

Offshore winds from satellite

Kartlegning av offshore vindforhold ved bruk av satellittobservasjoner

Charlotte Bay Hasager, Merete Bruun Christiansen, Poul Astrup,
Morten Nielsen

Vindkraft FoU Seminar - vinn eller forsvinn?
Trondheim, Norge, 25-26 Januar 2007

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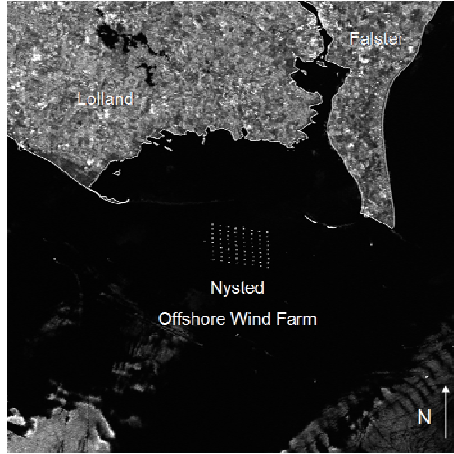
Offshore wind energy



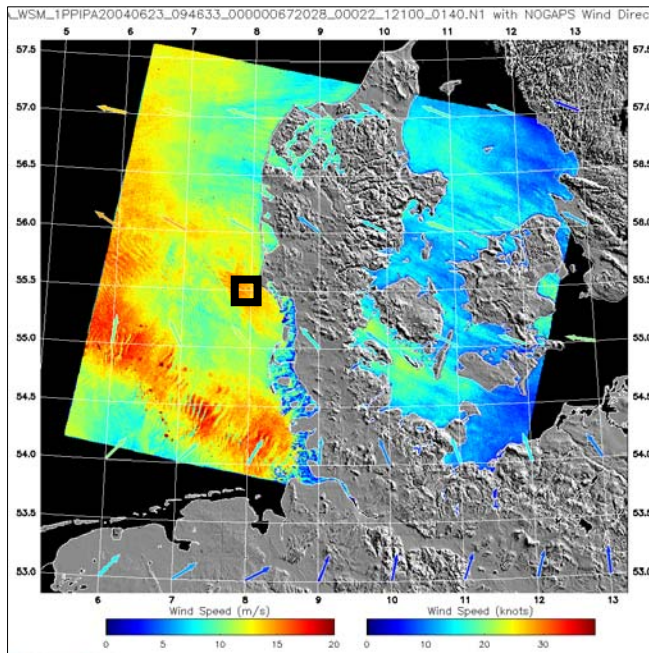
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Based on radar satellite images of high resolution



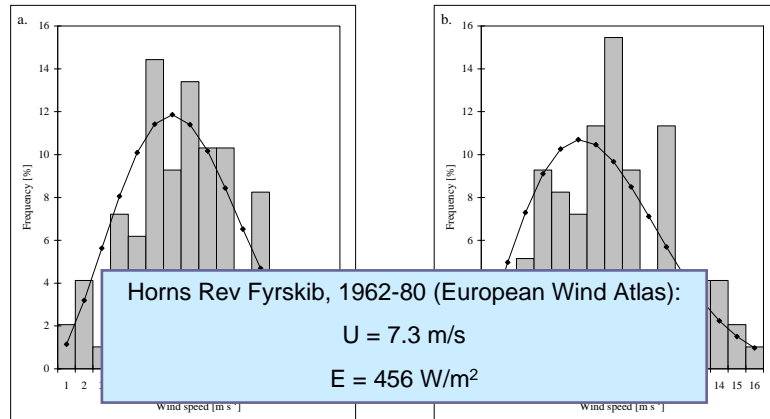
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We calculate from radar raw data to satellite wind maps

Envisat ASAR

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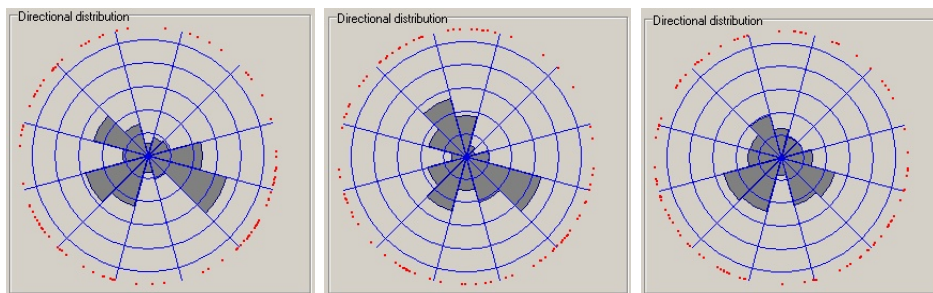
Meteorology mast wind speed

Satellite wind map wind speed

U = 7.6 m/s
E = 422 W/m²

U = 7.3 m/s
E = 421 W/m²

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Directions from met. mast

Directions from image,
LG supervised

Directions from image, LG
automatic

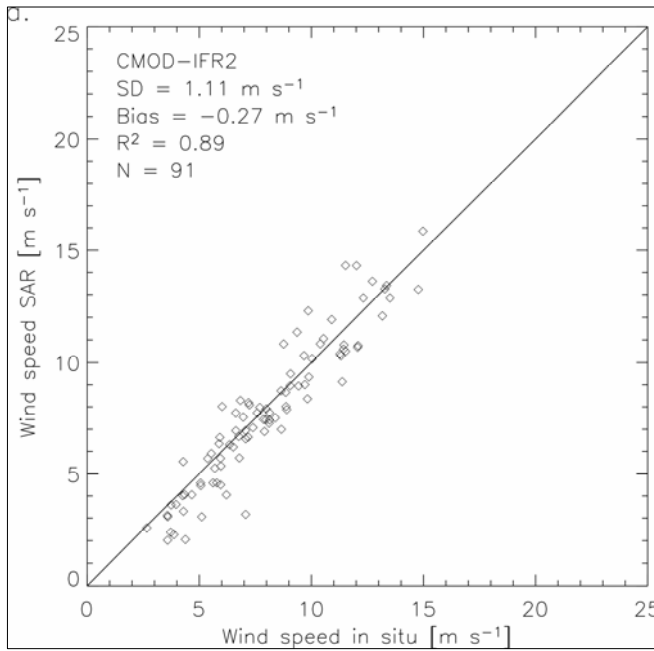
Deviation from mast = 21°

Deviation from mast = 33°

(U > 5 m/s, N = 78)

(U > 5 m/s, N = 78)

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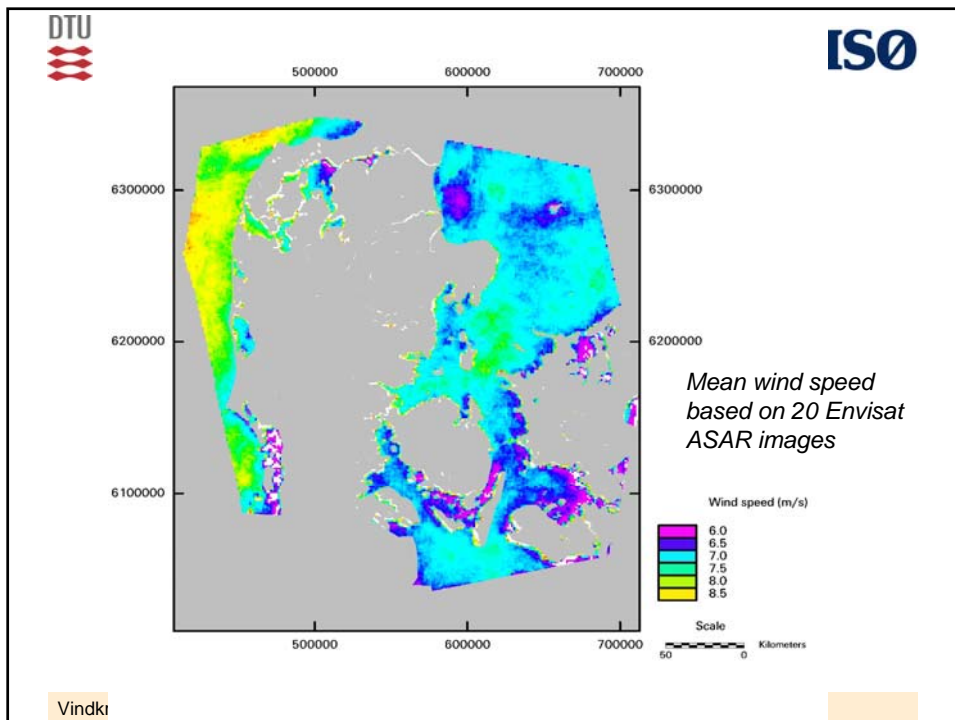
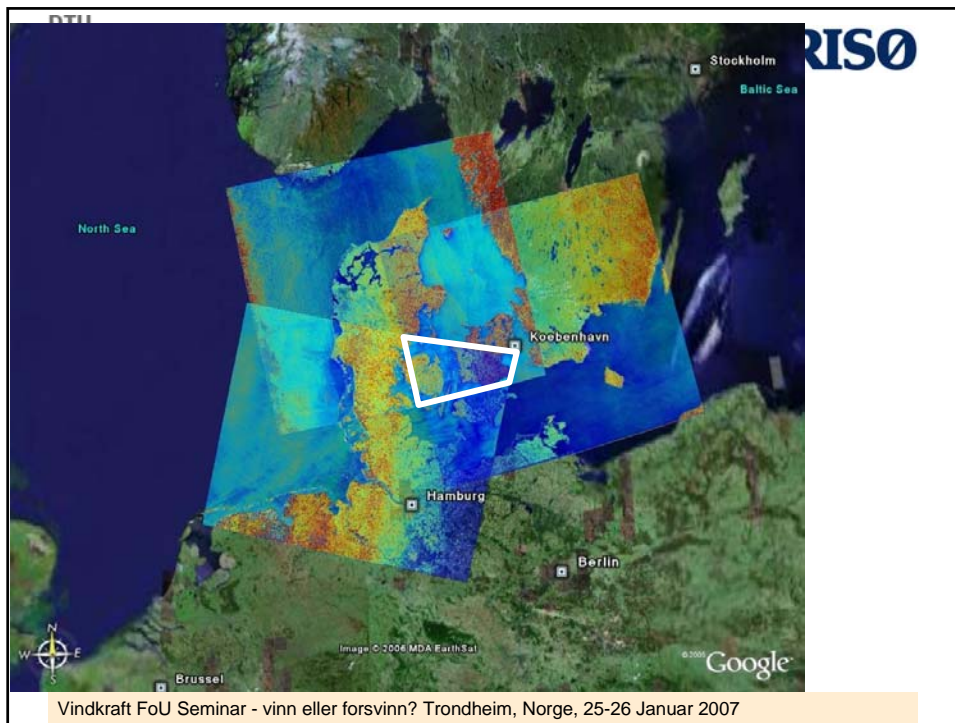
Atmospheric influences
- altering the vertical wind profile

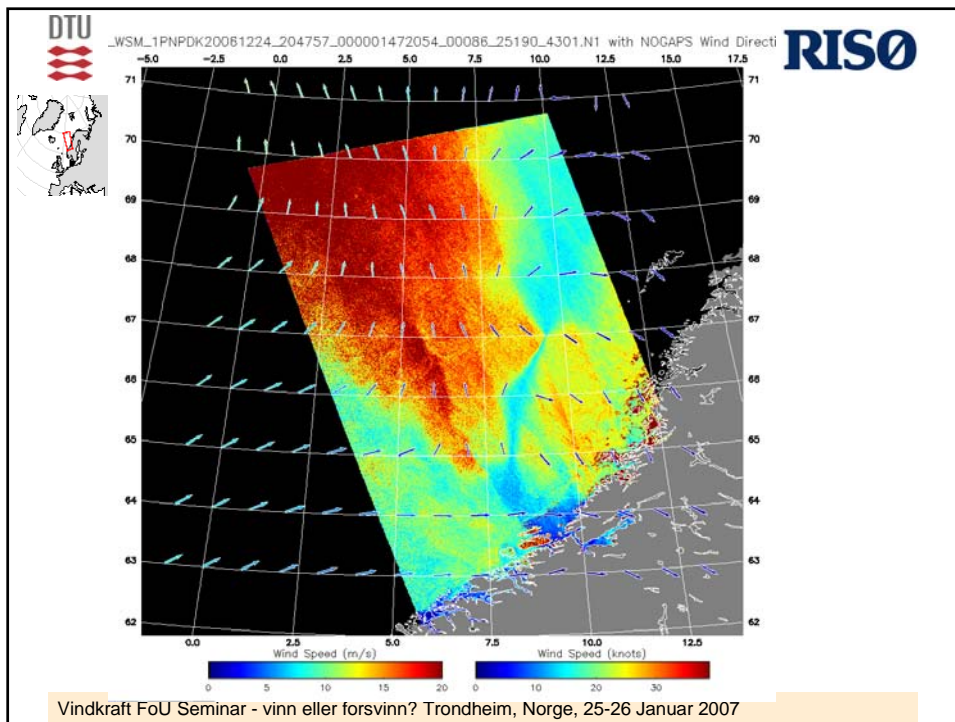
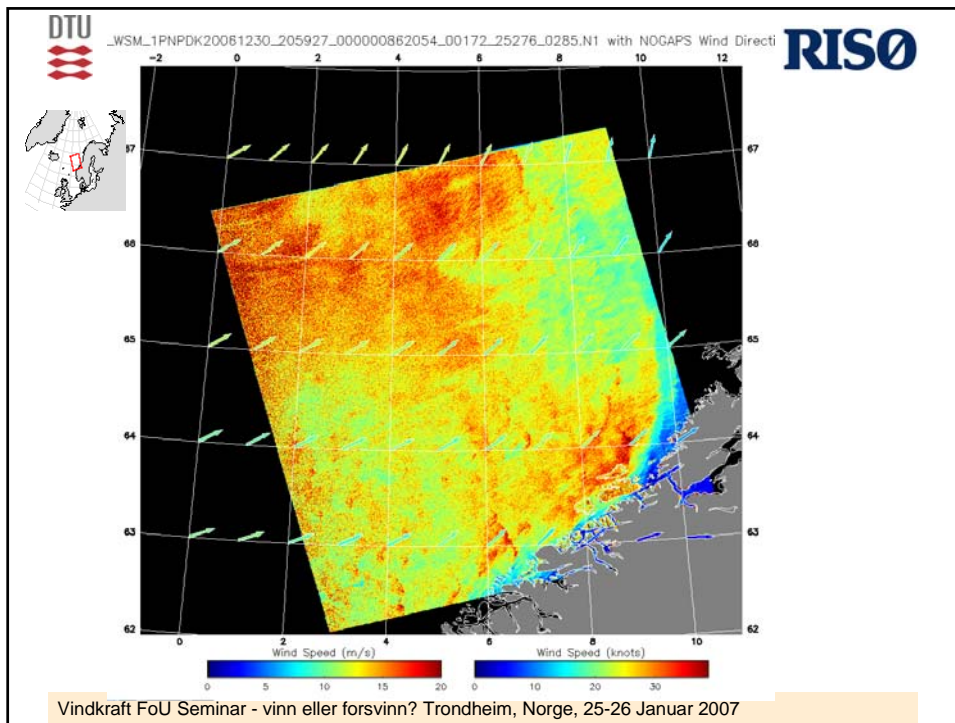
	SD [m s^{-1}]	Bias [m s^{-1}]	R^2	N
Onshore winds	1.10	-0.06	0.89	49
Offshore winds	1.08	-0.52	0.88	42

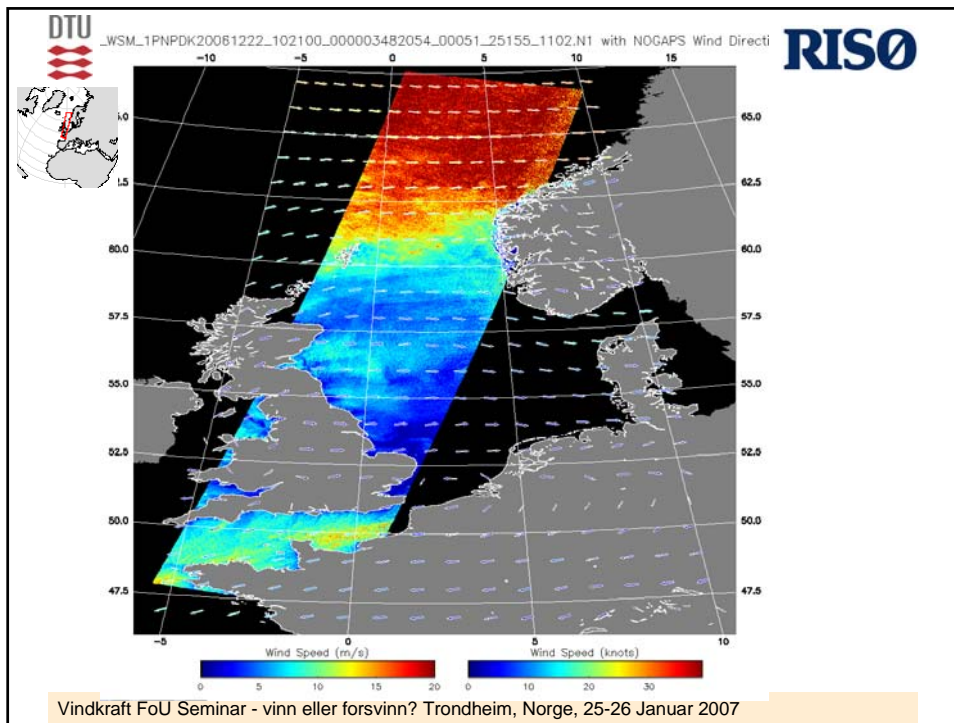
	SD [m s^{-1}]	Bias [m s^{-1}]	R^2	N
Stable	1.47	-0.86	0.88	11
Near-neutral	0.95	-0.13	0.93	22
Unstable	1.06	-0.26	0.85	52

	SD [m s^{-1}]	Bias [m s^{-1}]	R^2	N
No wind farm	0.93	-0.57	0.90	46
Wind farm	1.20	0.04	0.87	45

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DTU

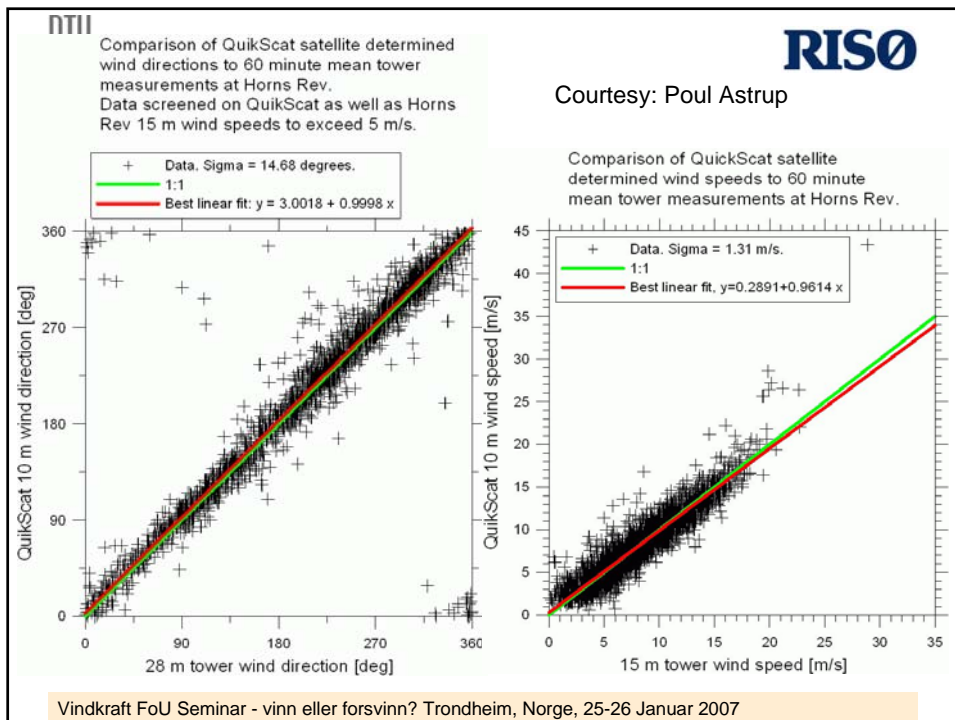
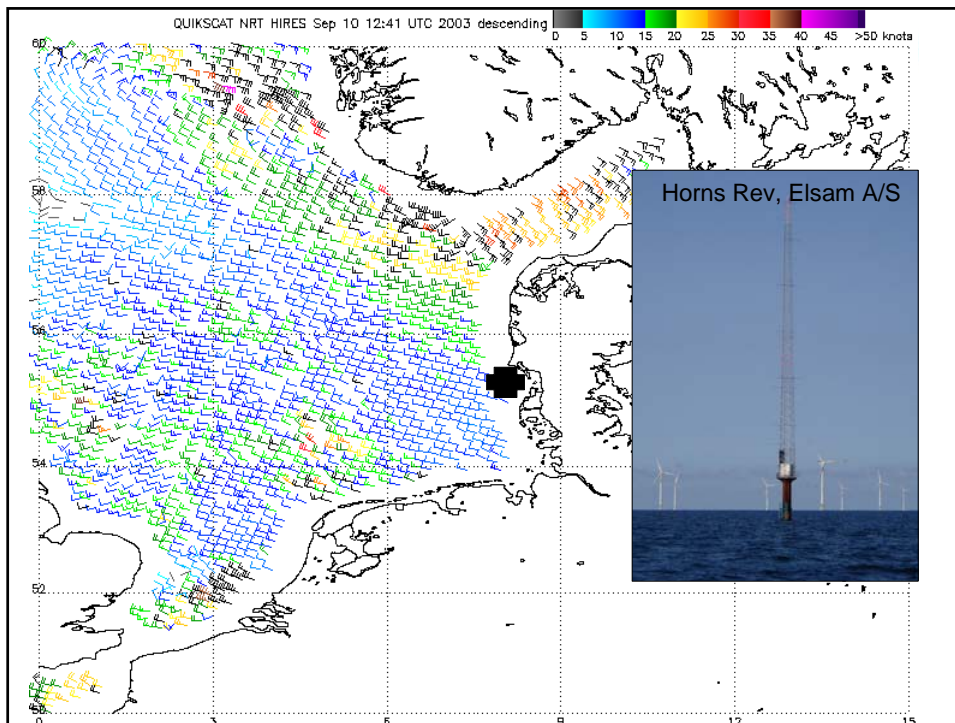
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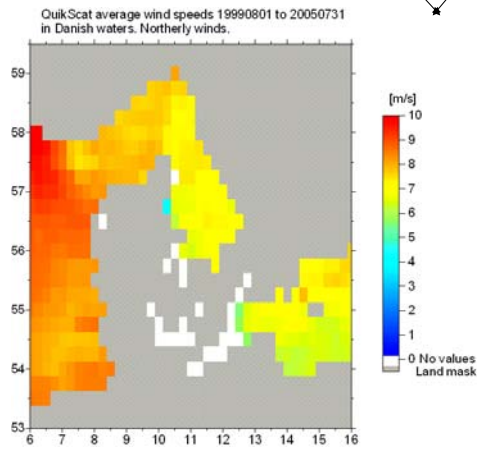
http://www.risoe.dk/galathea/opslag/satellit_arkiv.htm

Merete Bruun Christiansen
in cooperation with JHU APL (USA)

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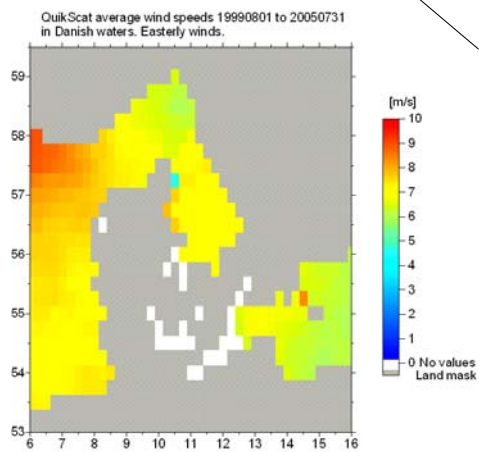


North



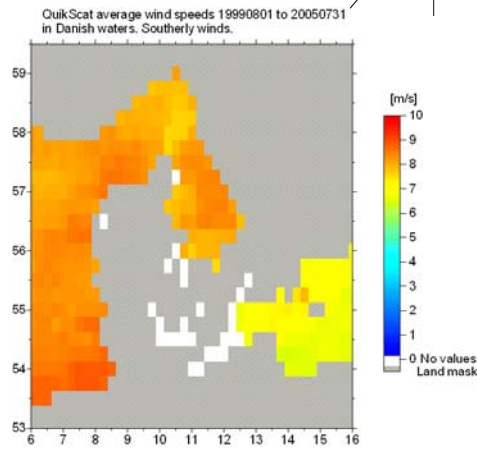
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East



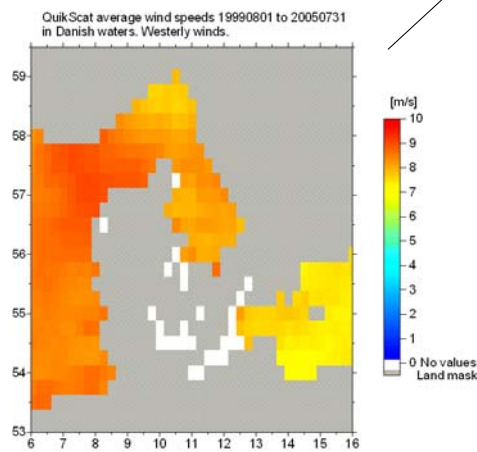
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South



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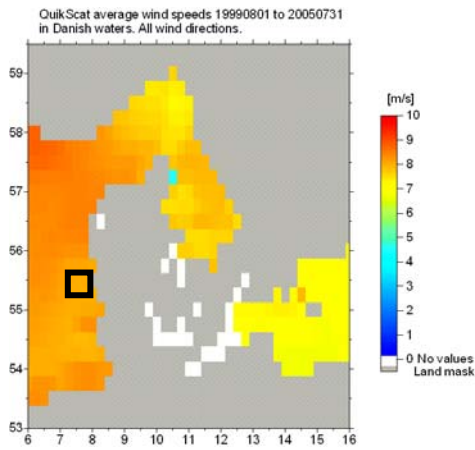
West



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QuikScat Mean wind speed 5 years



Grid cell:
ca. 25 km

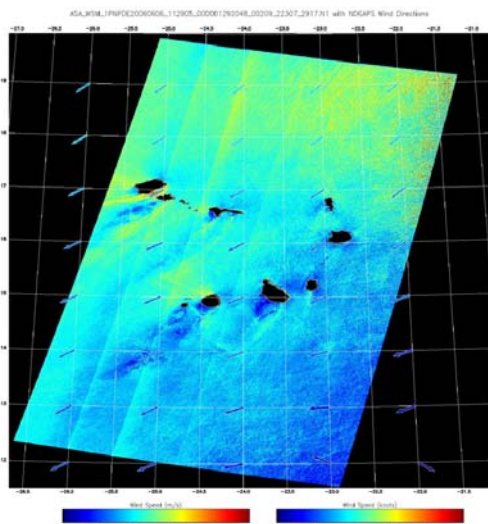
Number of observations: 3650 (twice per day for 5 years)

Weibull A and k per sector in WAsP tab-file format available

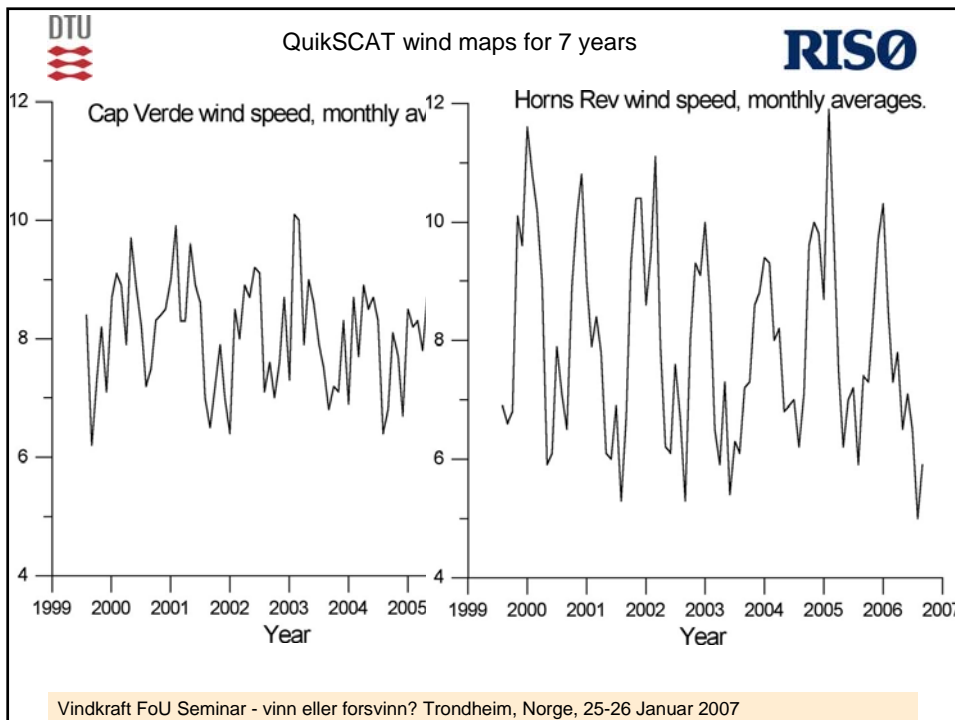
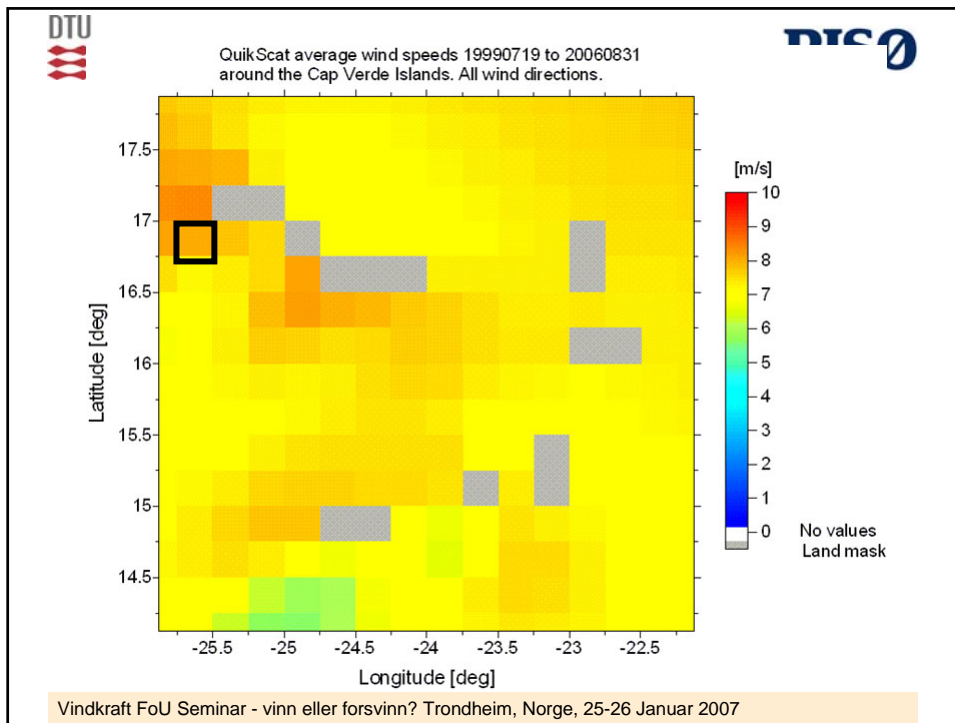
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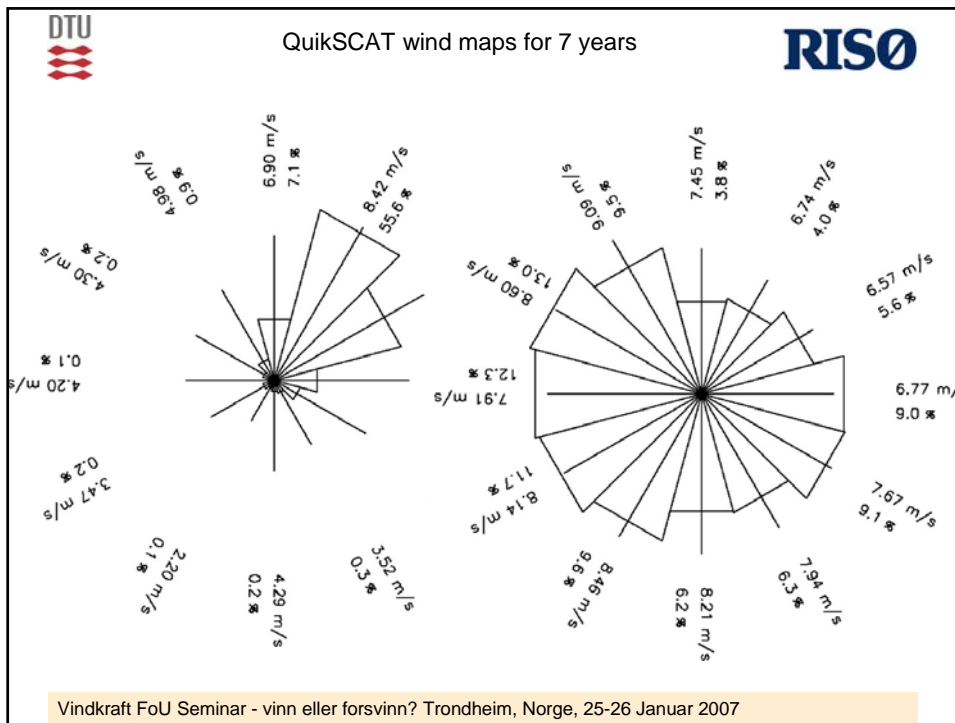


Cape Verde



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QuikSCAT wind maps for 7 years

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	Longitude and latitude (°)	Mean wind speed (m/s)	Weibull A (m/s)	Weibull k
Cape Verde	334.25 E, 16.75 N	8.04	8.86	4.57
Denmark	7.75 E, 55.50 N	7.95	9.06	2.26
Cape Horn	67.5 W, 56.50 S	11.2	12.88	2.44

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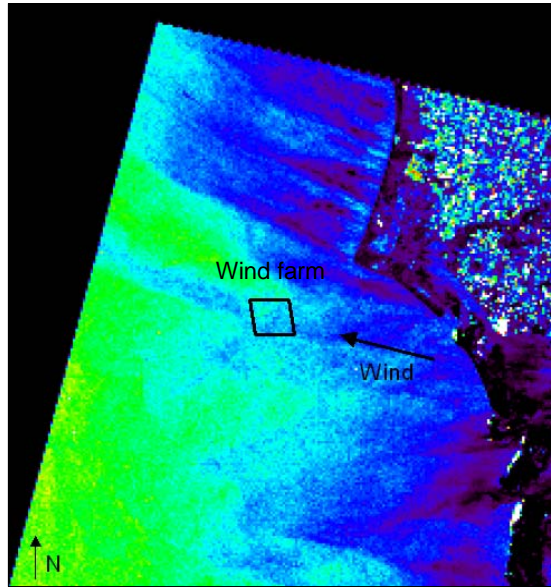
Wind farm wake effects



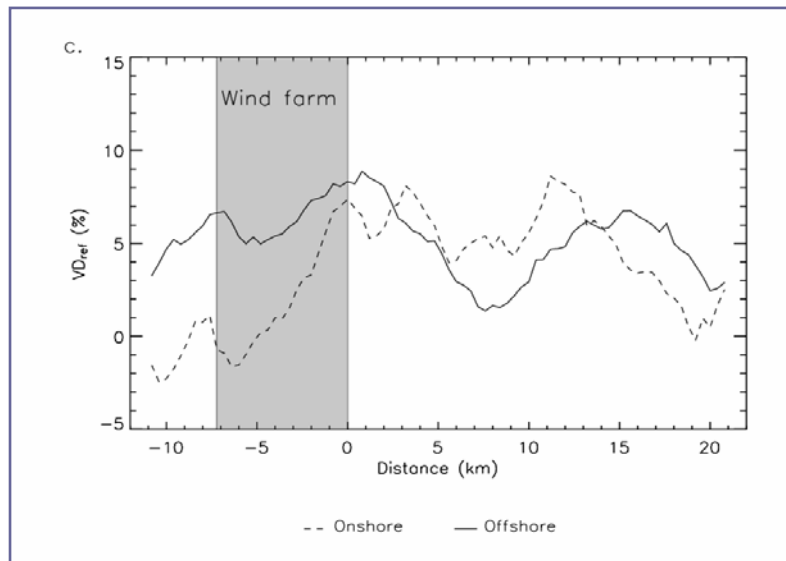
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Horns Rev

Merete Bruun Christiansen



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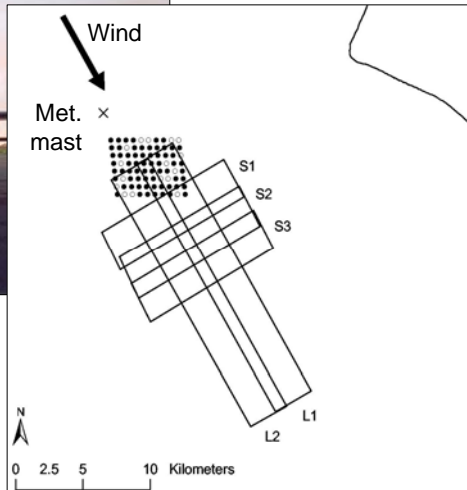
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Airborne SAR (E-SAR)



12 October 2003

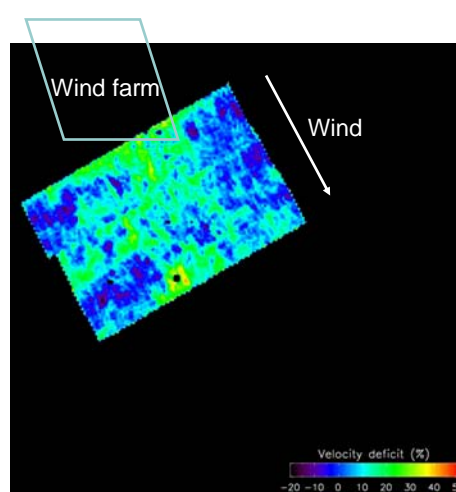
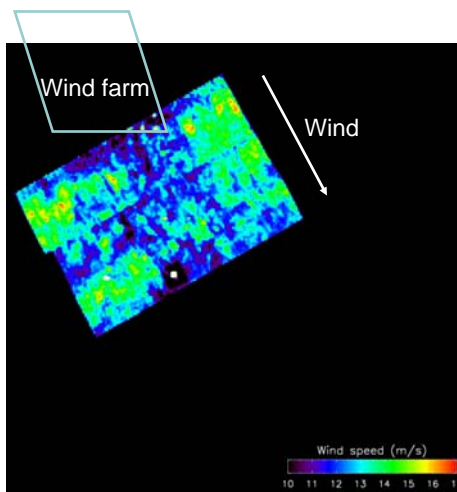


5 flight tracks in C-band VV

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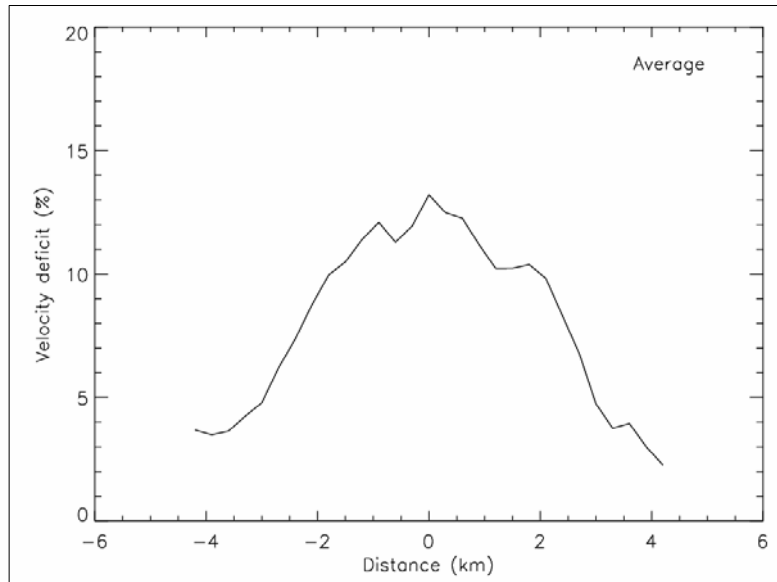


Winds from E-SAR in CVV



Merete Bruun Christiansen

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Conclusions

Wind resources can be estimated from satellite wind maps as a supplement to in-situ data:

- ERS SAR and Envisat ASAR with high spatial but low temporal resolution
- QuikSCAT with medium spatial but high temporal resolution

Wake velocity deficit can be quantified from SAR satellite and airborne wind maps.

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