

Norsewind wind atlas: Satellite derived wind atlas

Hasager, Charlotte Bay; Badger, Merete; Mouche, Alexis; Karagali, Ioanna; Driesenaar, M.L.; Berge, Erik; Hahmann, Andrea N.; Bredeesen, Rolv; Costa, Paolo; Oldroyd, Andy

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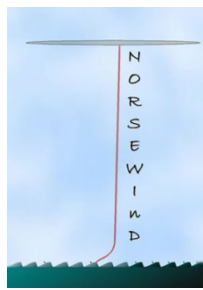
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Norsewind wind atlas: Satellite derived wind atlas

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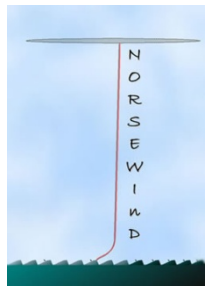
Ioanna Karagali (1) M.L. Driesenaar (5) Erik Berge (2)

Andrea Hahmann (1) Rolv Bredesen (2) Paulo Costa (6) Andy Oldroyd (7)

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- (6) LNEG, Lisboa, Portugal
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DTU Wind Energy
Department of Wind Energy





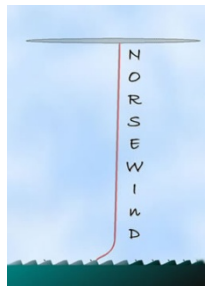
Introduction

The FP7 project Norsewind (2008-2012) focused on the offshore winds through observations with

- ground-based lidar
- offshore meteorological masts
- satellite remote sensing
- mesoscale modeling

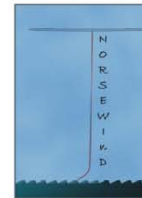
One of the key products is wind atlas based on satellite data.

Rationale for satellite data

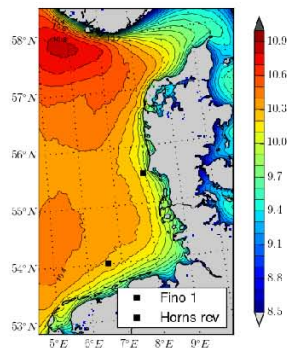


The NORSEWIND project (2008-12)

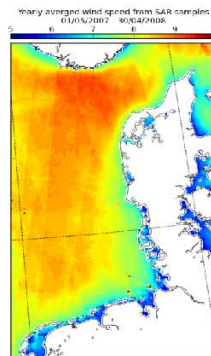
- Northern Seas Wind Index Database
- Combining the strengths of different data types to a state-of-the-art offshore wind atlas for the wind energy industry



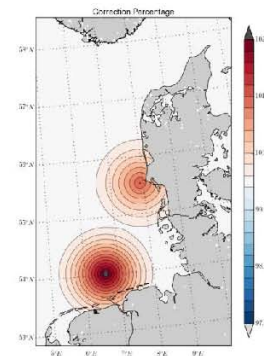
Numerical models



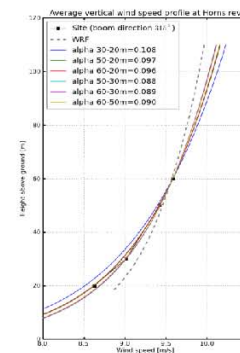
Satellite data



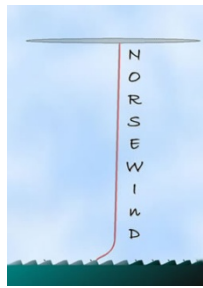
Measurements



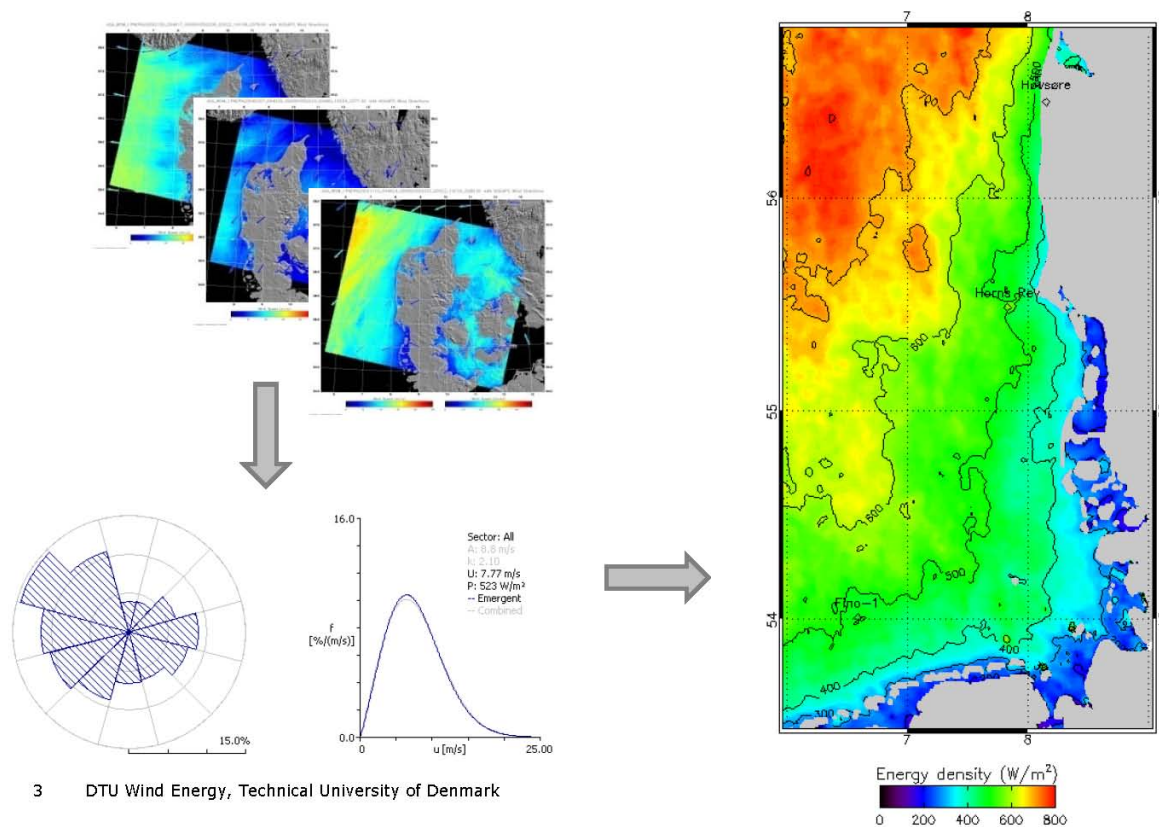
Vertical profiles



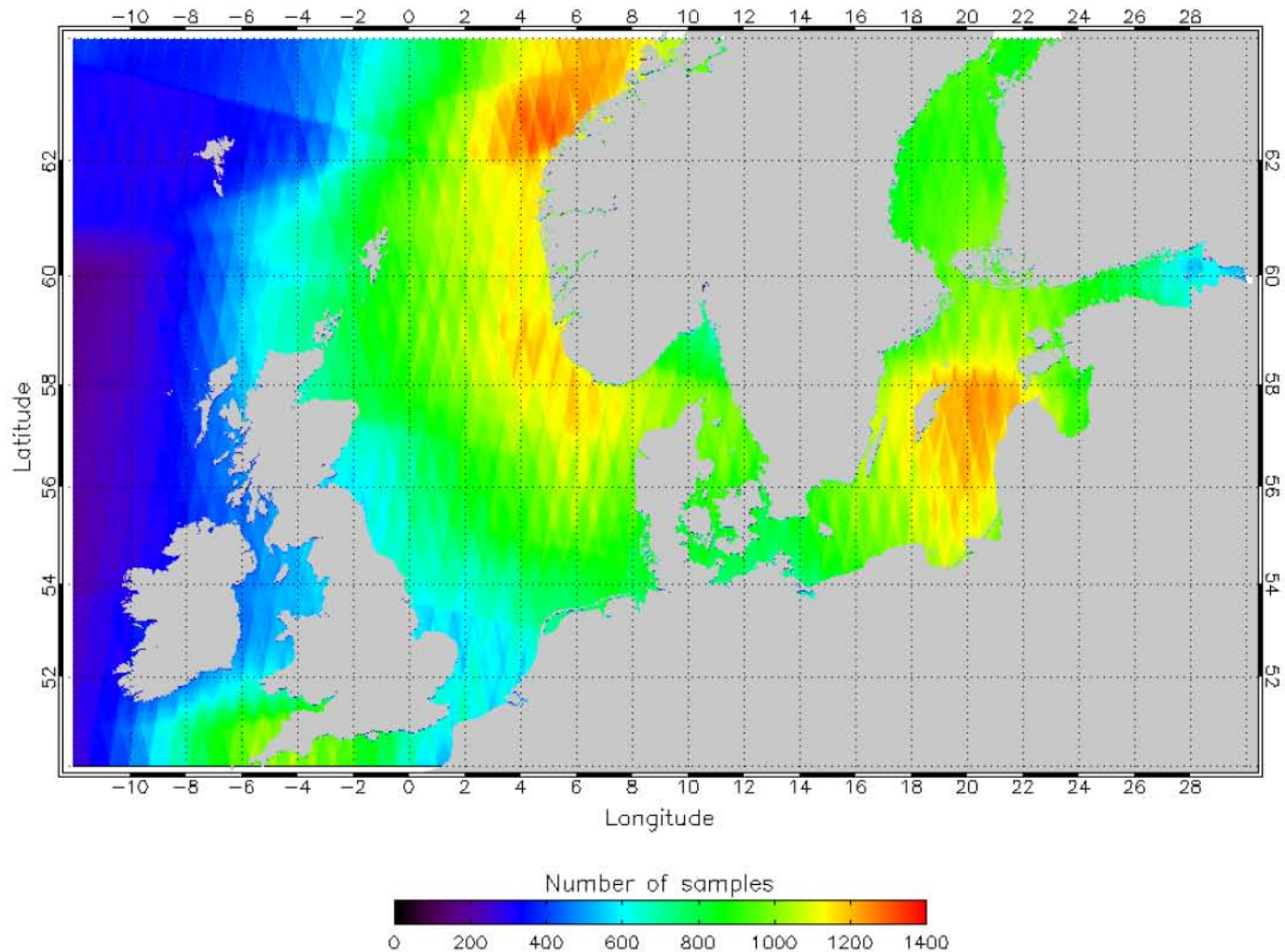
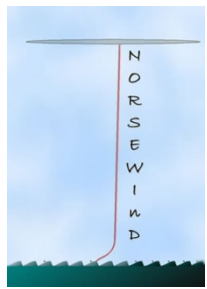
Satellite SAR – synthetic aperture radar

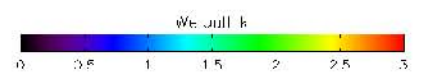
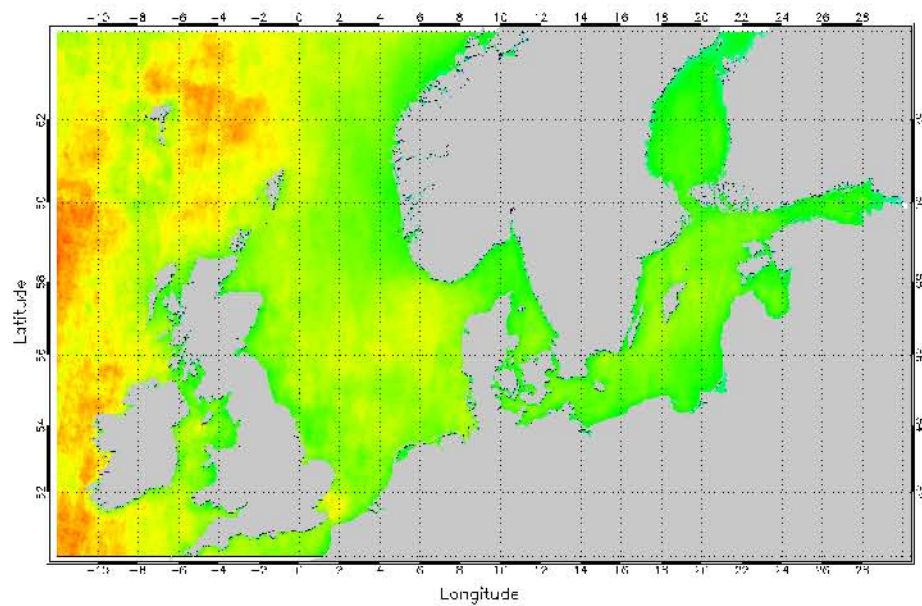
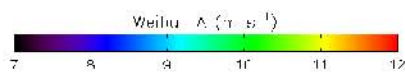
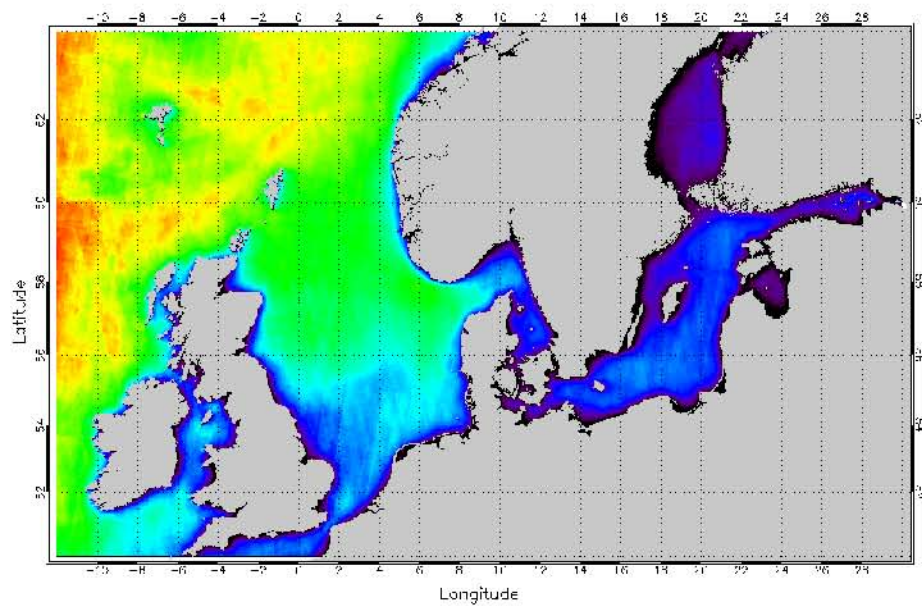
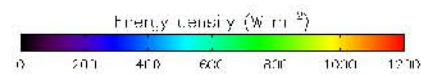
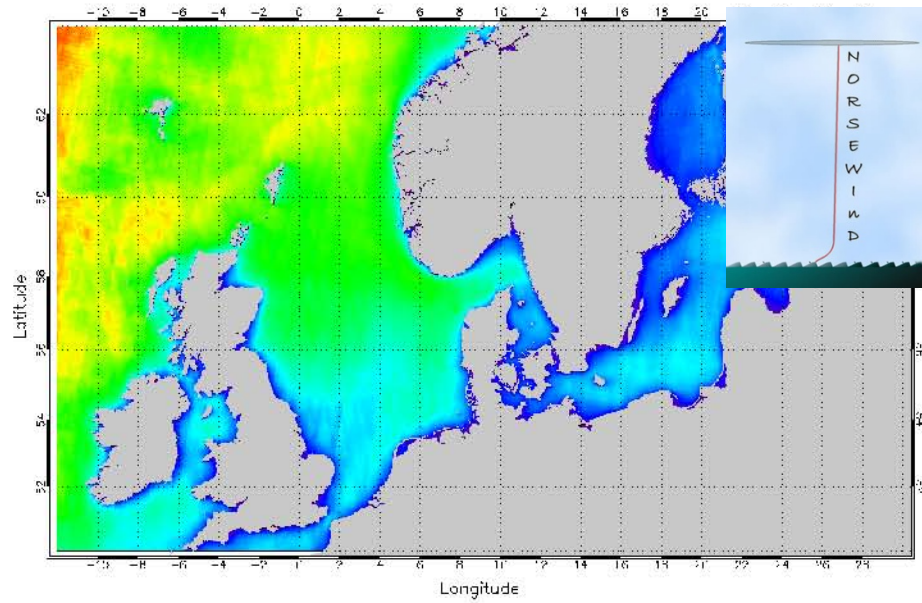
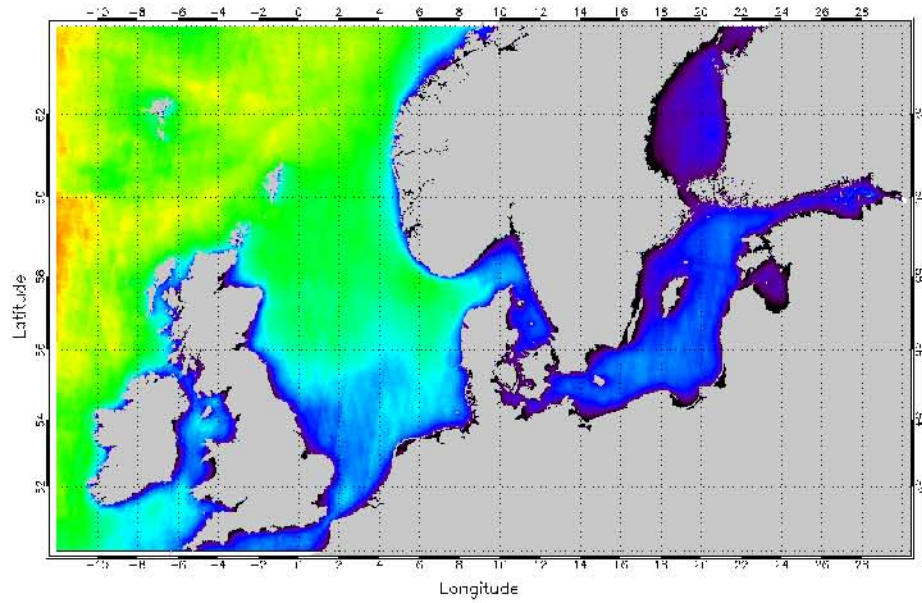


Wind resource mapping from satellite wind fields

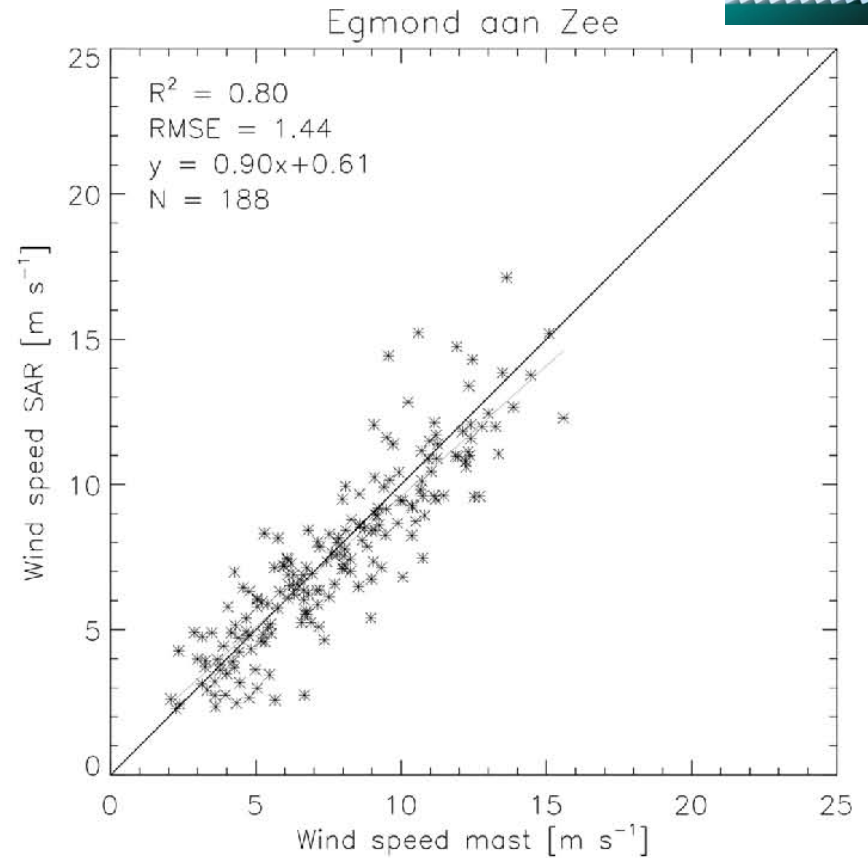
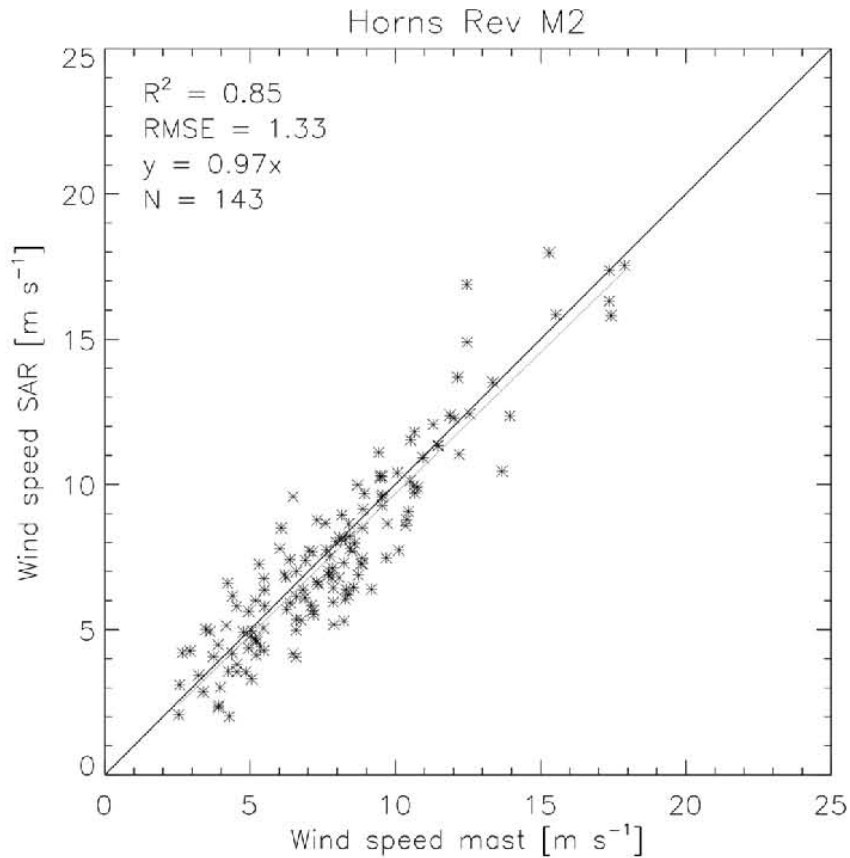
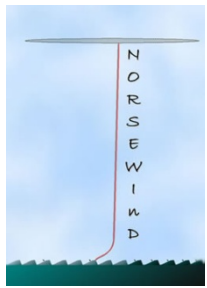


Envisat ASAR scenes in the NORSEWIND project - and the 10-m wind atlas from SAR

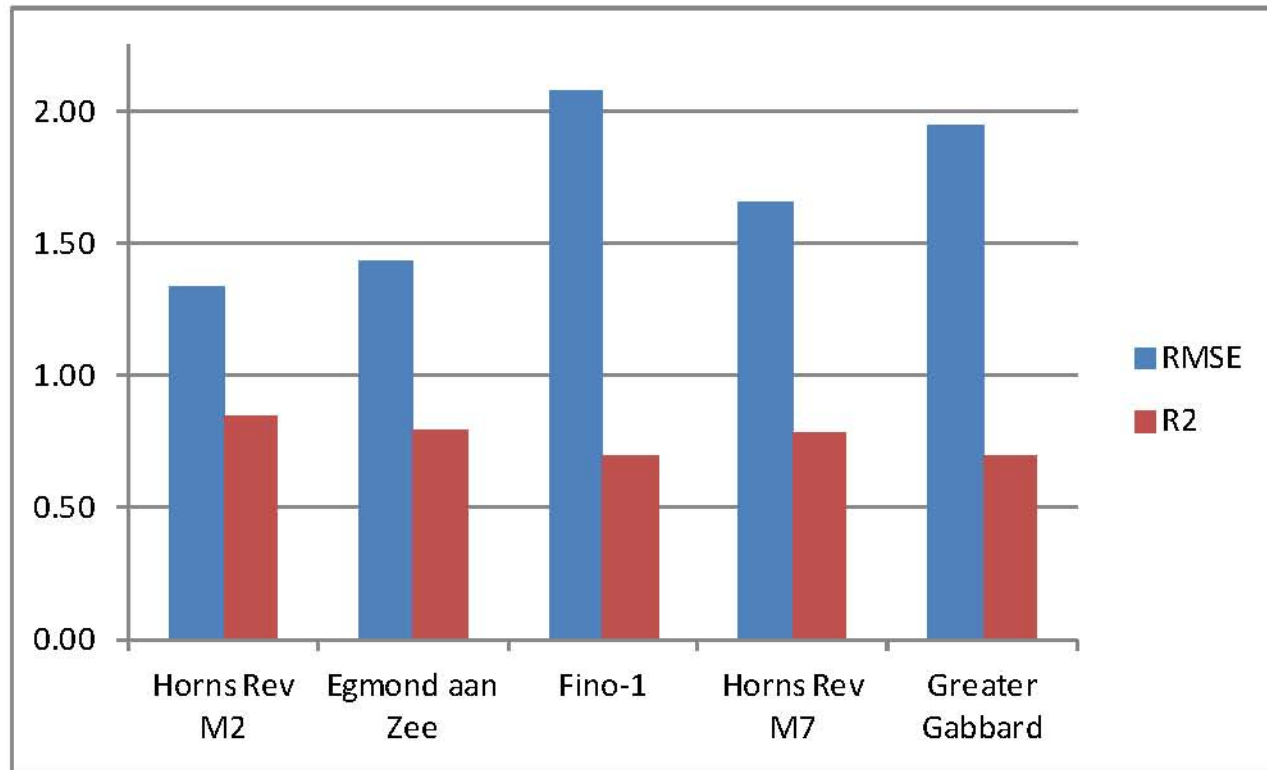
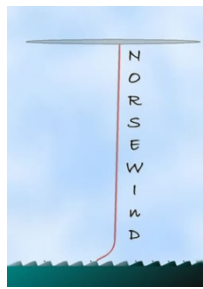




Comparison of SAR and mast winds at 10 m



Comparison of SAR and mast winds at 10 m

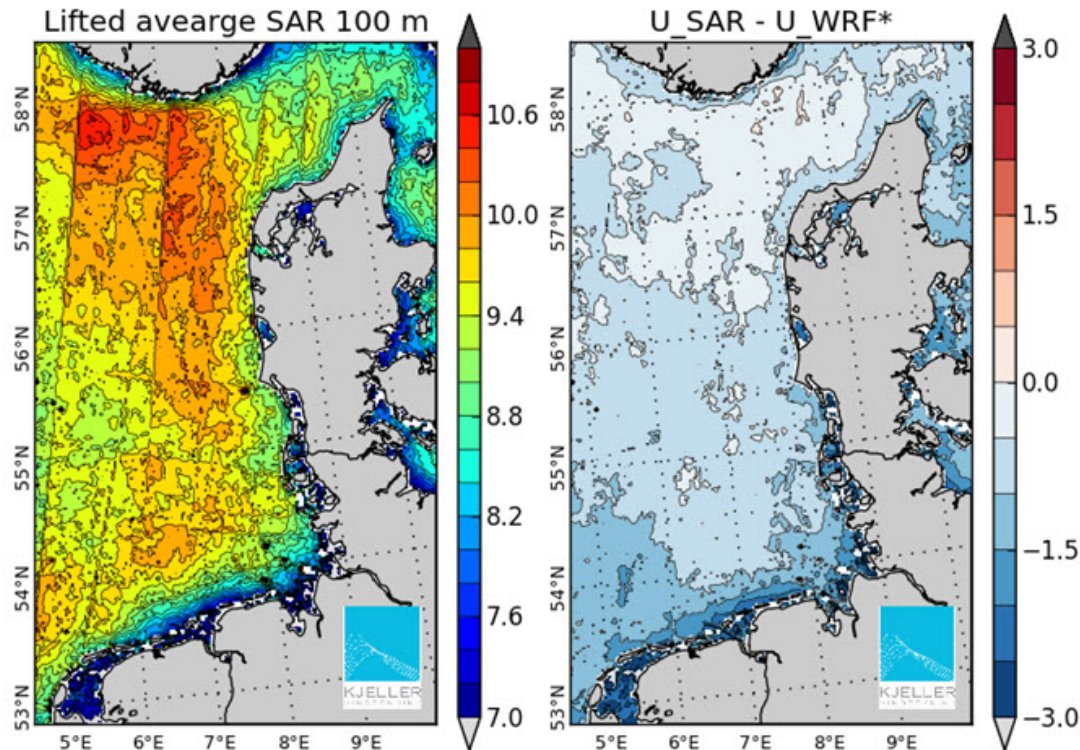


Wind speeds from SAR and 5 masts in the North Sea

Horns Rev M2 and Egmond aan Zee give stability dependent winds (SDW)

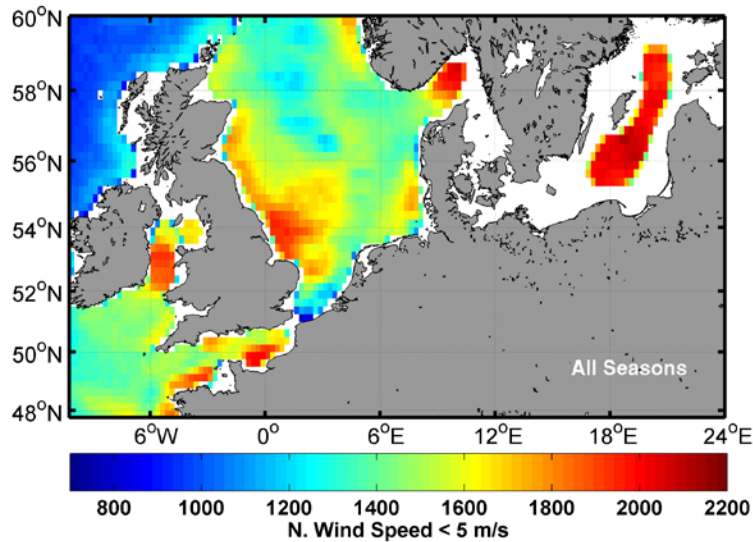
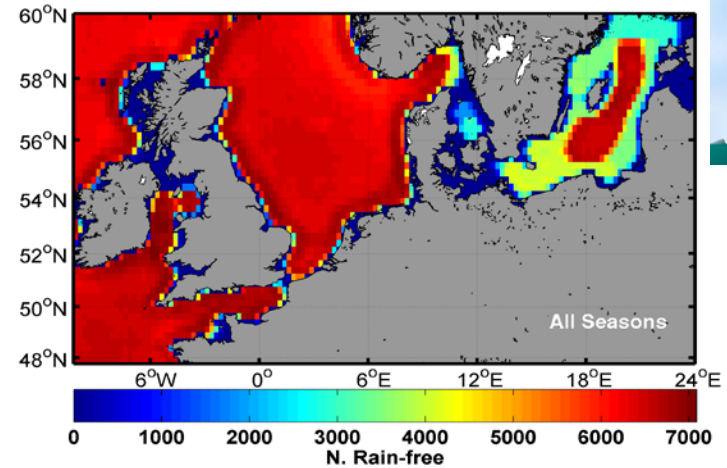
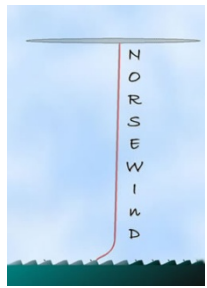
See also: Hasager et al. 2011, SAR-Based Wind Resource Statistics in the Baltic Sea. *Remote Sens.*, 3(1), 117-144.

Spatial wind variability over the North Sea

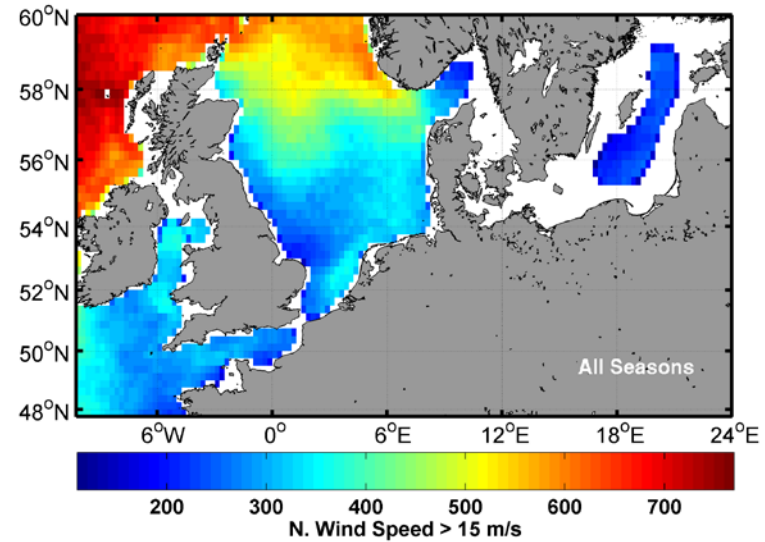


From : EWEA 2012 M. Badger, A. Peña, R. Bredesen, E. Berge, A. Hahmann, J. Badger, I. Karagali, C. Hasager, T.Mikkelsen, Bringing satellite winds to hub-height, Proceedings.

QuikSCAT

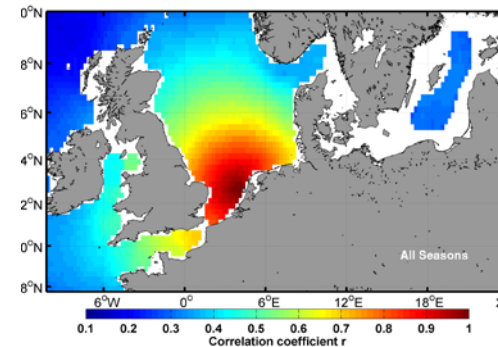
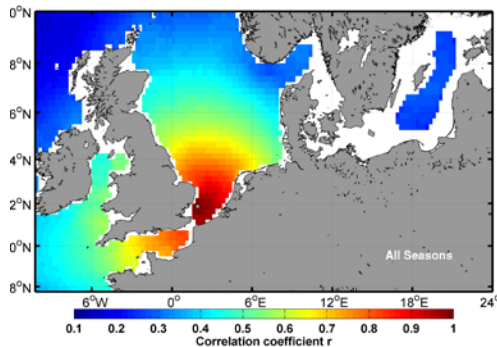
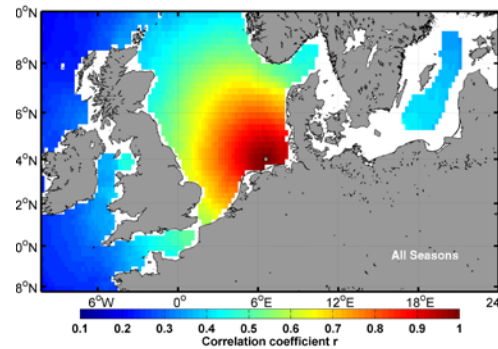
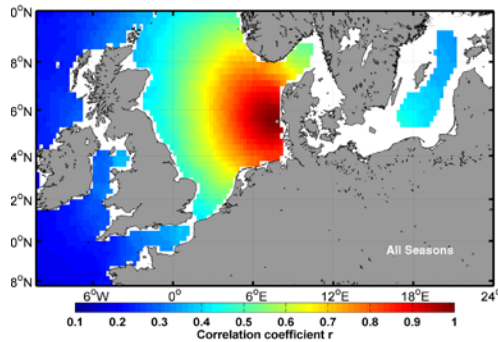
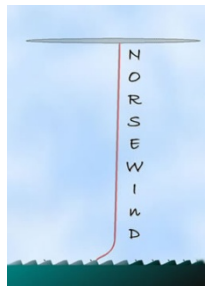


winds <5 m/s



winds >15 m/s

QuikSCAT – spatial correlations



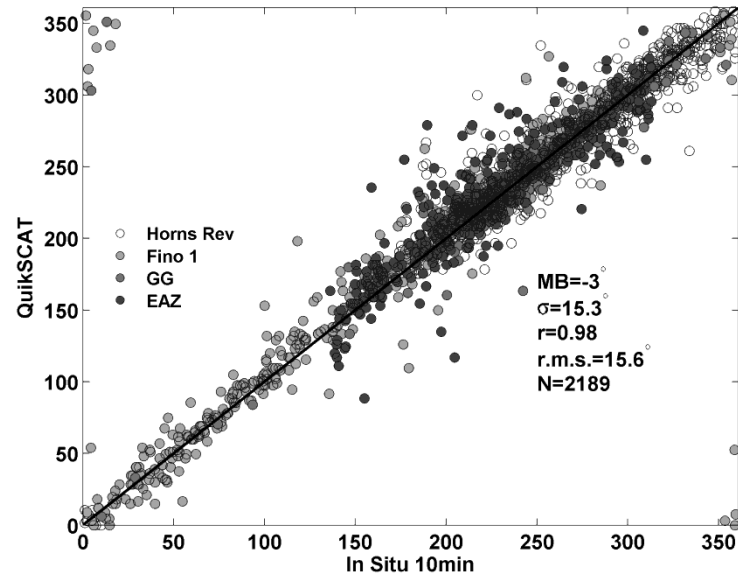
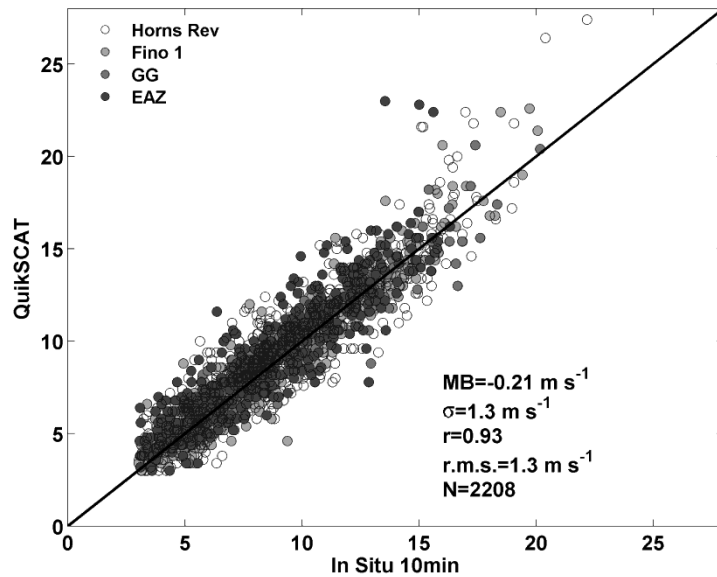
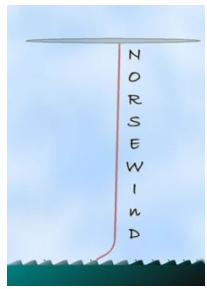
Horns Rev M2

FINO-1

Egmond aan Zee

Greater Gabbard.

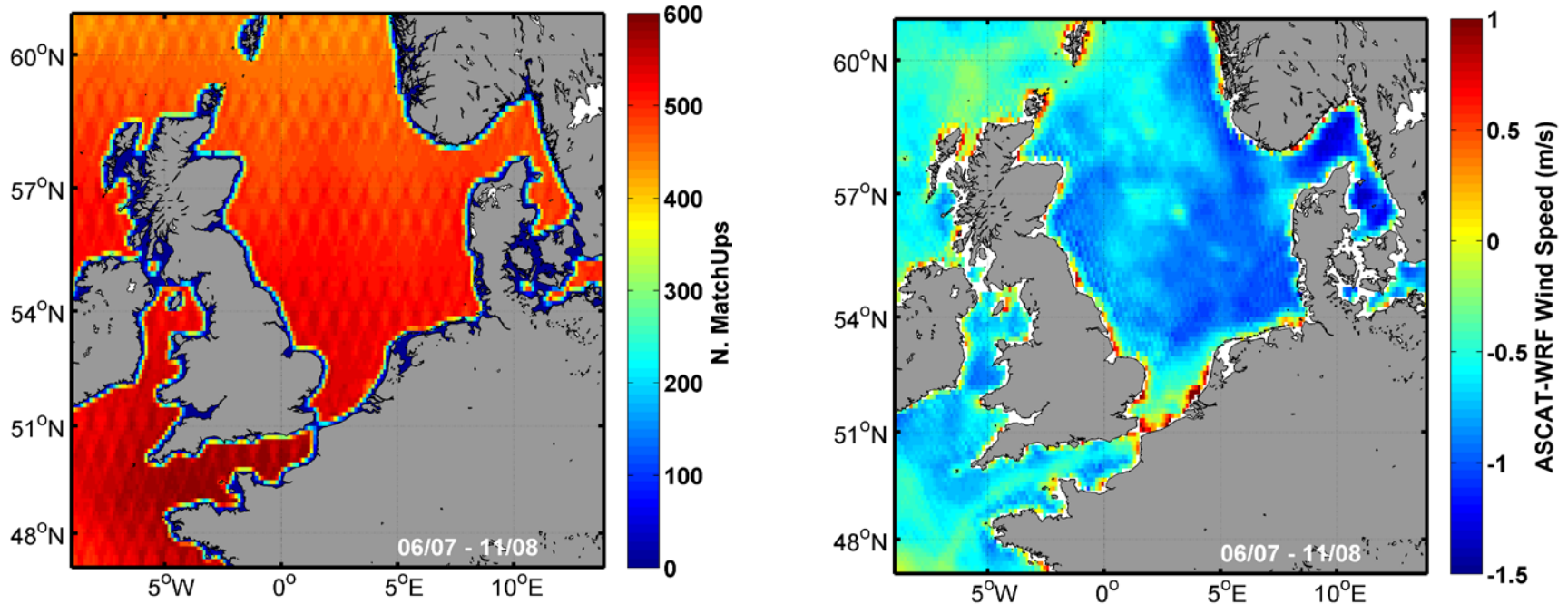
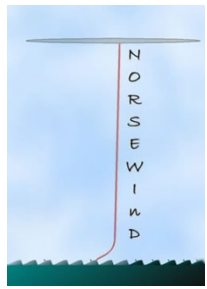
QuikSCAT versus four met-masts



GG is Greater Gabbard
EAZ is Egmond an Zee

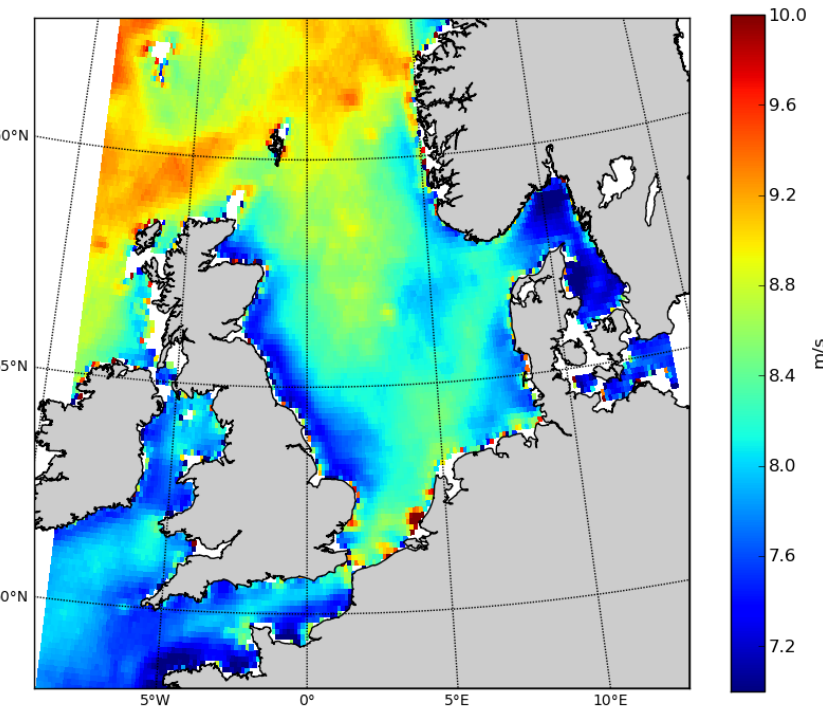
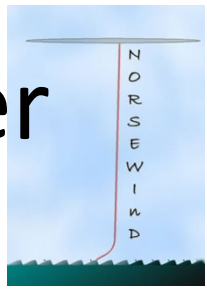
Karagali, I. (2012). Offshore Wind Energy: Wind and Sea Surface Temperature from Satellite Observations. PhD Thesis, DTU Wind Energy-PhD-003.

ASCAT versus WRF (wind speed)

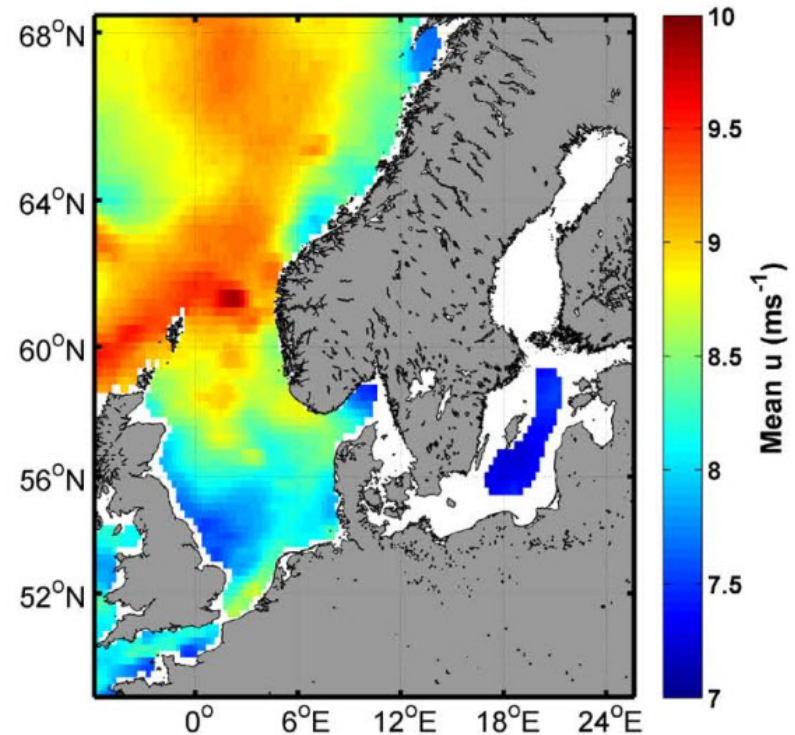


Number of ASCAT passes used for comparisons with the WRF model outputs (left) and mean bias between ASCAT and WRF.

ASCAT and QuikSCAT scatterometer mean wind speed

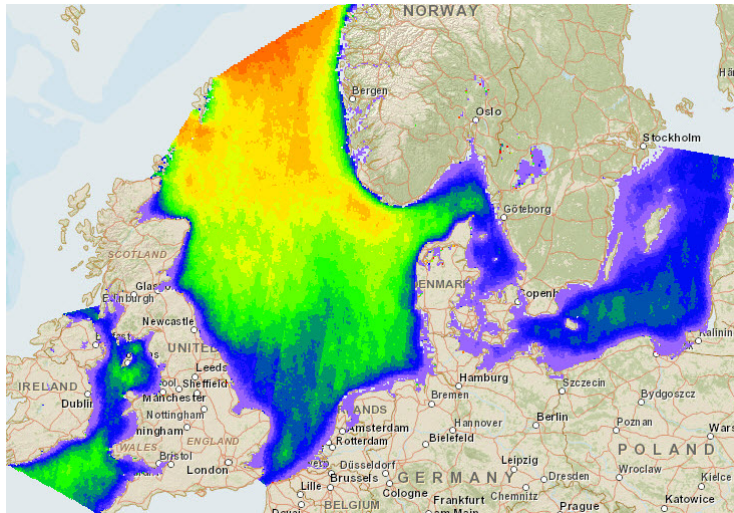
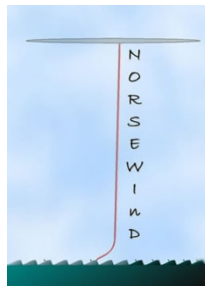


ASCAT coastal wind atlas (2007-08)



QuikScat wind atlas (1999-2009)

Access to wind resource maps



The maps are
Number of samples
Mean wind speed
Weibull A parameter
Weibull k parameter
Energy density

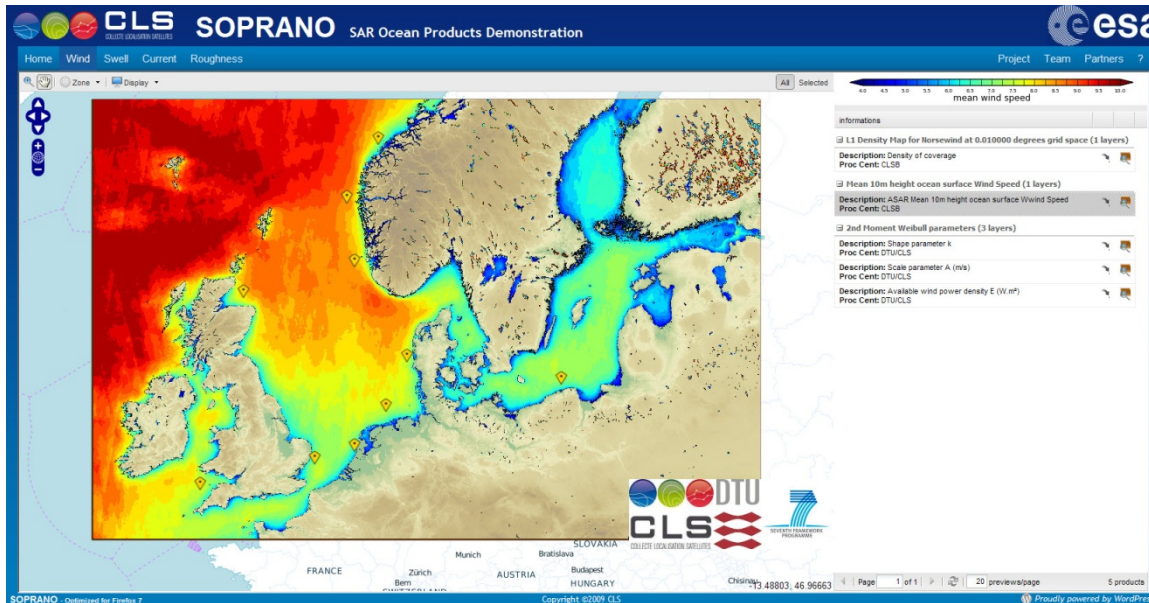
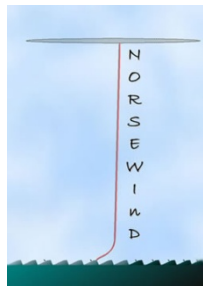
Maps at
<http://geoportal.ineg.pt//index.php?lg=en&state=Inicio>.

The results are based on 9000 Envisat ASAR WSM wind maps collected and processed by CLS and DTU Wind Energy.

Also QuikSCAT and ASCAT maps are available and WRF results.

See www.norsewind.eu

Access to wind resource maps

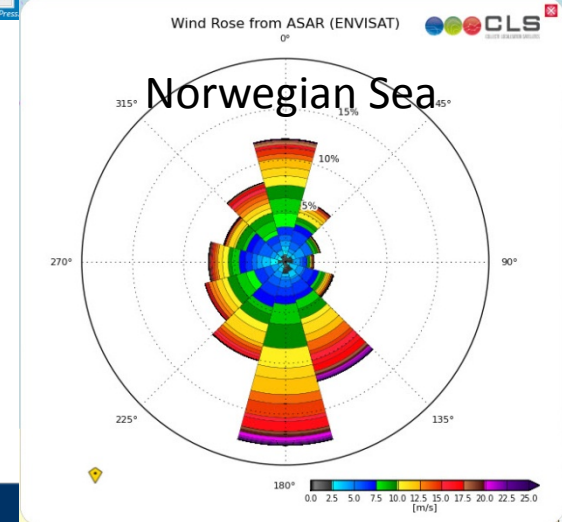
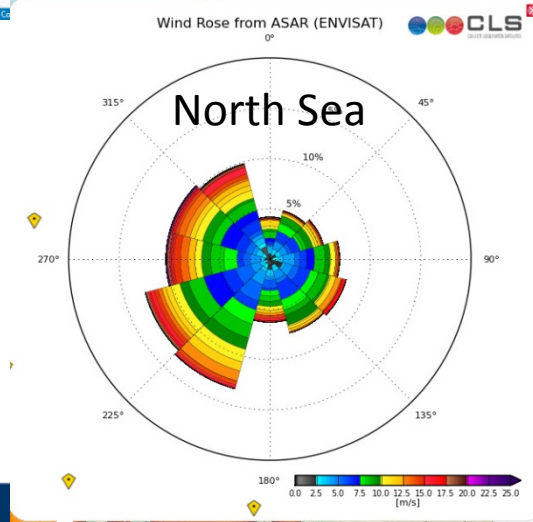
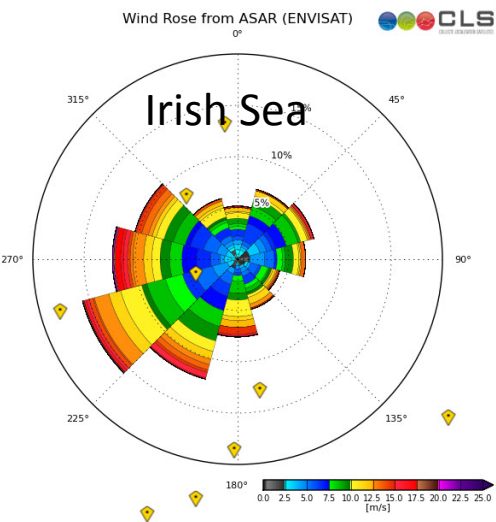
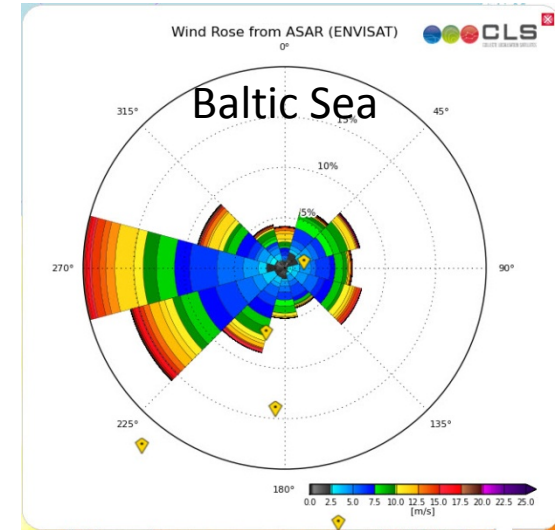
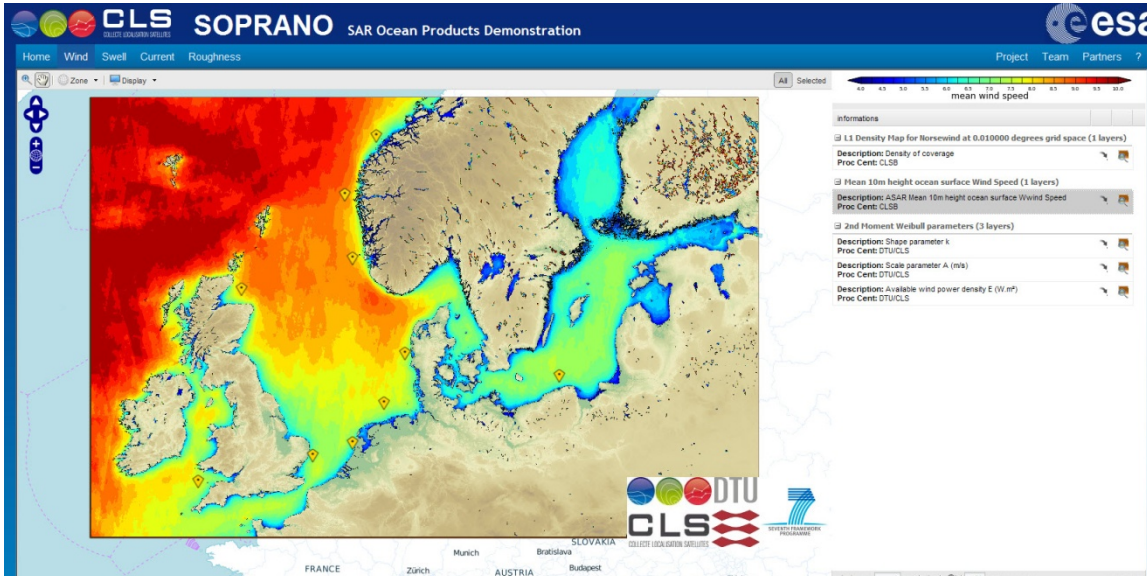
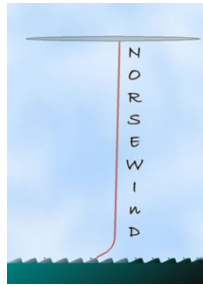


The maps are
Number of samples
Mean wind speed
Weibull A parameter
Weibull k parameter
Energy density

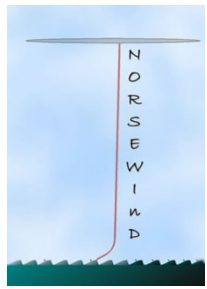
Maps at <http://soprano.cls.fr>
soprano/winds/statistics(L3)
select Norsewind.

The results are based on 9000
Envisat ASAR WSM wind maps
collected and processed by CLS
and DTU Wind Energy.

Access to wind resource maps



Conclusions



- Based on satellite SAR and scatterometer Earth Observations maps of many statistical parameters are calculated including mean wind speed, Weibull A and k, uncertainty estimates, spatial correlation, etc.
- Comparison to met-mast data and WRF results performed
- Lifting of satellite winds to hub-height is on-going (beyond the project)
- The satellite-based wind resource maps for 10 m height are publically available at
<http://soprano.cls.fr>
<http://geoportal.ineg.pt//index.php?lg=en&state=Inicio>
www.norsewind.eu

Report: Hasager et al. 2012 Norsewind satellite wind climatology, DTU Wind Energy-E-0007(EN), Roskilde, Denmark