Satellite winds in EU-Norsewind

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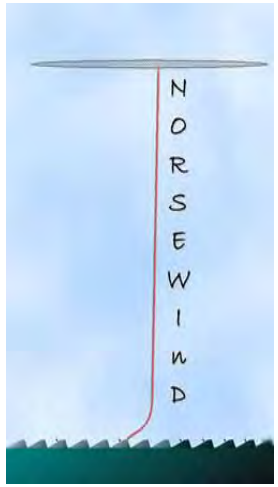
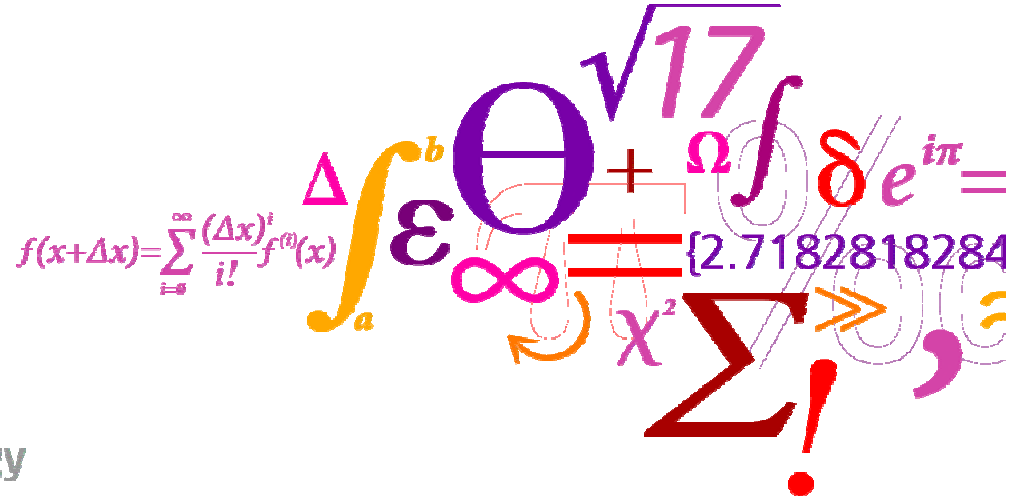
Romain Husson, ESA





Risø DTU
National Laboratory for Sustainable Energy

Introduction EU-Norsewind

- EU-Norsewind project (2008-2012) with the aim to produce a wind atlas for the Northern European Seas including the Baltic, Irish and North Seas.
- Ground-based using 15 lidars and some masts.
- Satellite-based wind mapping.
- Atmospheric modeling.
- Testning for location offshore Portugal.

EU-Norsewind team

- Coordinator: Andy Oldroyd of Oldbaum Services in Glasgow.

Oldbaum Services
Garrad Hassan & Partners
ISET
RISOE DTU
WINDTEST Kaiser Wilhelm Koog
DONG Energy
Statoil Hydro ASA
CLS

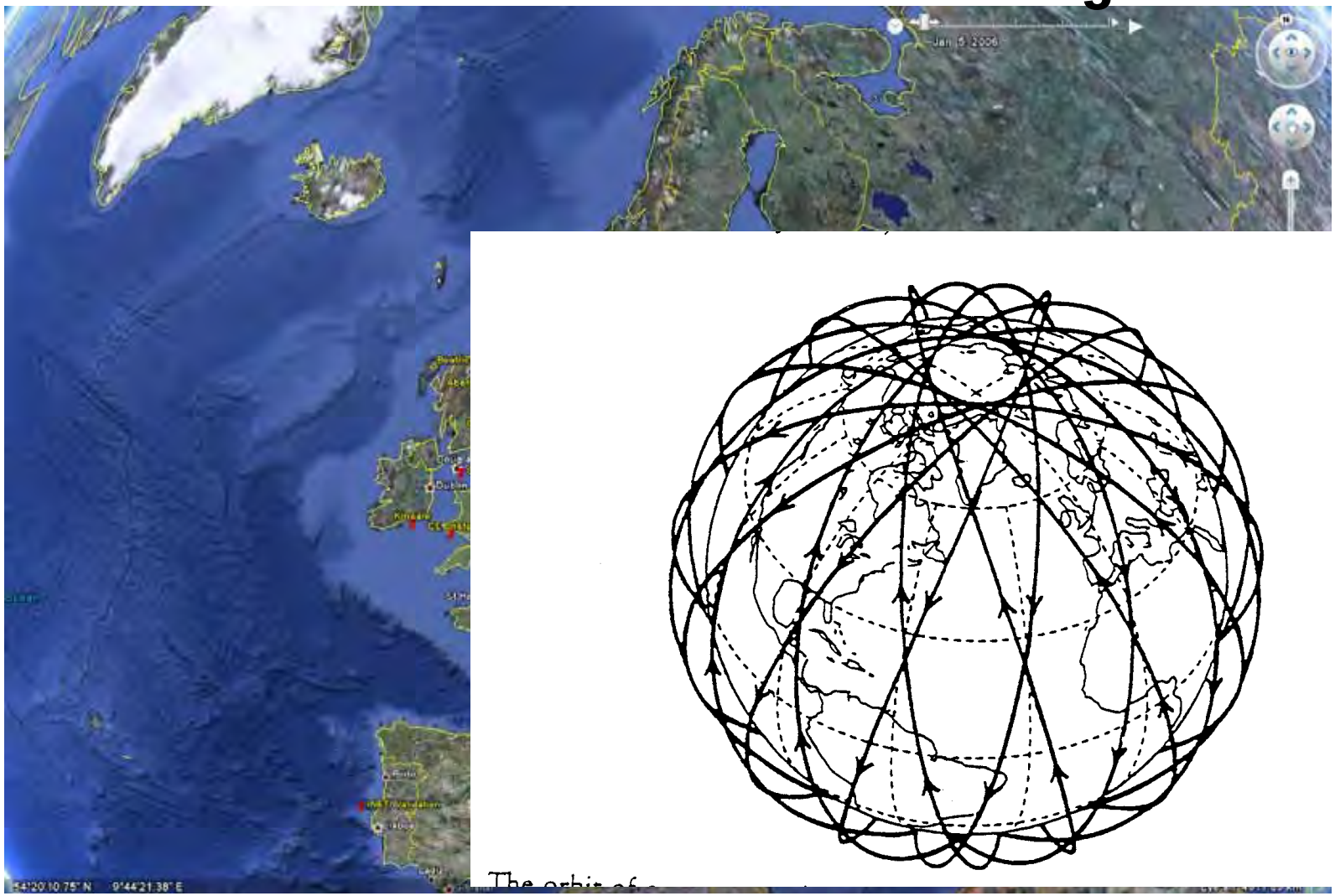
DanishTechnical University IMM
INETI
Kjeller Vindteknikk
University of Strathclyde
Scottish Enterprise
Nautilus Associates
3E

Web http://www.norsewind.eu/

Content

- SAR wind mapping from Risø DTU and CLS
- Aim
- Challenges
- Scatterometer wind maps
- Norsewind integration

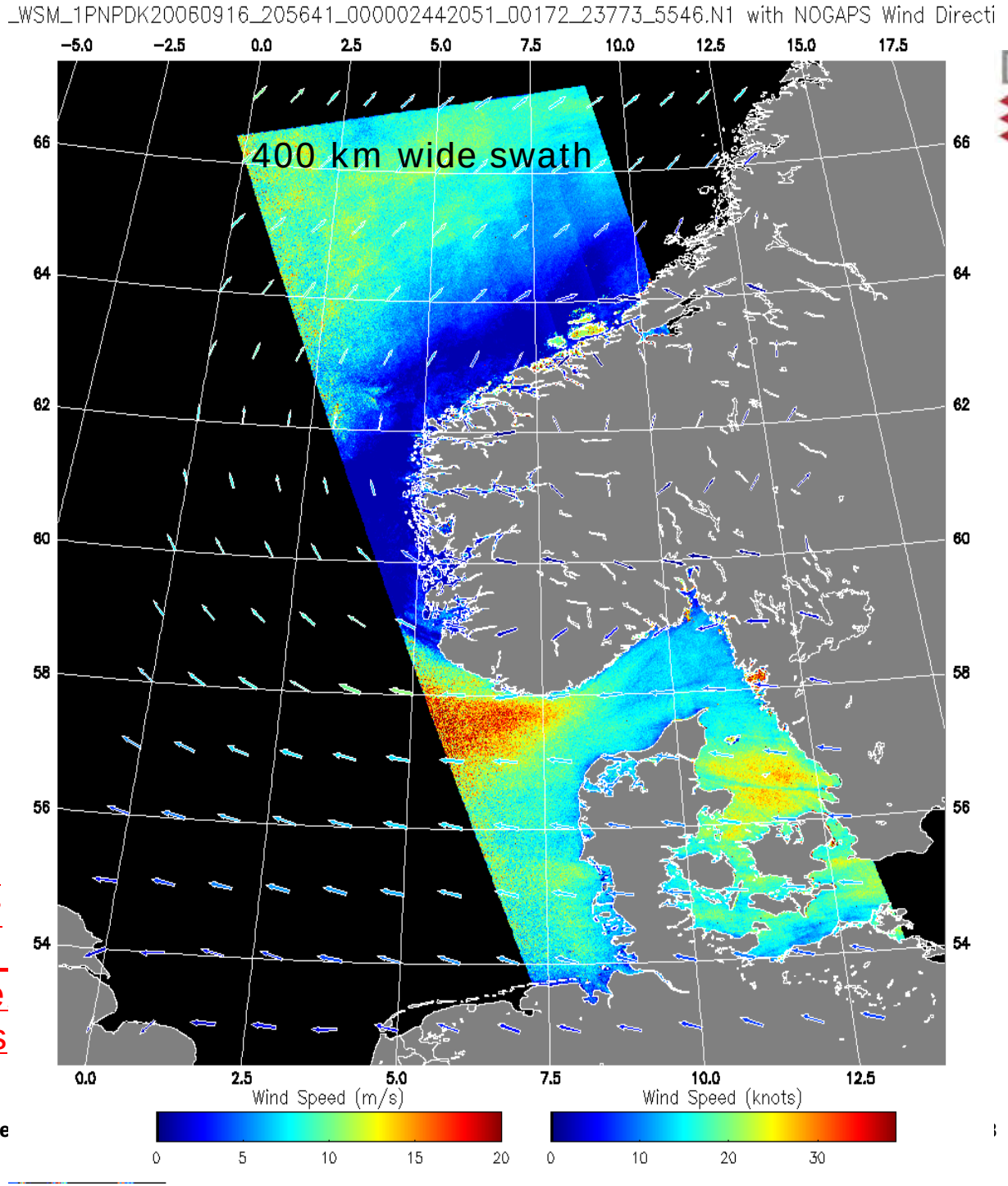
Norsewind: nominal remote sensing sites



Satellite SAR wind map

- Wind map covering Danish and southern Norwegian Seas based on Envisat ASAR WSM from 2006/09/16 at 20:56:41 UTC from Risø DTU/ JHU APL.

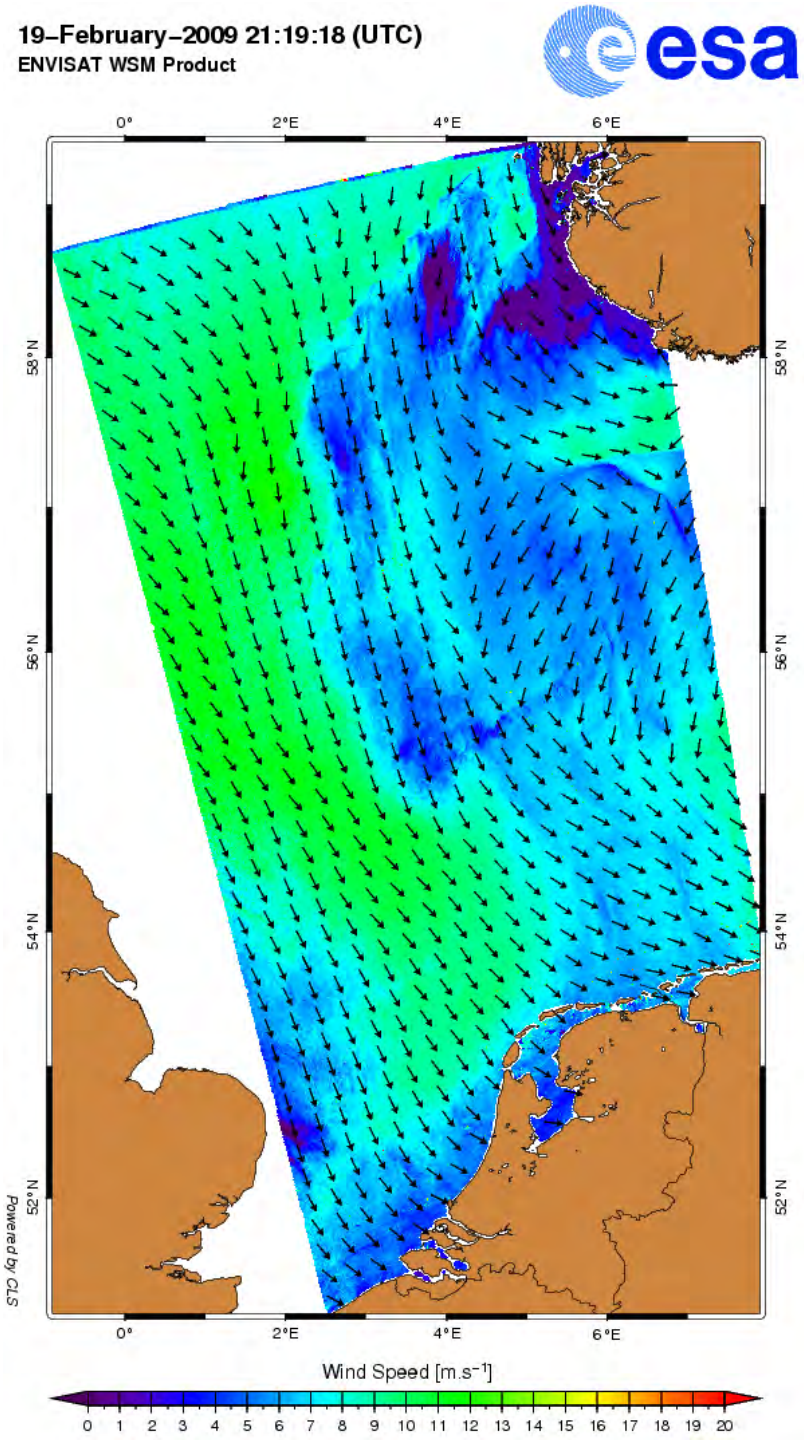
- See http://www.risoe.dtu.dk/business_relations/Products_Services/Software VEA_windmaps.aspx

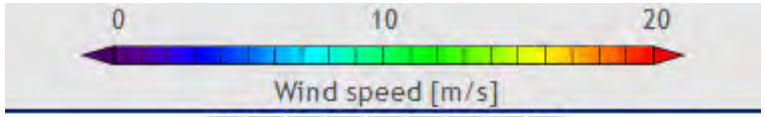


Satellite SAR wind map

- Wind map covering the North Sea based on Envisat ASAR WSM from 2009/02/19 at 21:19:18 UTC from CLS using the SOPRANO.

- See http://soprano.cls.fr/





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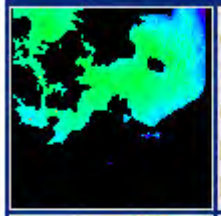
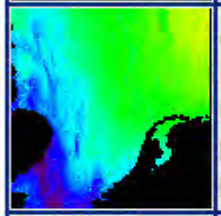
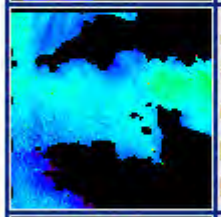
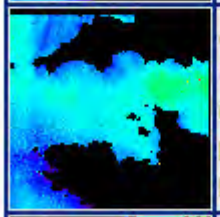
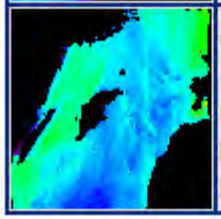
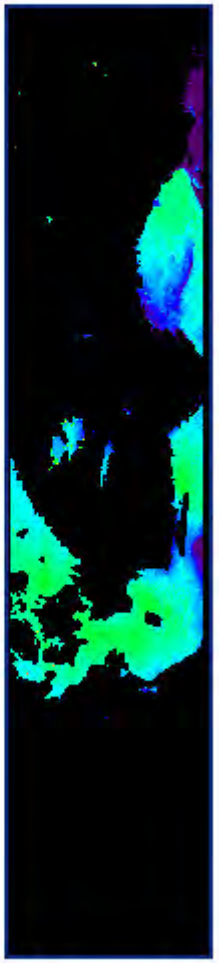
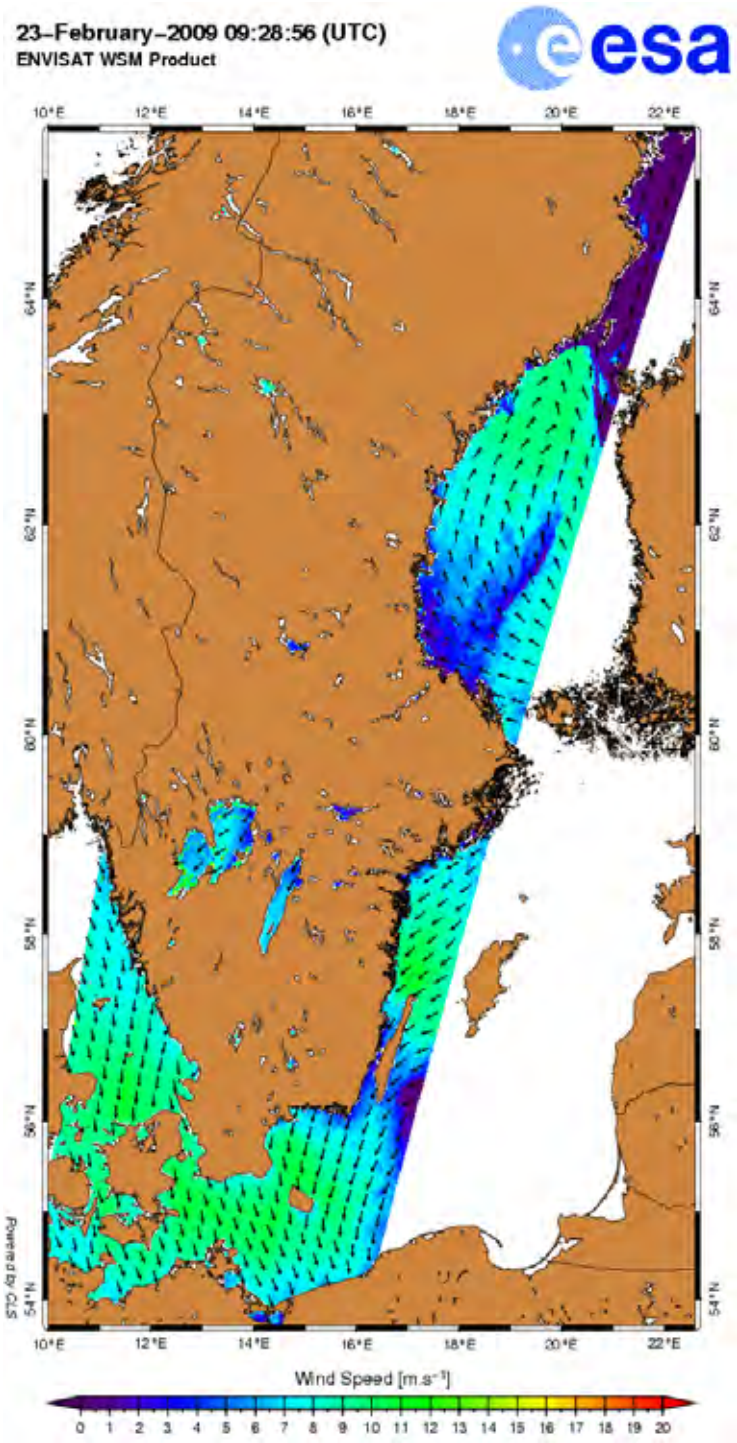
495 products available

informations	
	date: 23/02/2009 time: 09:26:18 UTC mode: WSM plateform: ENVISAT proc. center: PDHS-K
	date: 22/02/2009 time: 21:23:30 UTC mode: WSM plateform: ENVISAT proc. center: PDHS-K
	date: 21/02/2009 time: 21:55:05 UTC mode: WSM plateform: ENVISAT proc. center: PDHS-E
	date: 21/02/2009 time: 21:51:51 UTC mode: WSM plateform: ENVISAT proc. center: I-PAC
	date: 21/02/2009 time: 20:16:36 UTC mode: WSM plateform: ENVISAT proc. center: PDHS-K



view product



DTU

Project aim is to estimate

Wind statistics:

Weibull A

Weibull k

Mean wind speed U

Energy density E

..and the uncertainties.

What are the challenges?

What are the challenges?

- Number of samples
- Weibull fitting at conditional data
- Diurnal variation
- 10 m versus hub-height
- SAR-wind processing, in particular wind direction

Challenge 1

How many satellite wind maps?

- Random sampling (Barthelmie & Pryor 2003: J. Applied Meteorology 42, 83-94)

  - 70 scenes for mean wind speed within ±10% at 90% confidence interval

  - 2000 scenes for energy density within ±10% at 90% confidence interval

- Weighting according to wind sectors

  - measurements

  - models

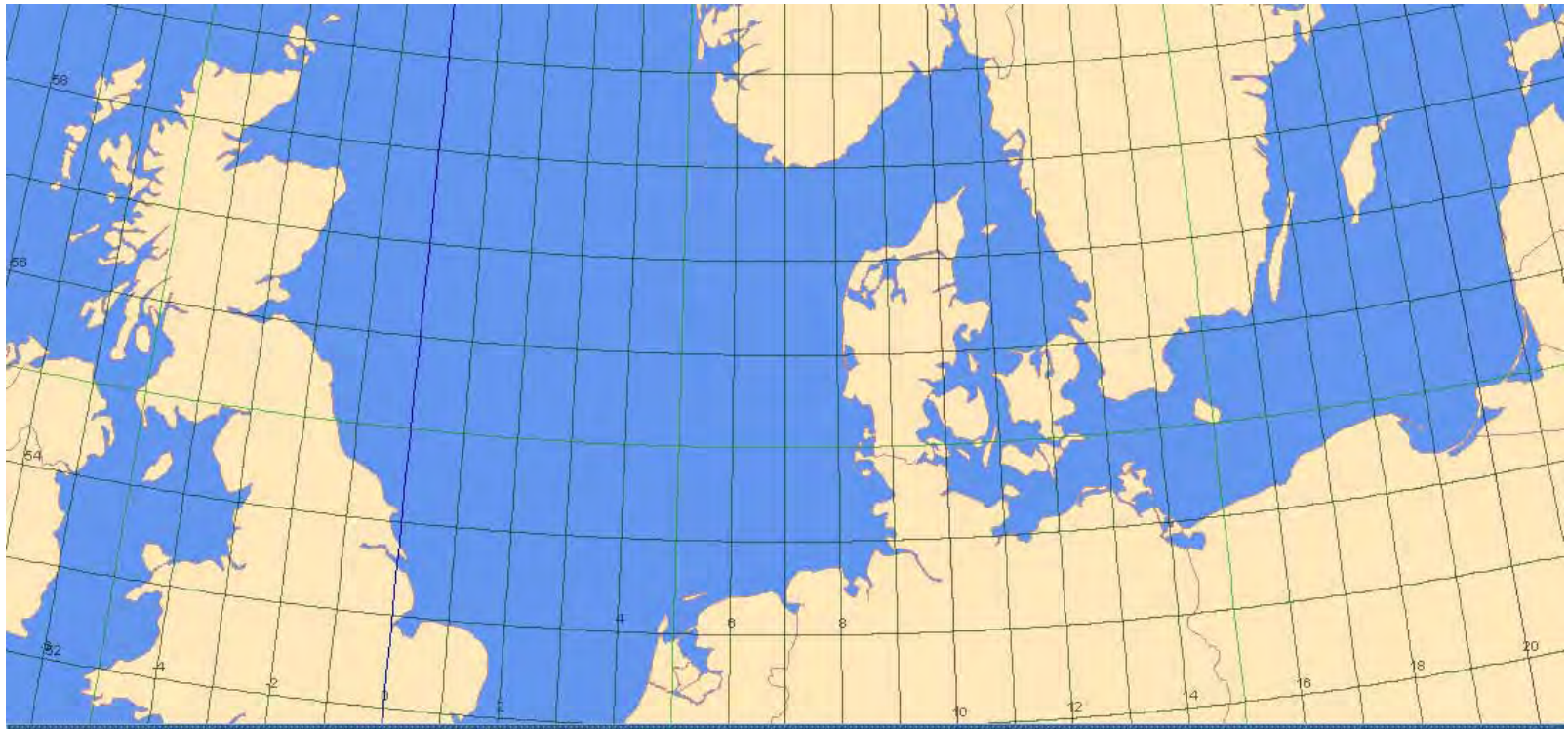
- Image selection according to wind classes

  - definition of ~200 typical wind situations from e.g. NCEP/NCAR data

Challenge 1

Envisat ASAR WSM

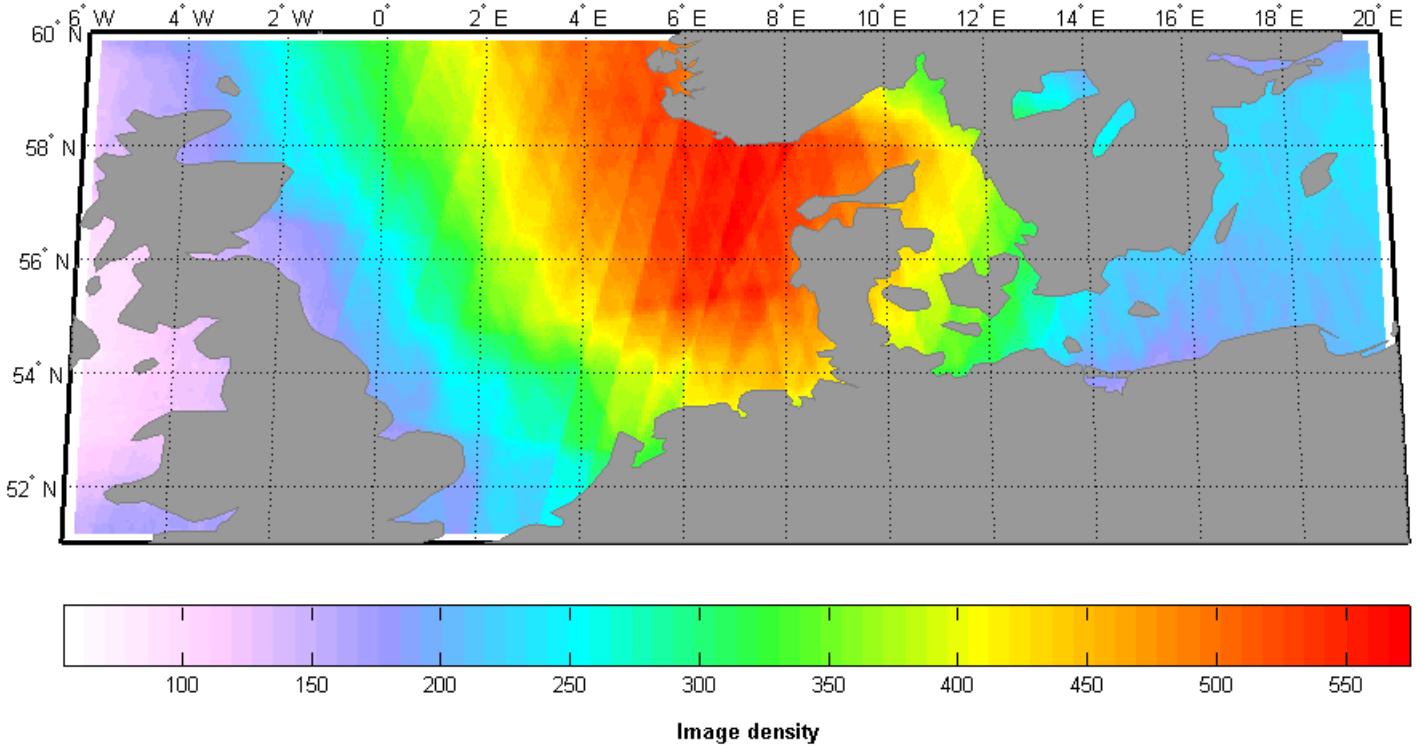
CLS 1300, Risø 600, ESA 6000, ~ 1000/year



Aim is 500 everywhere

Challenge 1

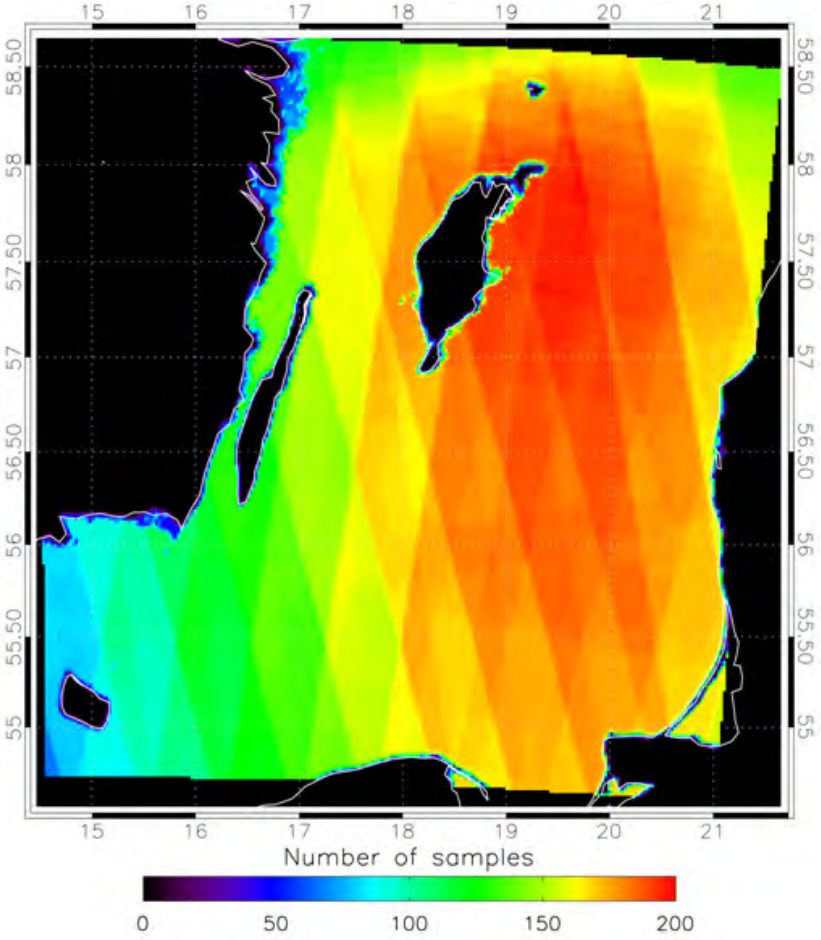
Envisat ASAR WSM: CLS archive coverage

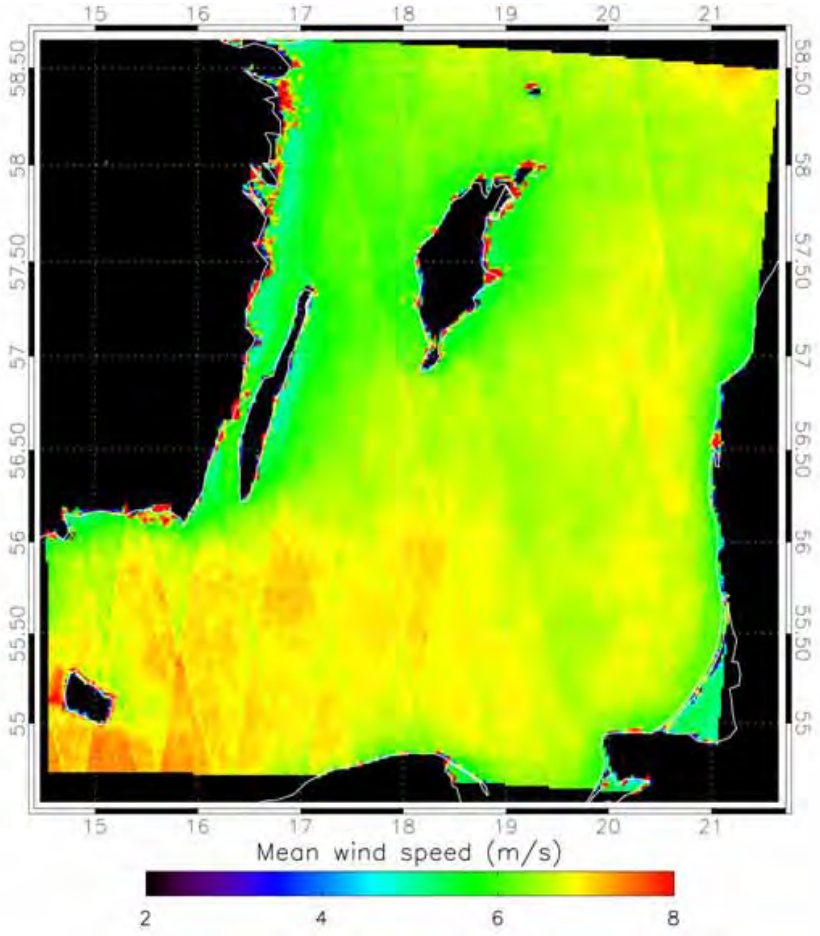


Aim is 500 everywhere

Challenge 1

Risø archive coverage and mean wind





Challenge 2

Weibull fitting conditional data

- Weibull fit example from Horns Rev using 92 SAR wind maps

U = 7.3 m/s E = 421 W/m²

- Compare to mast with same 92 data

- (
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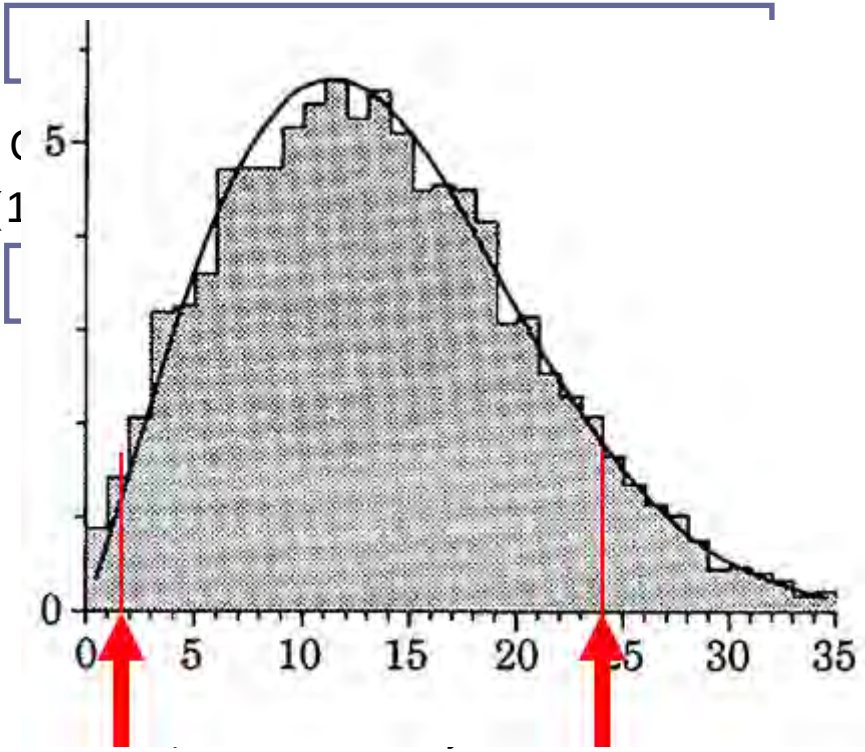
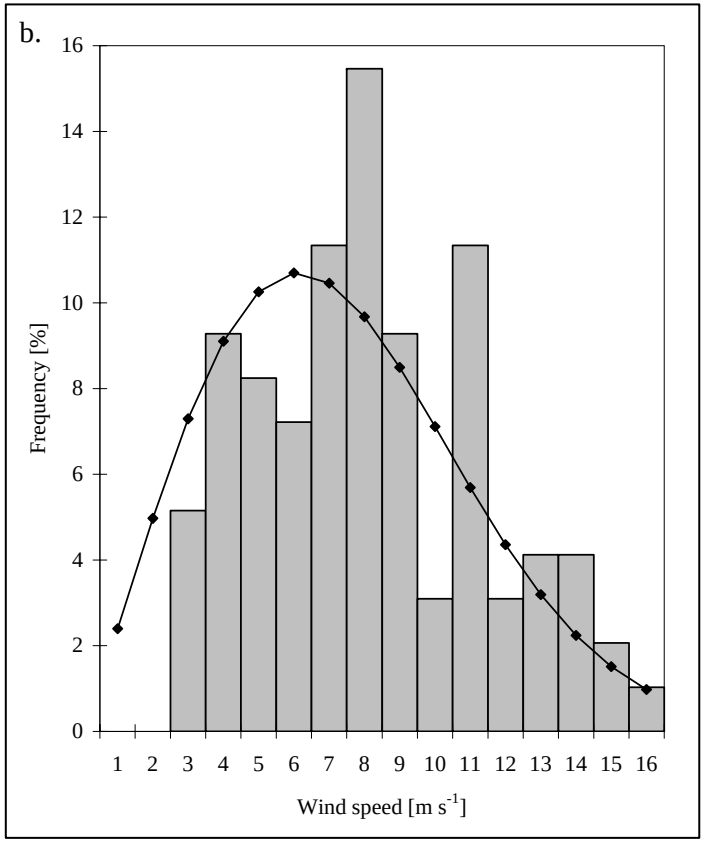




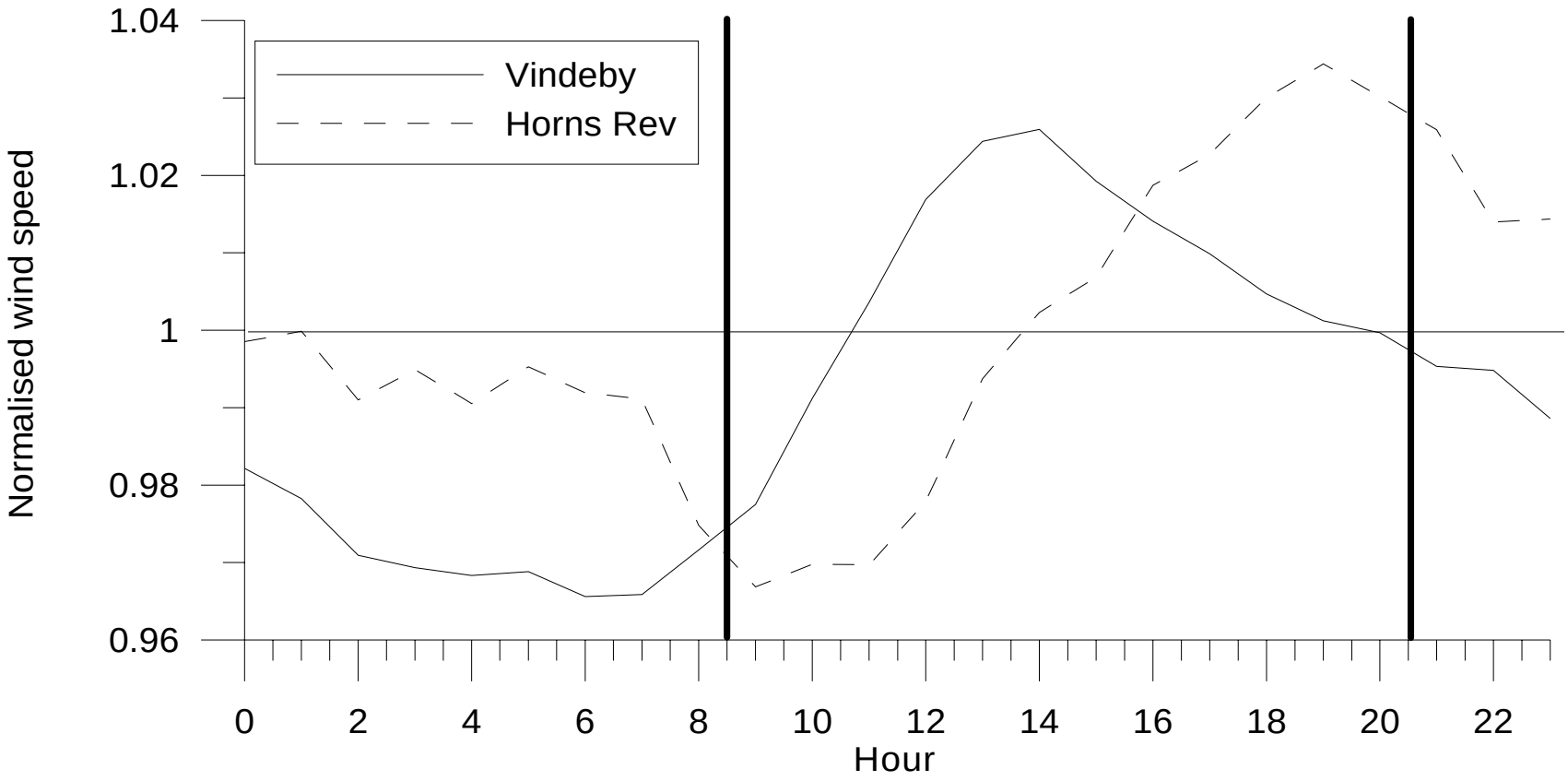
Christiansen et al. (2006): Remote Sens. Env.

Challenge 3

Diurnal wind speed variation

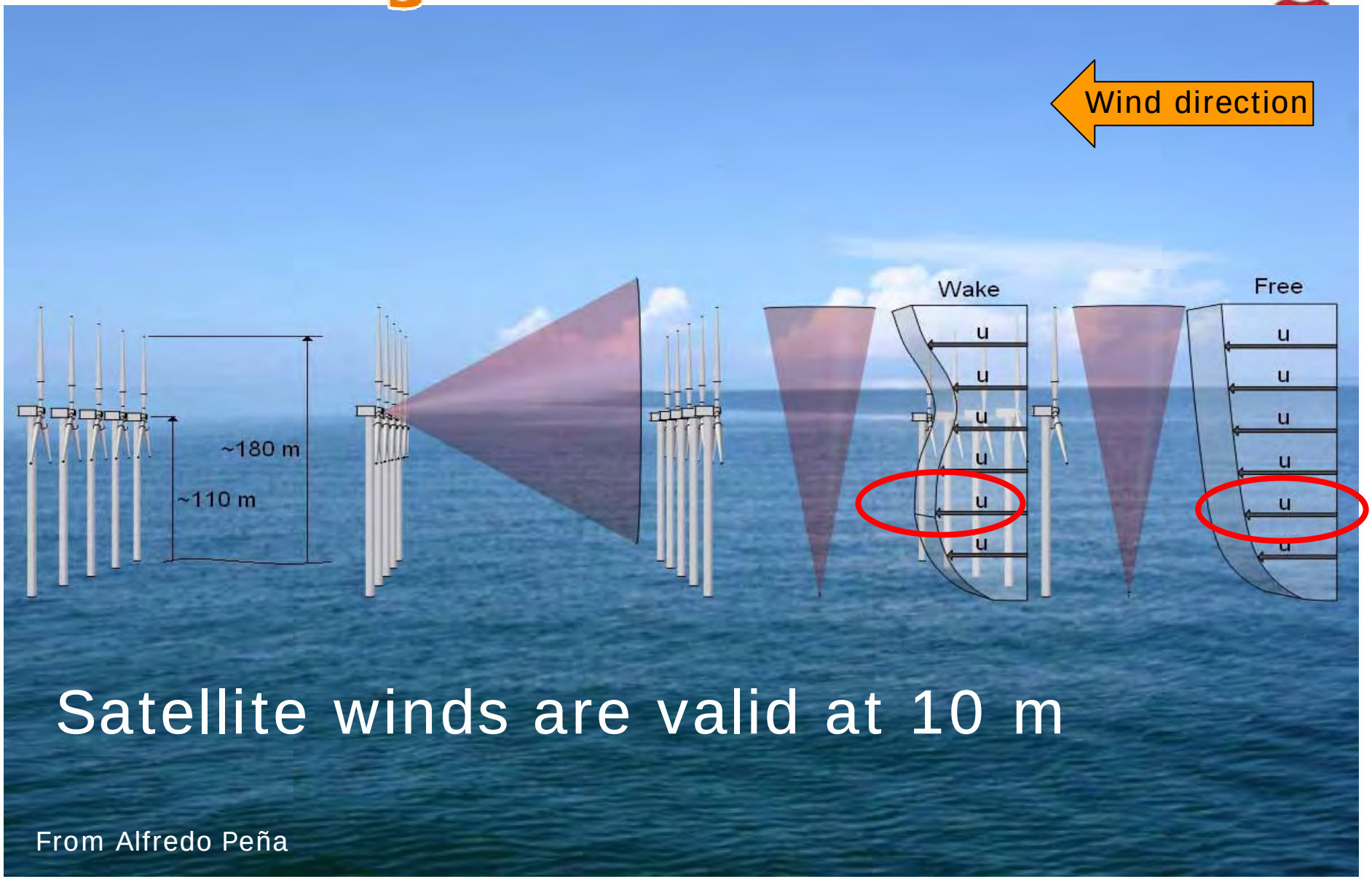
at Vindeby in Baltic Sea and Horns Rev in the North Sea.

The vertical lines indicate sampling times for SAR at the sites.



(Barthelmie & Pryor 2003: J. Applied Meteorology 42, 83-94)

Challenge 4

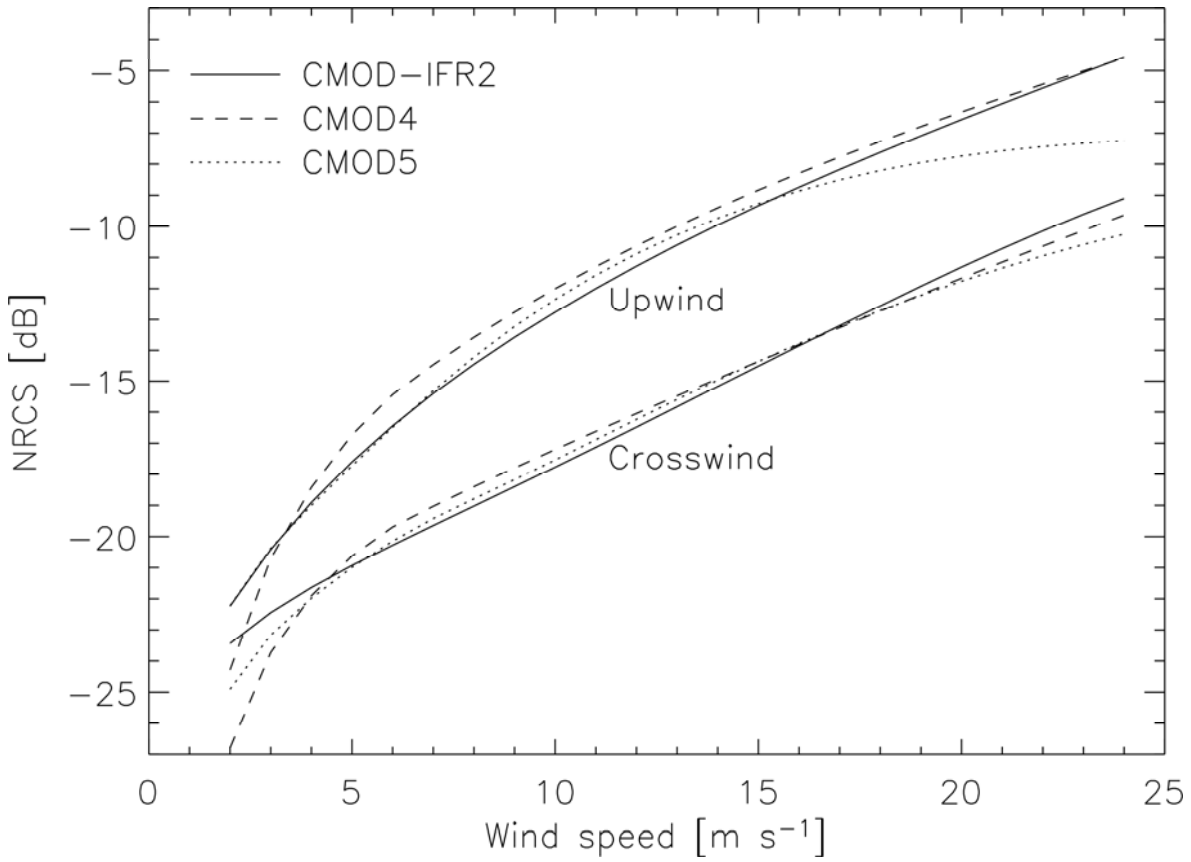


Satellite winds are valid at 10 m

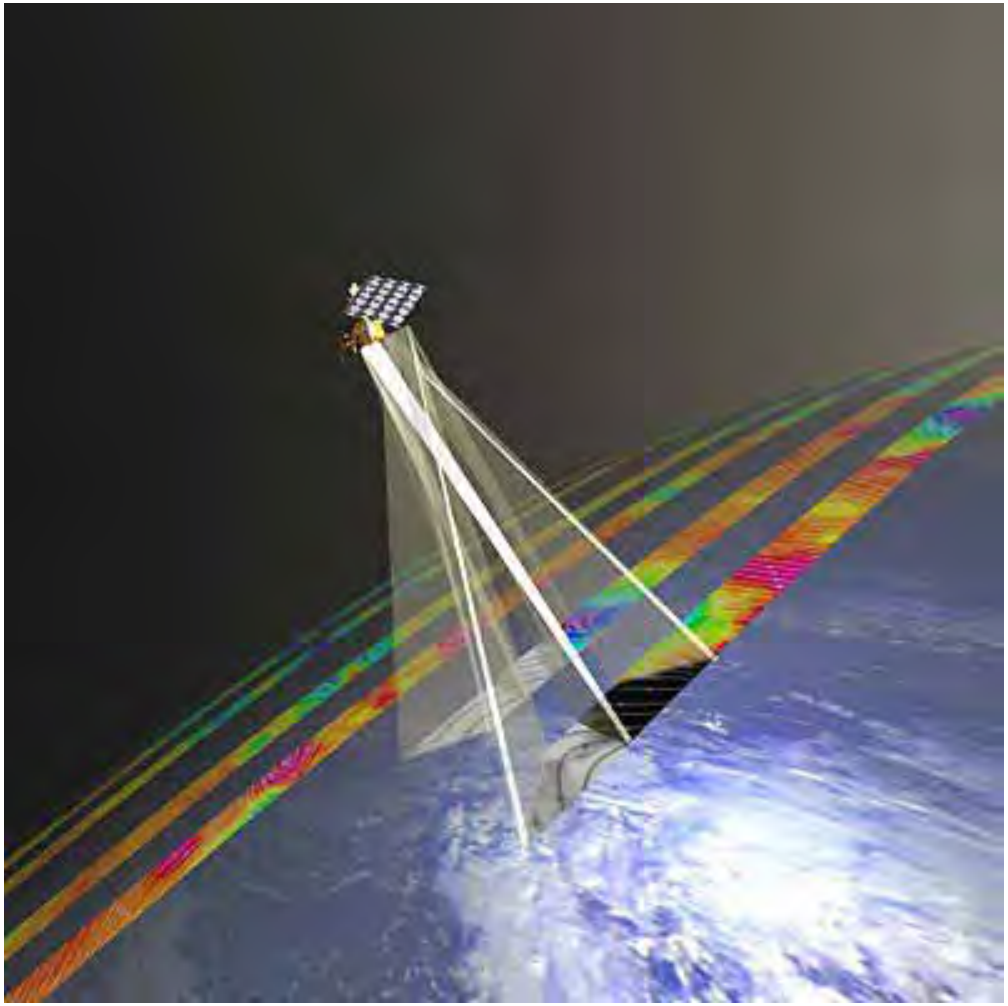
From Alfredo Peña

Challenge 5

Wind direction and Normalized Radar Cross Section (NRCS)

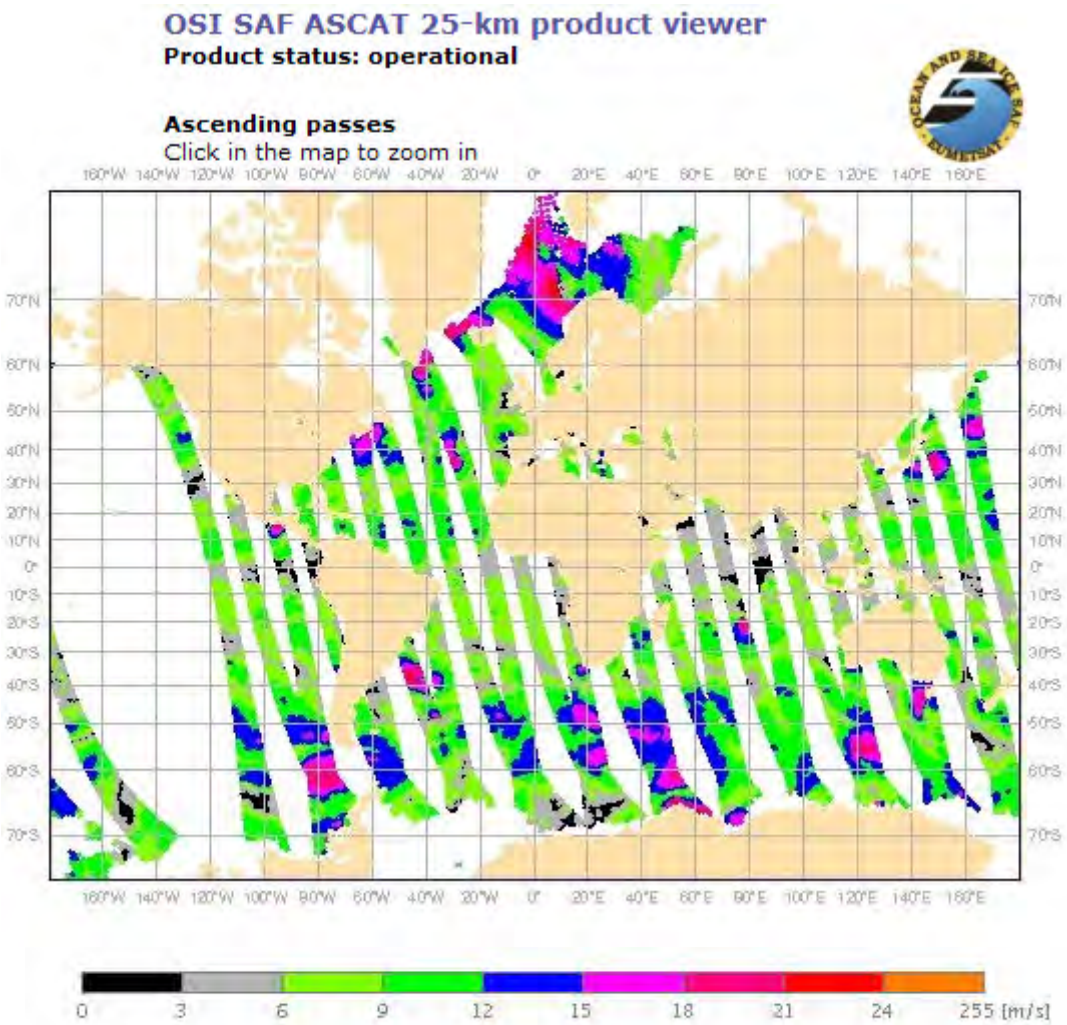


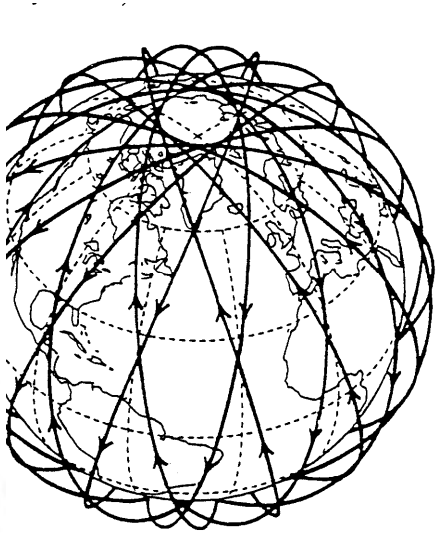
Scatterometer winds: ASCAT



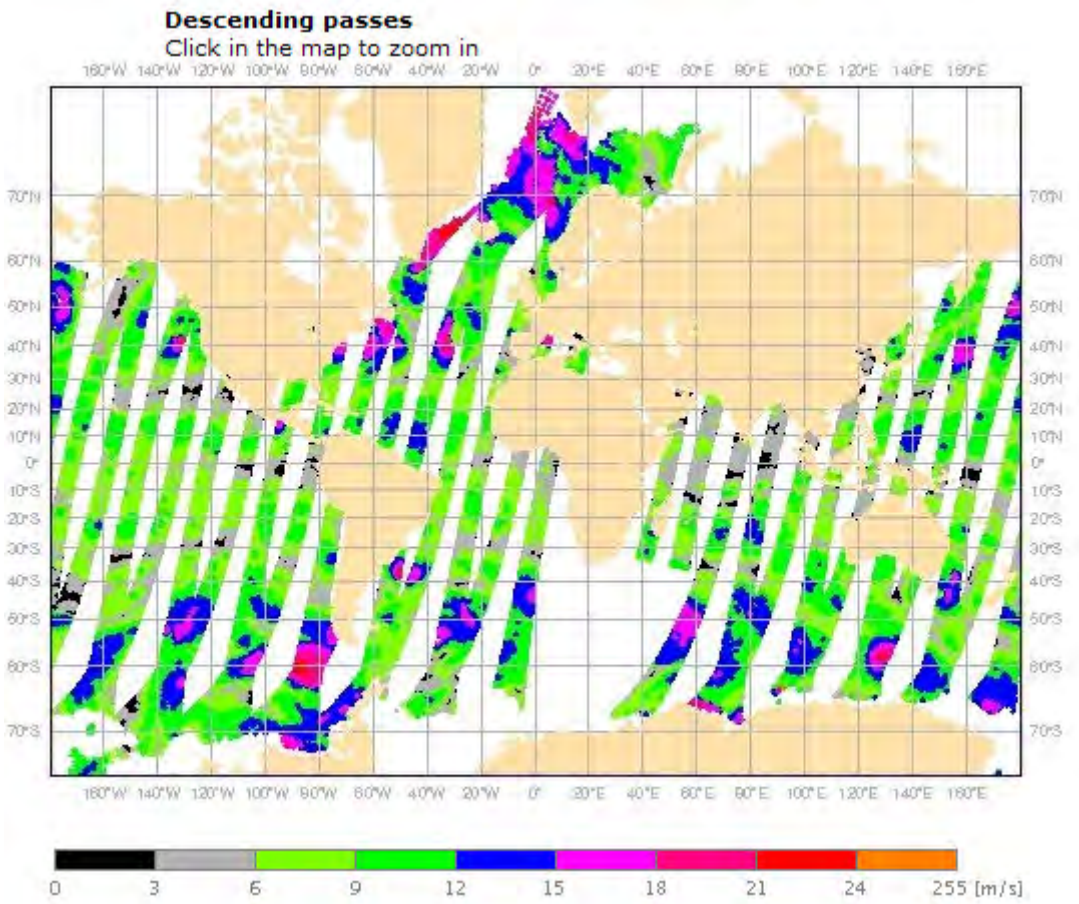
- Image of ASCAT from ESA

Scatterometer winds: ASCAT



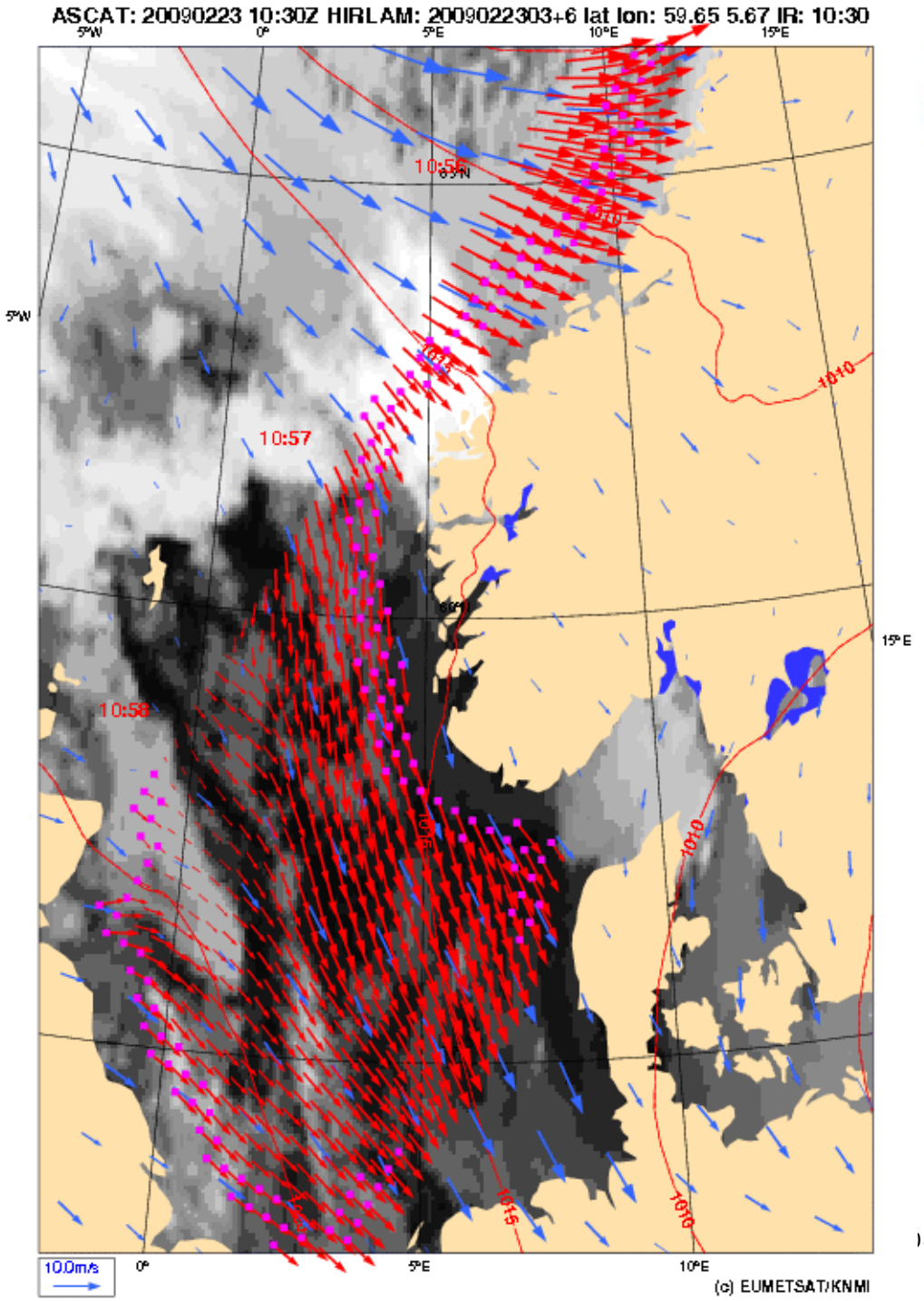


Scatterometer winds: ASCAT



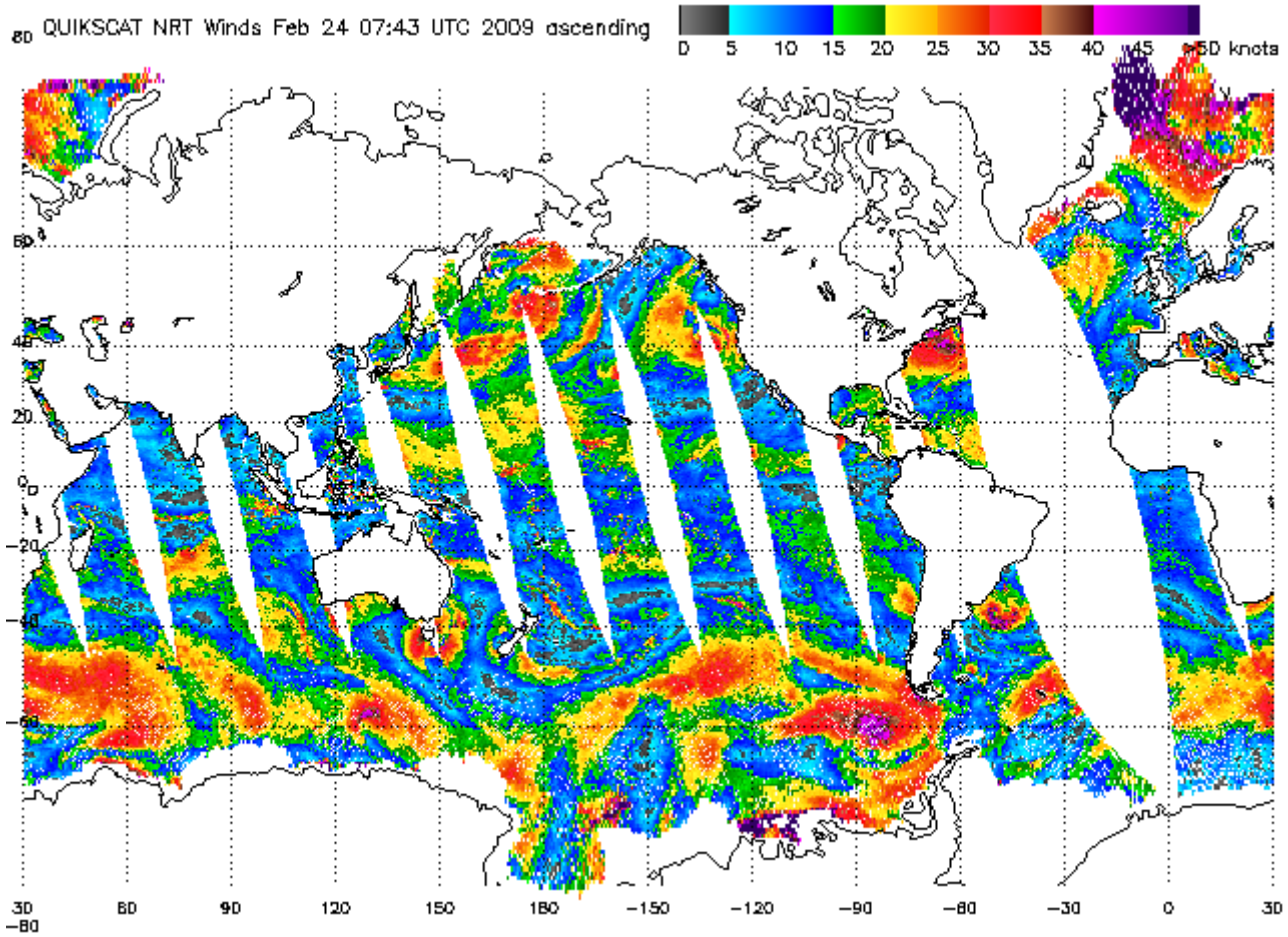
ASCAT

- 550 km swath
- Near-global coverage each 5 days
- Since October 2007
- 25 km resolution
- C-band
- Available ~300
- Available later ~900

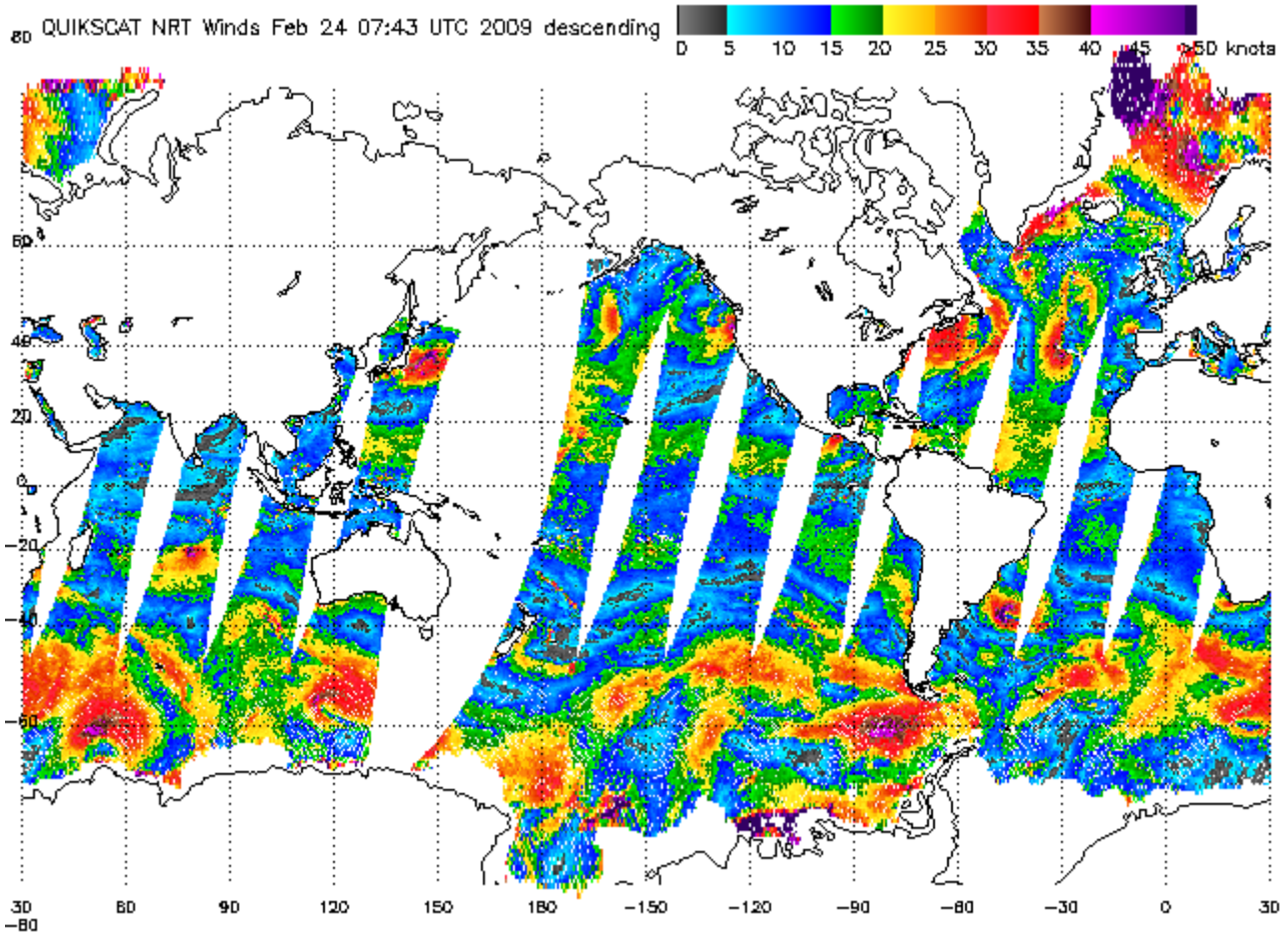


Scatterometer winds: QuikSCAT

Scatterometer winds (QuikSCAT)

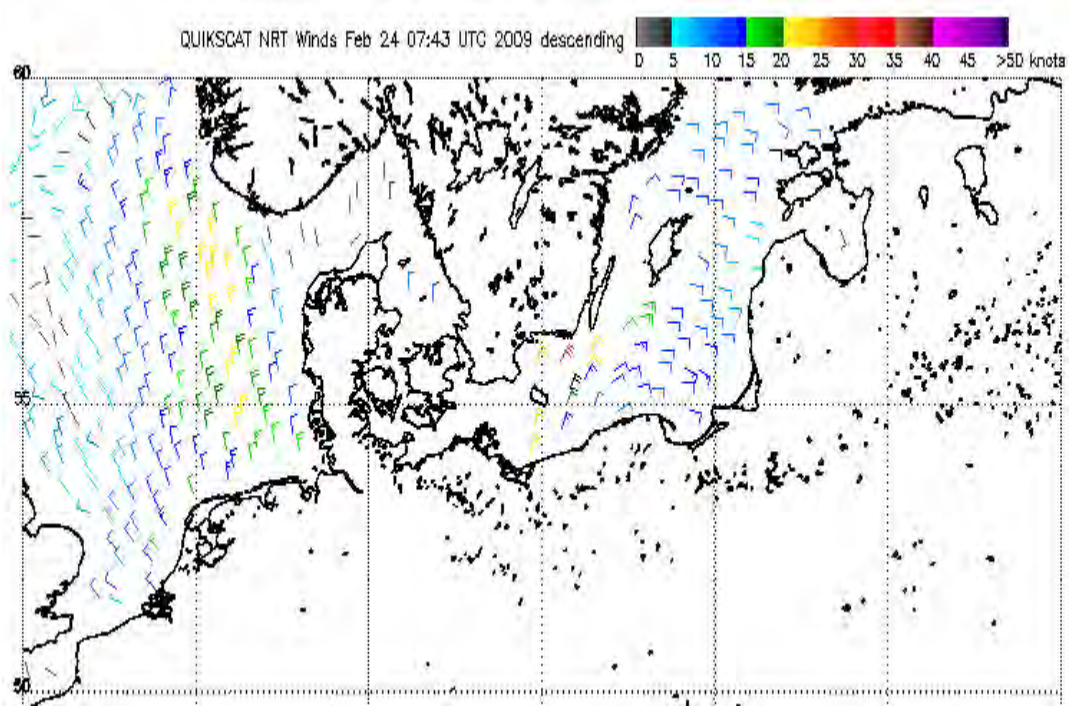


Scatterometer winds (ASCAT)



Scatterometer: QuikSCAT

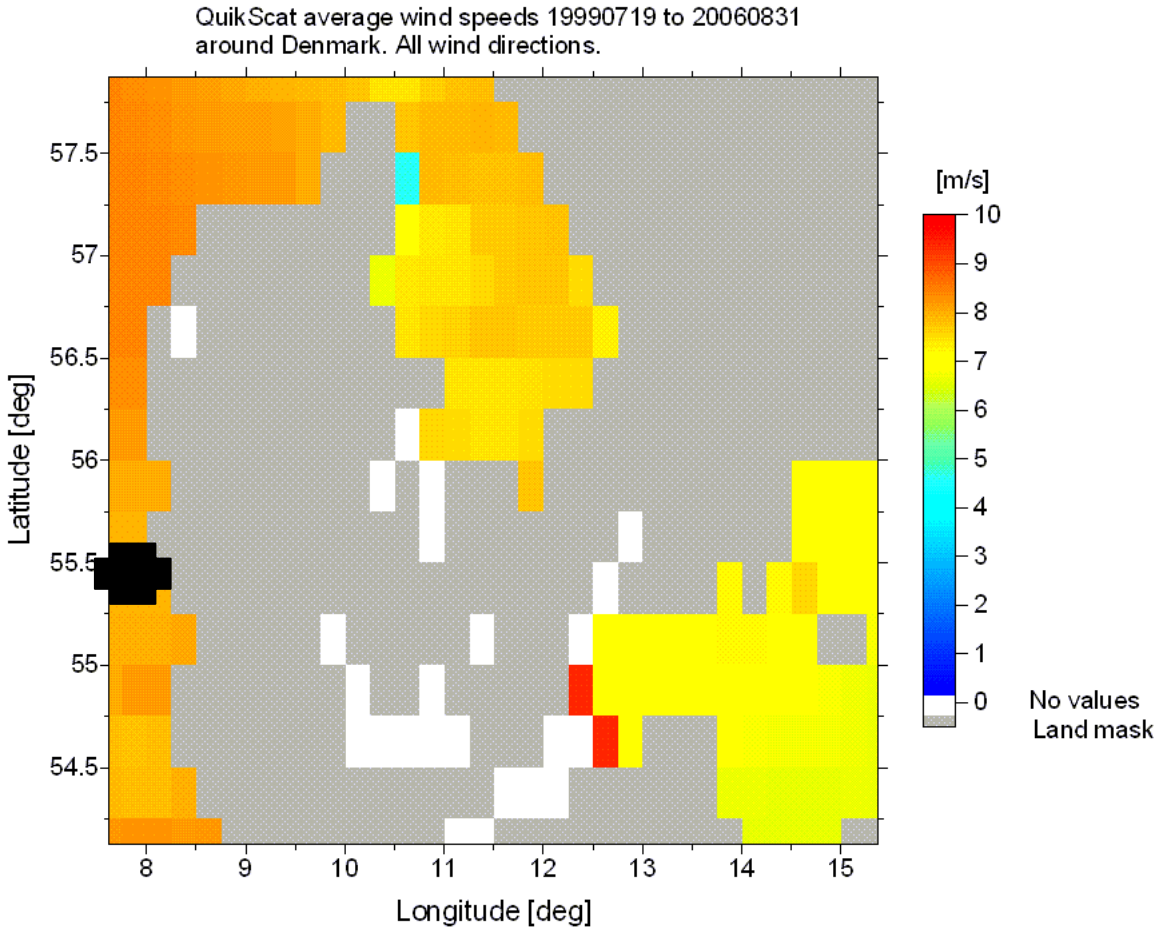
- 1800 km swath
- Near-global coverage daily
- Since July 1999
- 25 km resolution
- Available ~7000
- Available later ~9000



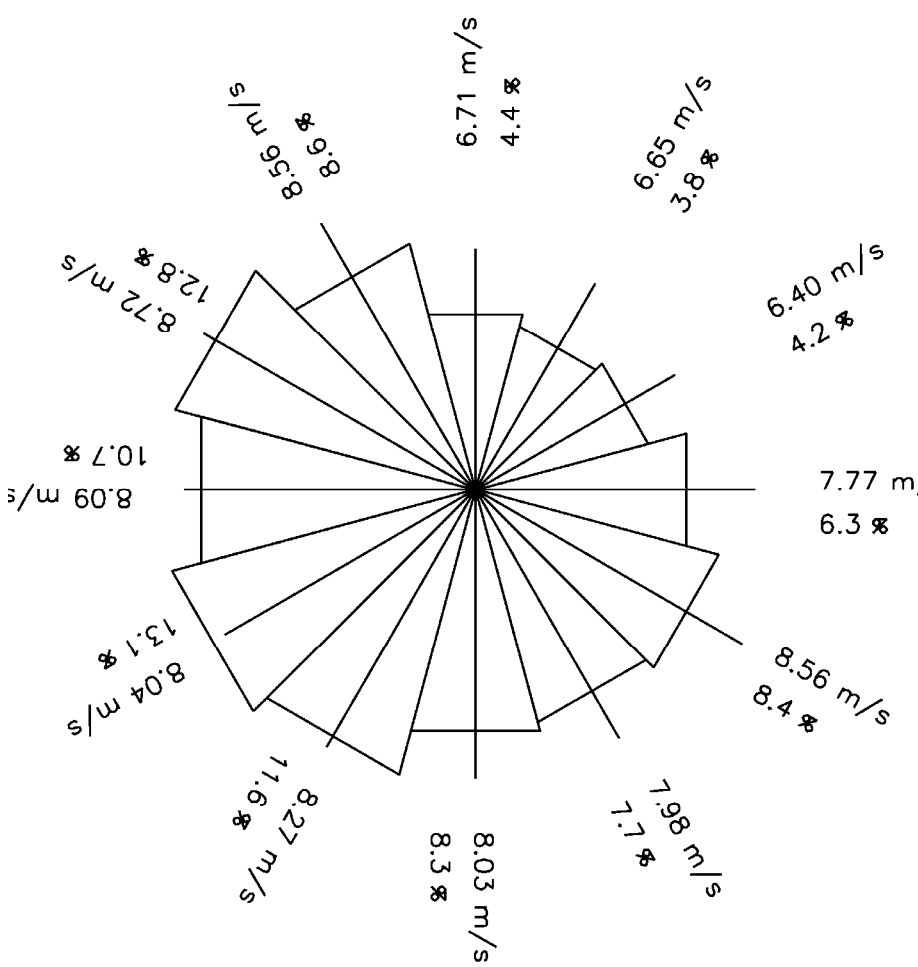
What are the challenges?

- Number of samples (NO)
- Weibull fitting at conditional data (YES)
- Diurnal variation (YES)
- 10 m versus hub-height (YES)
- SAR-wind processing, in particular wind direction (NO)

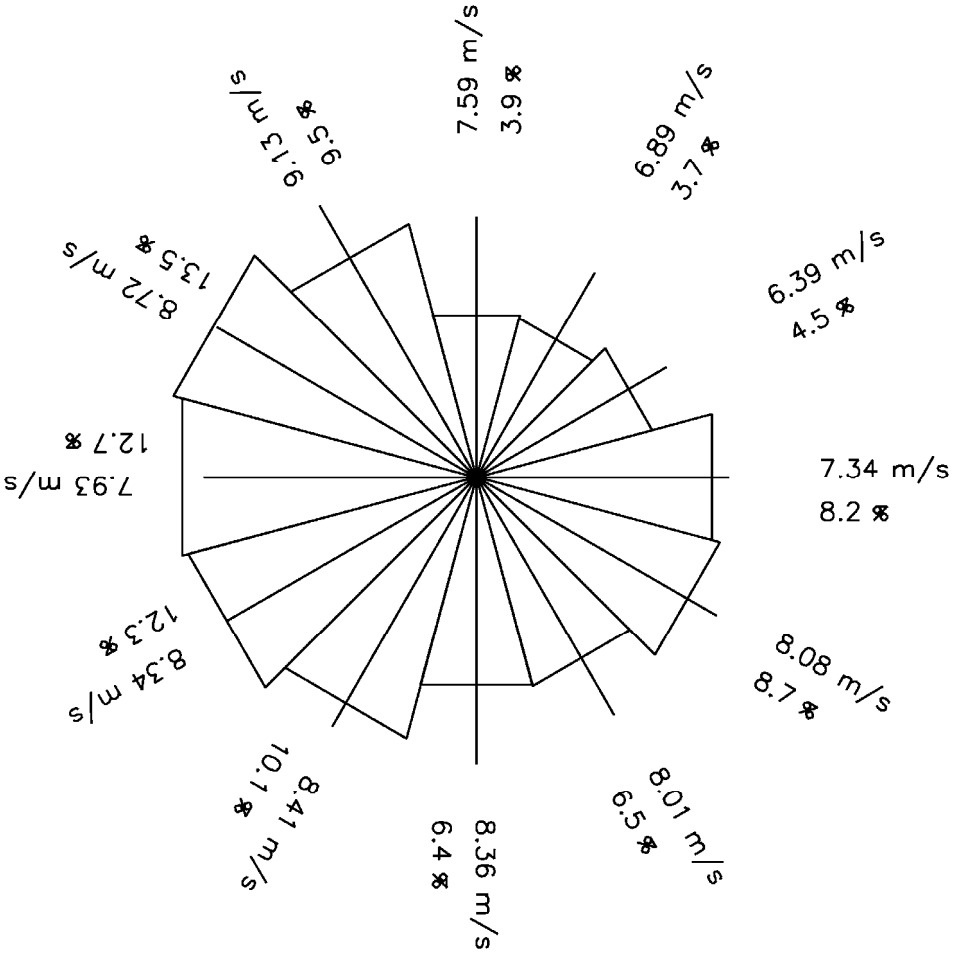
Example QuikSCAT mean wind



Example mast and QuikSCAT at Horns Rev



Mast (courtesy DONG energy)



QuikSCAT

Norsewind integration

- SAR- stand-alone map
- Scatterometer – stand-alone map
- Coastal focus: SAR versus scatterometer
- SAR wind direction from models, lidar and masts – integration
- Comparison: satellite winds versus ground-based winds
- Mesoscale (WRF) model results versus satellite-based - cases
- Mesoscale (WRF) model results versus satellite-based – entire Norsewind
- Testing offshore area in Portugal