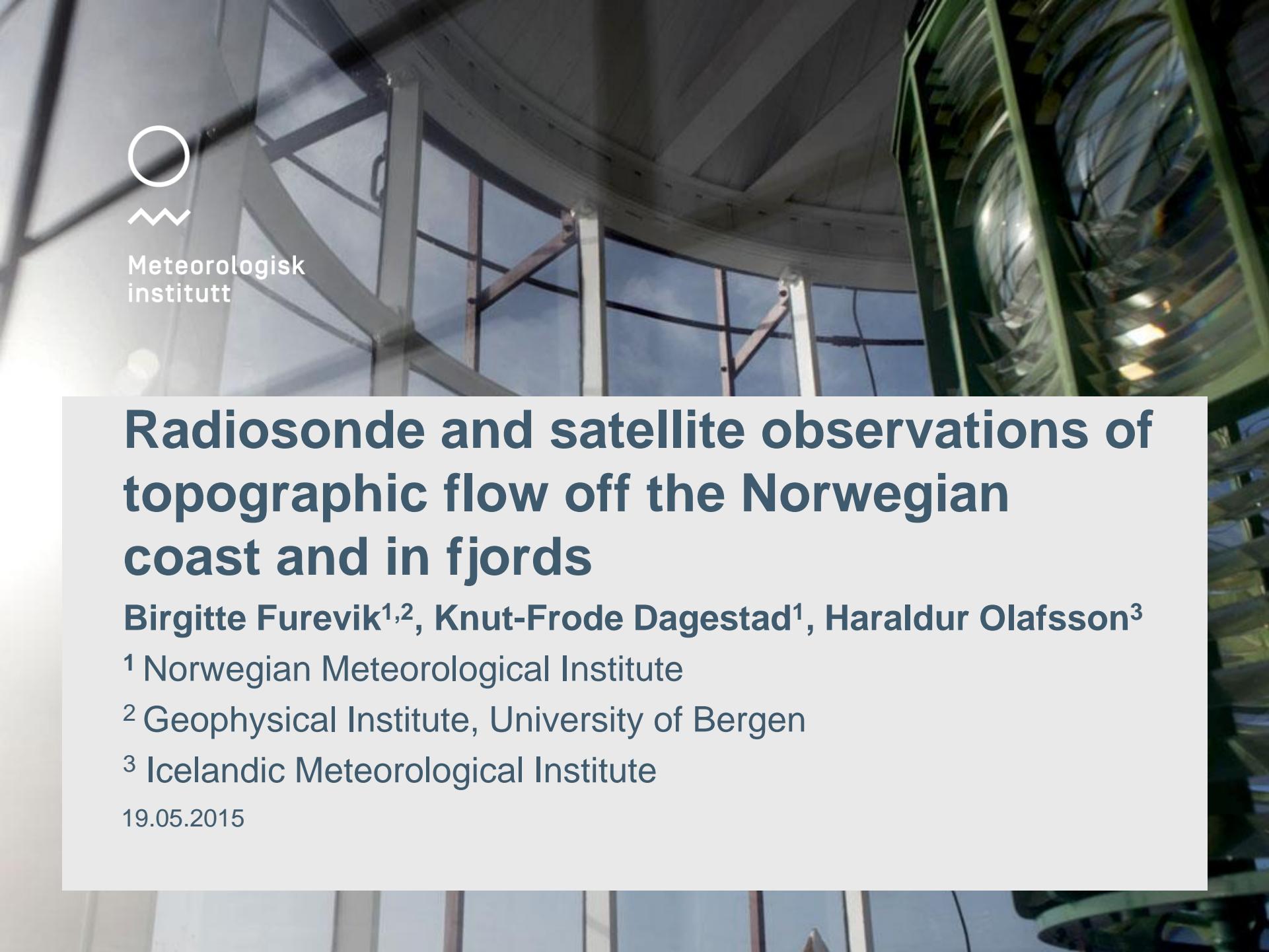




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Radiosonde and satellite observations of topographic flow off the Norwegian coast and in fjords

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³ Icelandic Meteorological Institute

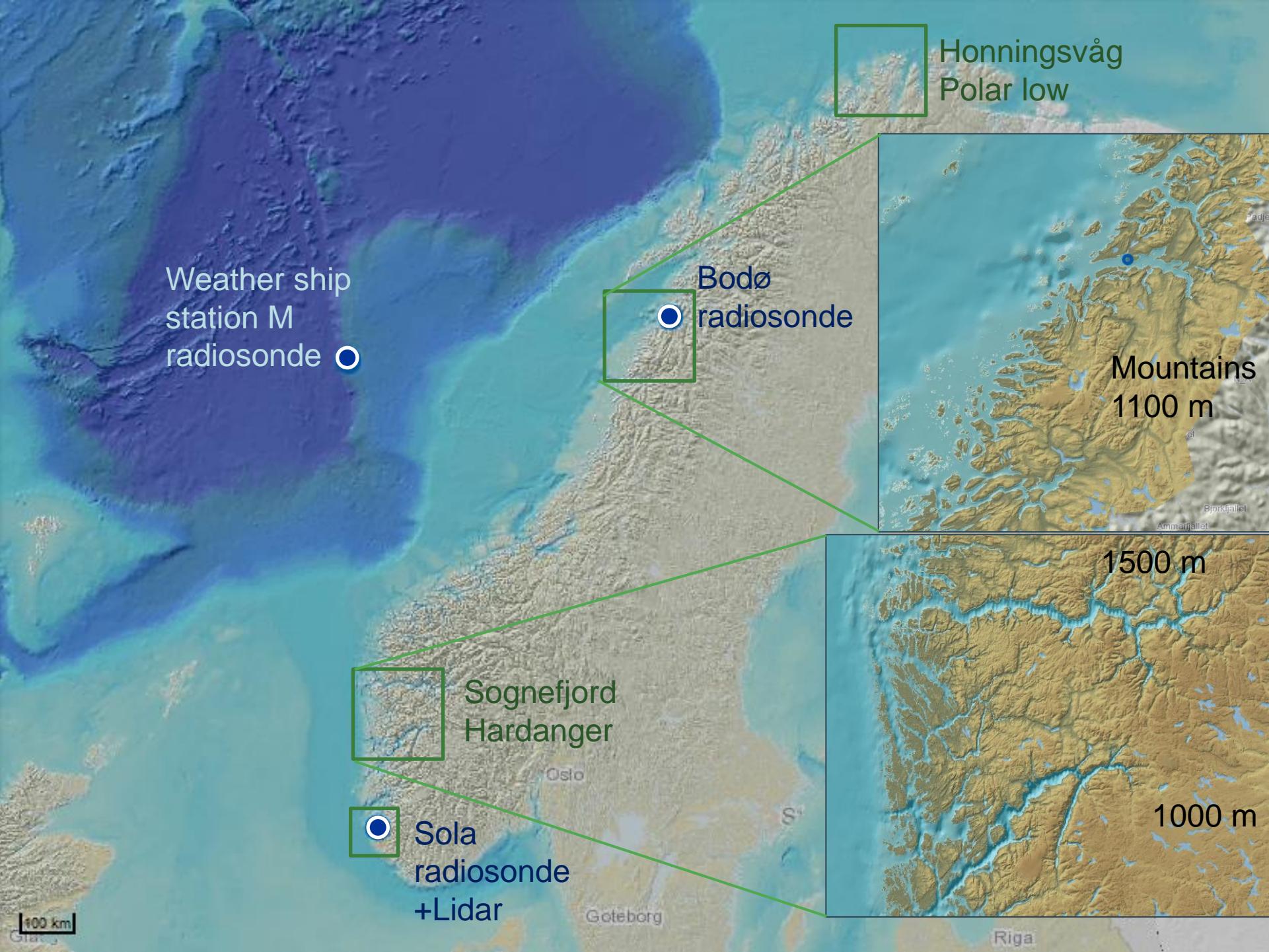
19.05.2015

Objective

**Determine sea surface winds near complex terrain
using high-resolution satellite-retrieved winds**

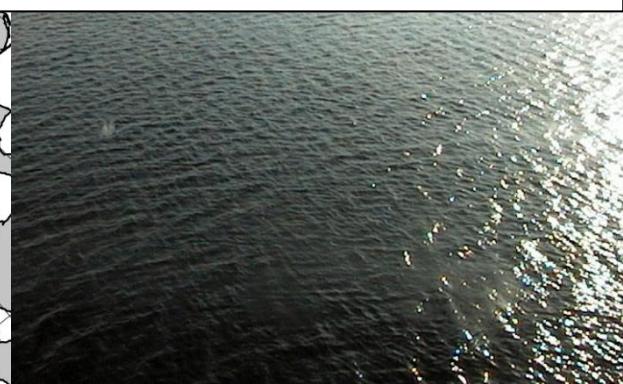
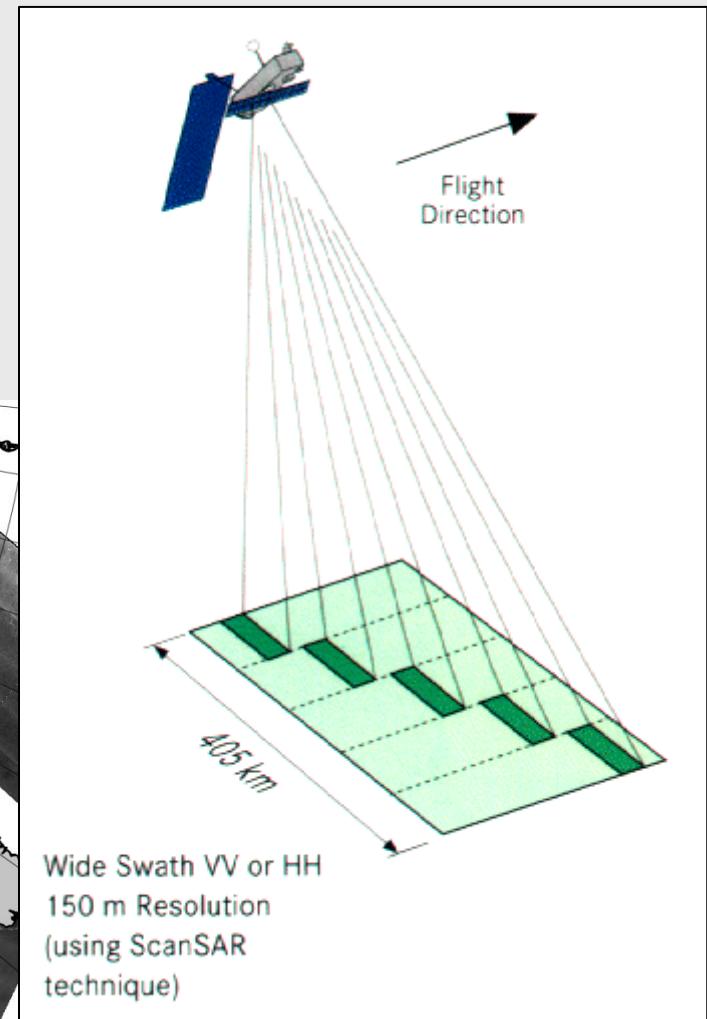
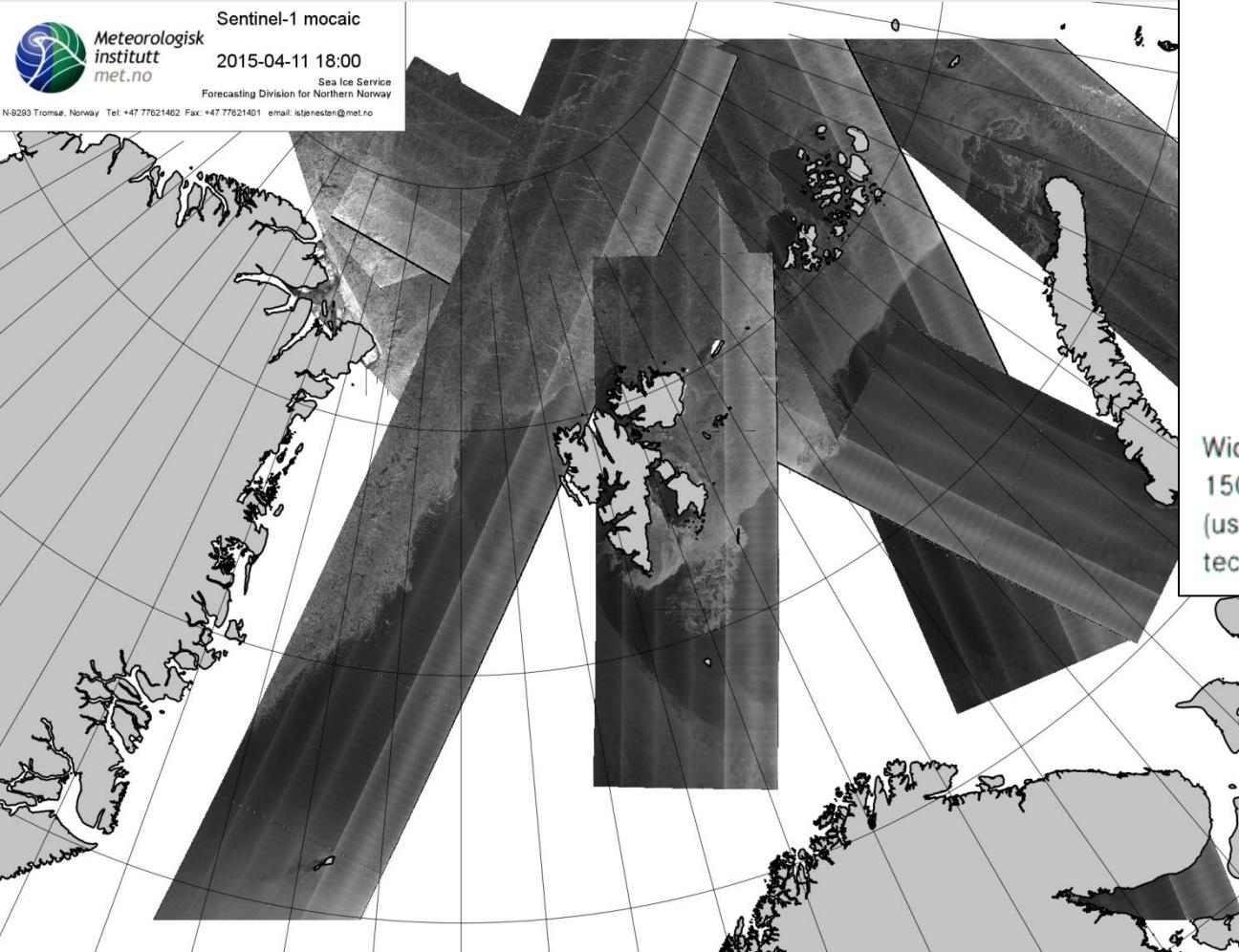
Outline

- Observations
 - Satellite **SAR**
 - Radiosonde
- Coast and fjord winds
 - Bodø
 - Western Norway fjords
- Conclusions



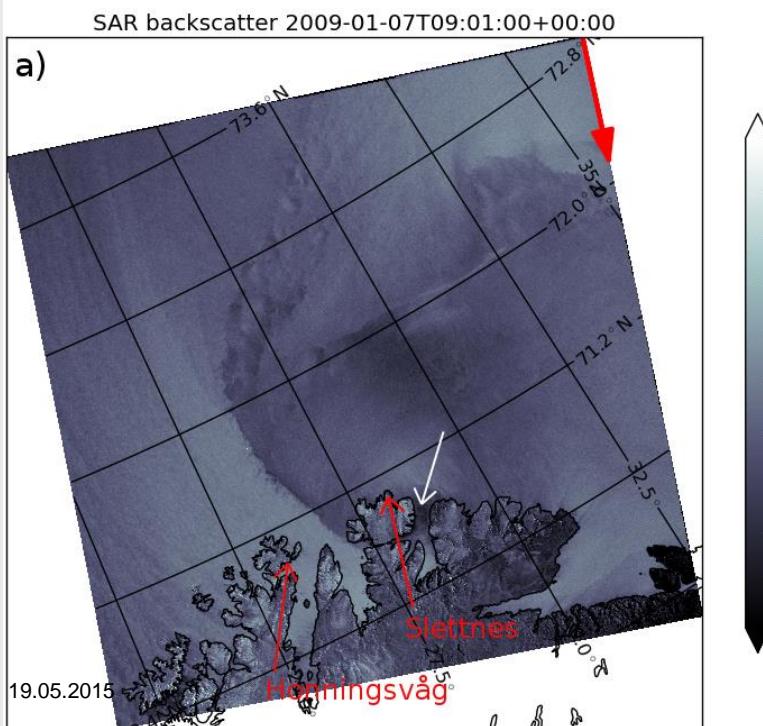
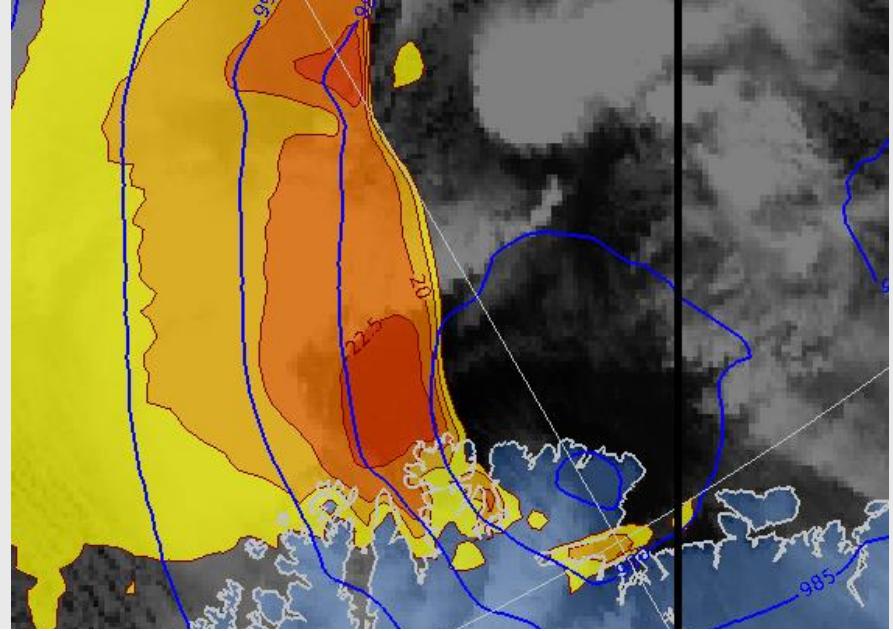
What is SAR?

- Synthetic Aperture Radar

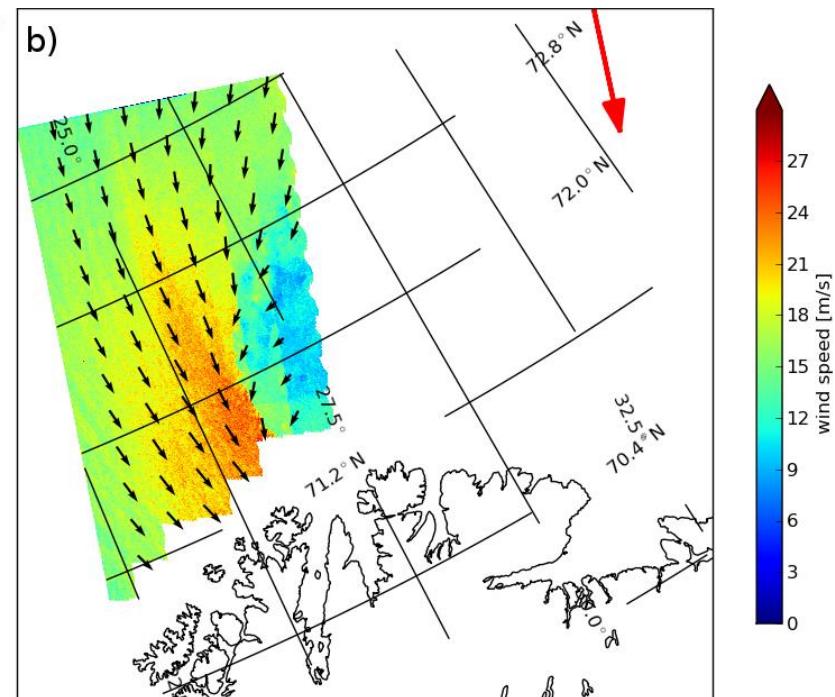


SAR wind field with external wind direction

Furevik et al., 2015, ASAR and ASCAT in polar low situations, J. Atmos. Oc. Tech.

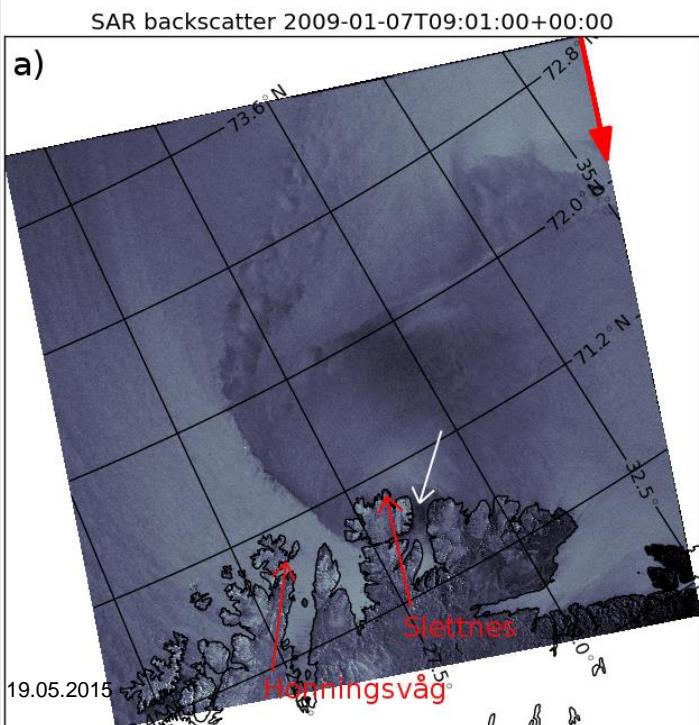
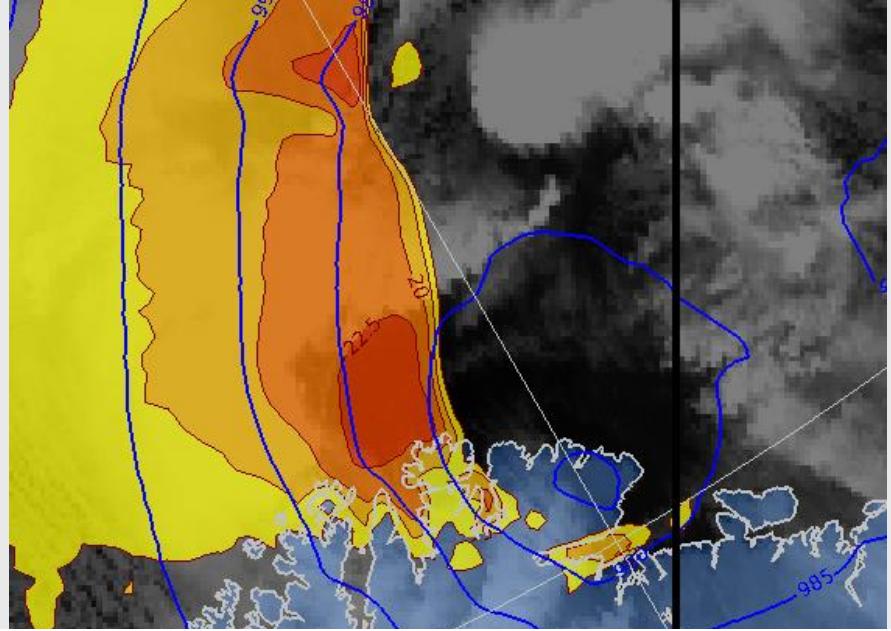


SAR wind field with ASCAT wind direction

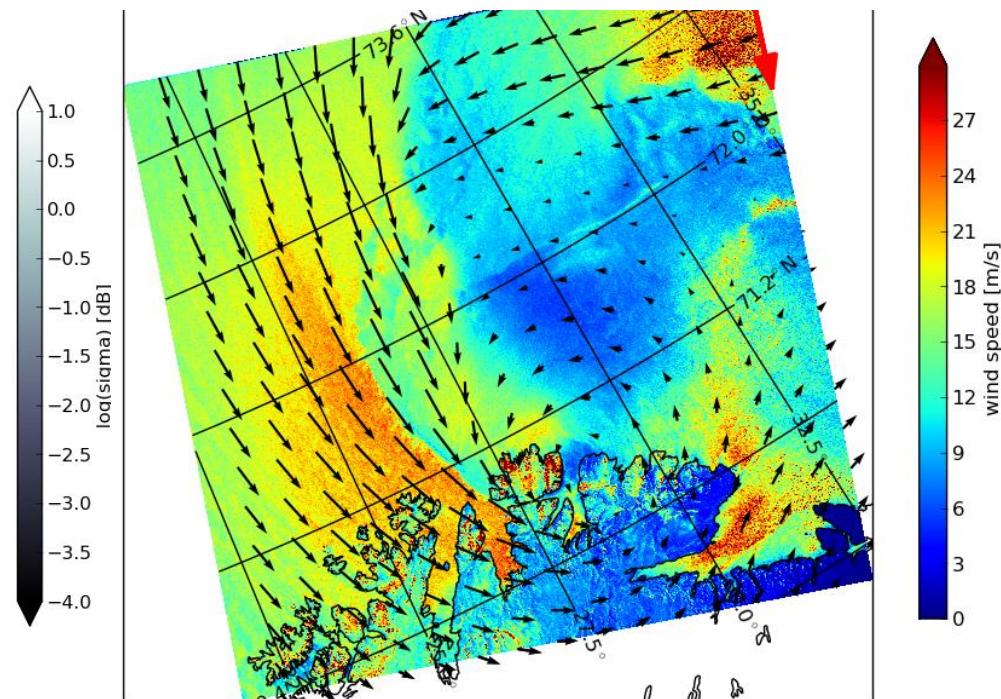


SAR wind field with external wind direction

Furevik et al., 2015, ASAR and ASCAT in polar low situations, J. Atmos. Oc. Tech.

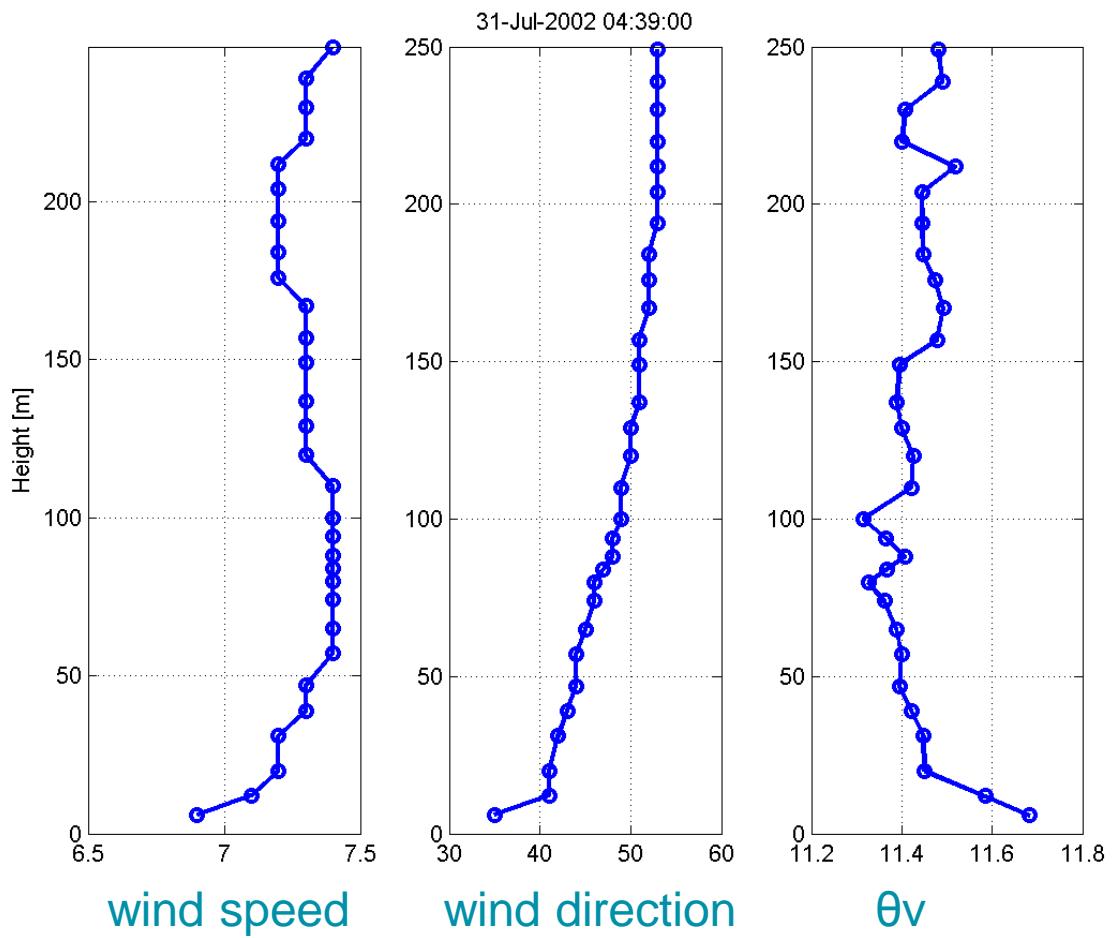


SAR wind field with model wind direction

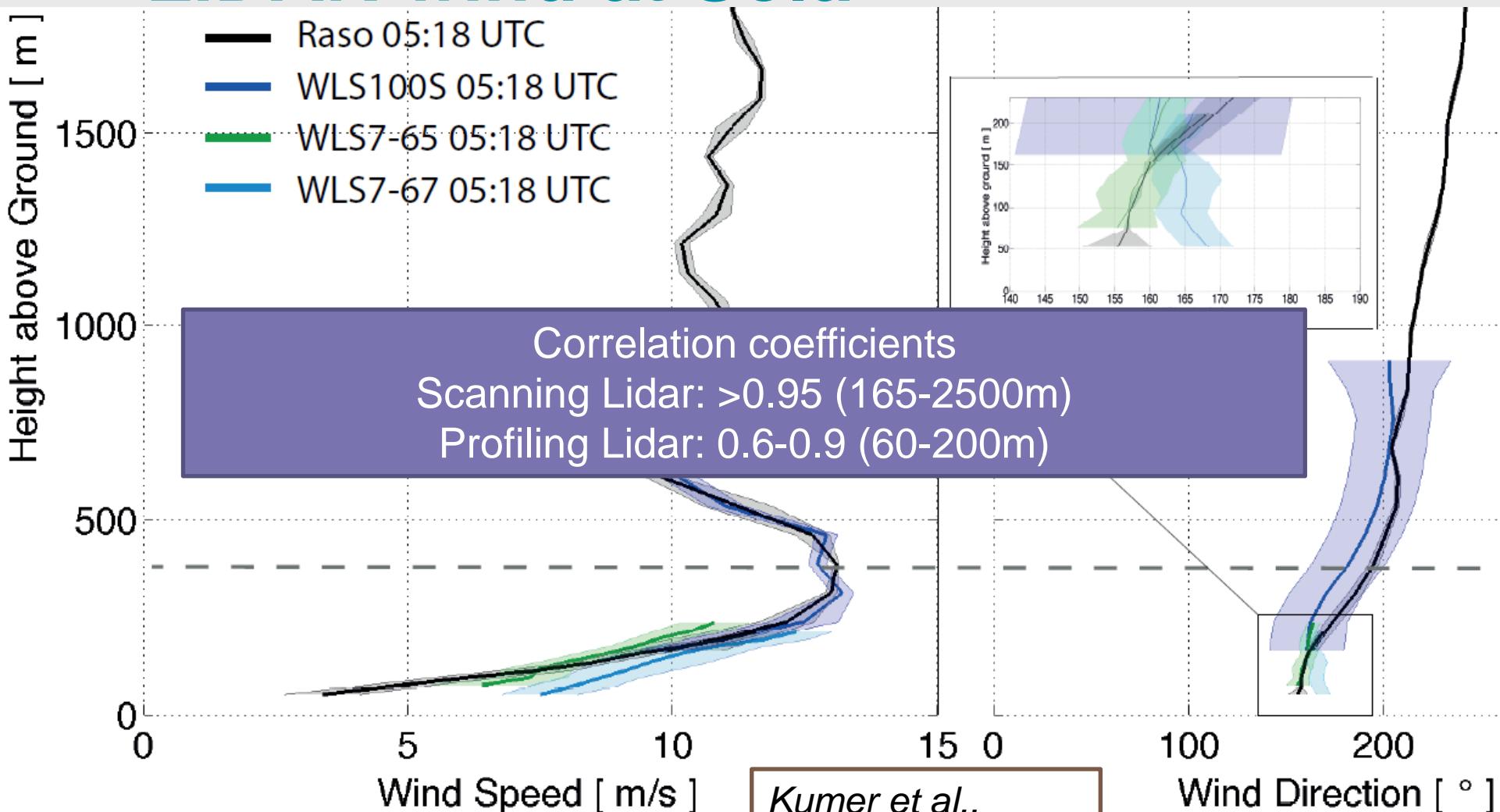


Radiosonde

2-second measurements



Comparison of radiosonde and LiDAR wind at Sola



Kumer et al.,
Energy Procedia,
2014

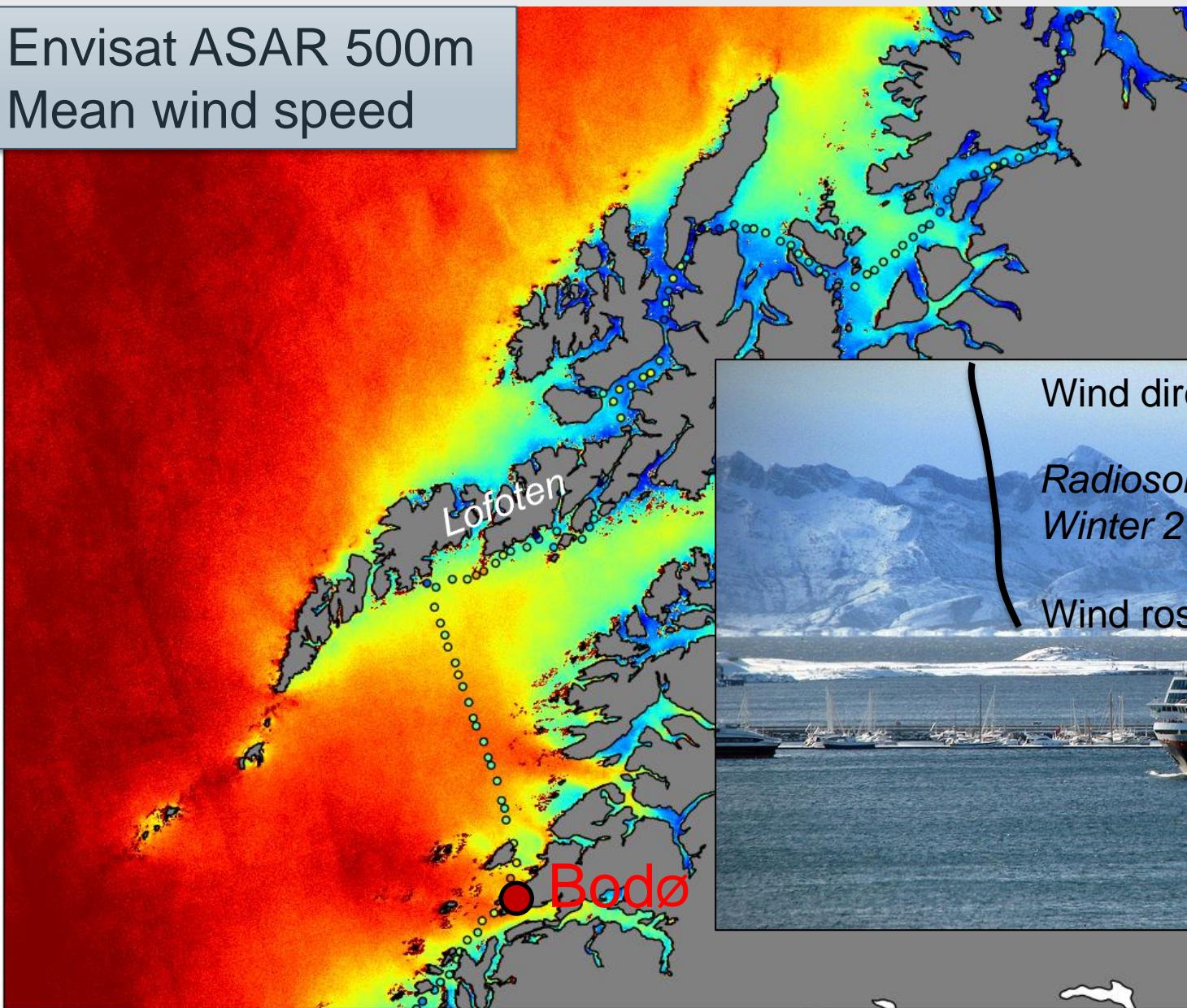


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Mean wind speed maps from satellite

8500 satellite images over Norway
500m spatial resolution

Envisat ASAR 500m Mean wind speed



Wind direction 850 hPa

*Radiosonde wind profiles
Winter 2013/2014*

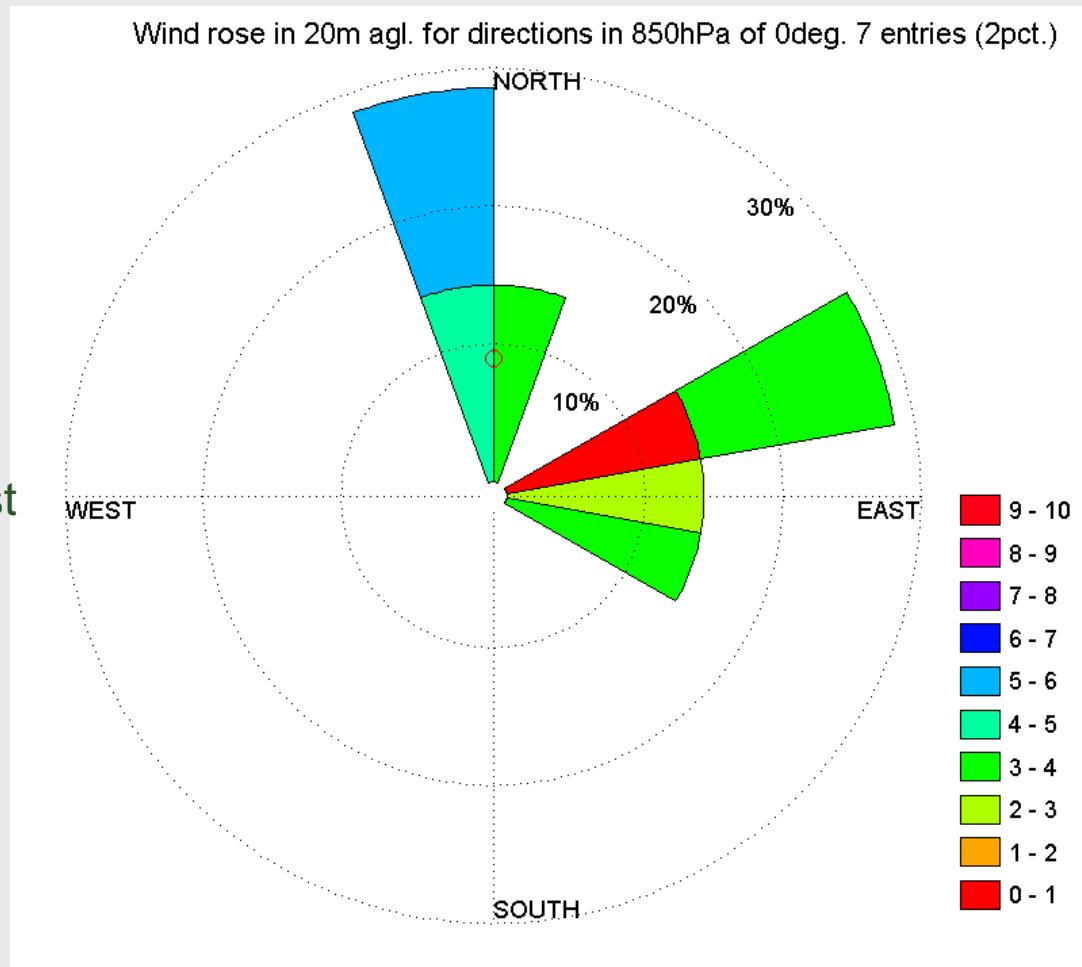
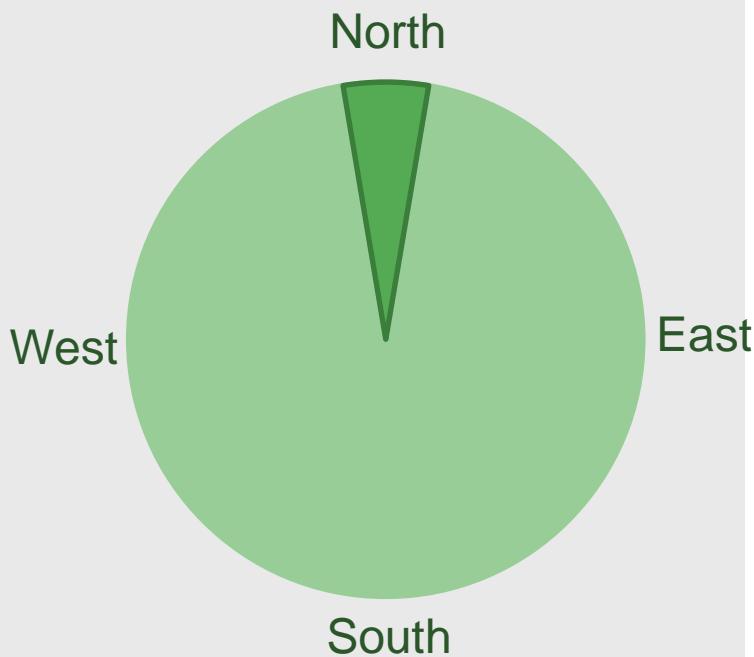
Wind rose 20m asl

4 m/s

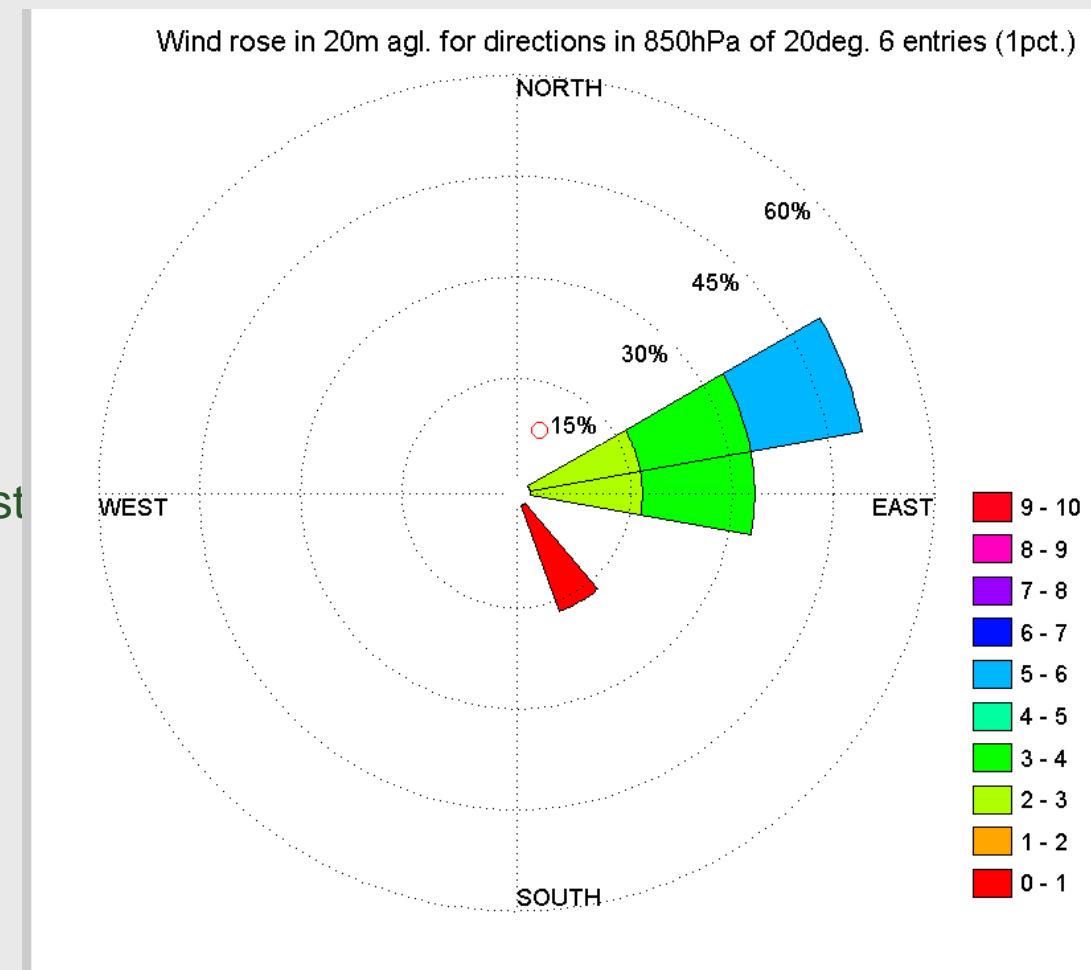
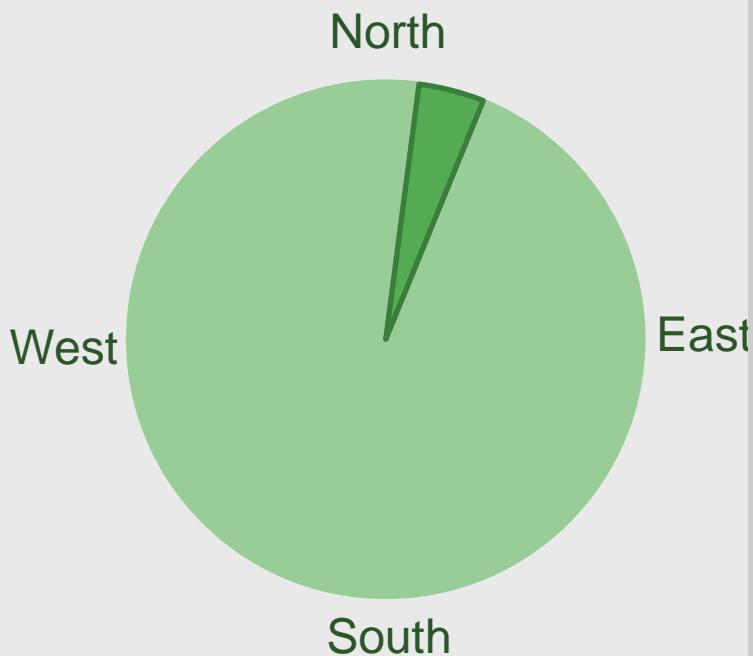
11 m/s

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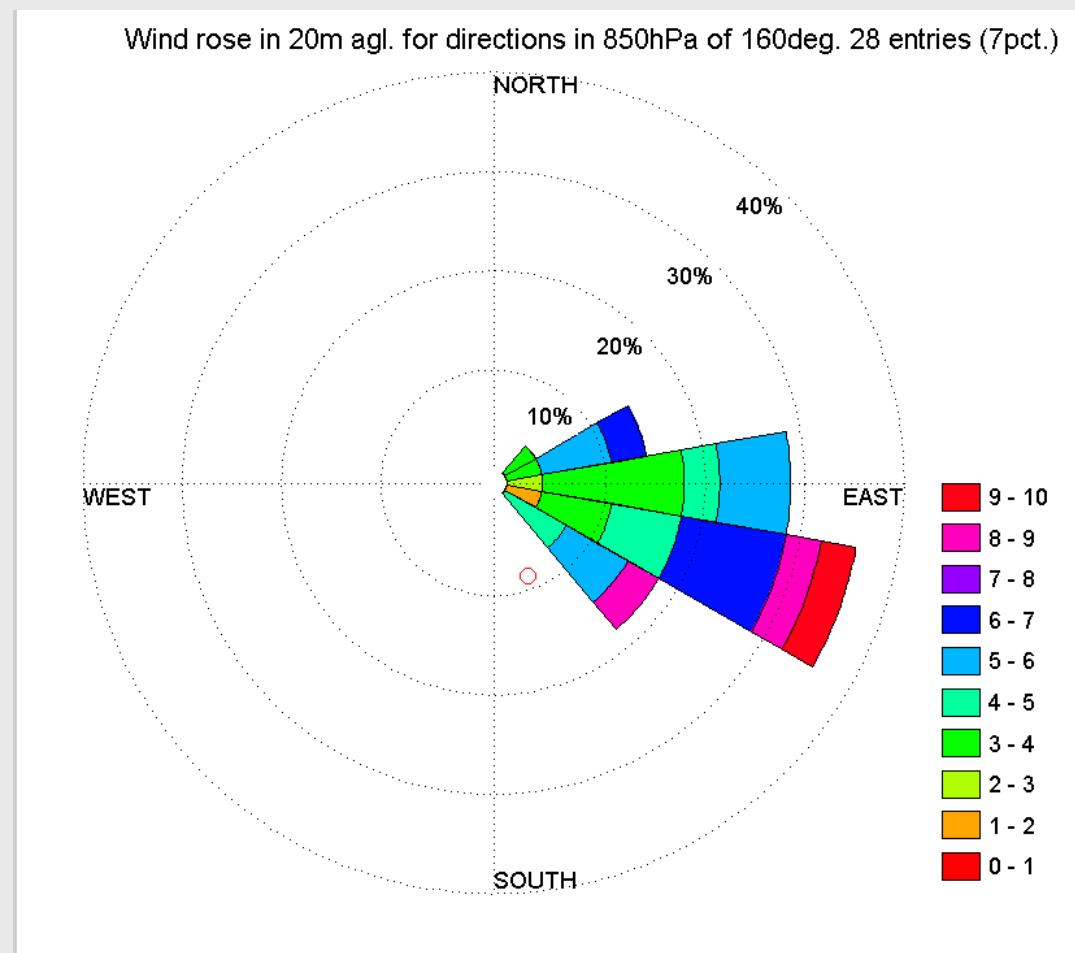
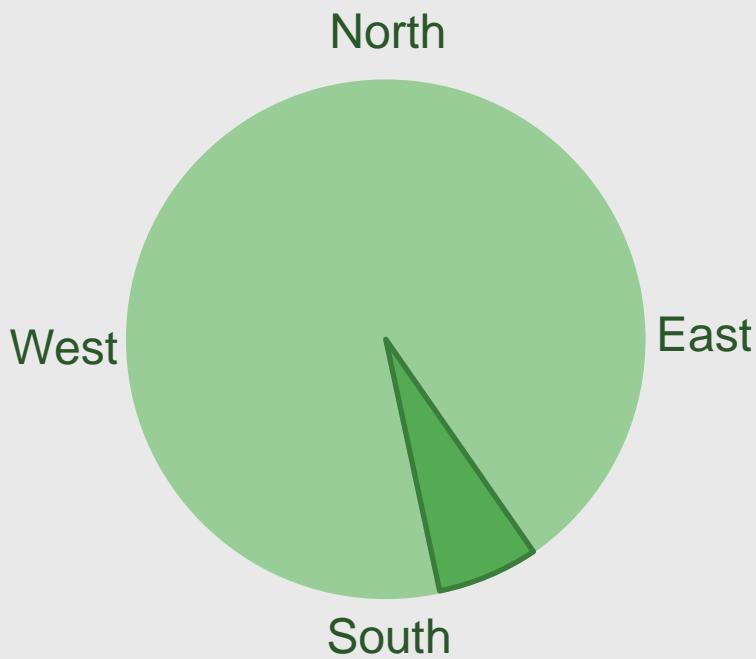
Wind rose in Bodø given the wind direction at 850 hPa



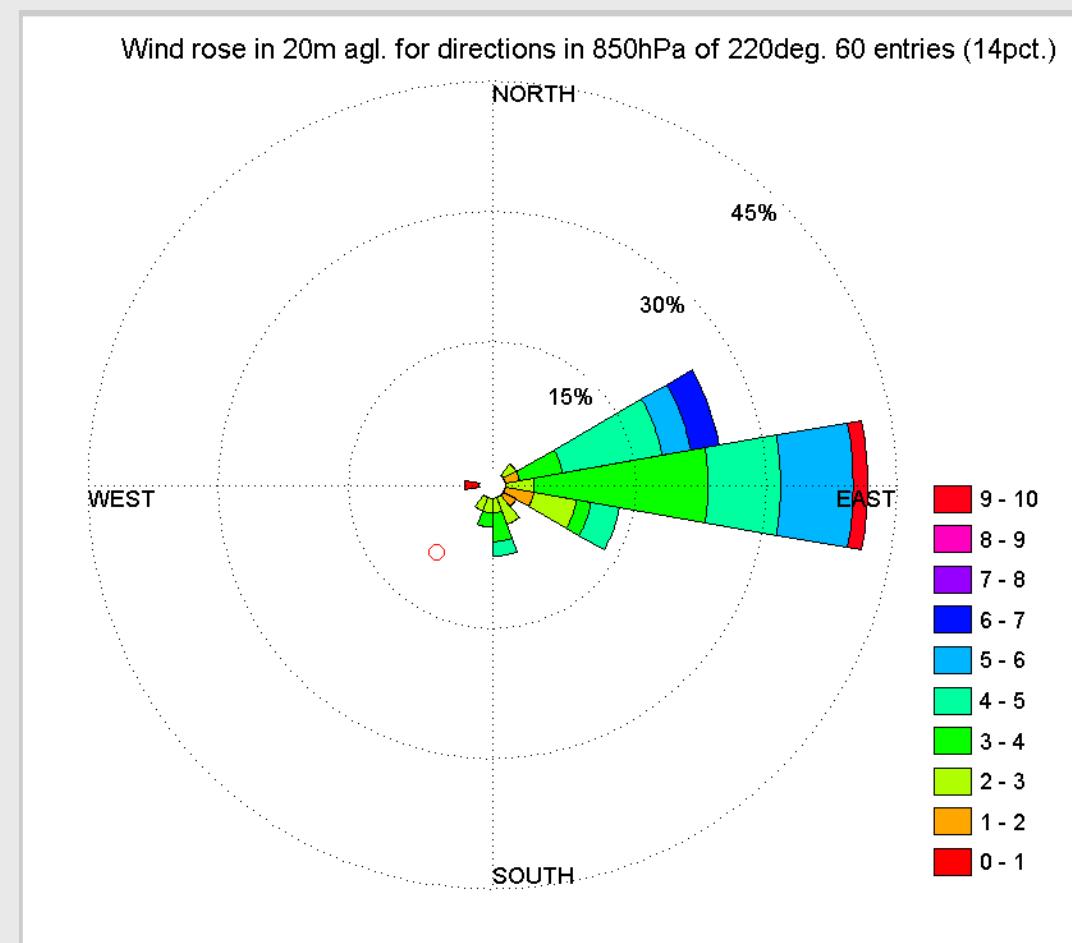
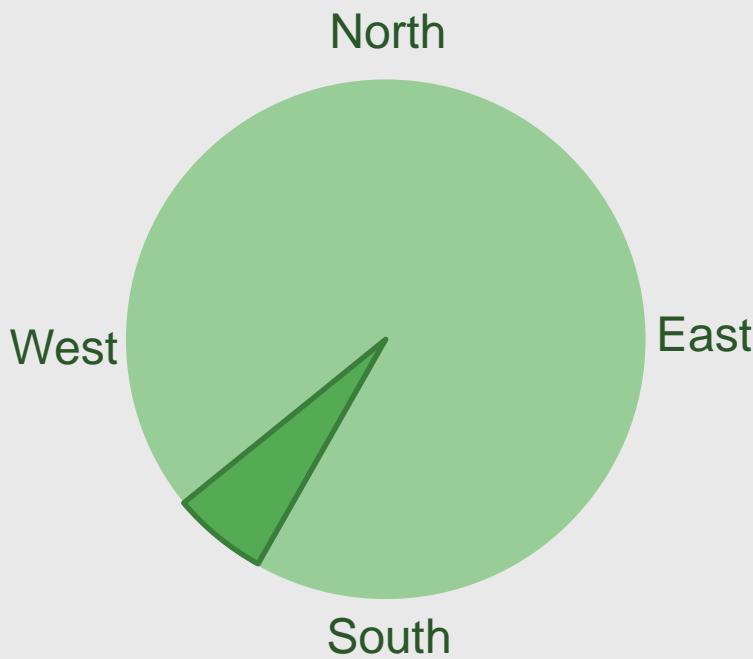
Wind rose in Bodø given the wind direction at 850 hPa



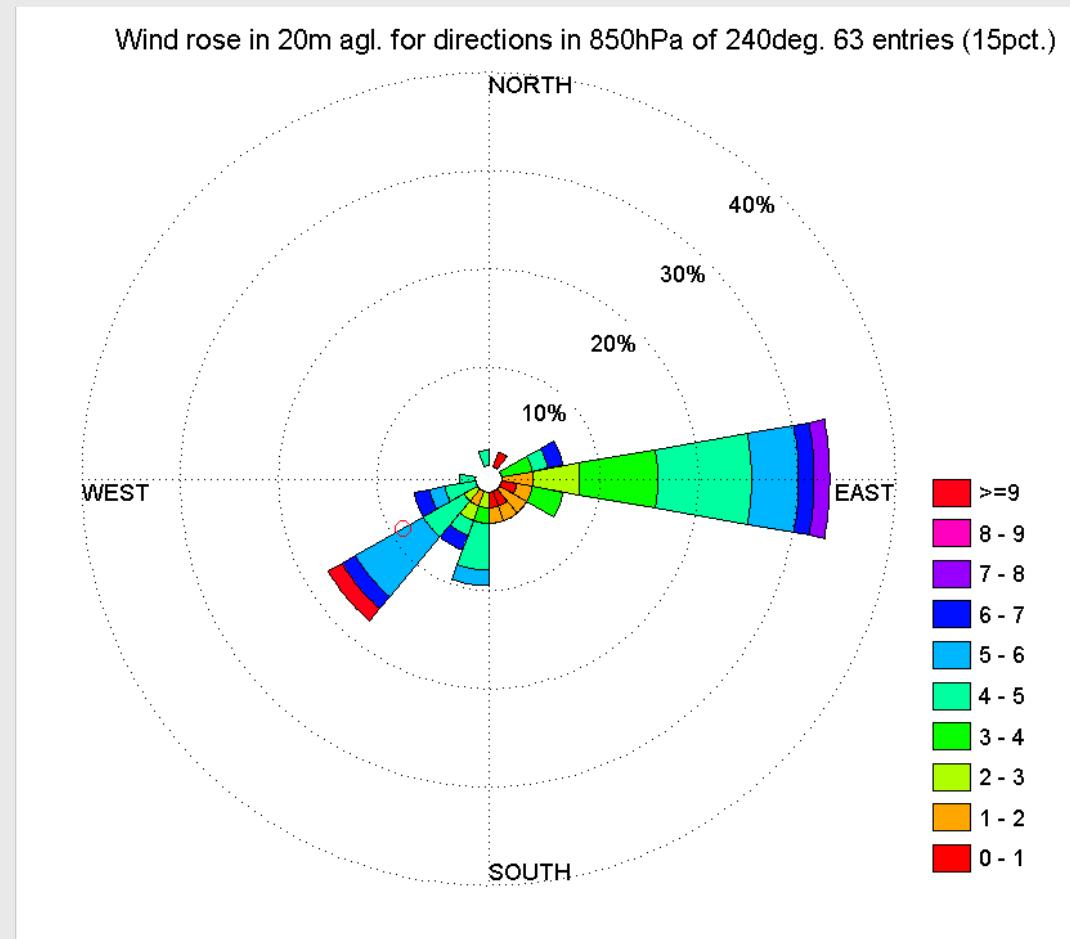
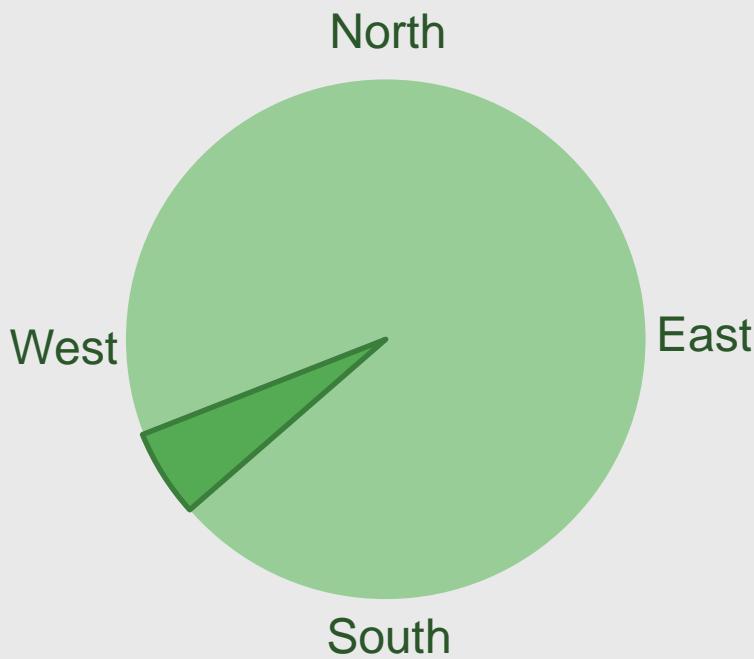
Wind rose in Bodø given the wind direction at 850 hPa



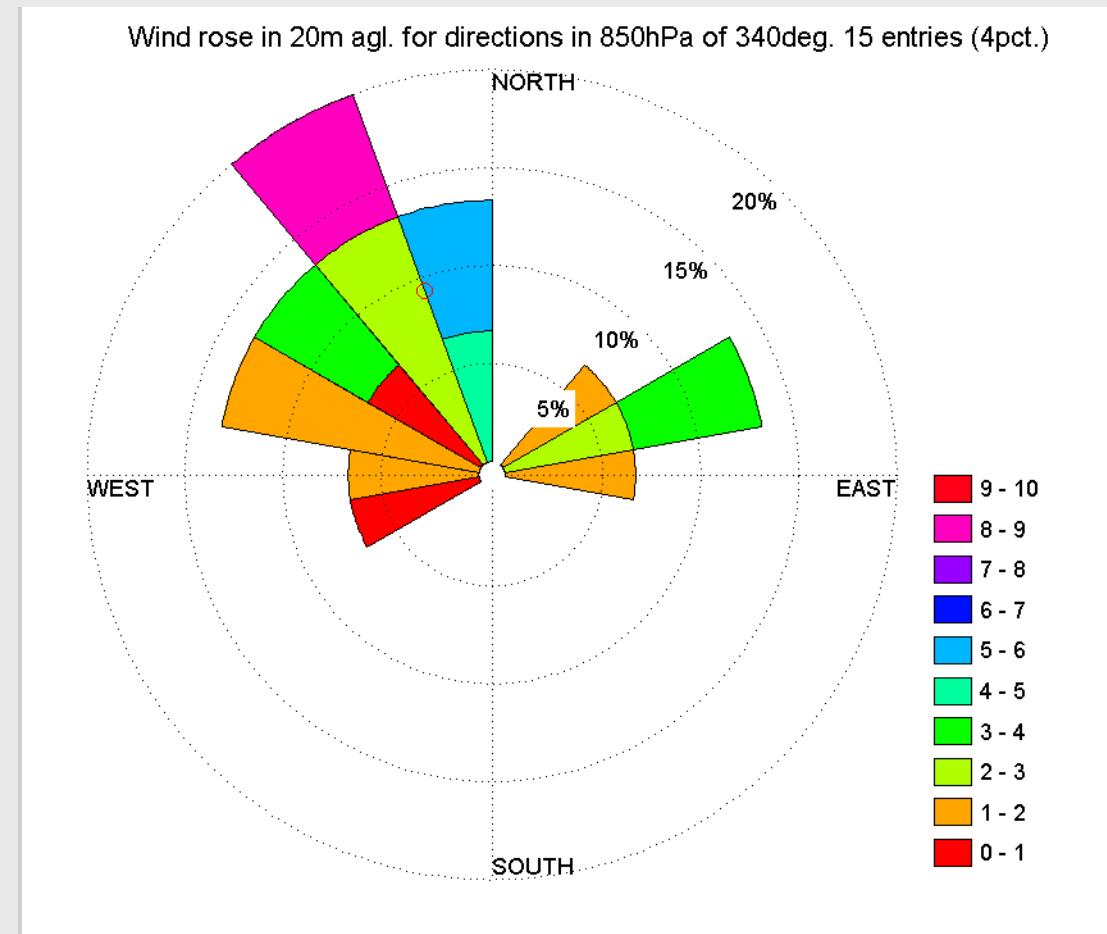
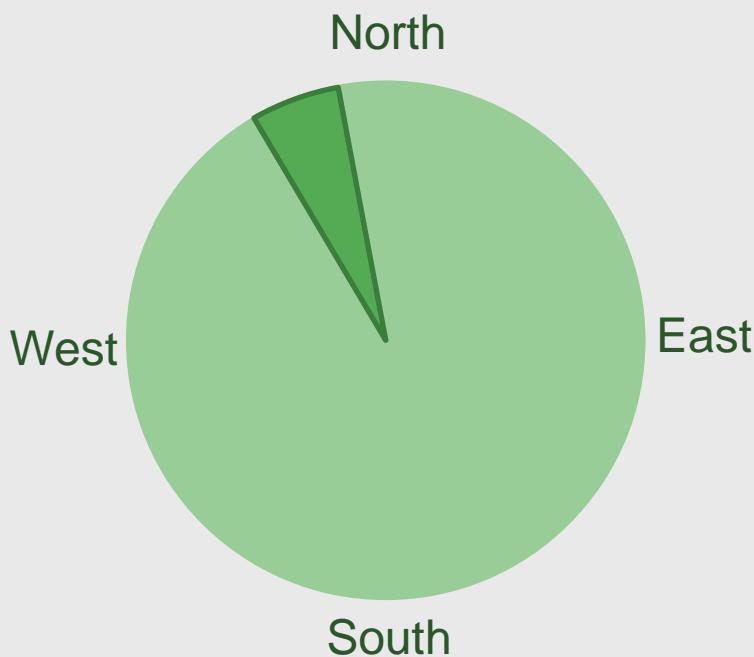
Wind rose in Bodø given the wind direction at 850 hPa



Wind rose in Bodø given the wind direction at 850 hPa



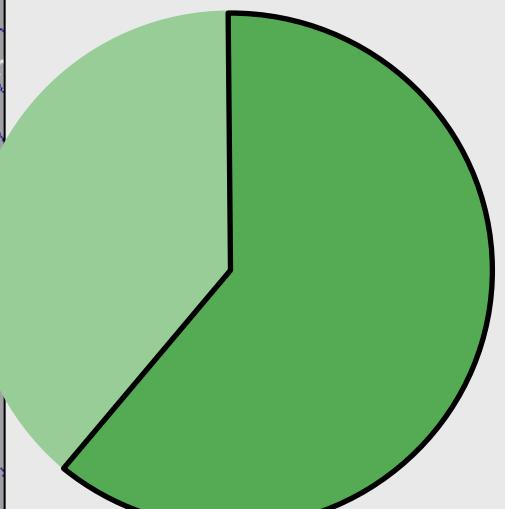
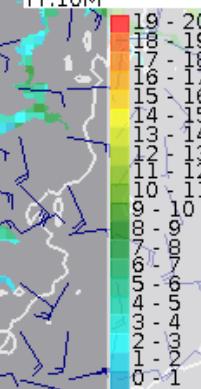
Wind rose in Bodø given the wind direction at 850 hPa



Tirsdag 2014-01-28 04 UTC

AROME 2.5km
2014-01-28 04UTC

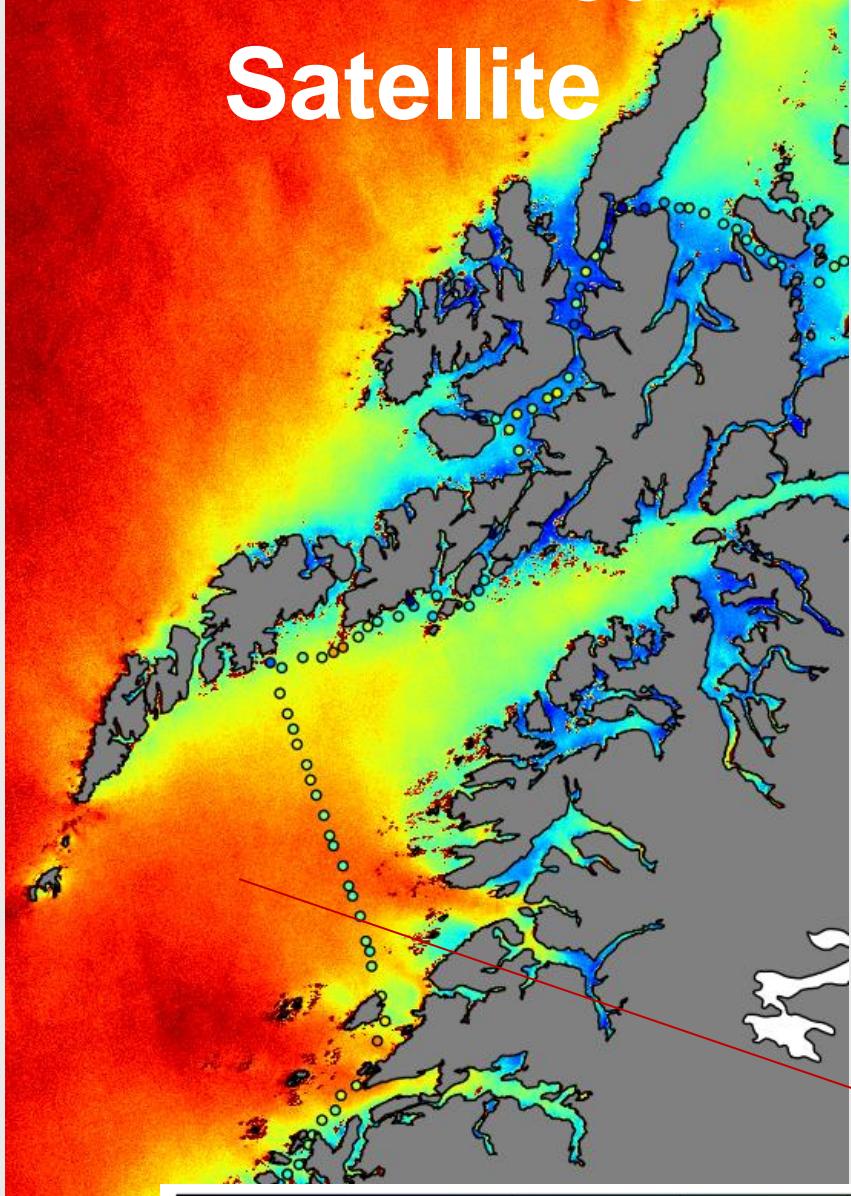
arome20140127
FF.10M



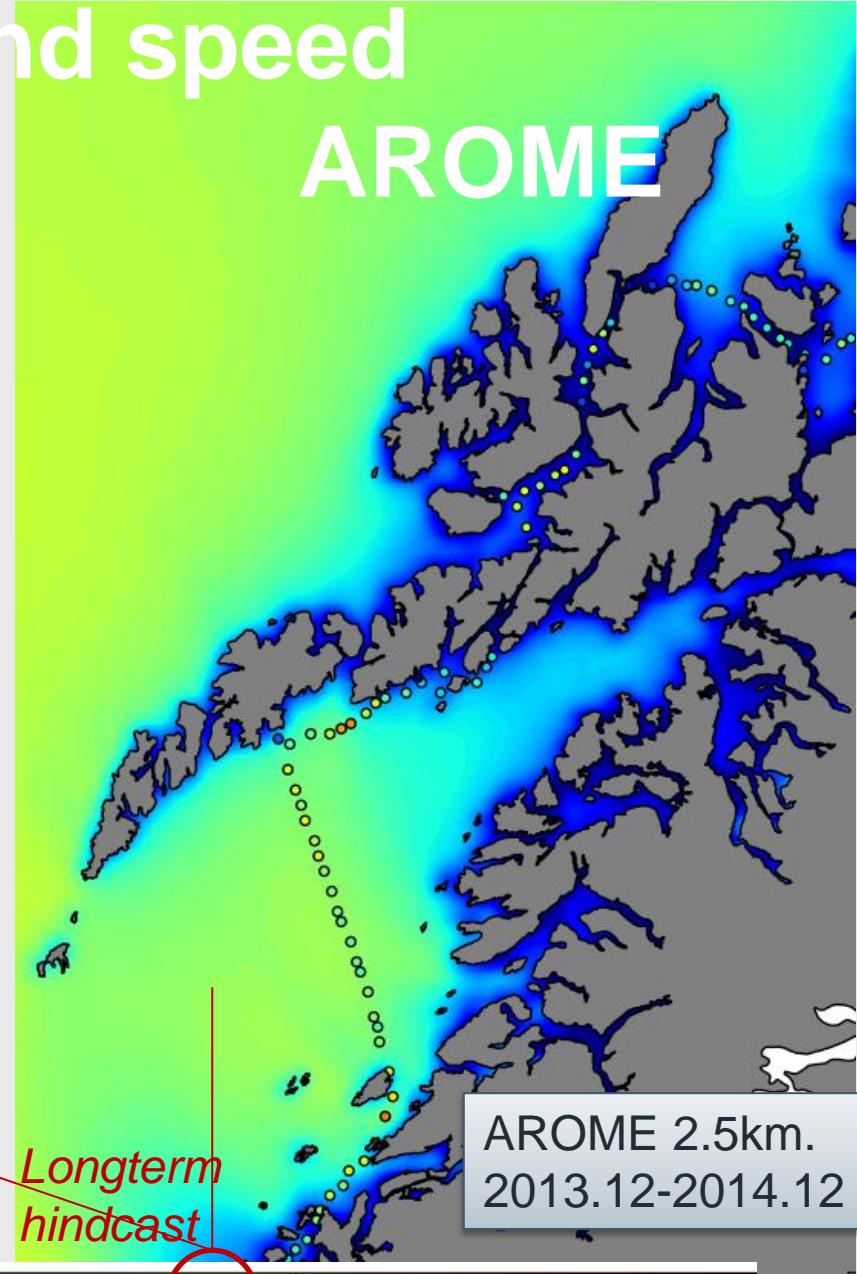
From the radiosonde:
All winds interacting with land are
directed through the fjord

Mean wind speed

Satellite



AROME



AROME 2.5km.
2013.12-2014.12

*Longterm
hindcast*

30

4 m/s

11 m/s

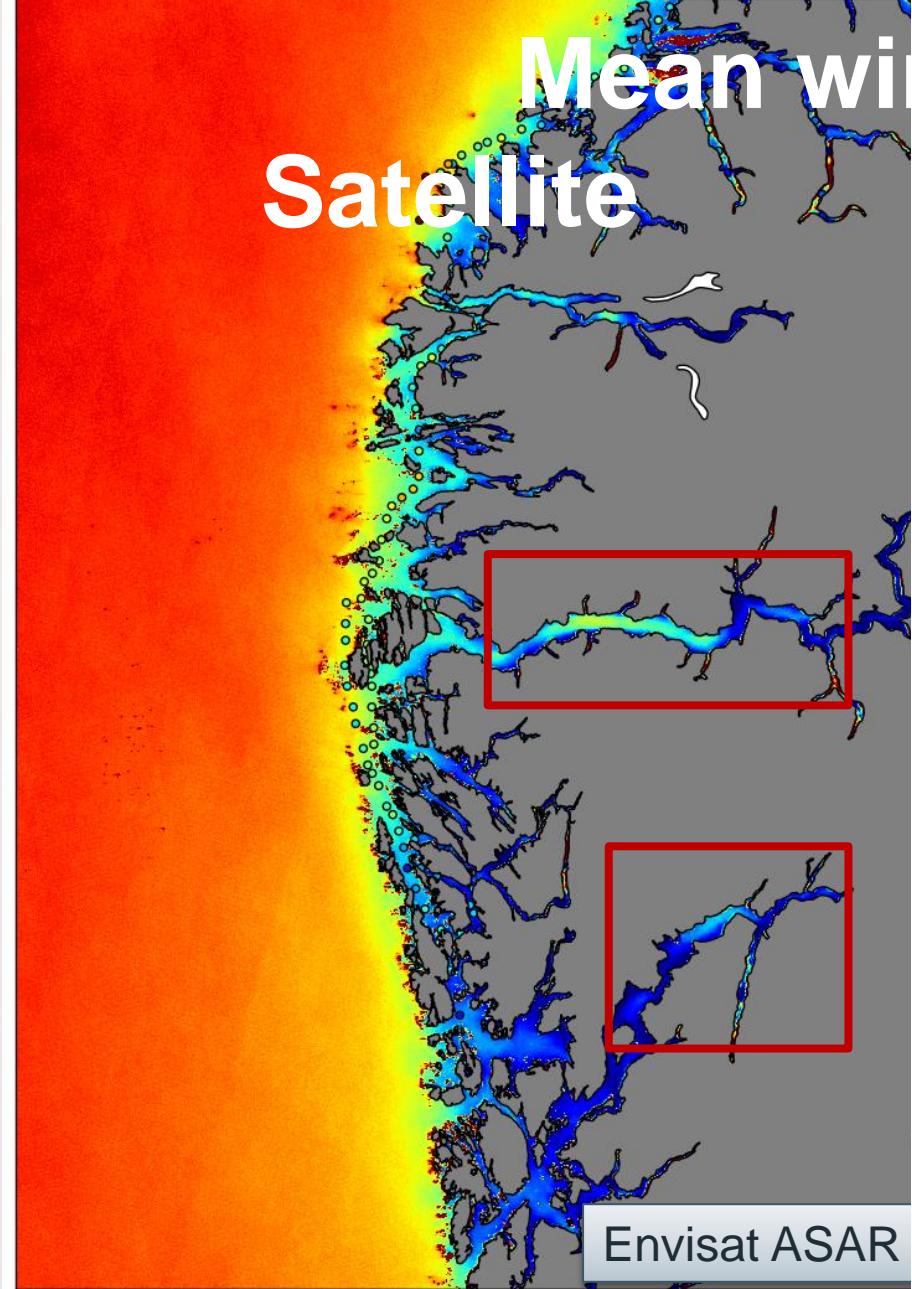
4.0 4.8 5.6 6.4 7.2

8.0 8.8 9.6 10.4

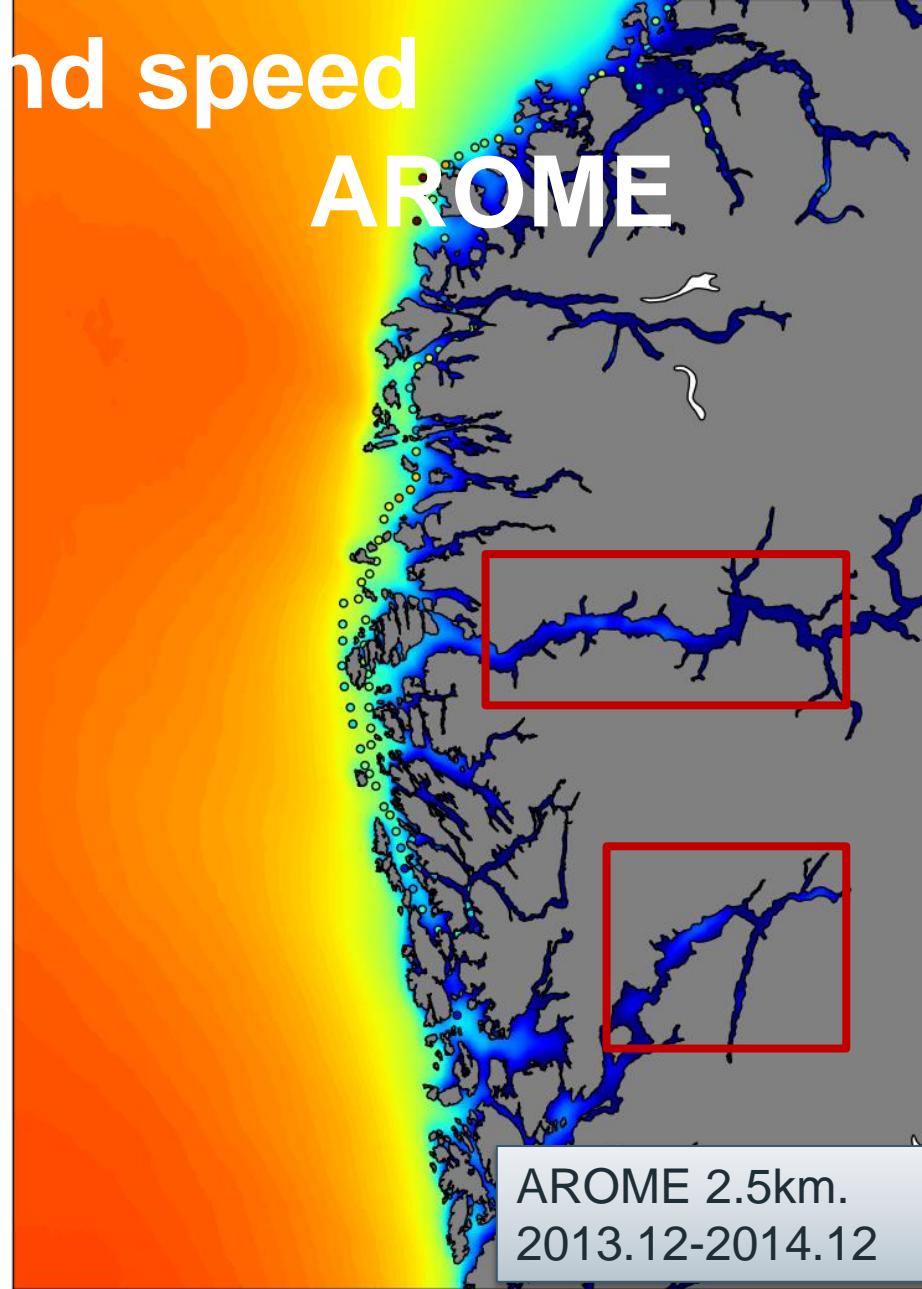


Satellite

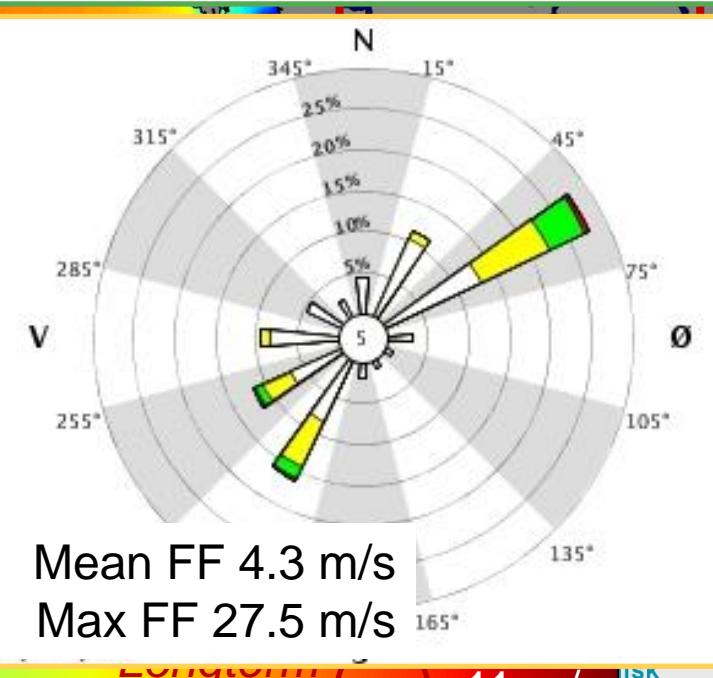
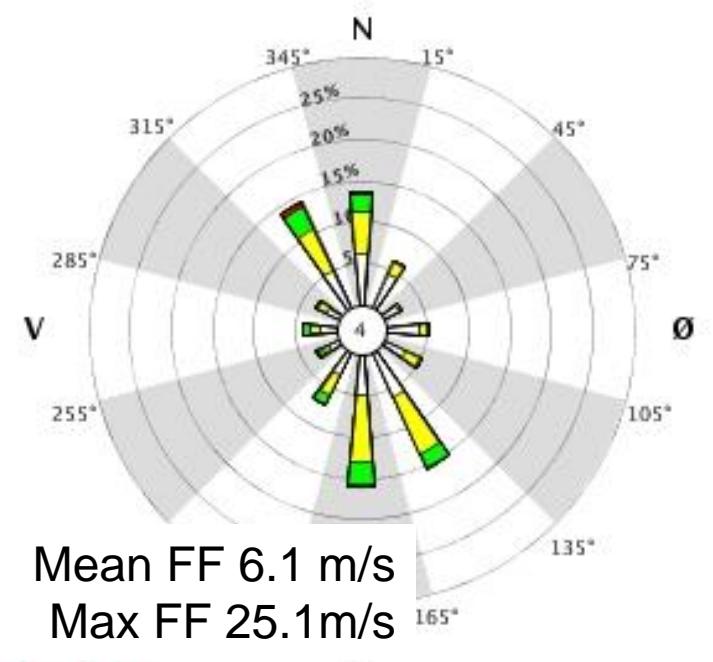
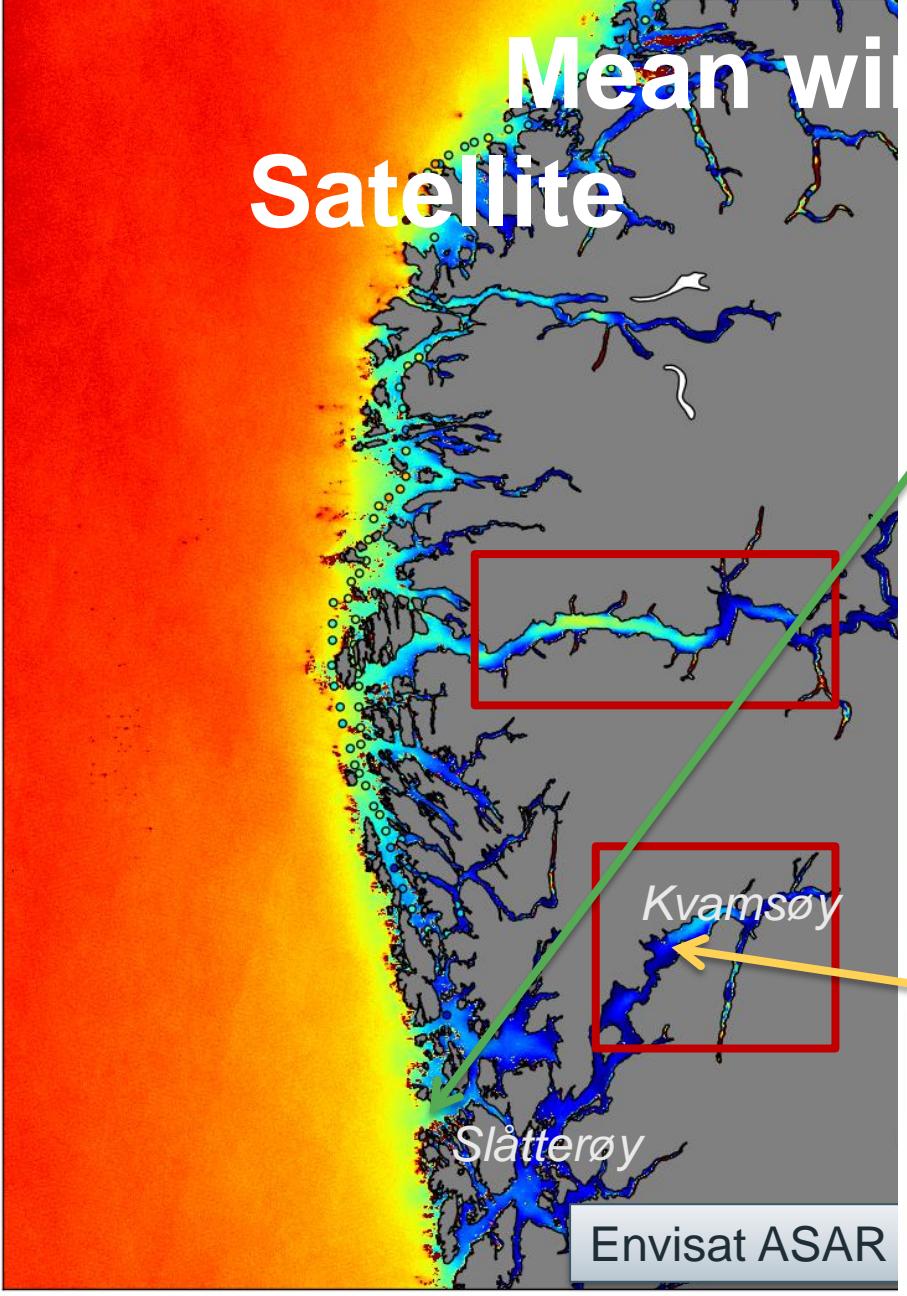
Mean wind speed



AROME



Mean wind Satellite



Longitude
hindcast

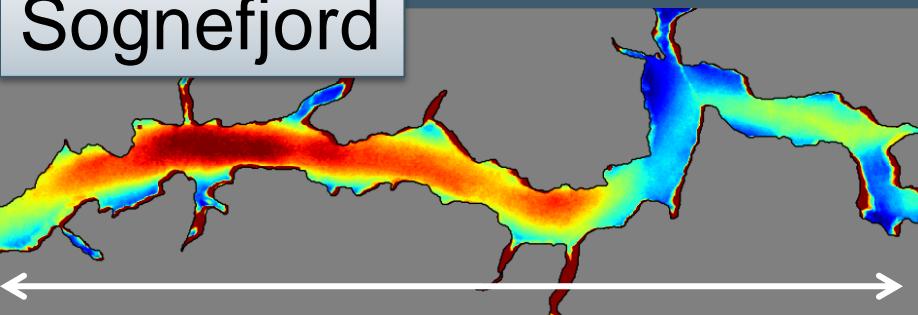
11 m/s

4.0 4.8 5.6 6.4 7.2 8.0 8.8 9.6 10.4

Mean wind speed

Satellite

Sognefjord



AROME

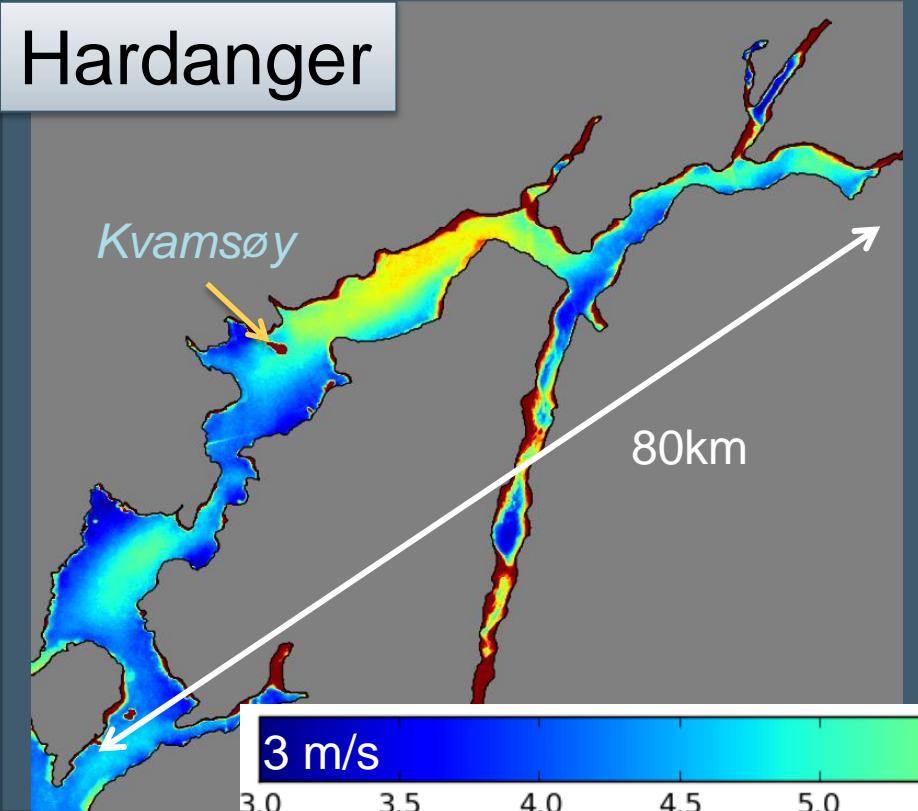
Takle

Vangsnes

Hardanger

Kvamsøy

80km



Varaldsøy

Odda

Utne

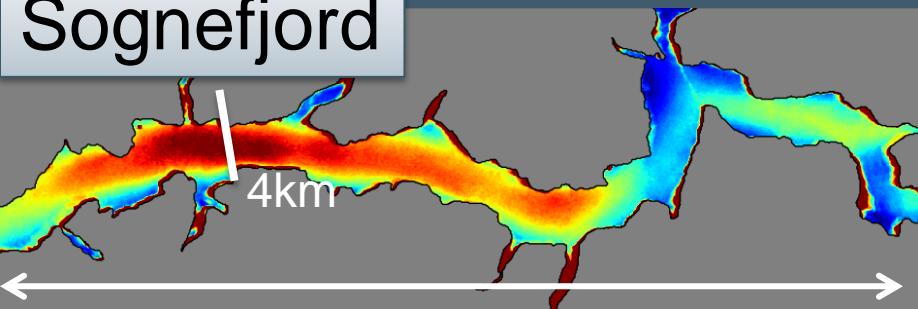
8 m/s

3 m/s

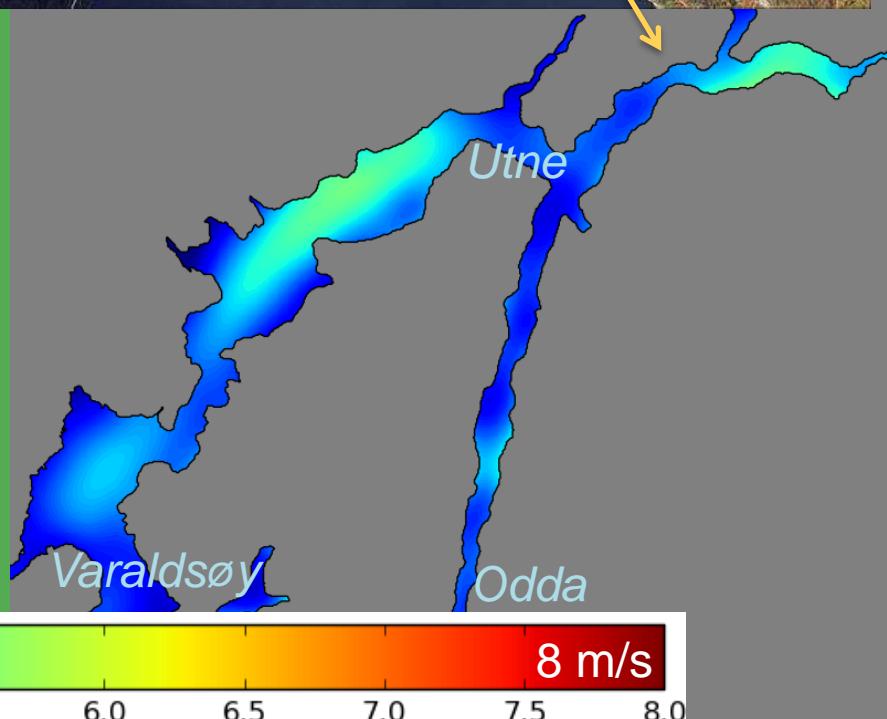
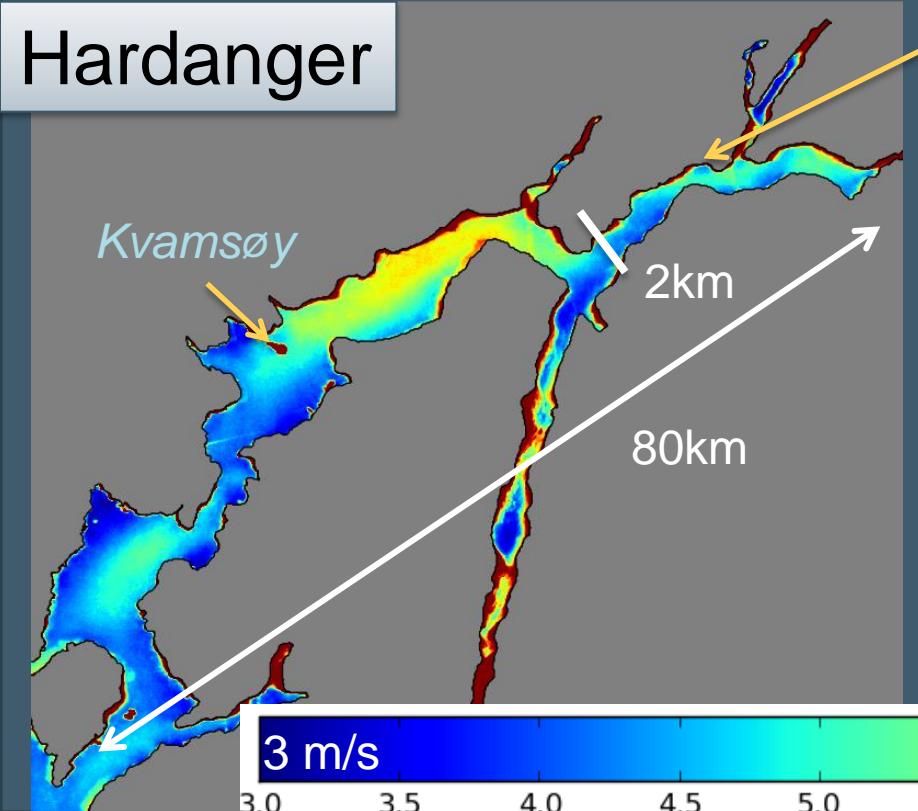
Mean wind

Satellite

Sognefjord



Hardanger



Conclusions

- 8500 ASAR images from Envisat satellite are averaged to form mean wind speed (10m height) maps over the Norwegian coast and fjords
 - Useful details about wind enhancements in parts of the fjords and at fjord outlets where there are no ground observations
 - Absolute wind speed may be too strong
- 2-second measurements from radiosonde are useful for studying the wind profiles starting at 15-20m
- The AROME 2,5km operational model at MET represent the fjord winds quite well
 - Weak gradients in the model are attributed to the resolution and the representation of the complex terrain in the model