European offshore winds based on satellite data relevant for the wind industry

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Satellite SAR wind data archive at DTU

- 30,000+ ENVISAT ASAR scenes (2002-2011)
- 170,000+ Sentinel-1 A/B SAR scenes (2014->)

https://satwinds.windenergy.dtu.dk/
Northern European offshore wind farms
Anholt wind farm study


Acknowledgement to Ørsted A/S.
Mesoscale modelling of Thornton Bank (BE) Belwind (BE)

Wind farm cluster effects

Satellite SAR shows wind farm wakes

WRF-EWP minus WRF

WRF shows wind farm wakes

RADARSAT-2 from Data and Products © MacDonald, Dettwiler and Associates Ltd


SAR and WRF Gibraltar, 22 March 2017
SAR and WRF Gibraltar, 7 August 2017
SAR and WRF Gibraltar, 5th December 2017
European wind atlas

Mesoscale model simulations were planned to:

- **Production** simulation: Mesoscale simulations for the wind atlas covering all Europe for 30 years (1989-2018)

- **Ensemble** of mesoscale simulations to:
  - Find the **best WRF setup** for the production run
  - Try to **quantify uncertainty** in the wind atlas resulting from the choices made in the model setup.
European wind atlas production run (validation)

One full year (2015) of simulation
Comparison against observations for 8 sites offshore or over "simple" terrain
No single other simulation performs better at all sites
Choice: Production run MYNN-MO

Long-term mean wind speed at 100 m, 2013-2017
Wind speed extrapolation from 10 m to hub-height

SAR Wind Atlas at 10 and 100 m

SAR-based mean wind speed map of Europe

10-m height wind atlas from Sentinel-1 and Envisat SAR, 2002-2016, at 2 km resolution

Courtesy: ESA and Copernicus for Envisat ASAR and Sentinel-1 scenes.
ASCAT Wind Atlas at 10 and 100 m


Courtesy: EUMETSAT and CMEMS
Comparison WRF vs. SAR *climate*, Winds from North

$330 < \text{wind direction} < 30$, $N=101$
Comparison WRF vs. SAR climate, Winds from West

240 < wind direction < 300, N=174
Conclusion

SAR satellite wind maps freely available
• Useful for quantification of coastal effects, wind farm effects, etc.

SAR and Scatterometer wind resource statistics for Europe
• Useful for validation of models and for pre-site assessment

Web links
SAR wind map archive https://satwinds.windenergy.dtu.dk/