

QuikSCAT for wind energy resource assessment

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QuikSCAT for wind energy resource assessment

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Purpose

- Wind farm planing and siting moves towards offshore locations
- Difficult to obtain in situ observations
- Use QuikSCAT observations for an initial estimation of the wind resource over large areas
- Demonstrate the high quality of QuikSCAT when compared with in situ measurements
- Evaluate wind characteristics relevant for wind resource assessment

Wind from QuikSCAT

- Sun-synchronous, polar orbiting platform, altitude 803 km
- Swath: 1800 km \rightarrow 90% of Earth's surface/day
- Wind Speed 3-20 m s⁻¹, accuracy of 2 m s⁻¹
- Wind Direction, accuracy of 20°
- **Active Microwave Radar**: emits radiation, measures backscattered signal
- Geophysical Model Function (GMF) to derive wind speed and direction
- Equivalent Neutral Wind (ENW) at 10 m above the sea surface

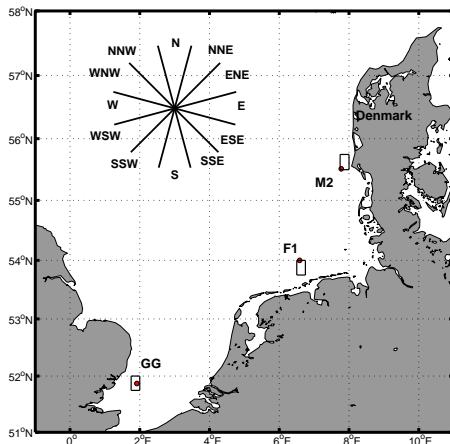
Data & Methods

Data:

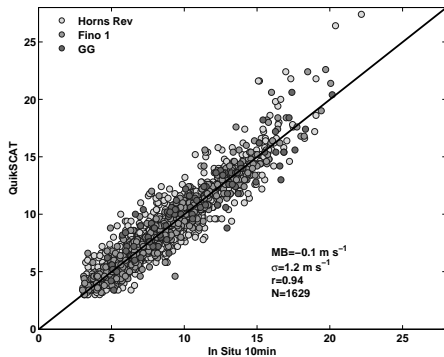
- 1 QuikSCAT, gridded winds from RSS
- 2 10 years (01/11/99 - 31/10/09), twice daily
- 3 4 years of met. mast measurements

Methods:

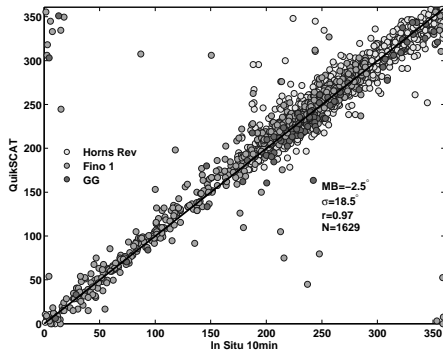
- 1 10 min measurement closest to QuikSCAT time
- 2 Convert in situ observations to ENW
- 3 Derive stability information (Ψ_M), from the air-sea temperature difference
- 4 Estimate u_* from measurements at a height: $u = \frac{u_*}{\kappa} \left[\ln \left(\frac{z}{z_0} \right) - \Psi_M \right]$
- 5 Estimate u_{10m} from u_* , assuming that Ψ_M is zero (neutral).



QuikSCAT and In situ observations



Wind speed



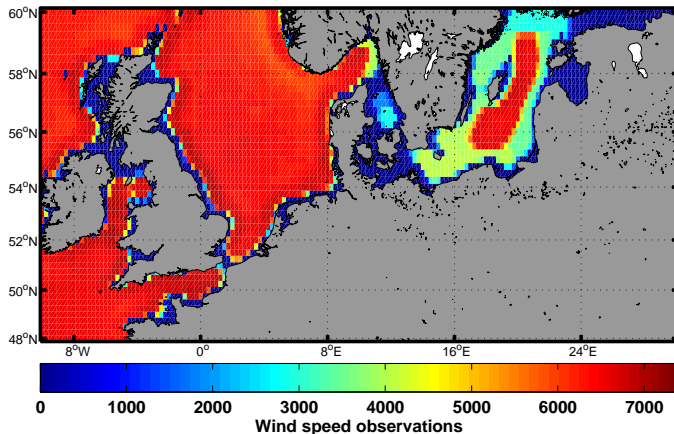
Wind direction

QuikSCAT and In situ observations

Table: Mean wind speed and wind power density estimates from QuikSCAT and in situ observations a) converted to ENW or b) preserving the stability information (SDIS: stability dependent in situ)

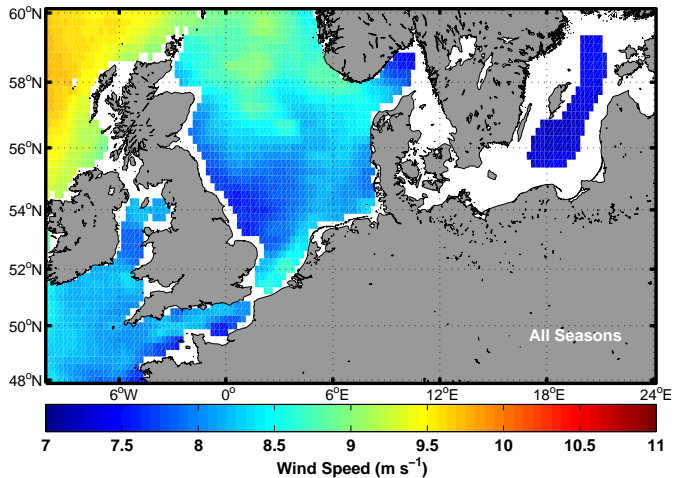
	Product	Sample N.	u (m s ⁻¹)	u Dev. (%)	E (W m ⁻²)	E dev. (%)
M2						
	QSCAT	1601	7.97	2.7	515	14.2
	10 m ENW	1601	7.96	2.5	479	6.2
	10 m SDIS	1601	7.88	1.54	470	4.2
	All 10 m SDIS	137717	7.76	–	451	–
Fino 1						
	QSCAT	642	8.42	0.8	593	2.6
	10 m ENW	642	8.26	-1.1	563	-2.6
	10 m SDIS	642	8.45	1.2	575	-0.5
	All 10 m SDIS	50349	8.35	–	578	–

Wind resources from QuikSCAT



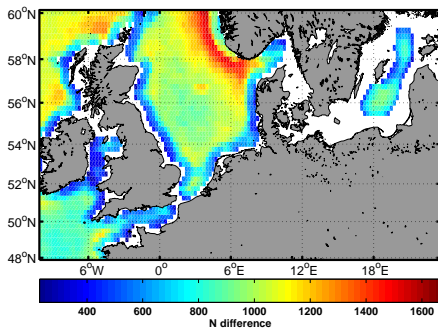
Rain free observations

Wind resources from QuikSCAT

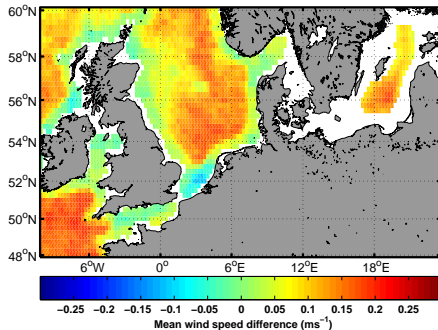


Mean wind speed

Wind resources from QuikSCAT



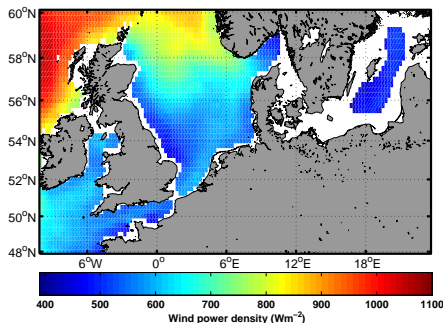
N of rain vs. rain-free retrievals



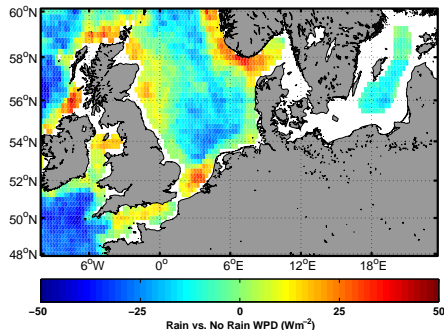
Mean wind speed difference

Wind resources from QuikSCAT

- Wind power density (WPD): $E = \frac{1}{2}\rho\overline{u^3}$



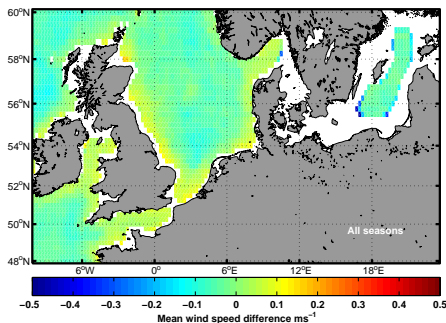
WPD: rain-free observations



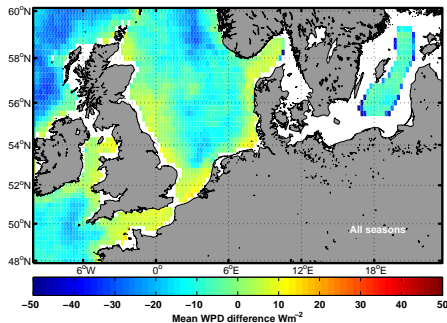
Difference in estimated WPD: rain vs. rain-free observations

2 passes per day: Is that representative enough?

- Hahmann et al: A reanalysis system for the generation of mesoscale climatographies, J Appl. Meteor. Climatol. 2010



U: 24hourly 10-yr vs. 2 fields/day



WPD: 24hourly 10-yr vs. 2 fields/day

Conclusions

- ① Very good agreement between in situ and QSCAT observations
 - QSCAT-In Situ wind speed: $MB=-0.1 \text{ m s}^{-1}$, $\sigma=1.2 \text{ m s}^{-1}$, $R^2=0.94$
 - QSCAT-In Situ wind direction: $MB=-2.5^\circ$, $\sigma=18.5^\circ$, $R^2=0.97$
- ② Worst case scenario: 14% higher WPD estimates from QuikSCAT when compared to in situ
- ③ Highest mean wind speeds in the North Atlantic and northern North Sea
- ④ Intense lee effects from the British Isles
- ⑤ Maximum wind speed difference of 0.25 m s^{-1} for rain contaminated vs. rain free retrievals
- ⑥ Maximum data loss, 1650 observations
- ⑦ Estimated wind power density in the North Sea: $600-700 \text{ W m}^{-2}$
- ⑧ In the North Atlantic, WPD up to 1100 W m^{-2}
- ⑨ Maximum bias in WPD estimates, 50 W m^{-2}
- ⑩ No significant impact of the low temporal frequency to the long-term representativity
- ⑪ QuikSCAT not operational but new missions: ASCAT, OceanSat-2

Thank you for your attention