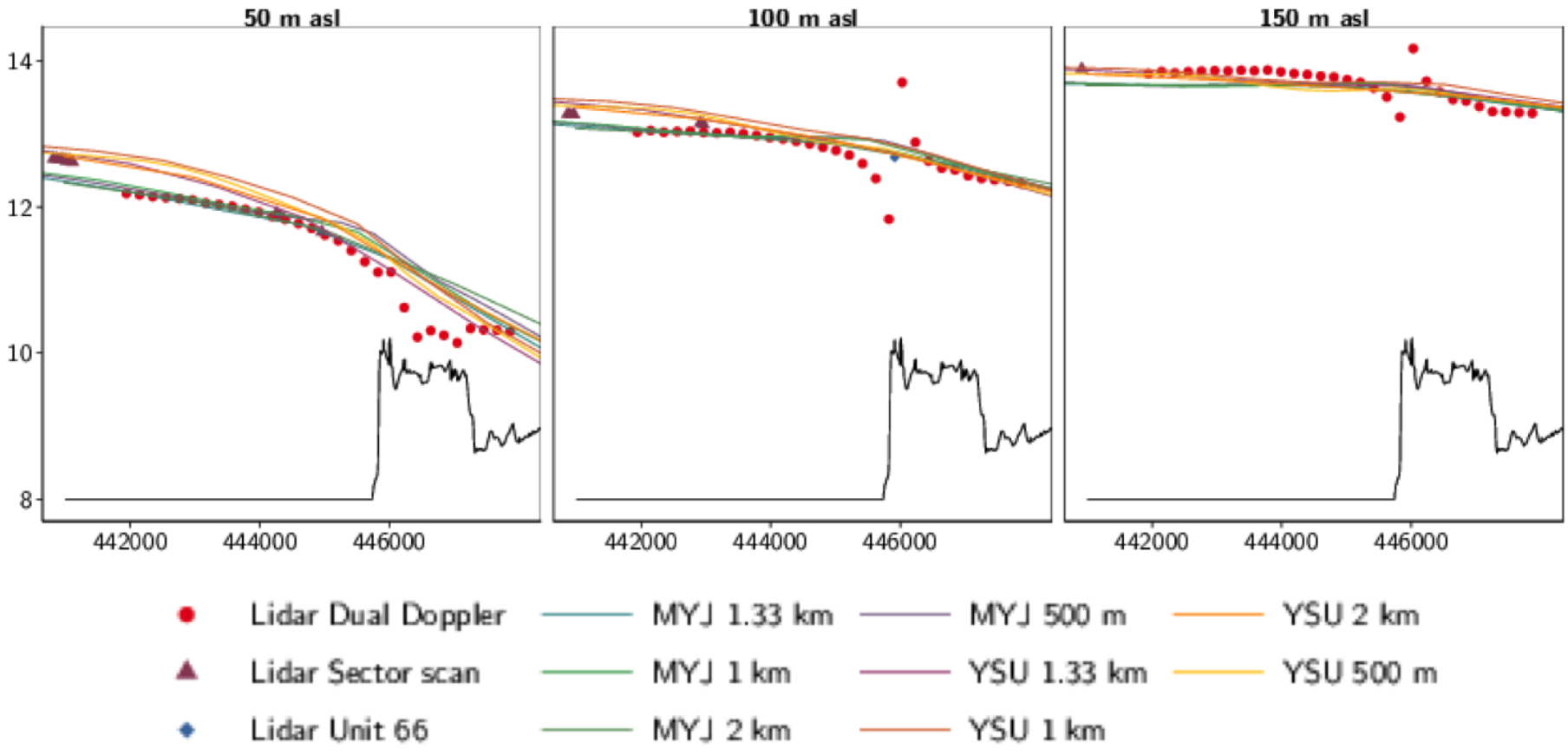


Figure: Mean wind speed using 1904 10-min measurements with 100% availability of the DD up to a distance of 5 km offshore and onshore (total 7 km - not filtered by wind direction).

Summary

- NS_BS_L4_SST now routinely processed as input for WRF
- At 50 m, YSU PBL simulations agree well with observations
- Jump at the coastline for 100 & 150 m heights, due to instrument limitation
- Offshore wind speed difference $\sim$0.3 m s^{-1} due to resolution

Thank you!