



Simulating wind energy resources with mesoscale models: Intercomparison of state-of-the-art models

Olsen, Bjarke Tobias; Hahmann, Andrea N.; Sempreviva, Anna Maria; Badger, Jake; Ejsing Jørgensen, Hans

Publication date:
2015

Document Version
Peer reviewed version

[Link back to DTU Orbit](#)

Citation (APA):

Olsen, B. T., Hahmann, A. N., Sempreviva, A. M., Badger, J., & Ejsing Jørgensen, H. (2015). Simulating wind energy resources with mesoscale models: Intercomparison of state-of-the-art models European Wind Energy Association (EWEA). [Sound/Visual production (digital)]. EWEA Annual Conference and Exhibition 2015 , Paris, France, 17/11/2015

DTU Library

Technical Information Center of Denmark

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Simulating wind energy resources with mesoscale models: Intercomparison of state-of-the-art models

Bjarke Tobias Olsen (btol@dtu.dk)

Andrea N. Hahmann

Anna Maria Sempreviva

Jake Badger

Hans E. Jørgensen

Acknowledgement

Lorenzo Morselli



Overview

Introduction

- EWEA mesoscale models benchmarking exercise
- Intercomparison study of mesoscale models
- Wind energy community submits their model output

Objective

- To highlight common issues with mesoscale models
- To identify weaknesses and strengths for further evaluation of uncertainties

Question to be answered

- How good are simulated time series from mesoscale models?
- How is the model setup related to performance?

Overview

- Data submission facilitated by EWEA ensuring anonymity of participants
- ‘Raw’ mesoscale output for 6 sites in Northern Europe
- Hourly data for all of 2011
- Wind speed, direction, temperature, and humidity, surface fluxes.
- Many vertical levels 10-200 m.
- A lot of metadata:
 - Model name
 - Model version
 - Grid spacing (horizontal and vertical)
 - Forcing (Boundary data)
 - Surface roughness
 - and more...



Participants:

- 3E (Belgium)
- Anemos GmbH (Germany)
- ATM PRO (Belgium)
- CENER (Spain)
- CIEMAT (Spain)
- DEWI (Germany)
- DTU Wind Energy (Denmark)
- DX Wind Technologies (China)
- EMD International (Denmark)
- ISAC-CNR (Italy)
- KNMI (The Netherlands)
- Met Office (United Kingdom)
- Noveltis (France)
- RES Ltd. (United Kingdom)
- Statoil ASA (Norway)
- University Oldenburg (Germany)
- Vestas (Denmark)
- Vortex (Spain)

Models:

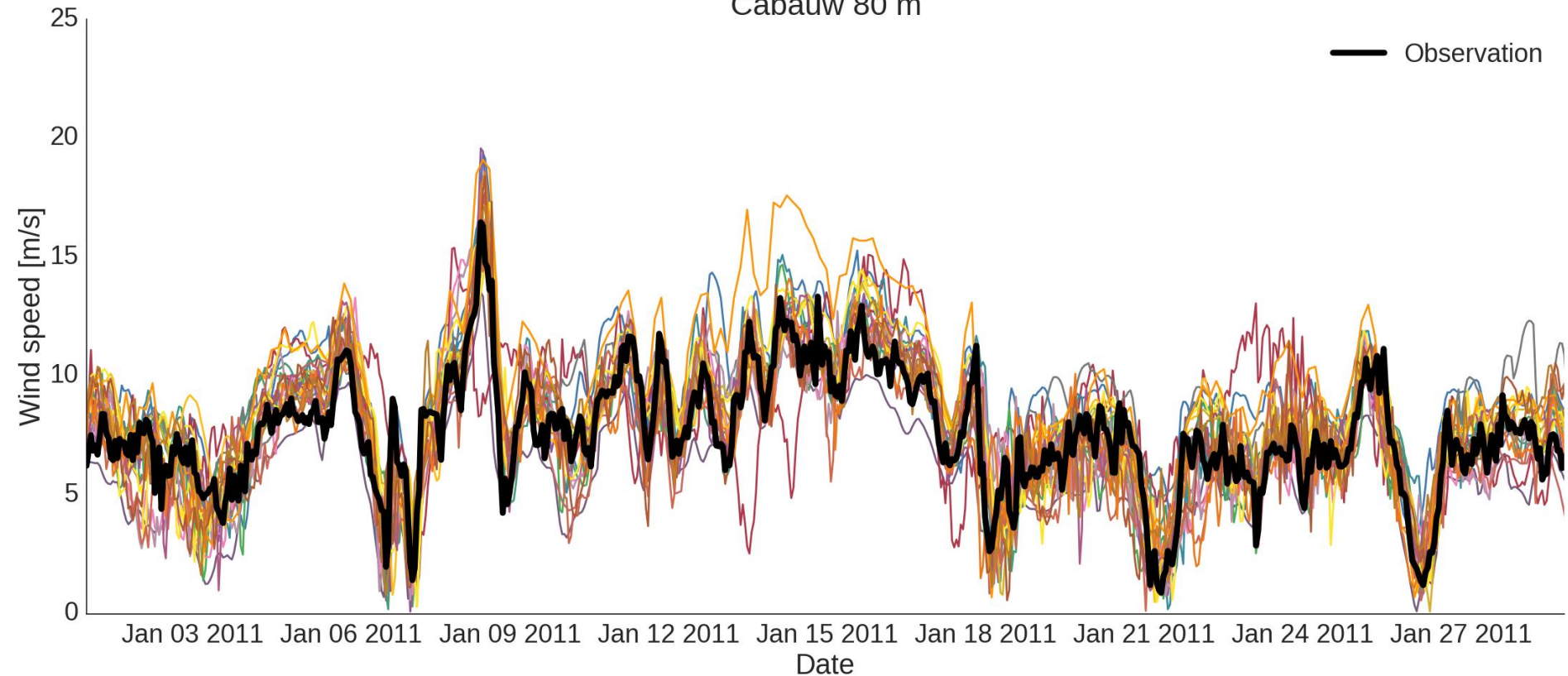
- Harmonie37h1.1
- HIRLAM, v6.4.2
- Met Office v8.4
- MM5
- RAMS 6.0
- SKIRON 6.9
- WRF v3.0.1
- WRF v3.1
- WRF v3.2.1
- WRF v3.3.1
- WRF v3.4
- WRF v3.5.1
- WRF v3.6
- WRF v3.6.1

First impressions... wind speed at Cabauw (80 meters)



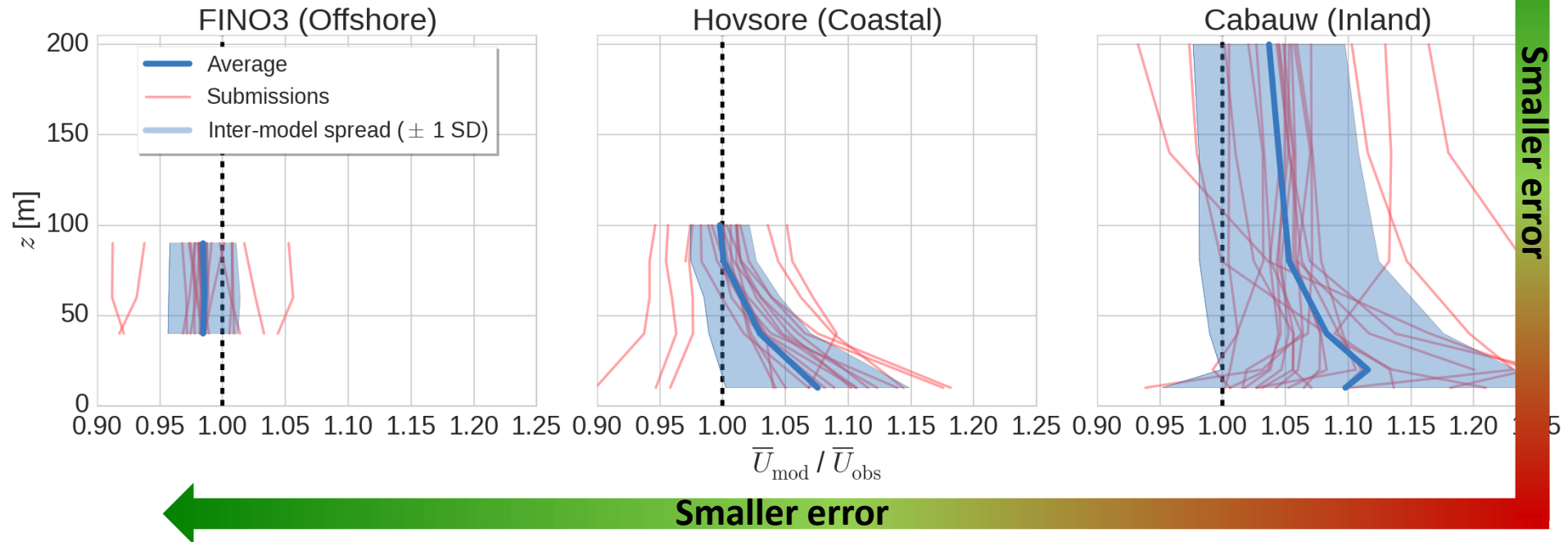
Cabauw 80 m

— Observation



1st order statistics – mean wind speed

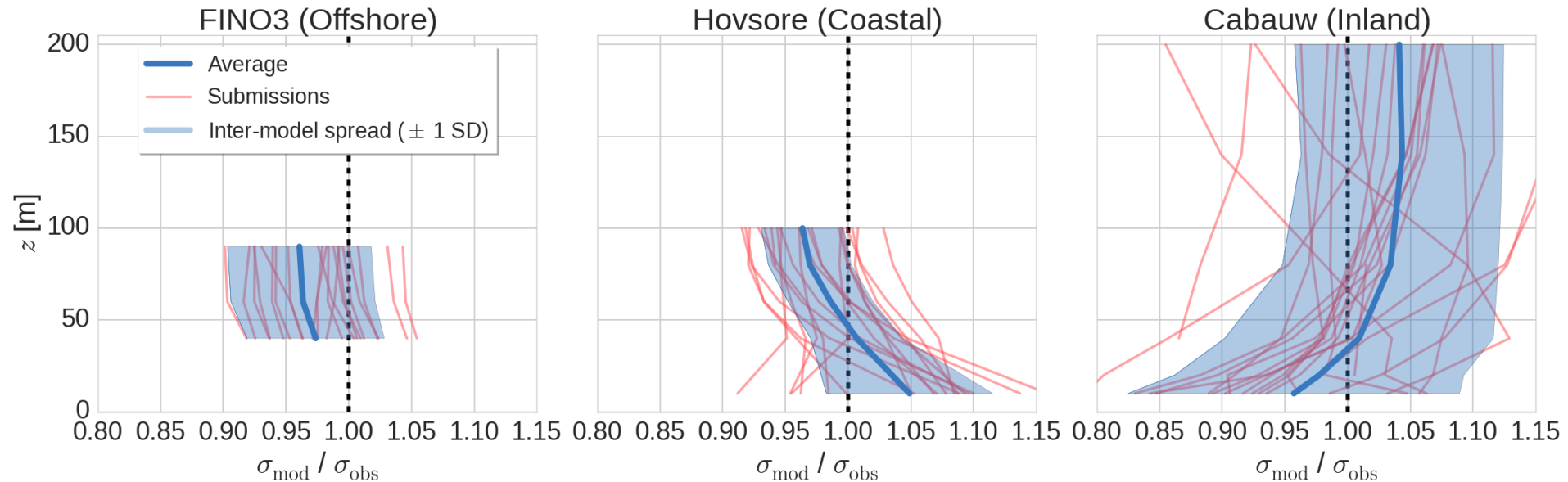
- Smaller errors offshore and aloft, larger inland and near the surface
- Same pattern for inter-model spread



1st order statistics – standard deviation

- Underprediction offshore
- Near surface: overprediction at Høvsøre, underprediction at Cabauw
- Greater inter-model variance inland

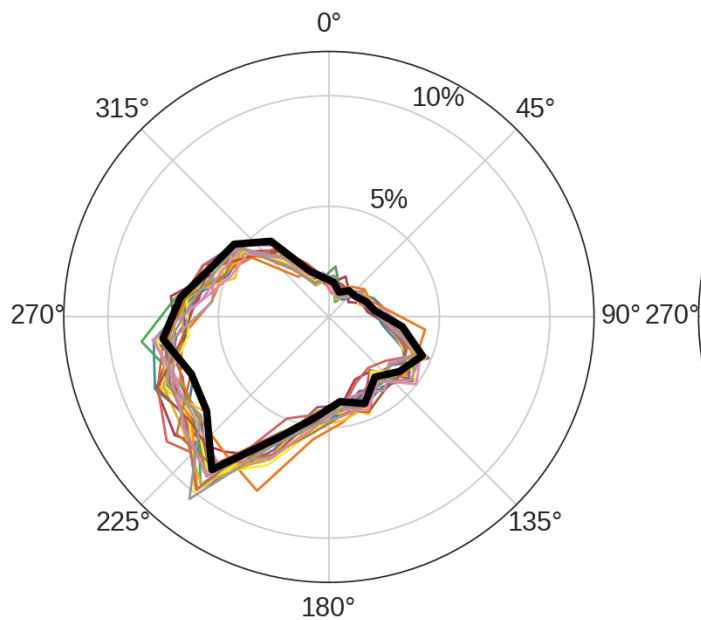
$$\sigma = \sqrt{\frac{1}{N} \sum_{t=0}^{N_t} (U_t - \bar{U})^2}$$



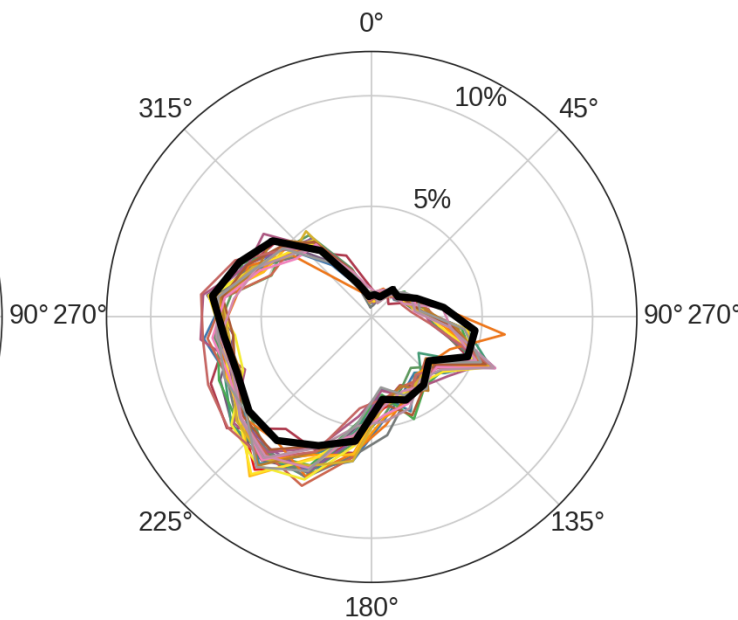
Direction wind rose

- 24 direction sectors
- Wind directions are well captured

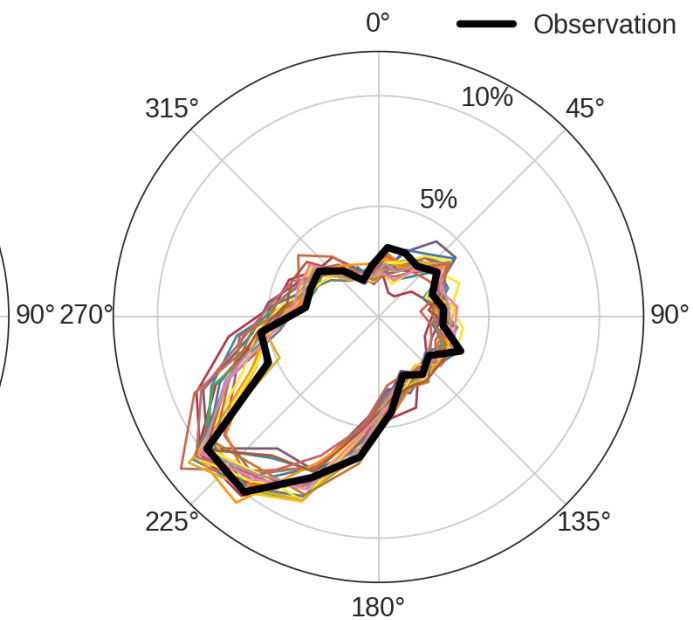
FINO3 (Offshore) 90 m



Hovsore (Coastal) 80 m

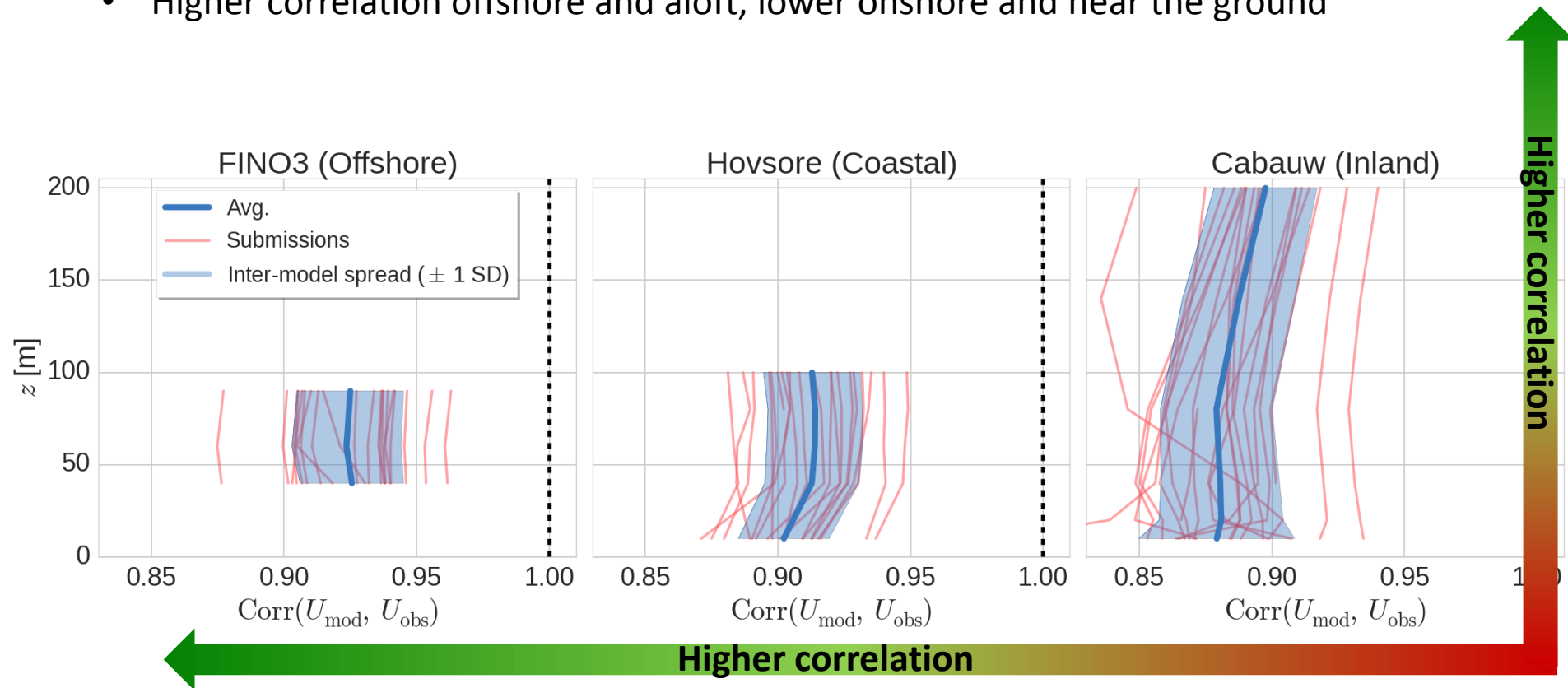


Cabauw (Inland) 80 m



2nd order statistics - Correlation

- Generally high correlation $> \approx 0.85$
- Higher correlation offshore and aloft, lower onshore and near the ground



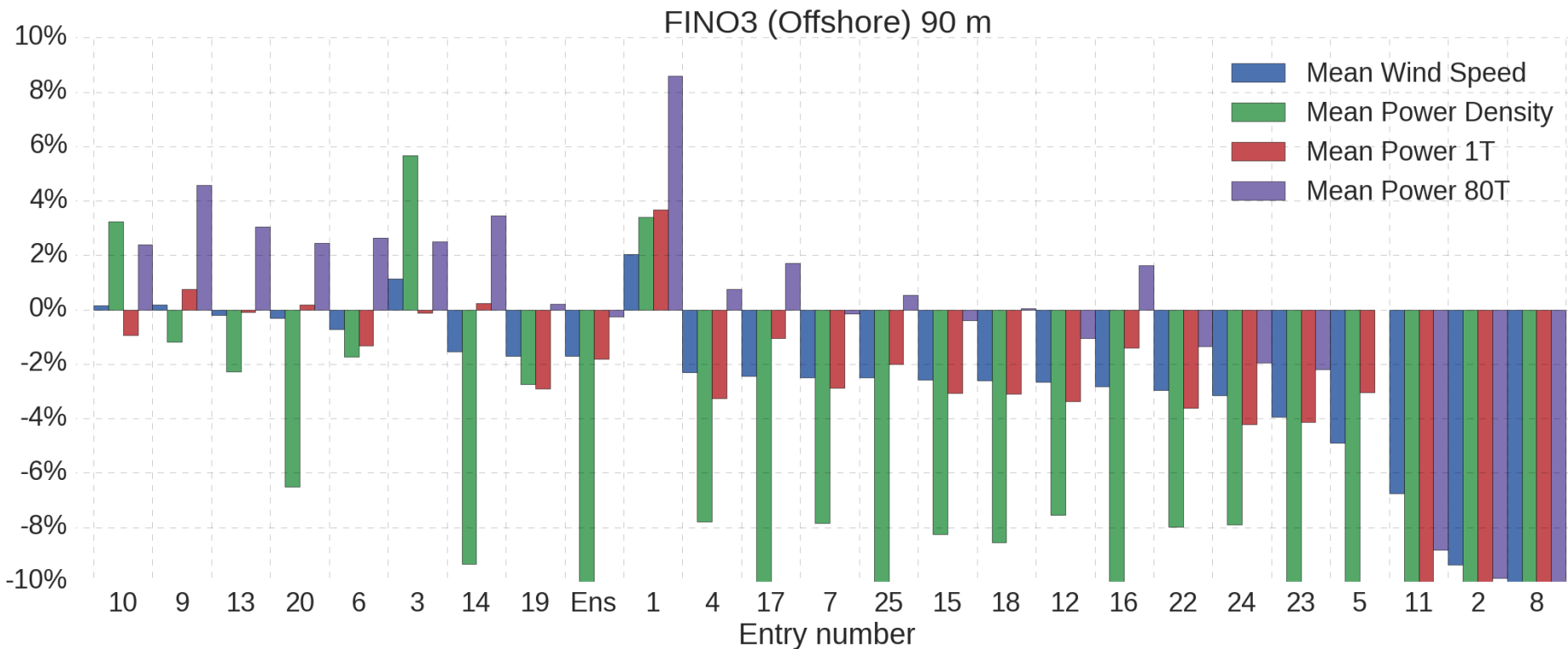
Applying mesoscale data for wind energy – FINO3 90 m



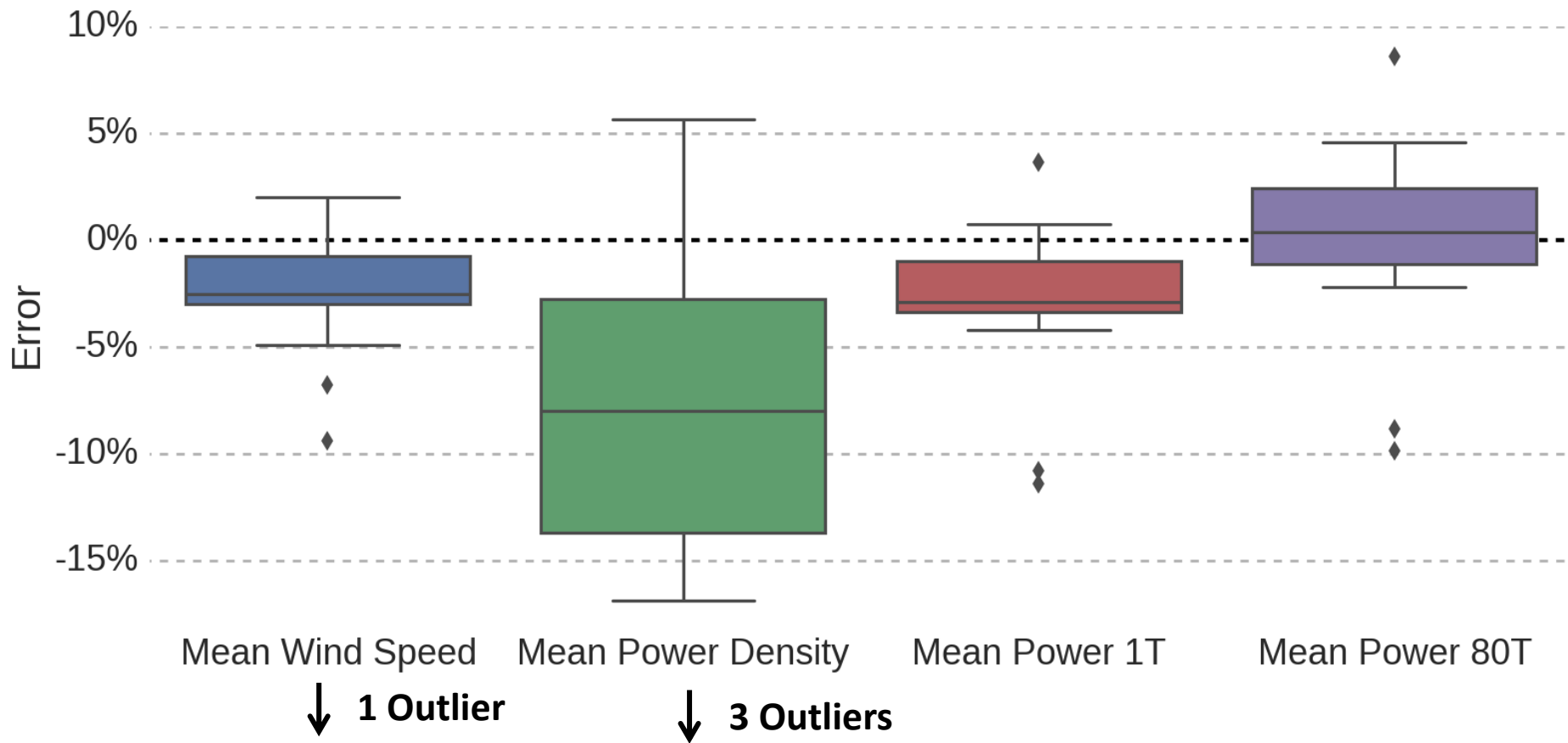
Wind farm: Horns Rev 1

Power curve: Vestas V80 (2 MW)

Wake calculation using WASP



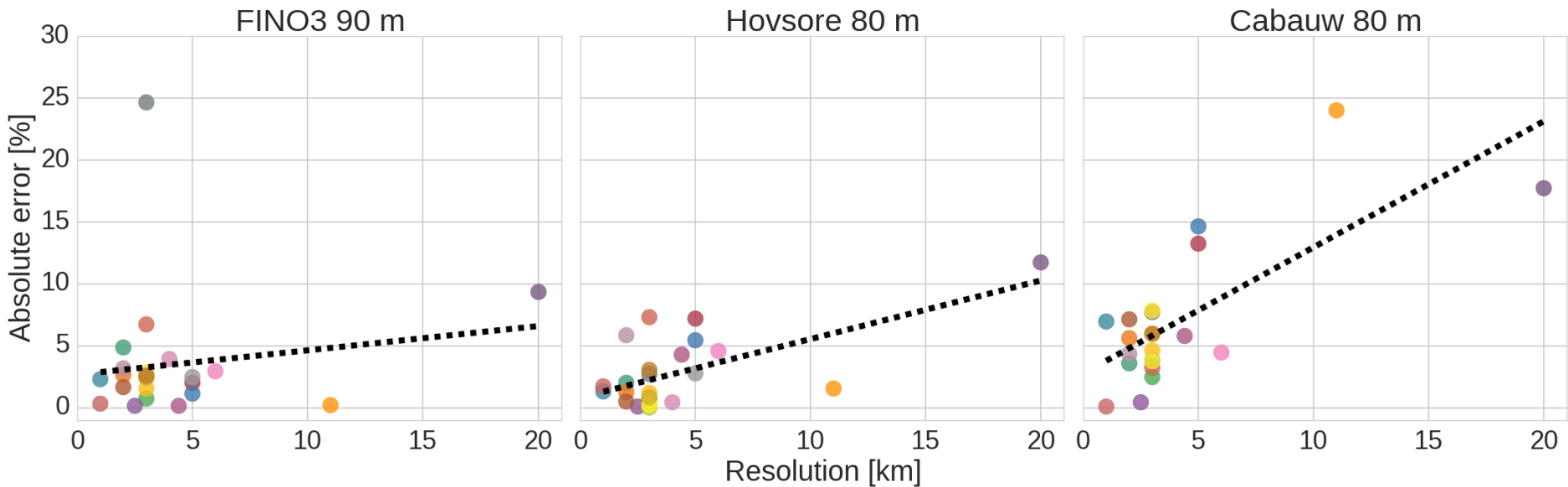
Applying mesoscale data for wind energy – FINO3 90 m



Can we link the model setup to performance?

- Number of vertical level
- Forcing data
- Surface roughness
- PBL scheme
- Resolution: **Yes – some evidence**

Inconclusive – too little data



So?

- How good are simulated time series from mesoscale models?
- How is the model setup related to performance?

Summary

- Distribution of wind directions (Wind rose) well captured
- Smaller mean wind speed errors and higher correlation offshore and aloft
- Overprediction of mean wind speed near the surface inland
 - Misrepresentation of surface characteristics?
- Variance of wind speed underpredicted offshore
- Some evidence that higher resolution is linked to a lower mean wind speed errors
- Inconclusive evidence for others factors – too little data

Thank you for your attention!

btol@dtu.dk

Some early results from this exercise was presented in Juli, see:

http://www.ewea.org/events/workshops/wp-content/uploads/2015/06/Hahmann_MesoBenchmark_V2.pdf