Global Wind Atlas – validation and uncertainty

Mortensen, Niels Gylling; Davis, Neil; Badger, Jake; Hahmann, Andrea N.

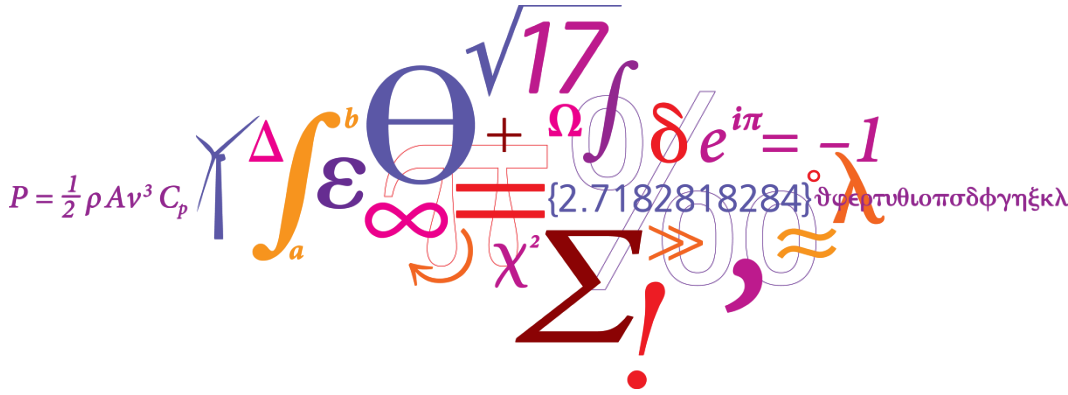
Publication date:
2017

Document Version
Publisher's PDF, also known as Version of record

Global Wind Atlas – validation and uncertainty

Niels G Mortensen, Neil Davis, Jake Badger, Andrea N Hahmann

WindEurope Resource Assessment 2017



DTU Wind Energy
Department of Wind Energy

Global Wind Atlas

The objective of the Global Wind Atlas is to

- Provide global wind resource data sets
- Account for high resolution topography
- Employ microscale modelling world-wide
- Use a unified and documented methodology
- Ensure transparency about the methodology
- Validate results in representative areas

(*globalwindatlas.com*)

The correct usage of the Global Wind Atlas is

- Aggregation
- Upscaling analysis
- Energy integration modelling
  - energy planners and policy makers

It is not correct to use the data and tools for

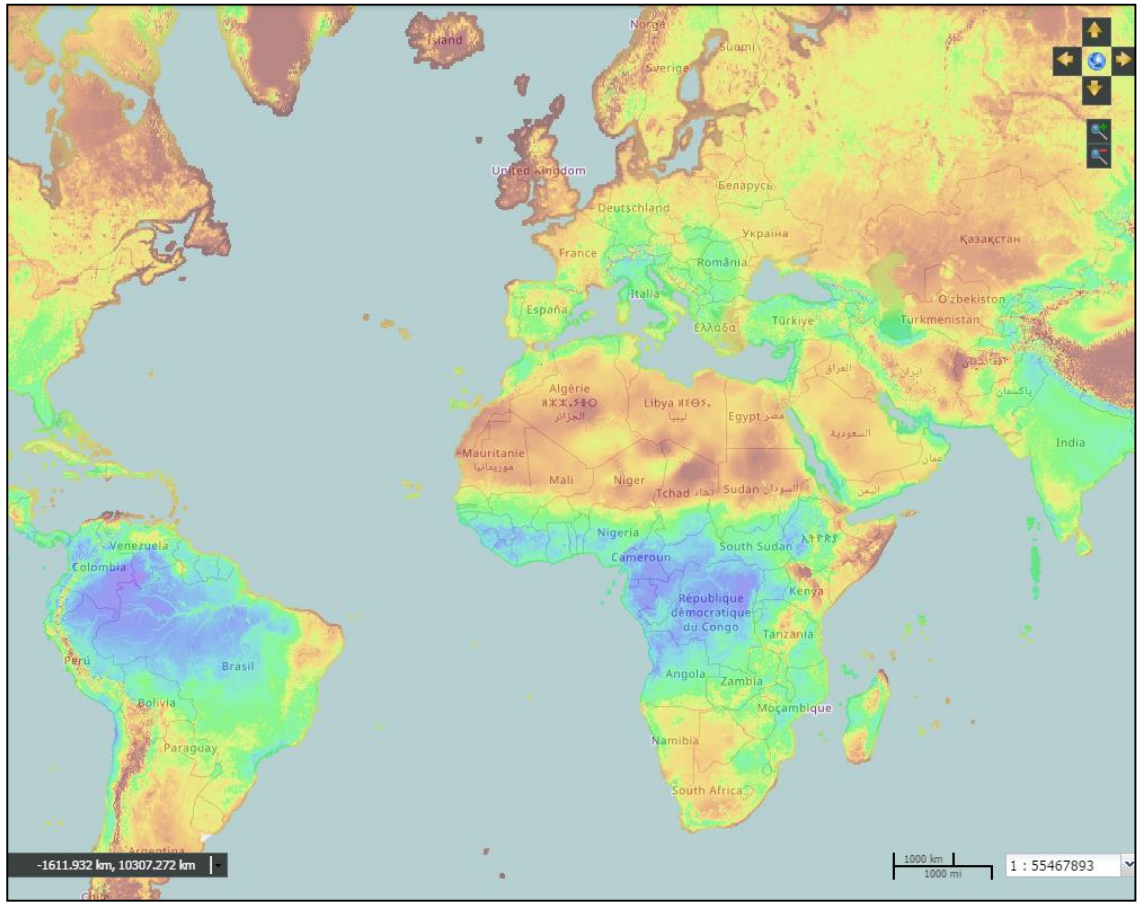
- wind turbine and wind farm yield calculations

Topics for this presentation

- Validation of GWA at high-quality mast sites
- Highlight proper use of numerical wind atlases

Global Wind Atlas characteristics

- Climatological data
  - MERRA reanalysis 1979-2013
  - Horizontal resolution, $\Delta = 0.5 \times 0.625$ deg.
  - GWC interpolation to every prediction site
- Topographical data
  - Viewfinder Panoramas (SRTM), $\Delta = 150$ m
  - GlobCover 2009 land cover, $\Delta = 300$ m
  - DTU translation table from LC to z_0
- Methodology
  - WAsP modelling (Frogfoot), $\Delta = 250$ m
  - Results aggregated to Δ = 1 km
  - Heights above ground 50, 100, 200 m
- For the present validation
  - Generalised wind climates at MERRA nodes



Global Wind Atlas validation

- Climatological data @ ~90 sites
  - Meteorological masts (25-125 m, 1-13 y)
  - Winddata.com, CREYAP, DTU & partners, …
- Topographical data
  - SRTM-based elevation vector maps
  - Google Earth-based land cover maps
- Methodology
  - Observed statistics at mast height
  - Predicted statistics at mast height from GWA generalised wind climate + WAsP
- Results (at mast or hub height)
  - Mean wind speed and power density
  - Mean wind turbine and wind farm yields
  - Wind direction distributions

Masts used for validation

Projects and analyses

- DTU Course 46200 (2016, 2017)
- EWEA CREYAP 1-4
- Wind Atlas for South Africa
- Mesoscale and microscale modelling in China
- Cape Verde Wind Farm Extension Project
- Danish Wind Atlas
- Wind Atlas for Egypt

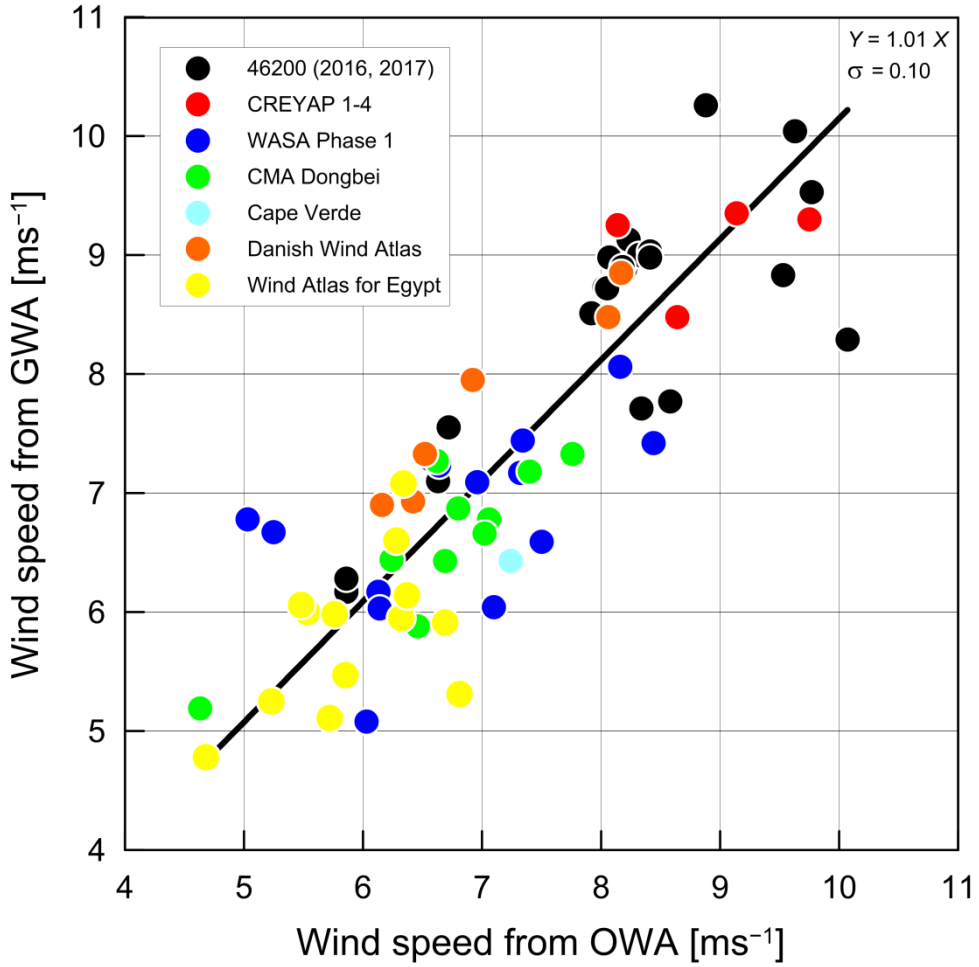
Results for four types of sites

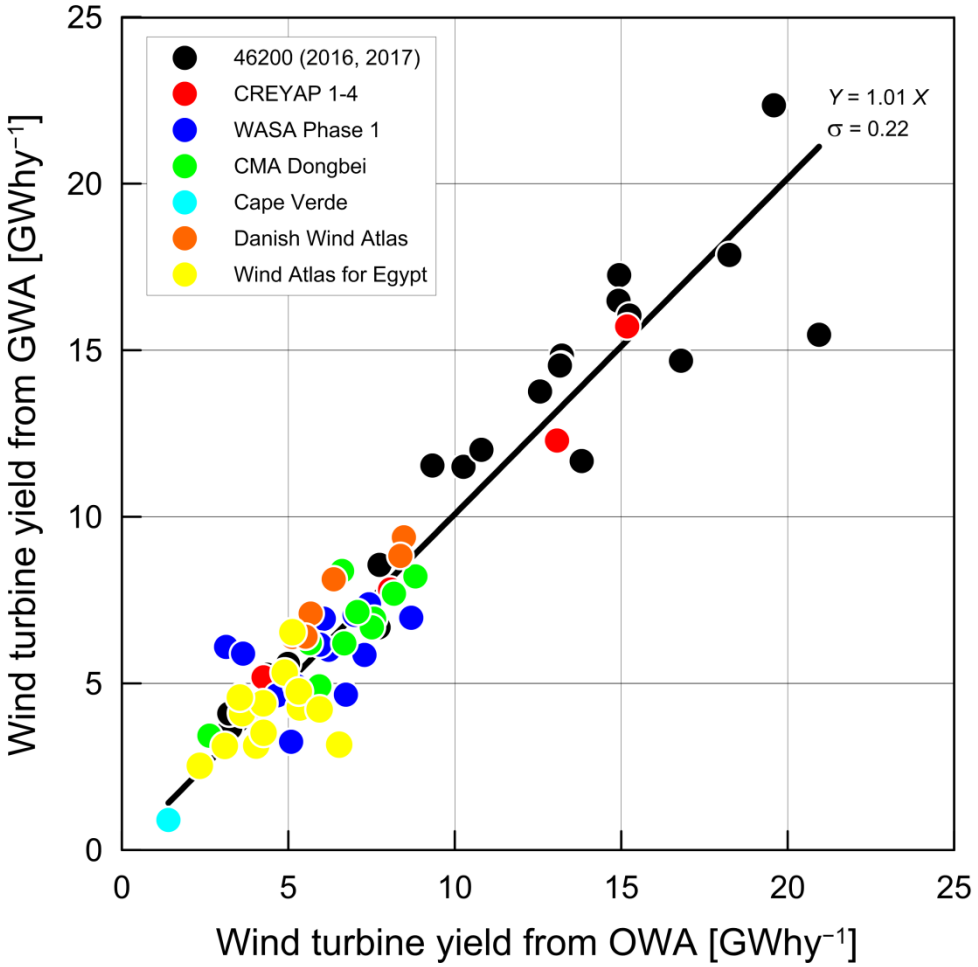
- Non-complex, offshore, complex terrain (RIX > 5%), complex flow (mesoscale)

Countries (projects)

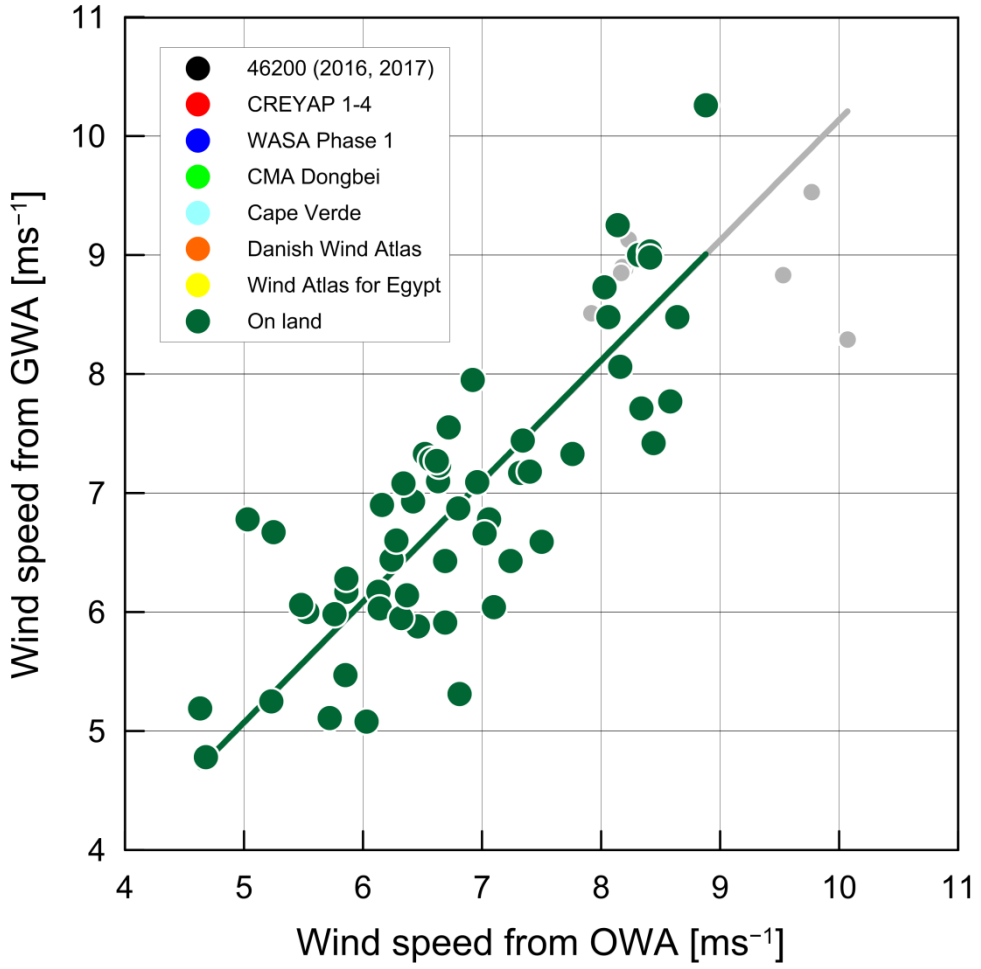
- Cape Verde (4)
- China (12)
- Denmark (12)
- Egypt (23)
- Faroe Islands (1)
- France (2)
- Mexico (4)
- South Africa (17)
- United Kingdom (13)

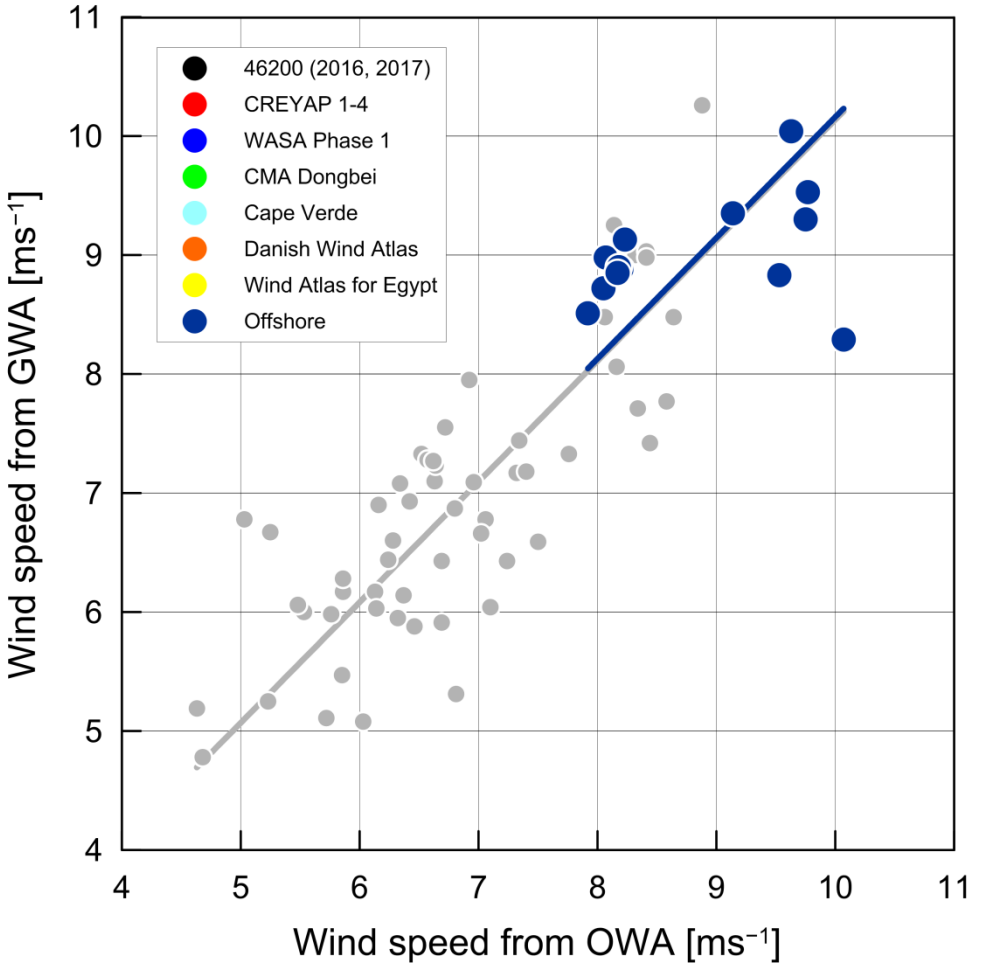
GWA wind speeds and energy yields (simple + offshore)



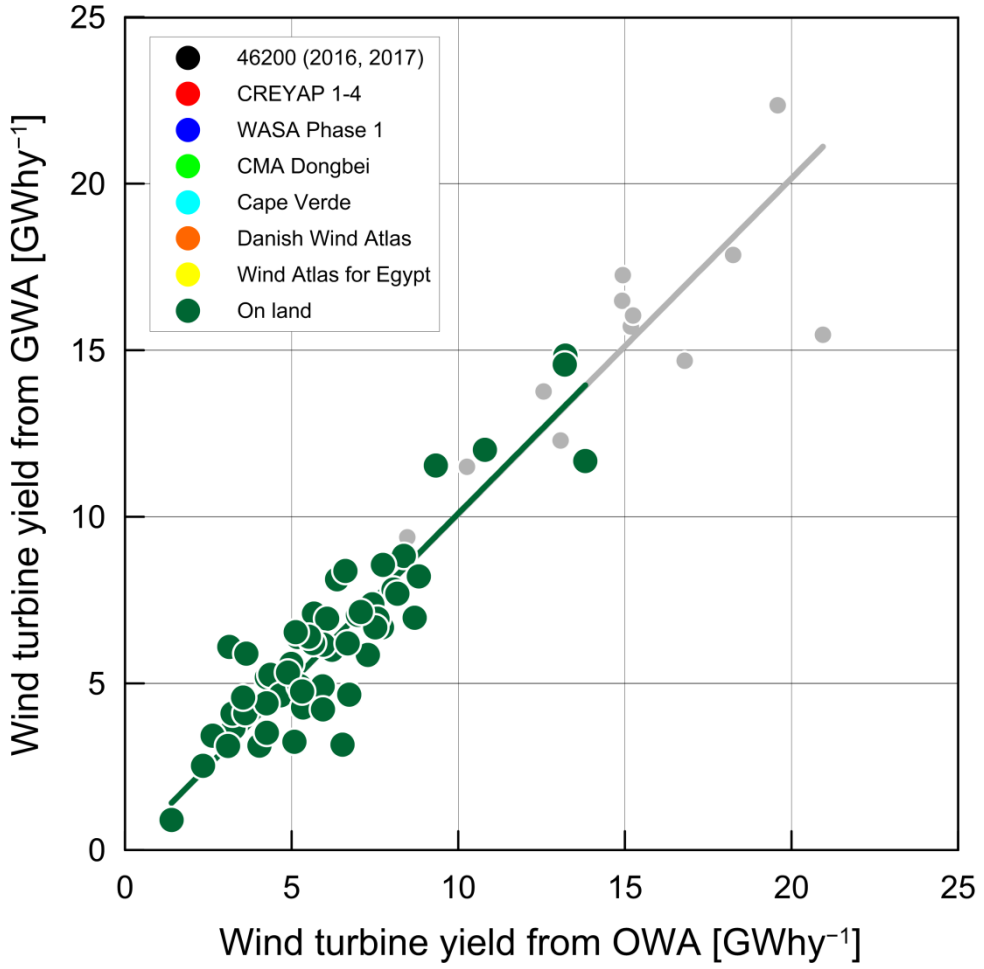


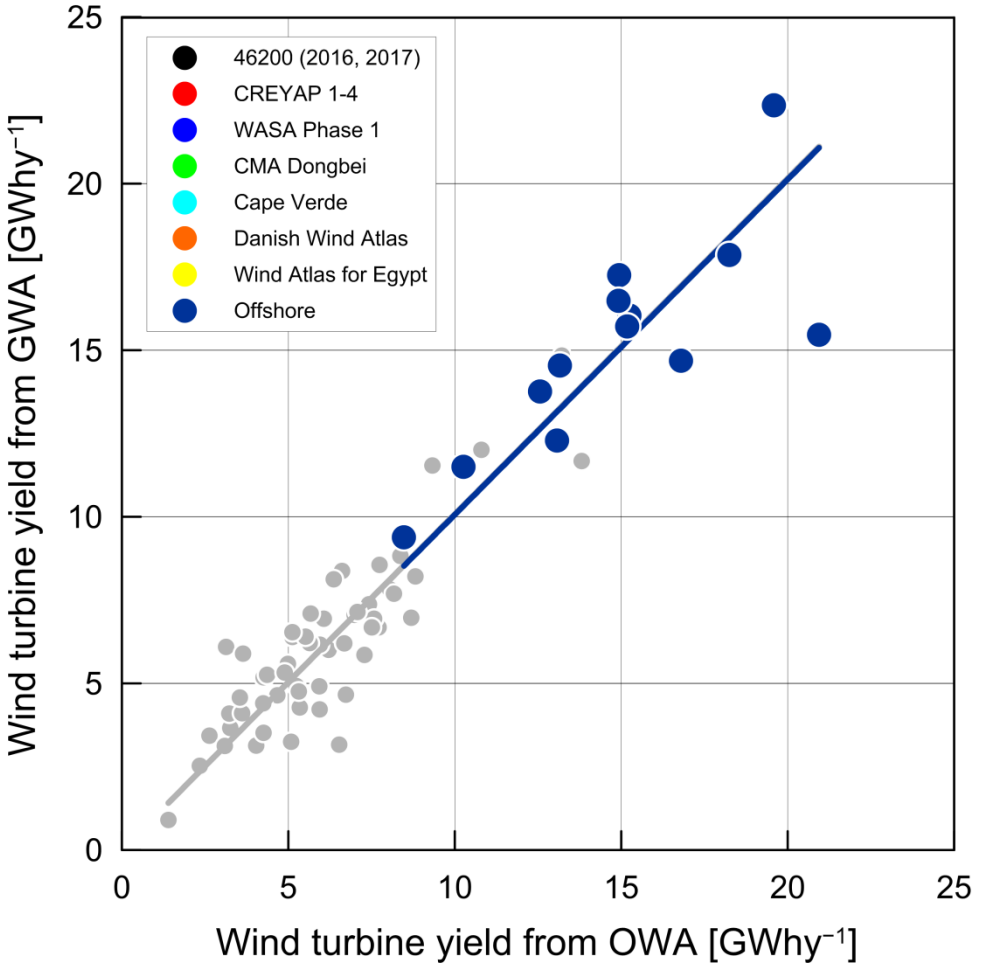
Onshore and offshore wind speeds



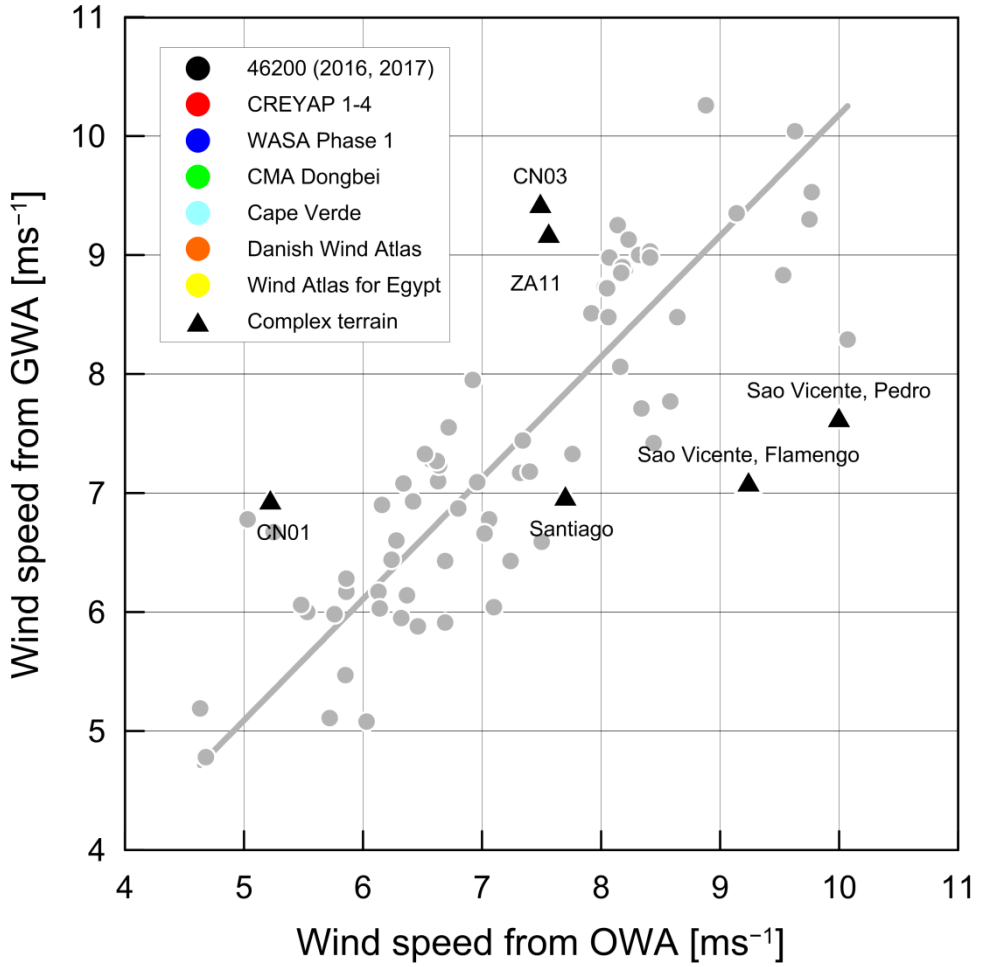


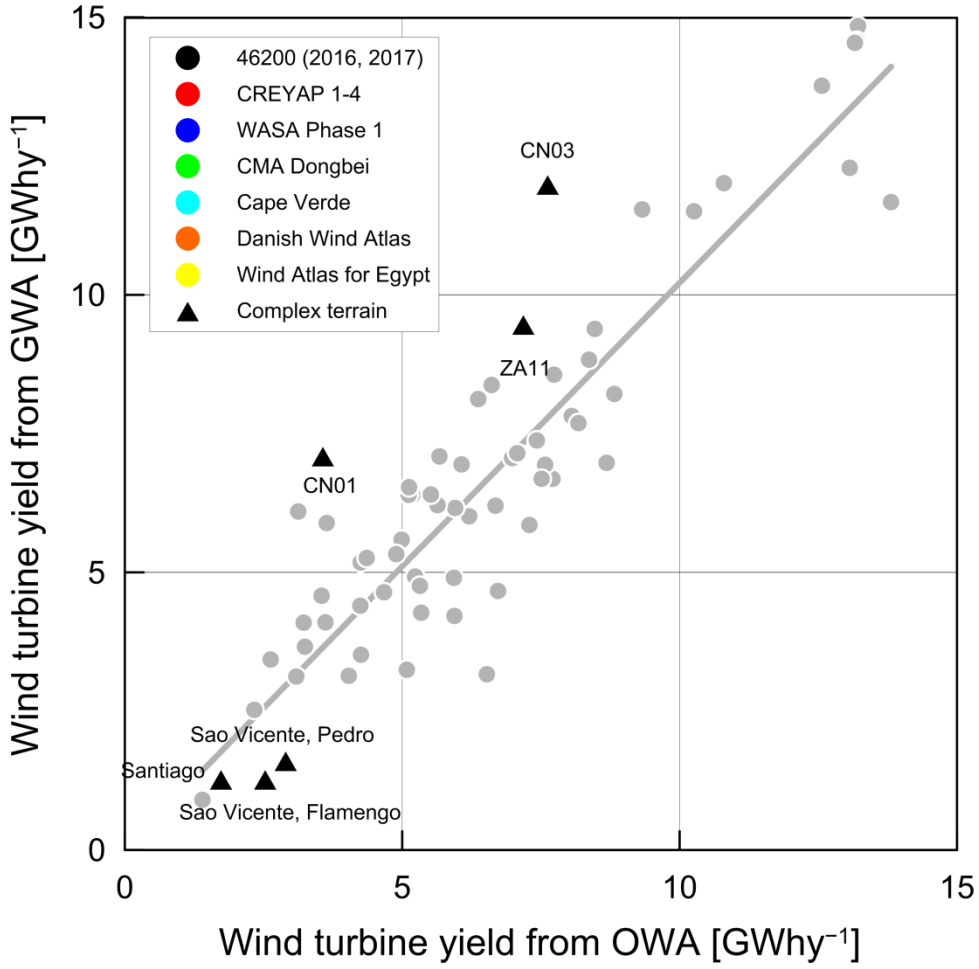
Onshore and offshore energy yields



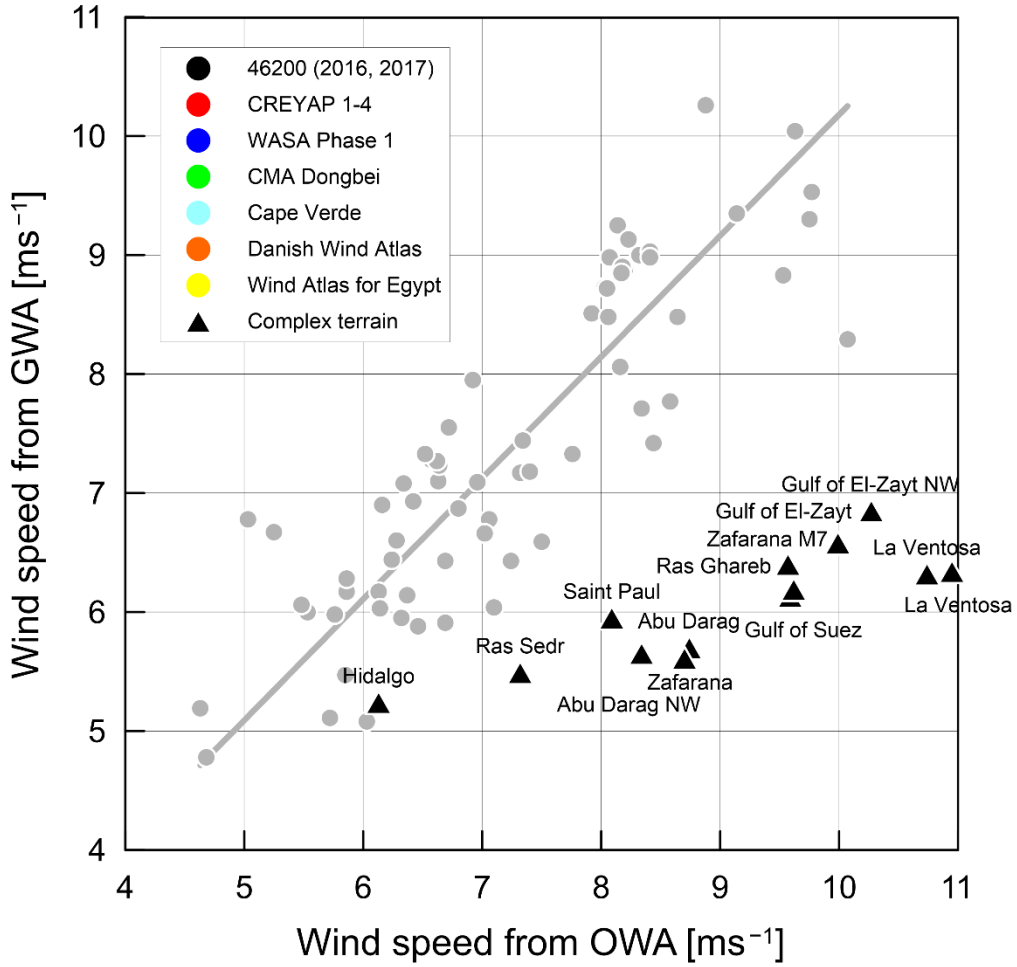


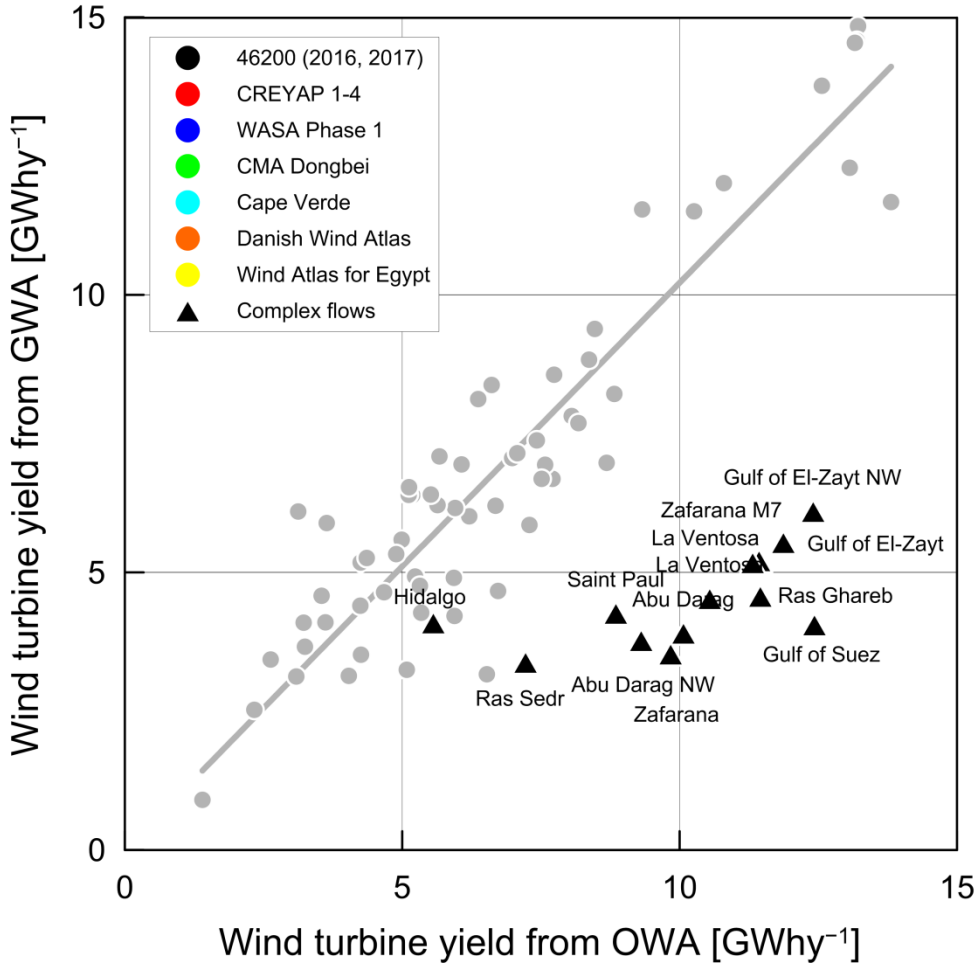
Complex terrain (RIX > 5%) – wind speed and energy yield



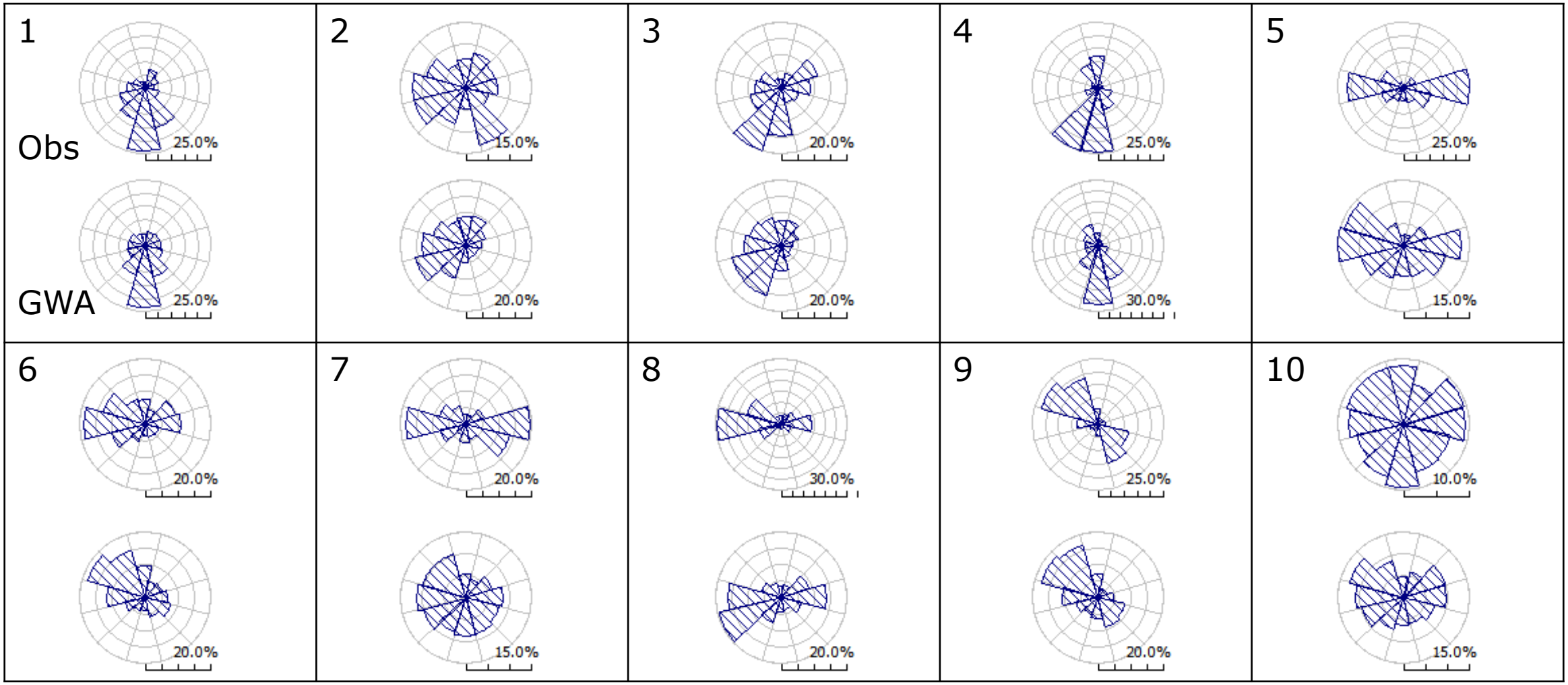


Complex flows (mesoscale) – wind speed and energy yield

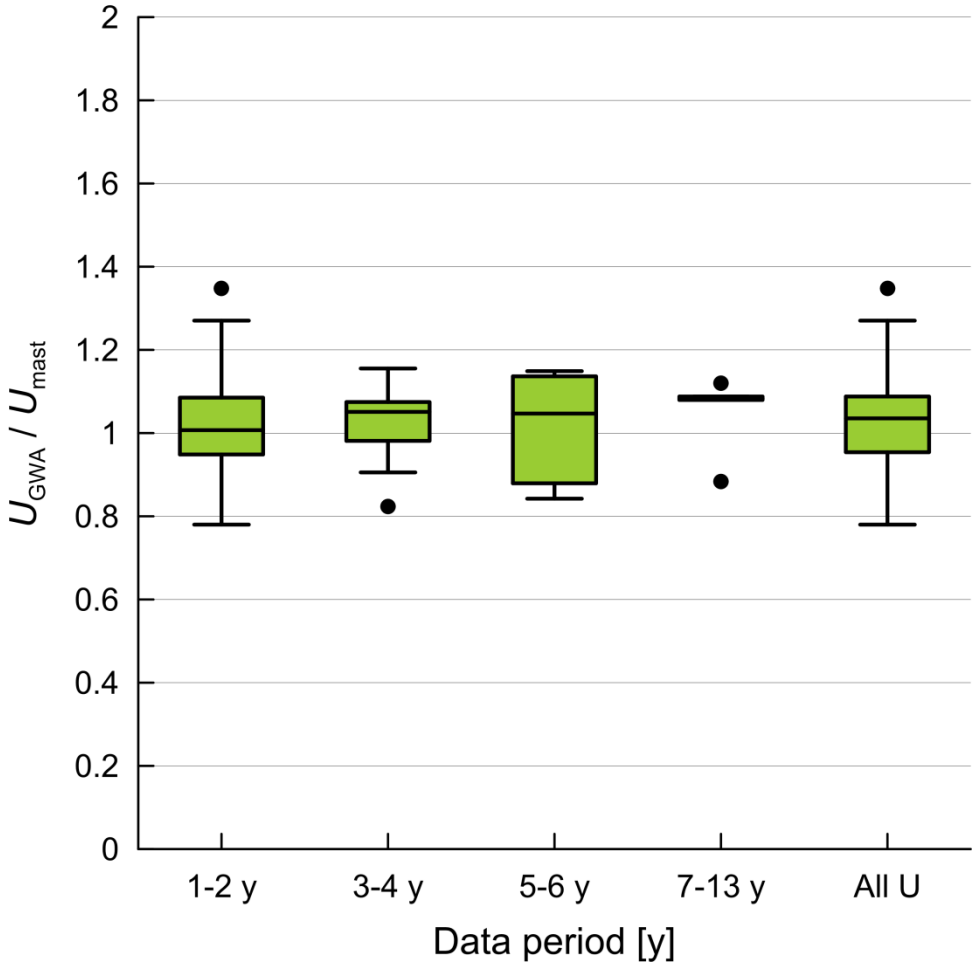


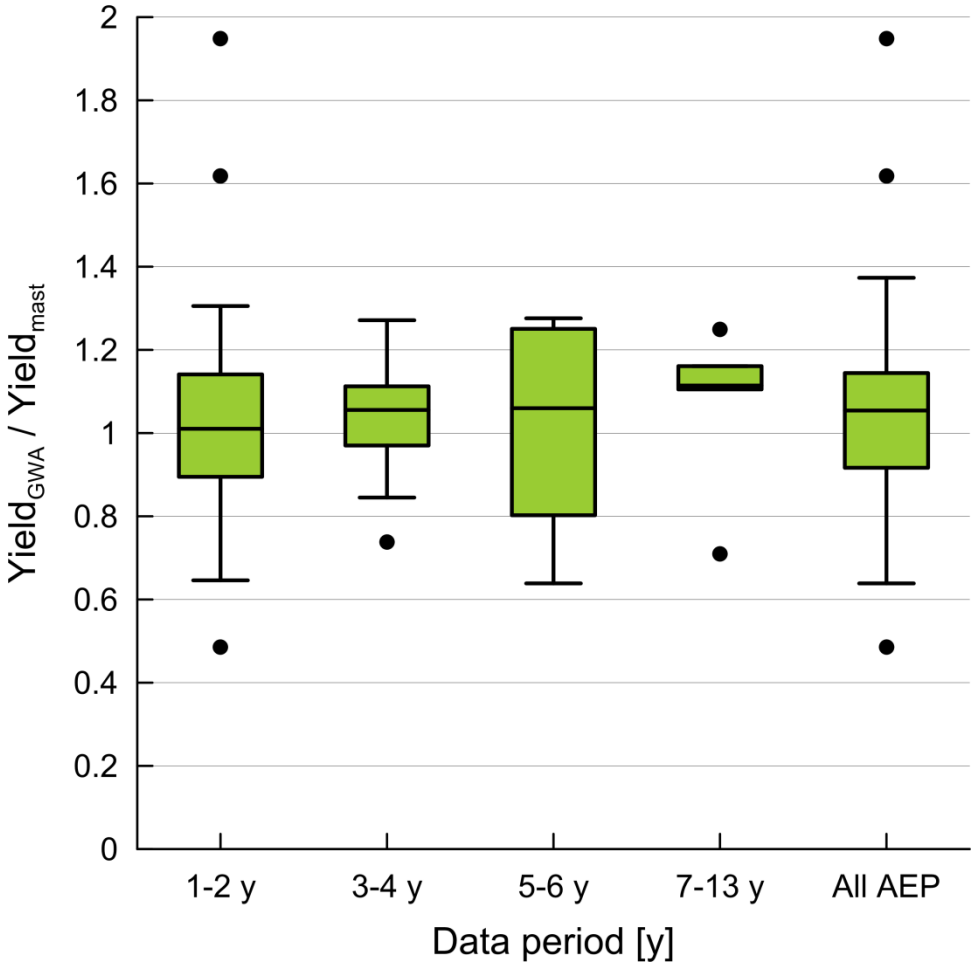


Comparison of wind direction distributions (WASA 1)

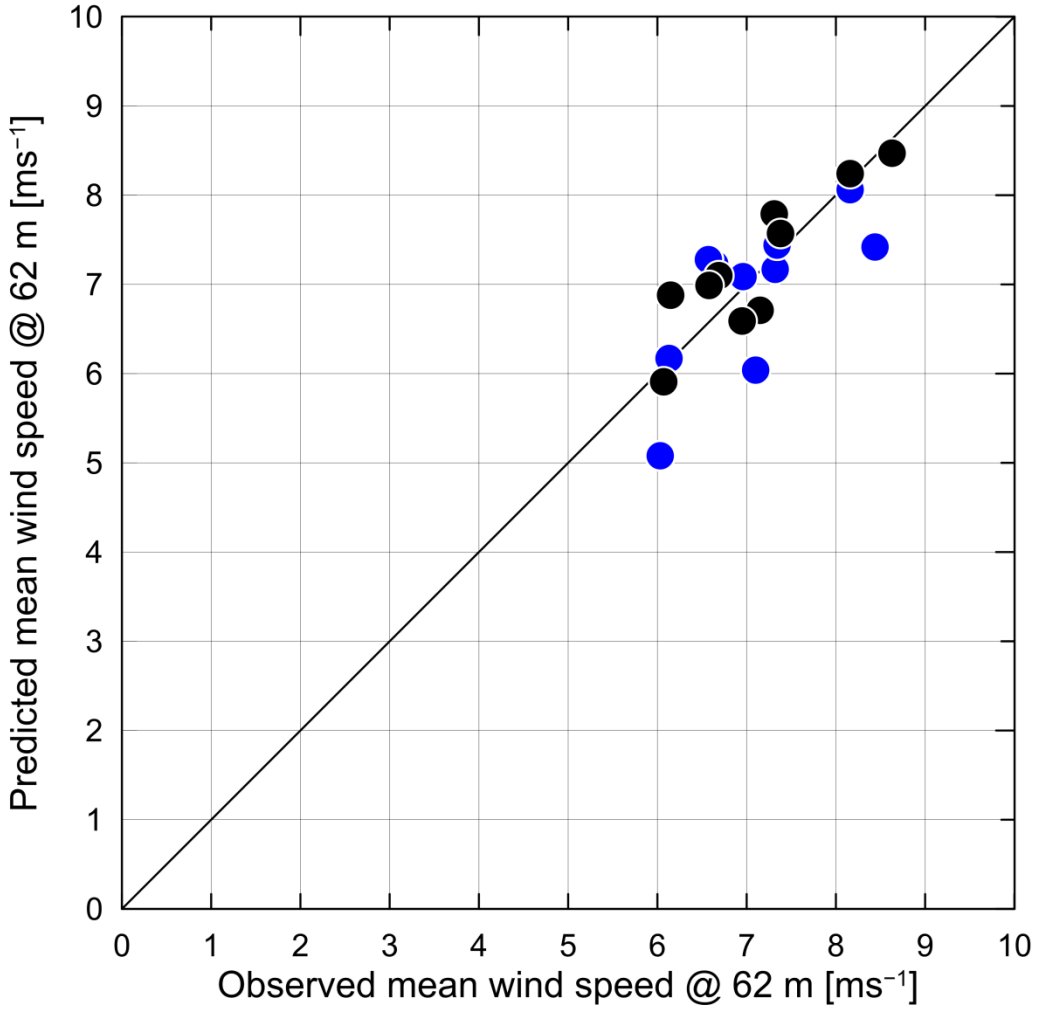


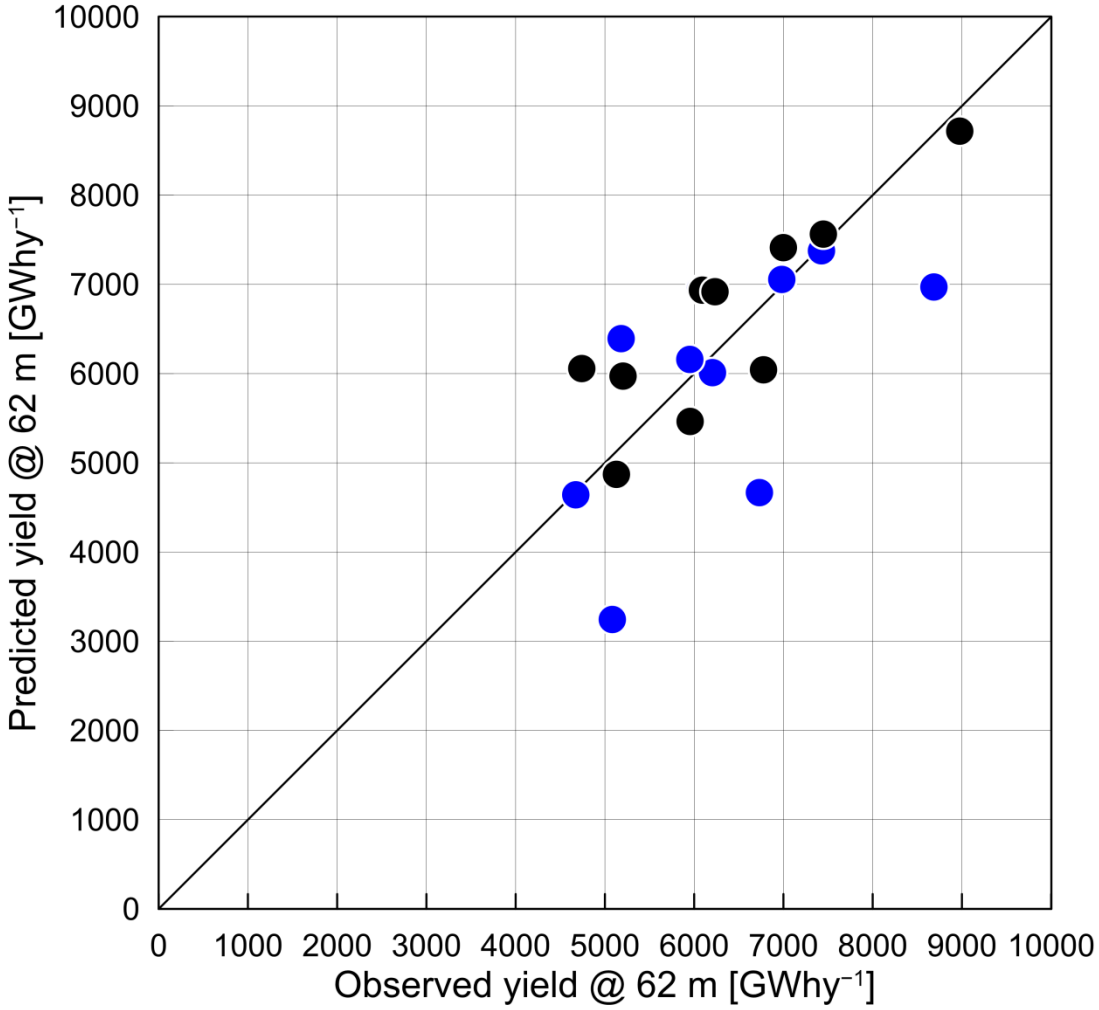
Effect of length of measured time-series





Comparison of GWA and WRF modelling (WASA 1)





Conclusions

Parameter	Trueness, a ($Y = a \cdot X$)	Spread, σ (σ_a)
Wind speed	101%	10%
Power density	103%	31%
Turbine yield	101%	22%

- GWA provides on average a reliable picture of the wind climate and wind resources for both
  - Onshore and offshore conditions
- The spreads of GWA-based predictions of wind speed, power density and yields are significant
  - Single predictions may deviate significantly
- GWA predictions may be strongly biased in
  - Complex and steep topography
  - Flows with strong mesoscale forcing
- No simple correlation between prediction statistics and length of observed time-series
- Global Wind Atlas fulfils its intended role, and may also be used for
  - Project preparation
  - Measurement campaign design

Acknowledgements

- China Meteorological Administration (CMA)
- Danish Ministry of Foreign Affairs (Danida)
- DTU Course 46200 – classes of 2016 and 2017
- Joule project "Measurements and modelling in complex terrain"
- Sund & Bælt
- Wind Atlas for Egypt project
- Wind Atlas for South Africa project (WASA 1 & 2)
- Winddata.com
- WindEurope CREYAP initiative

Thank you for your attention!