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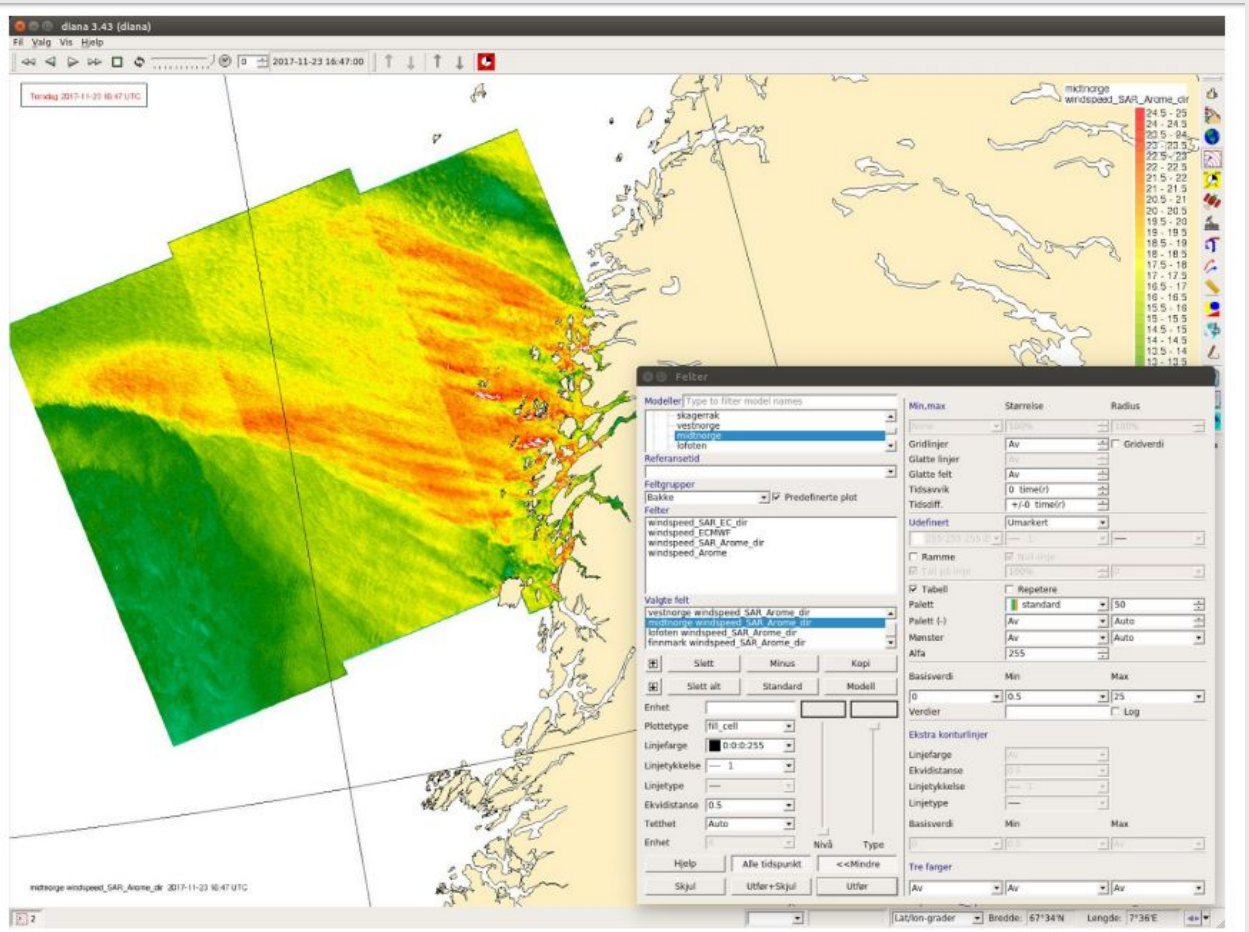
Coastal wind from Synthetic Aperature Radar

Birgitte Rugaard Furevik (MET Norway & DMI), Knut Frode Dagestad and Ivar A. Seierstad (MET Norway)

Project Metvind funded by the Norwegian Space Center

19.06.2018



Metvind-project (2017) Norwegian Space Center [Sluttrapport]

Can we use SAR to calibrate coastal wind in AROME MetCoop 2.5km forecasts?

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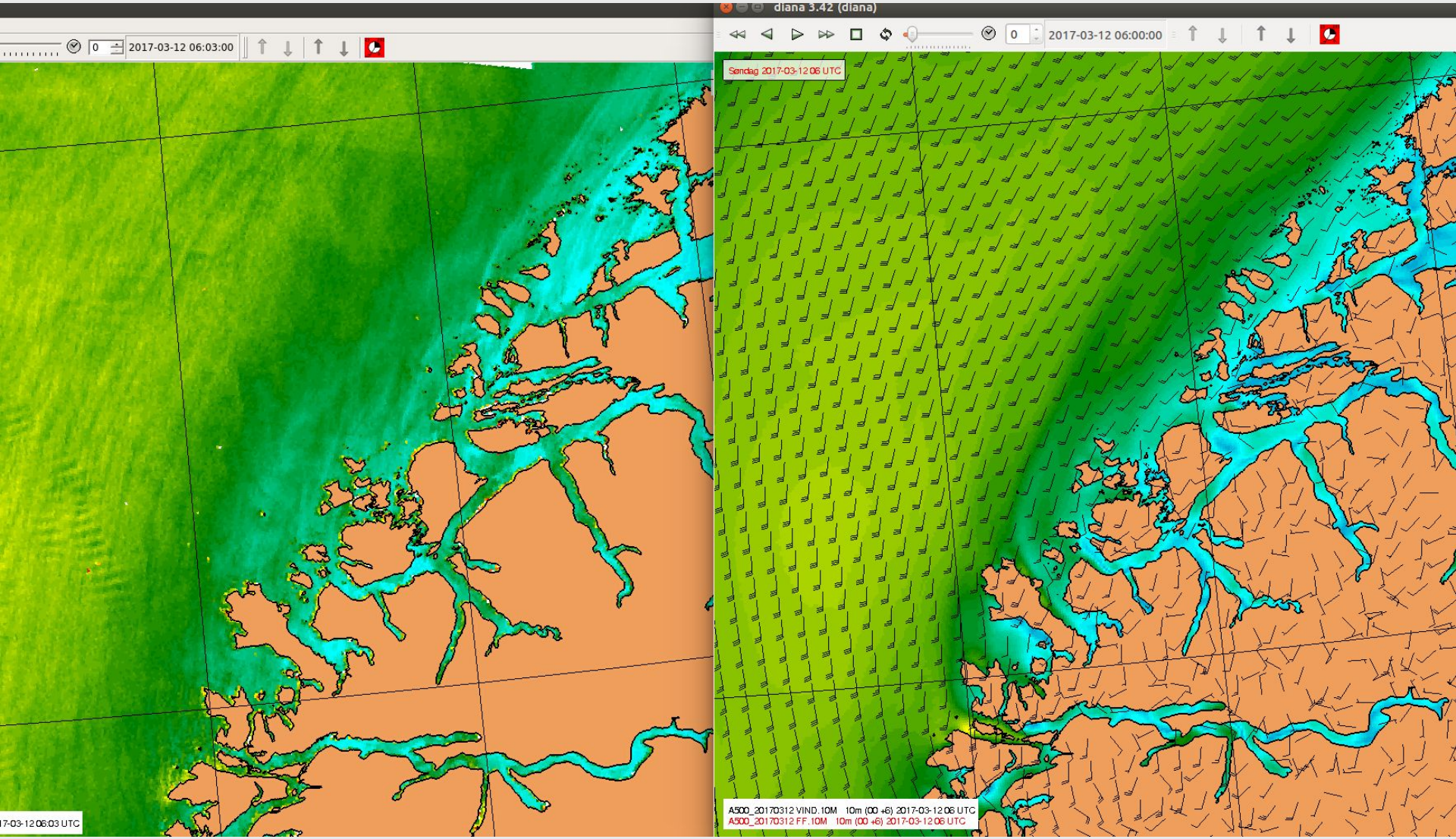
SAR and AROME 500mx500m 10m wind



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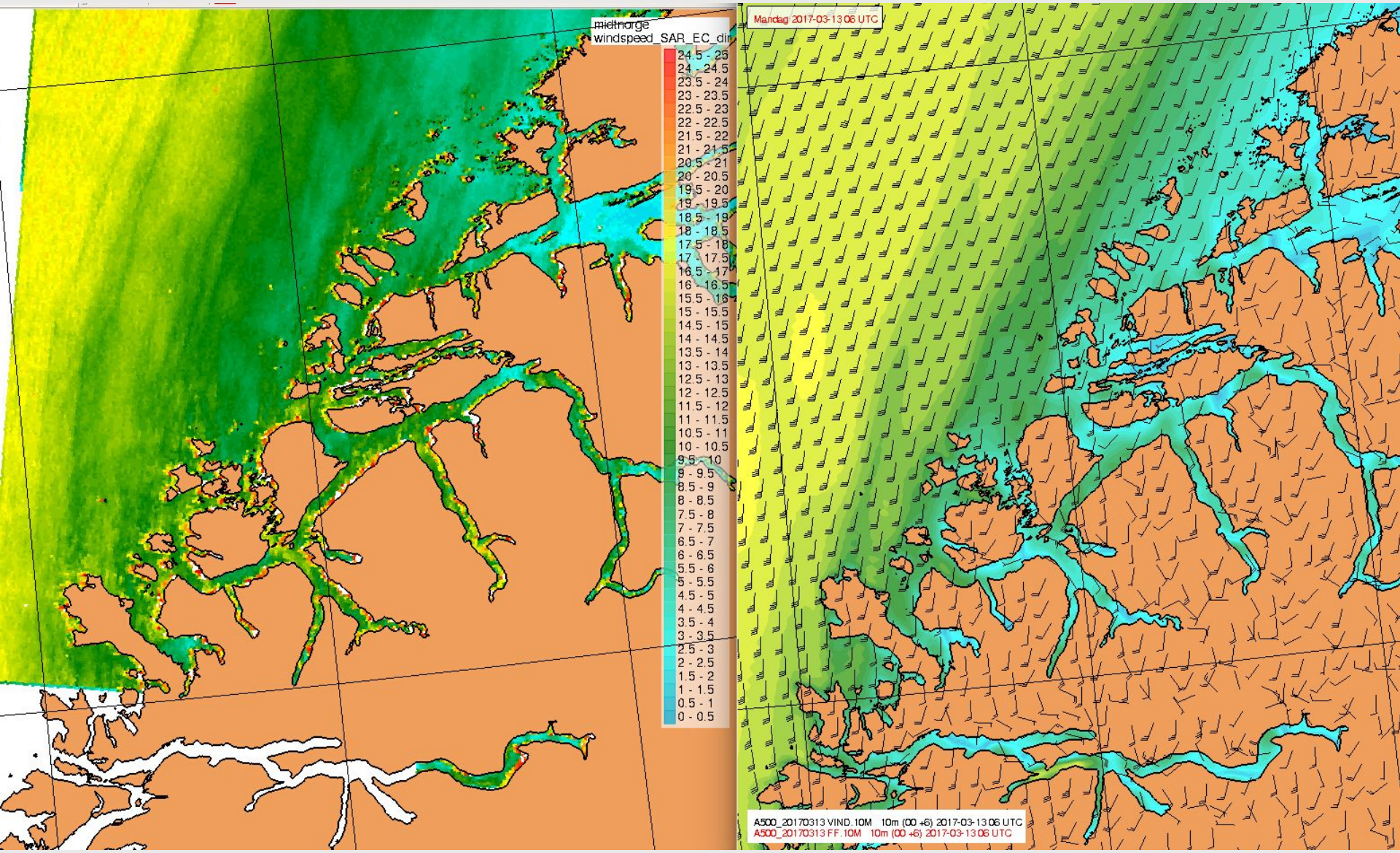
SAR and AROME 500mx500m 10m wind



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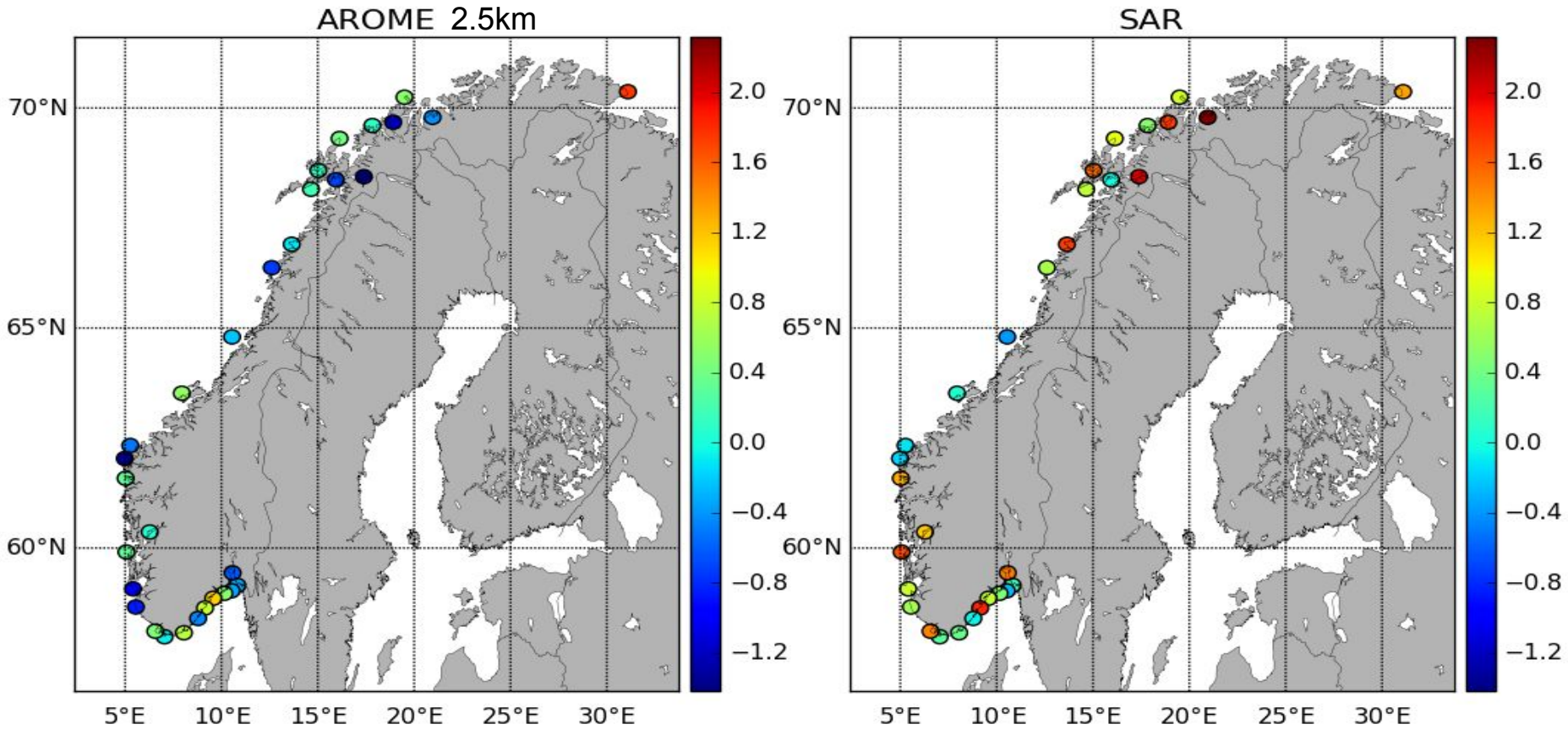
Synthetic Aperture Radar

- Sentinel1 A & B
- SAR measures sea surface roughness
- Roughness is mainly dependent on wind speed and air-sea temperature difference for wind speed above ~3m/s
- Conversion to 10m wind speed is dependent on external wind direction (e.g. from a model)
- A value is calculated over all of the image - even over land, ships, platforms etc.

Three data sets:

- NERSC/MET processing Level-1 data using Nansat and OpenWind software (available on github)
- Danish Technical University (DTU) on satwinds.windenergy.dtu.dk
- ESA Ocean (OCN) Level-2 product on colhub.met.no

Bias to coastal stations



Bias [m/s] coastal stations

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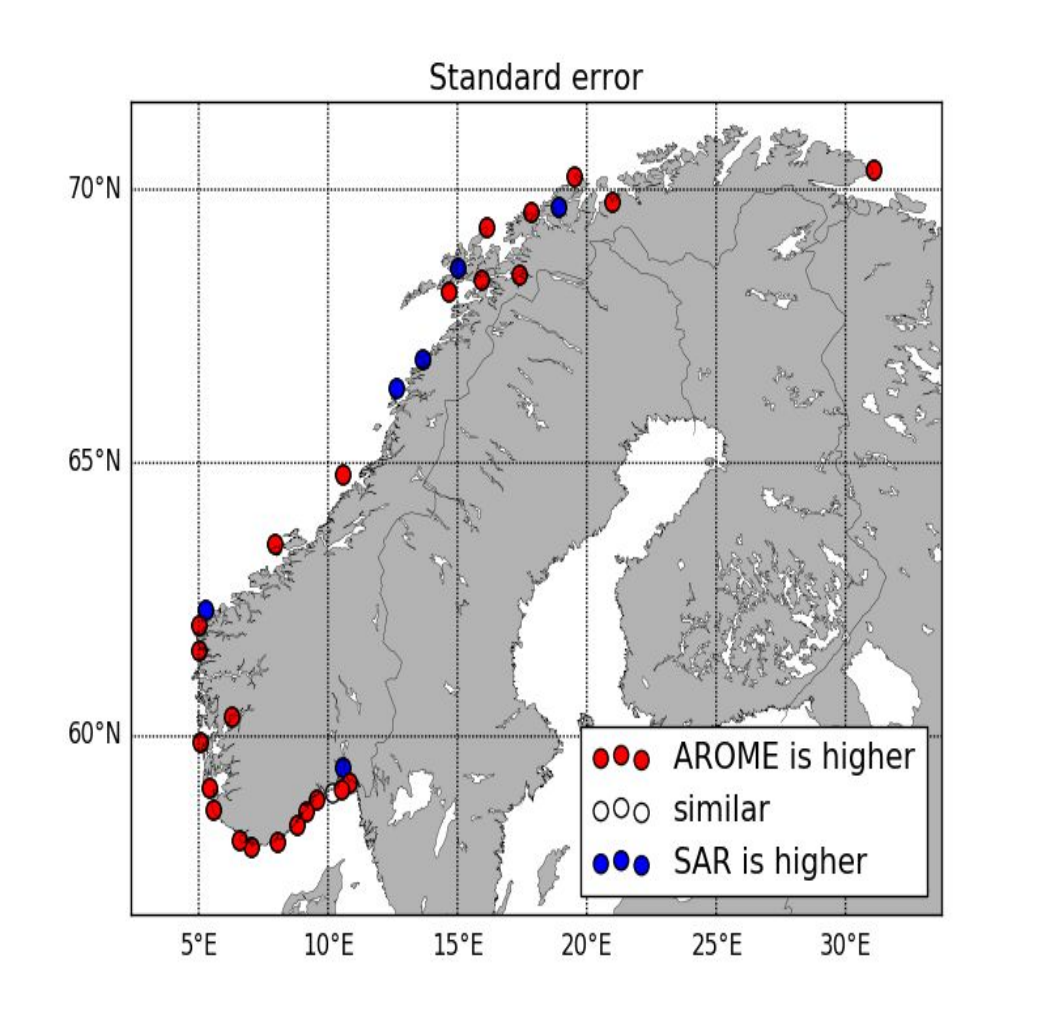
Standard Error



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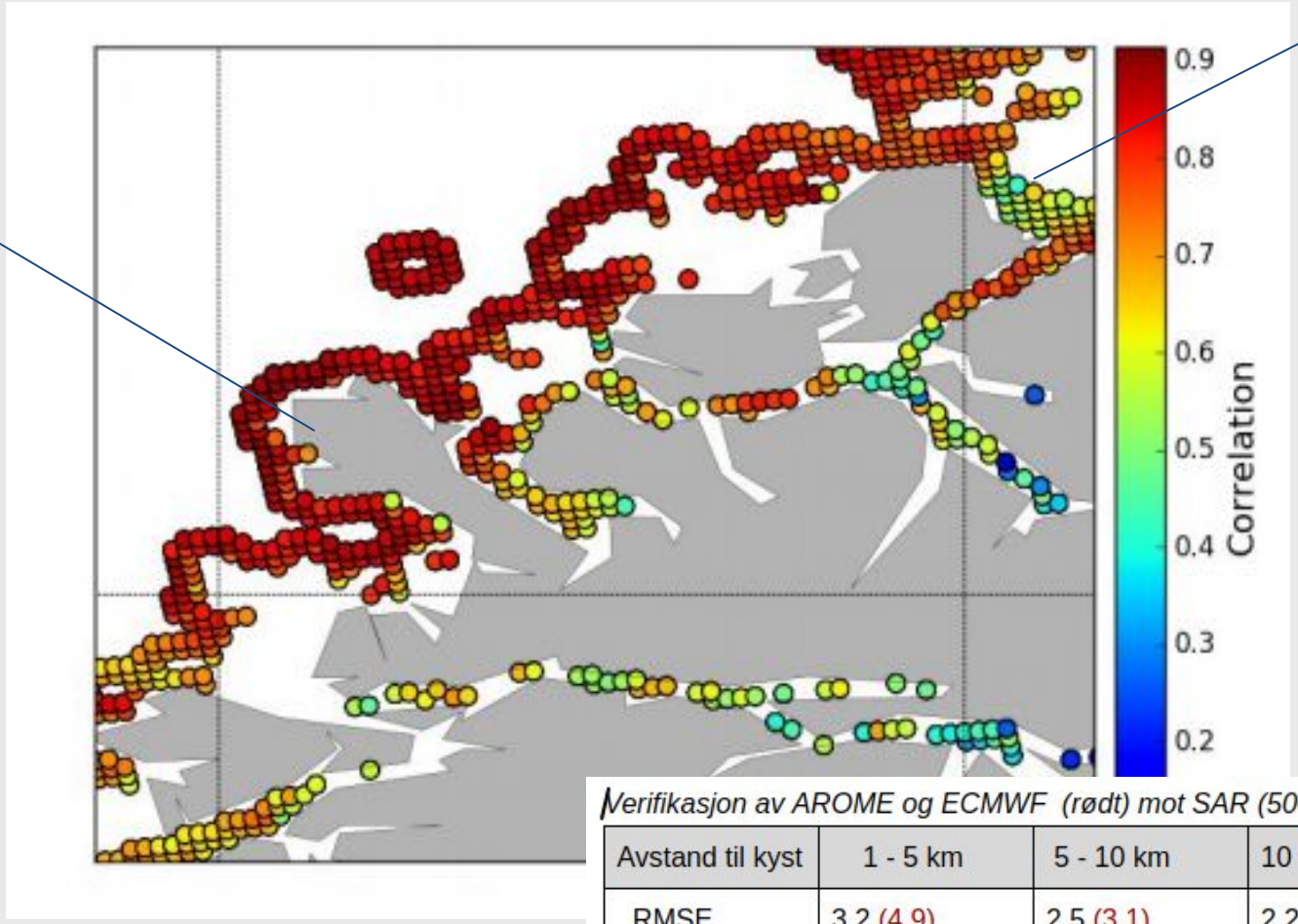
AROME - SAR correlation



ECMWF and AROME comparable offshore

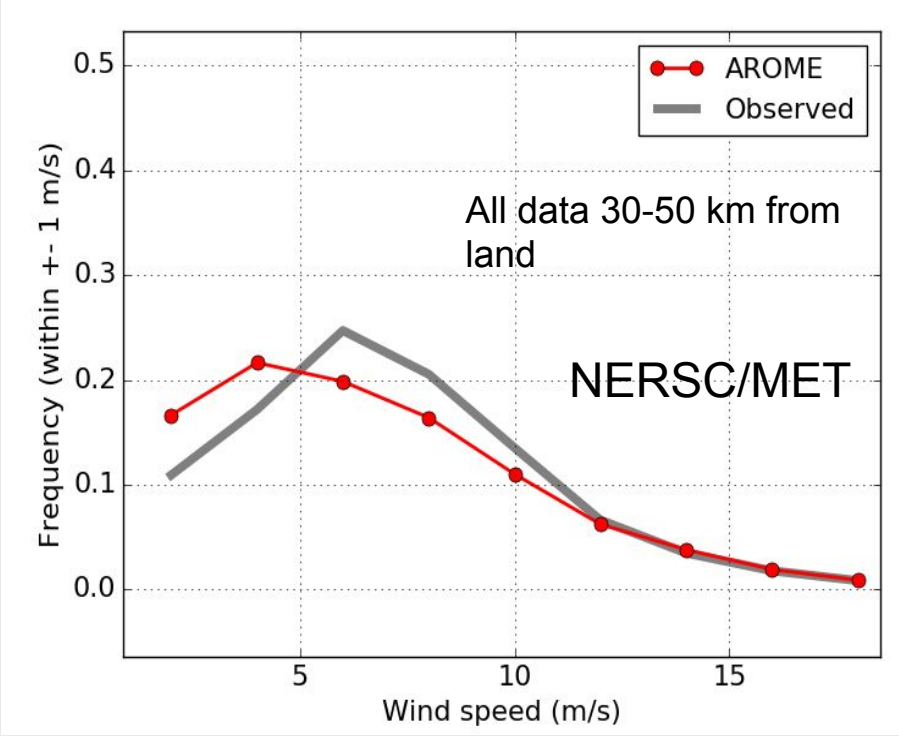
Correlation in wind speed between AROME and SAR

Verifikasjon av AROME og ECMWF (rødt) mot SAR (5000 punkter i hver "region")

Avstand til kyst	1 - 5 km	5 - 10 km	10 - 30 km	30 - 50 km
RMSE	3.2 (4.9)	2.5 (3.1)	2.2 (2.4)	2.1 (2.1)
COR	0.7 (0.4)	0.8 (0.7)	0.8 (0.8)	0.9 (0.8)
STDERROR	2.5 (3.7)	2.3 (2.6)	2.1 (2.2)	2.0 (2.0)
BIAS	-2.1 (-3.2)	-1.1 (-1.6)	-0.9 (-0.9)	-0.6 (-0.7)

Offshore wind speed distribution of AROME 2.5km and SAR

Distributions should be the same



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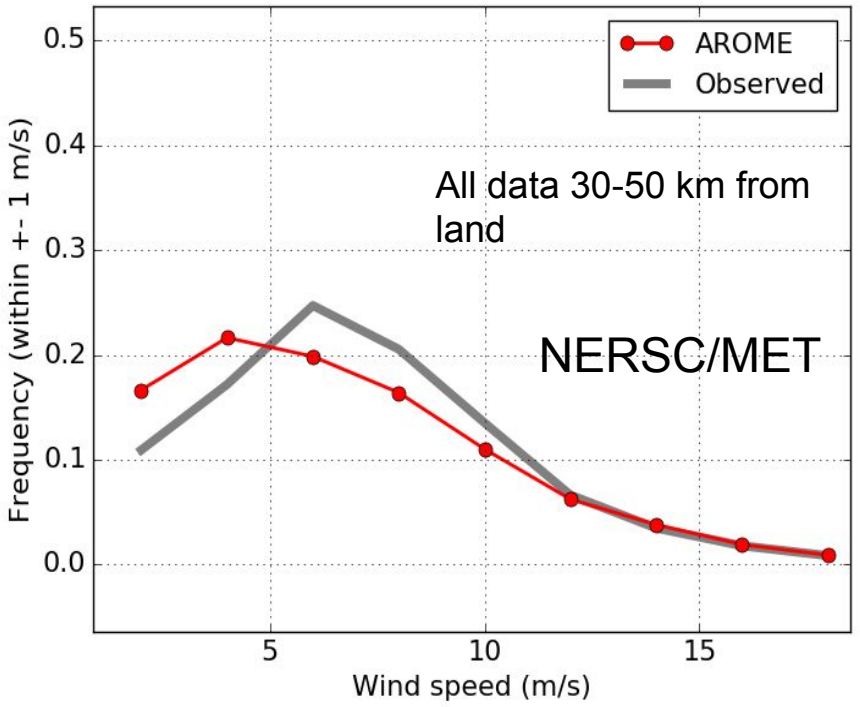
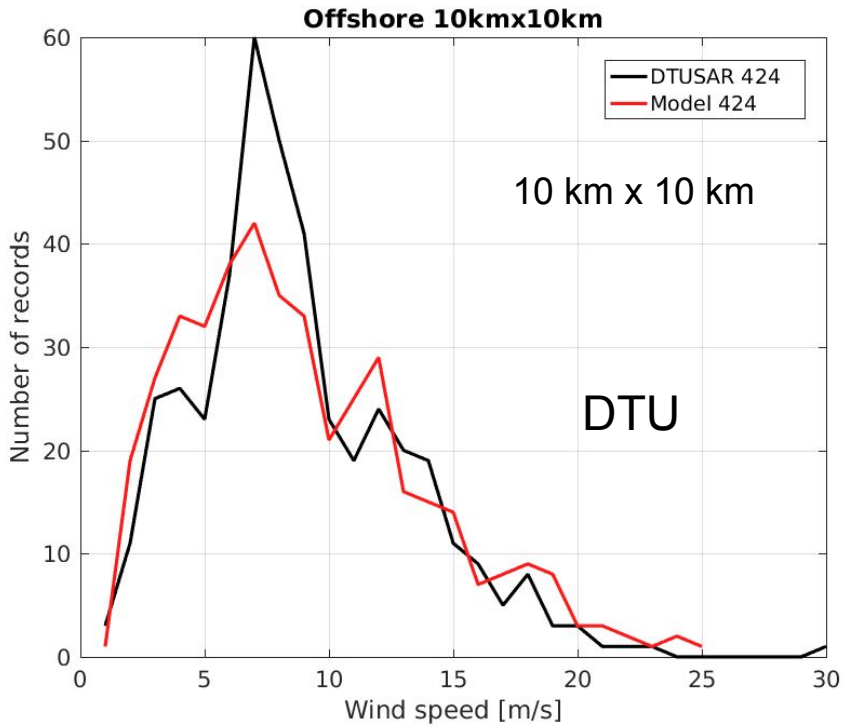
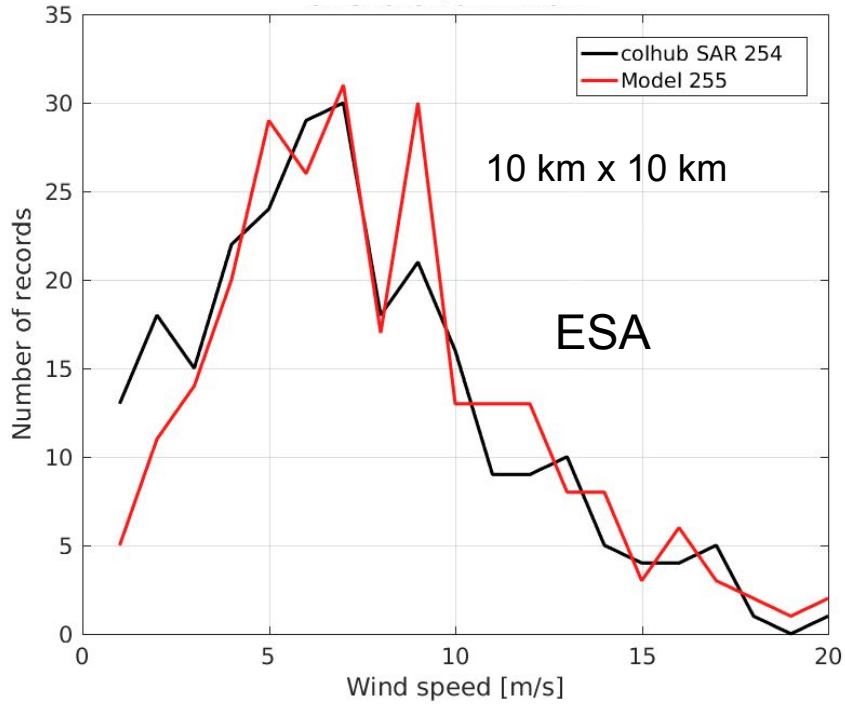
Offshore wind speed distribution of AROME 2.5km and SAR



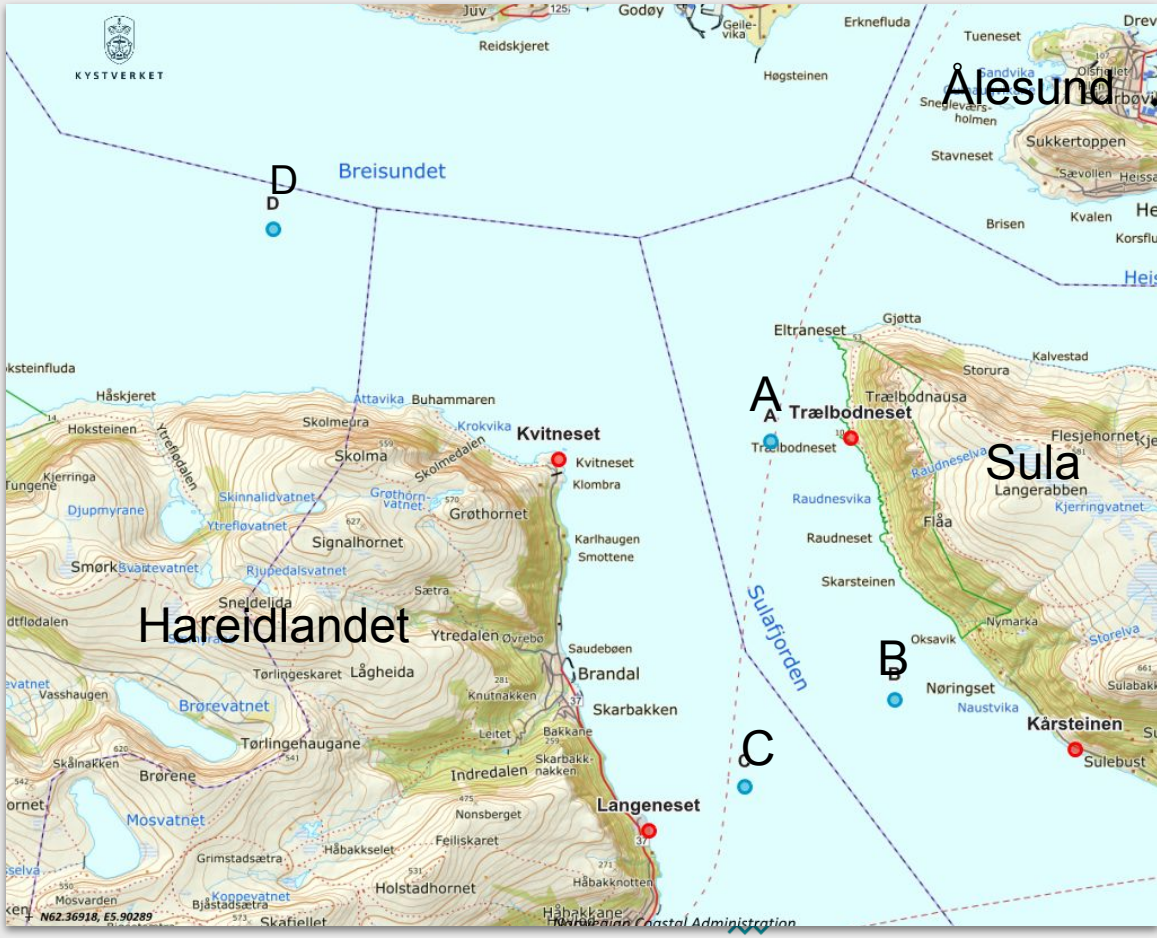




Measurements in Sulafjord

Wave buoys (A, B, C, D) with anemometer (blue)

Data from the Norwegian Public Roads Administration Ferry-free E39 project.



Geo-location problem

In NERSC/MET and DTU images

Uncorrected image

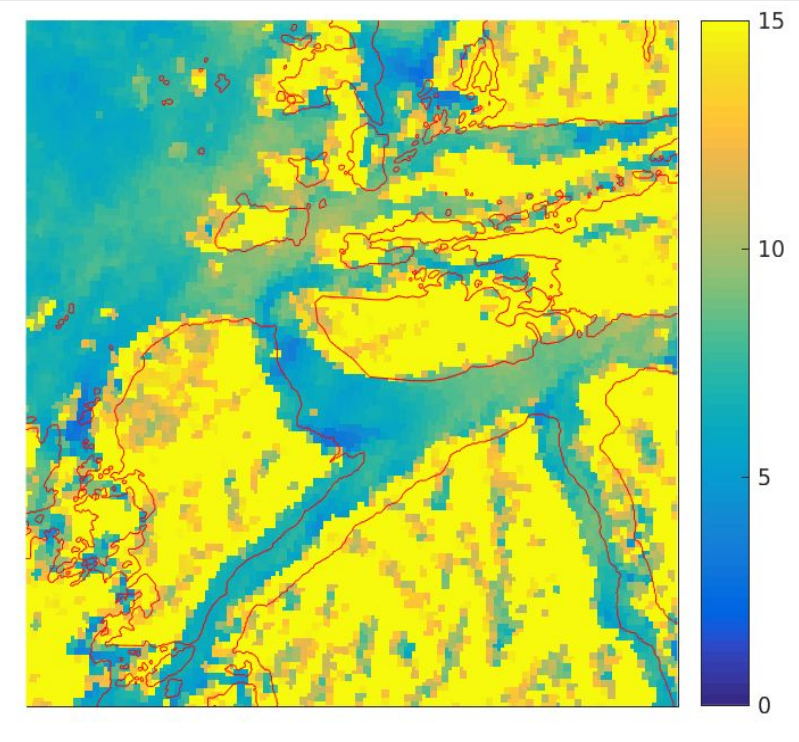
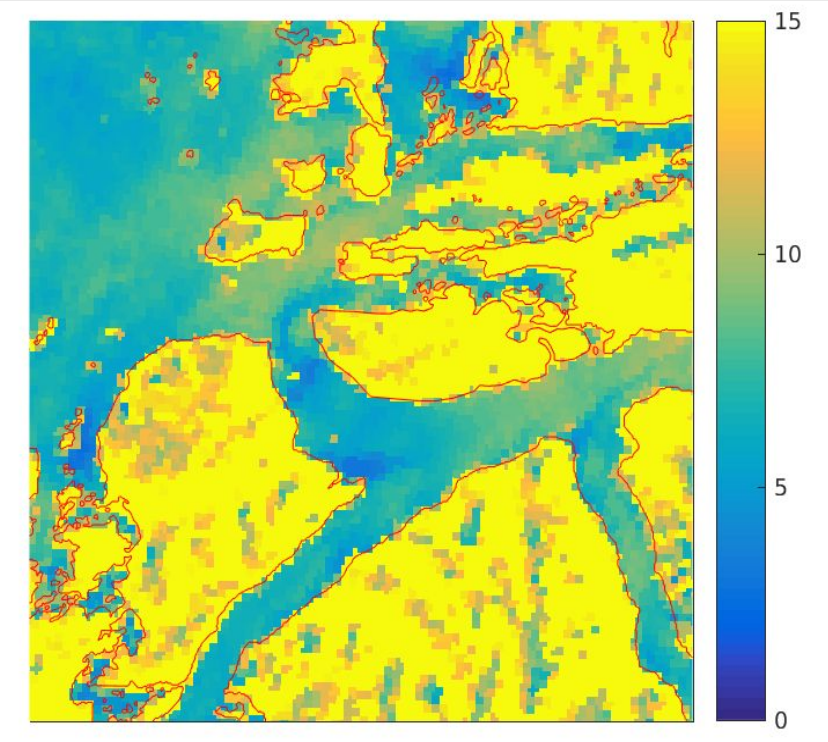


Image moved 3km to the east



Some of the results may be affected

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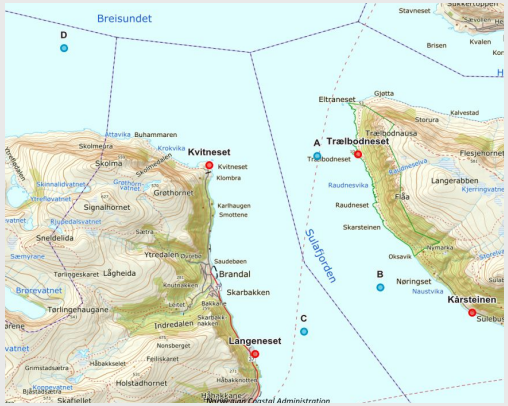
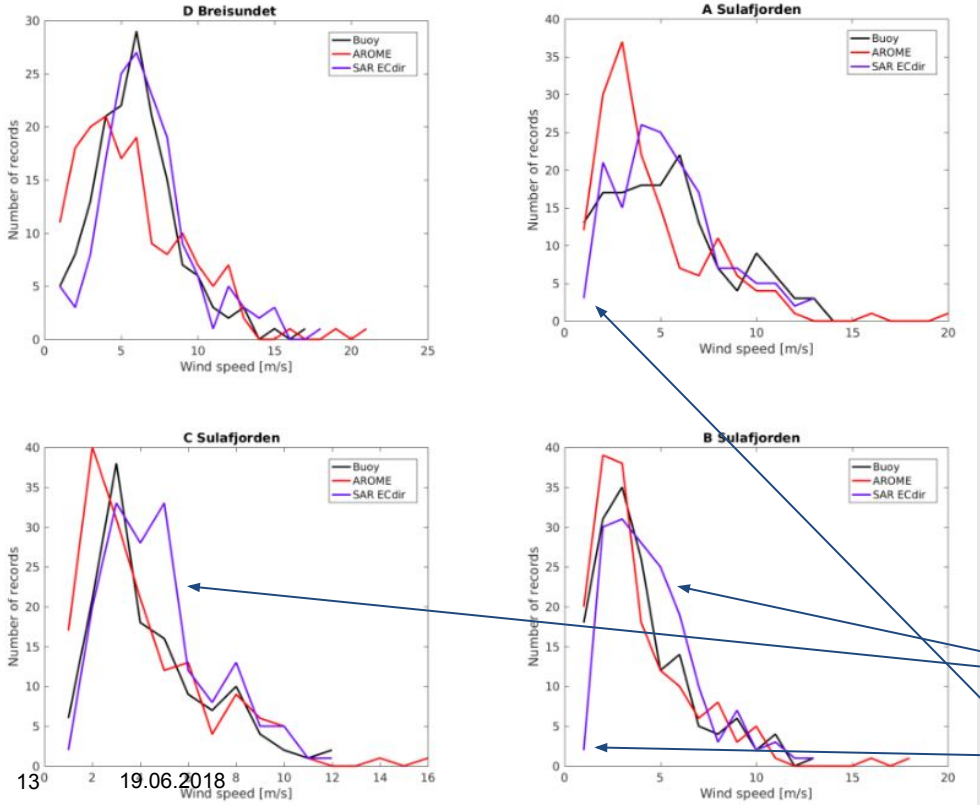


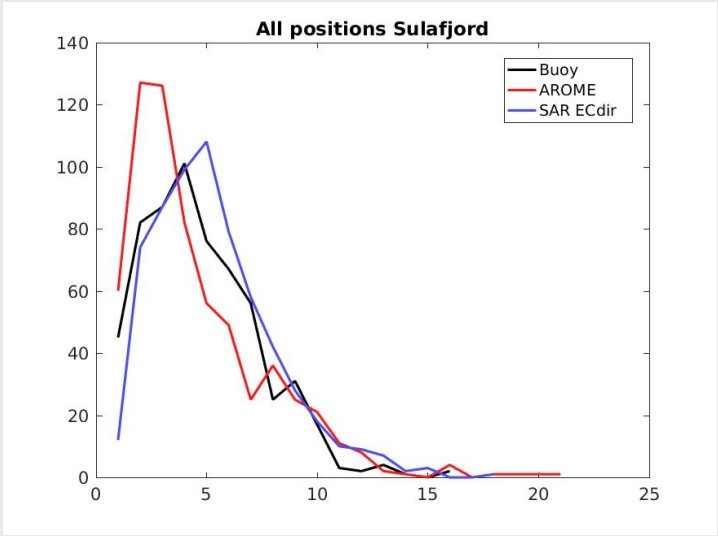
SAR - black
AROME - red

Verifikasjon av SAR og AROME (rødt) mot justerte bøyemålinger (justert til estimert 10m vind).

BØYE	Sula A	Sula B	Breisundet D	Halsafjorden G1	Halsafjorden G2*	Halsafjorden G
RMSE	1.9 (2.7)	2.1 (2.4)	1.9 (2.7)	1.6 (2.1)	1.7 (1.6)	1.7 (2.1)
COR	0.8 (0.7)	0.6 (0.5)	0.8 (0.7)	0.8 (0.6)	0.8 (0.7)	0.8 (0.7)
STDERROR	1.9 (2.1)	1.8 (2.3)	1.7 (2.5)	1.4 (1.8)	1.2 (1.4)	1.5 (1.9)
BIAS	0.1(-1.7)	1.1(-0.5)	0.9(-0.8)	0.8(-1)	1.3(-0.8)	0.8(-0.9)

*Kortere tidsserie med observasjoner tilgjengelig for Halsafjorden G2.





too many

too few

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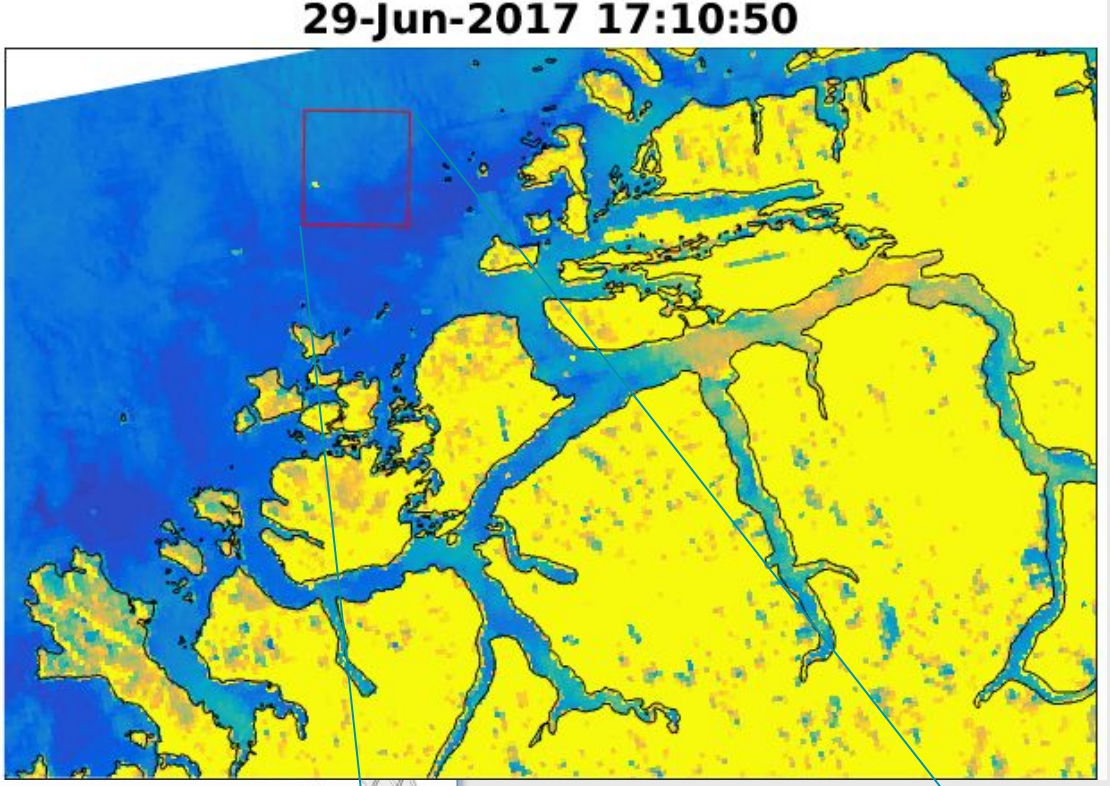
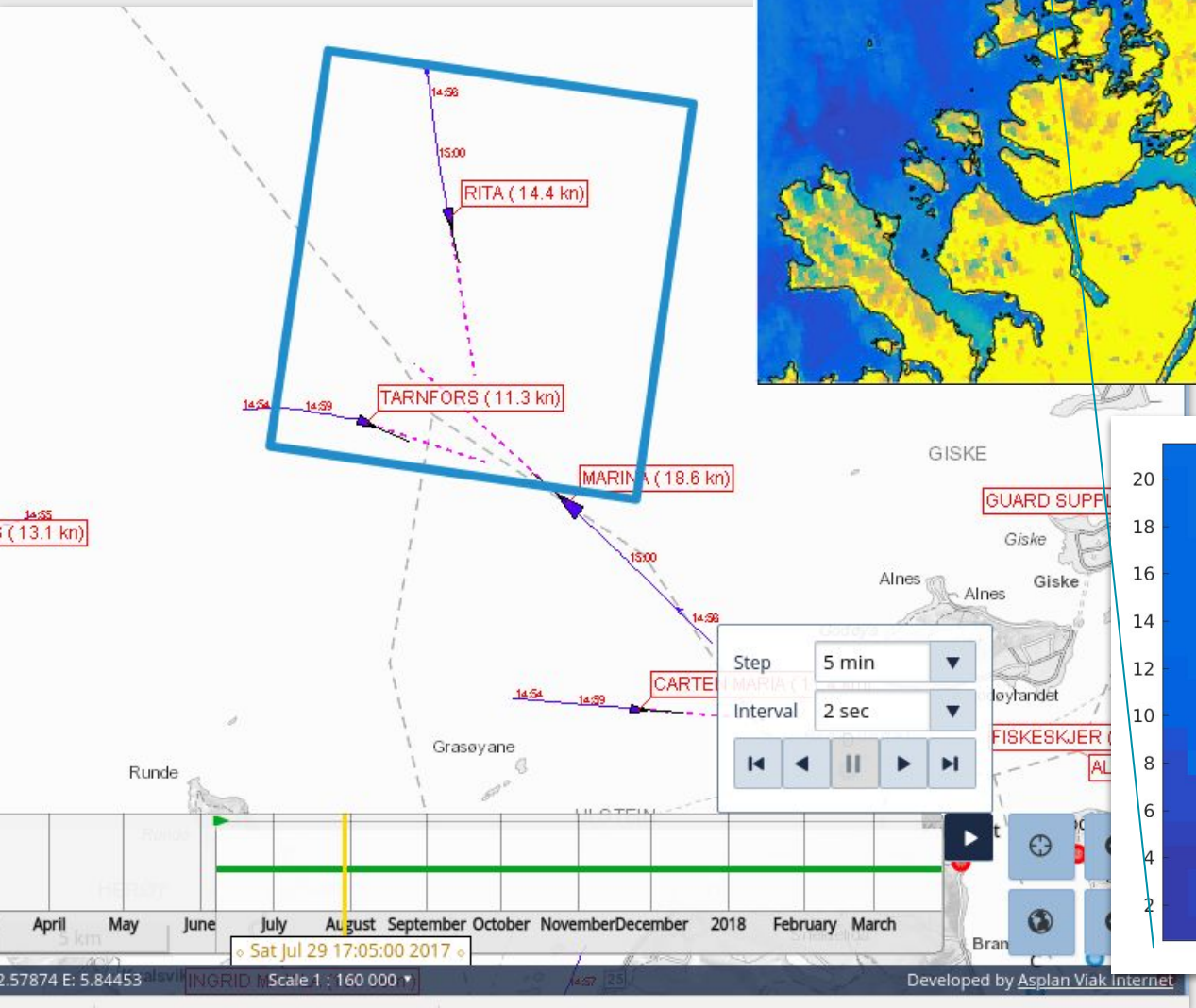
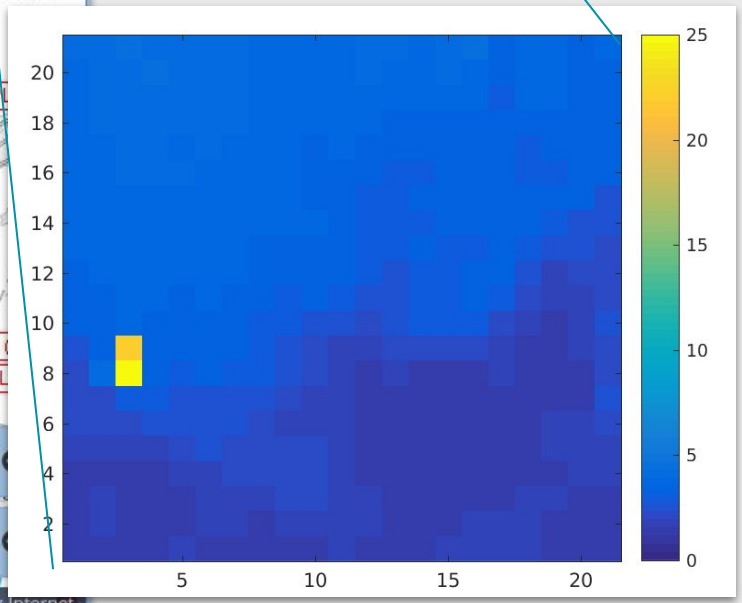
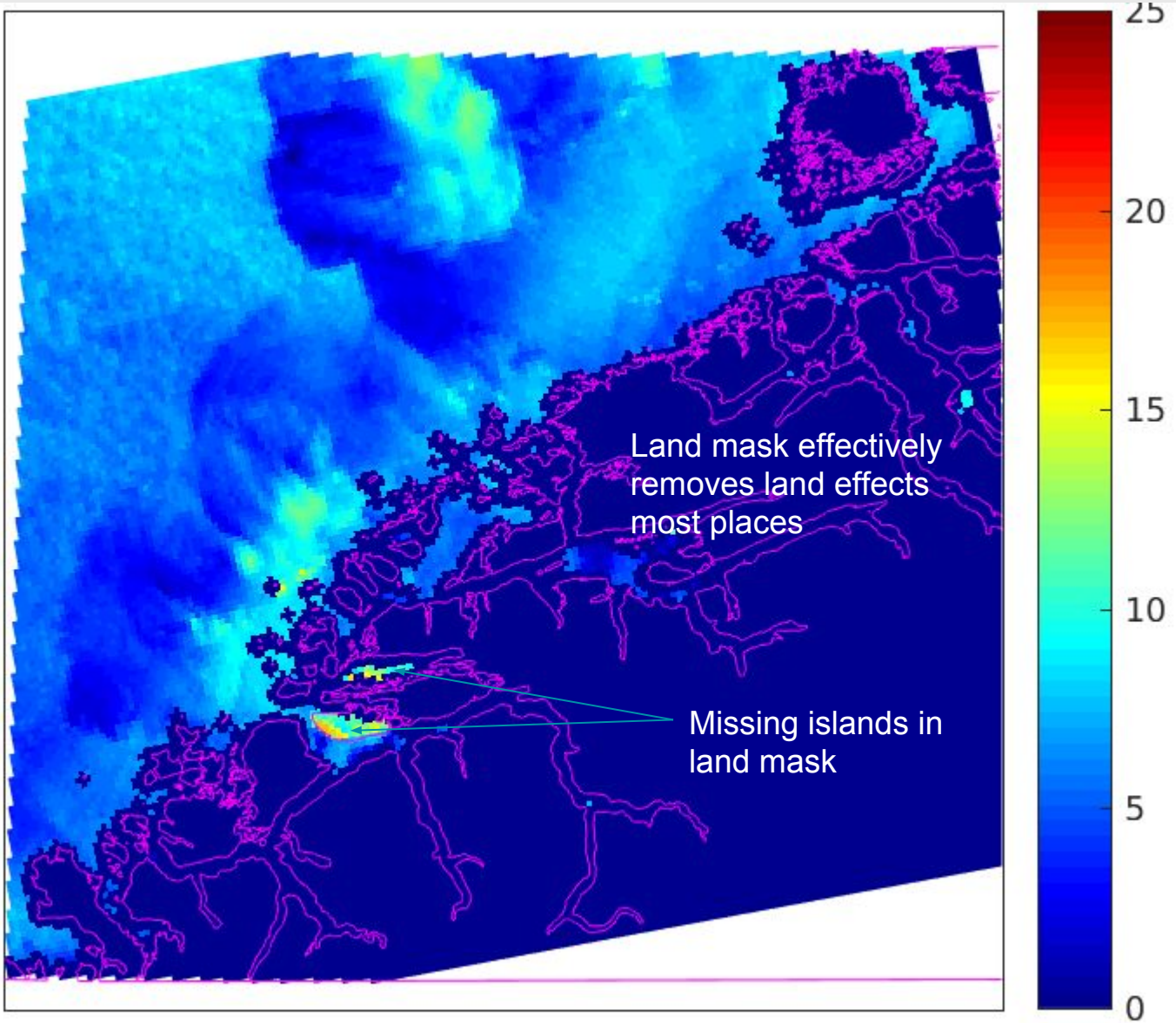
Ships - a possible source of error

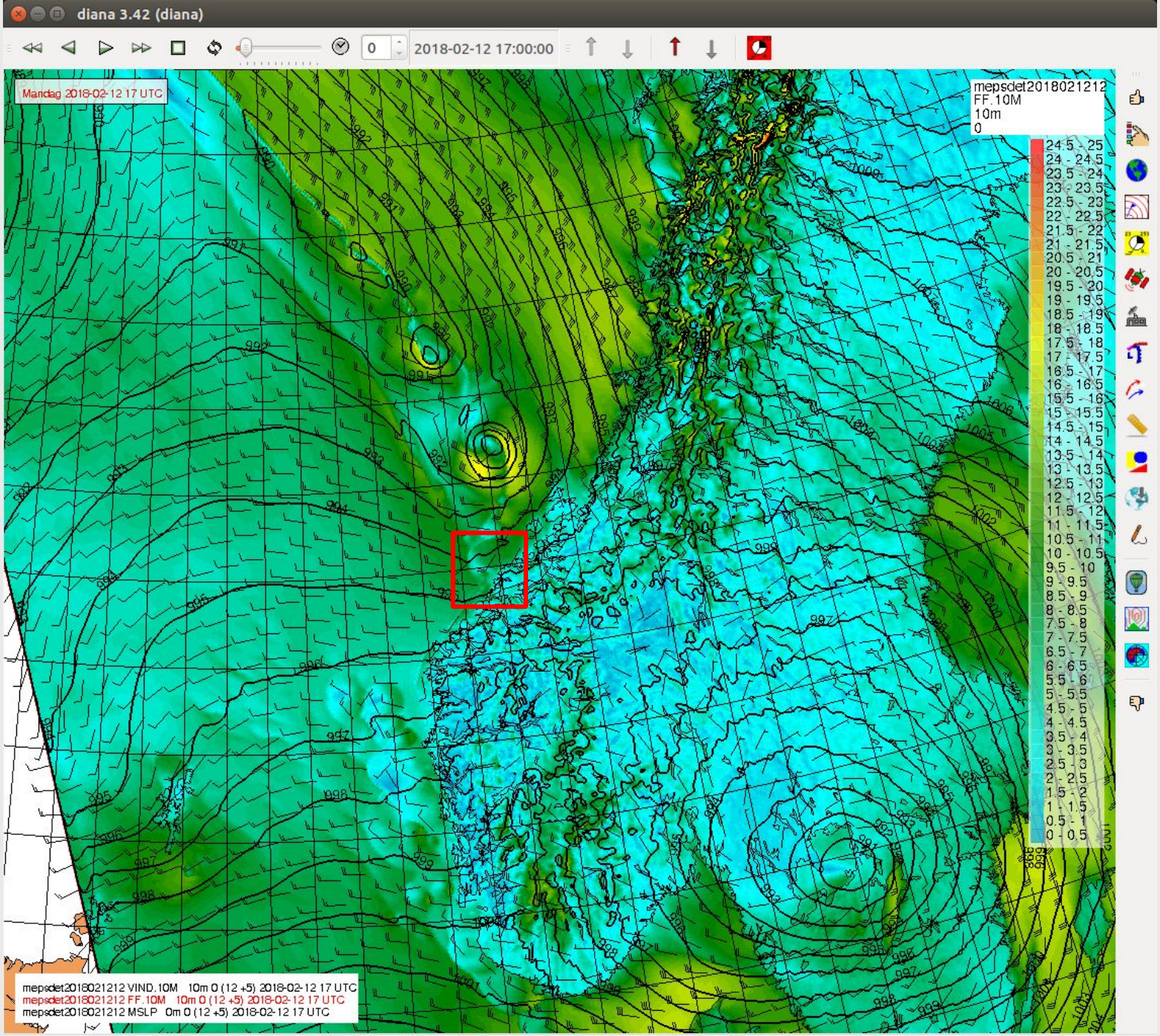






ESA Level-2 ocean product (OCN)

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Mandag 2018-02-12 17 UTC
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10m
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24 - 24.5
23.5 - 24
23 - 23.5
22.5 - 23
22 - 22.5
21.5 - 22
21 - 21.5
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7.5 - 8
7 - 7.5
6.5 - 7
6 - 6.5
5.5 - 6
5 - 5.5
4.5 - 5
4 - 4.5
3.5 - 4
3 - 3.5
2.5 - 3
2 - 2.5
1.5 - 2
1 - 1.5
0.5 - 1
0 - 0.5
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mepsdet2018021212 FF.10M 10m 0 (12 +5) 2018-02-12 17 UTC
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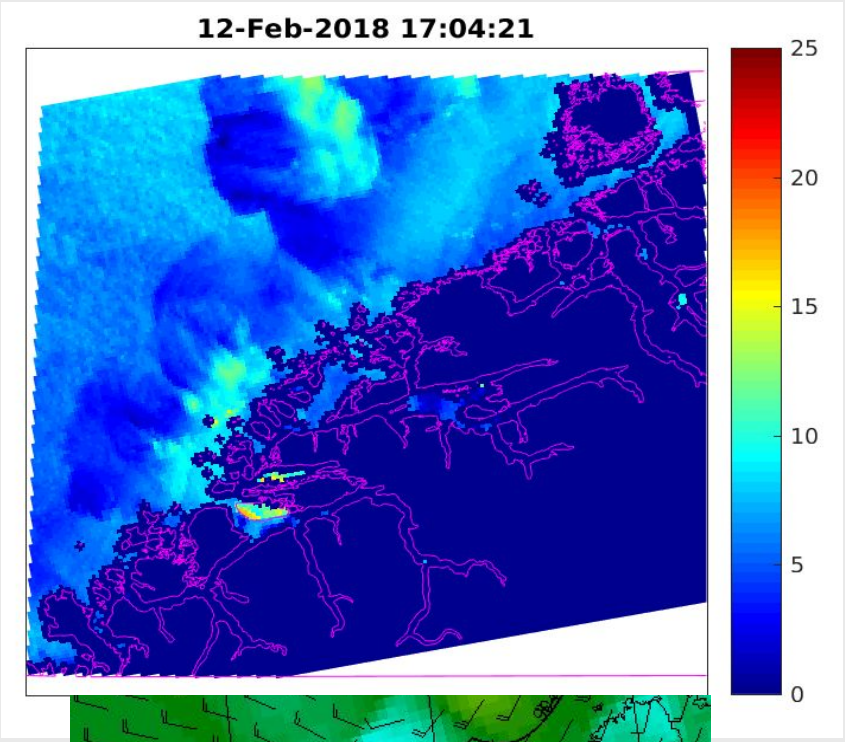
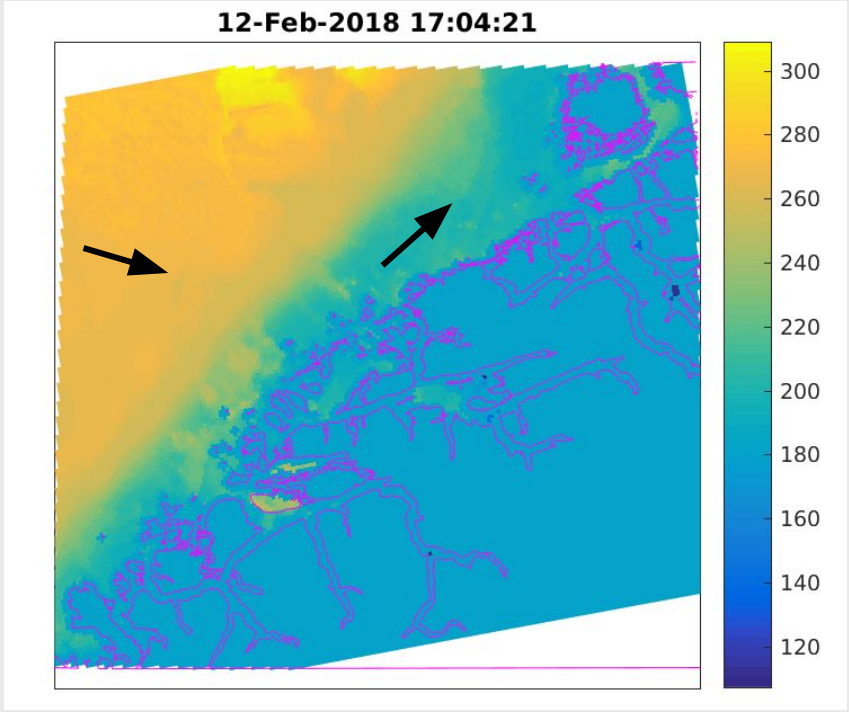
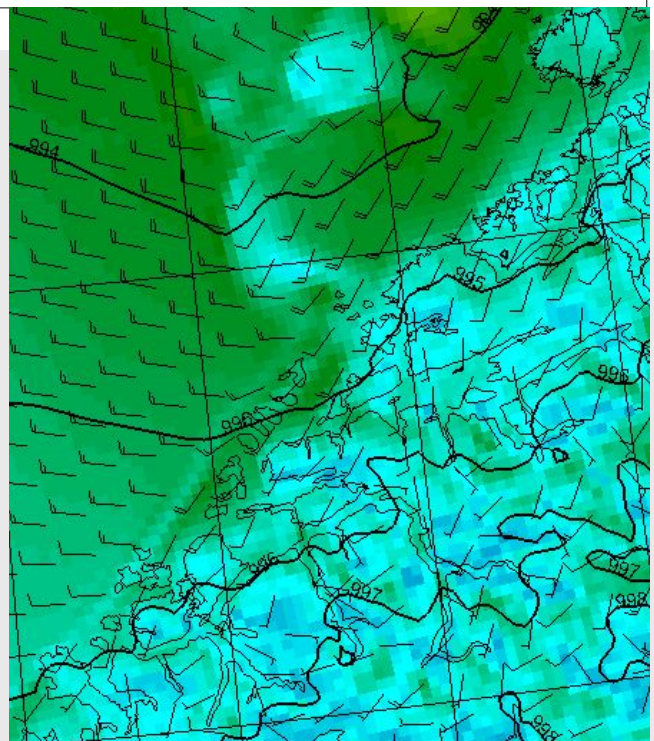
Lat/lon-grader
Bredde: 64°52'N
Lengde: 3°29'E



Wind speed from Sentinel level-2 OCN OWI product

Wind direction from Sentinel level-2 OCN OWI product





SAR backscatter can not be interpreted to wind speed without wind and antenna look direction

AROME 2.5km forecast (+5 hr)

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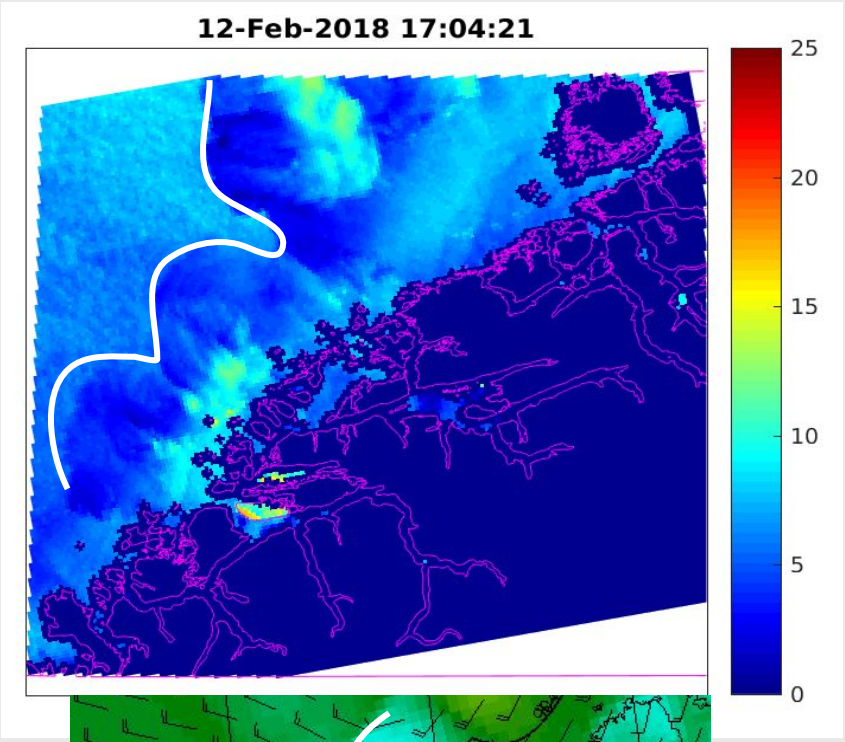
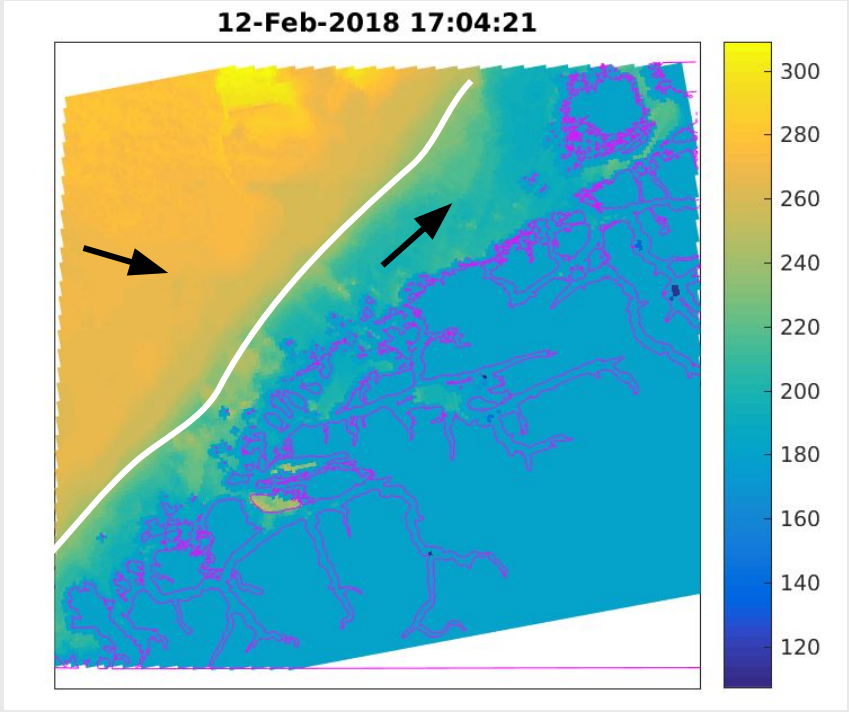
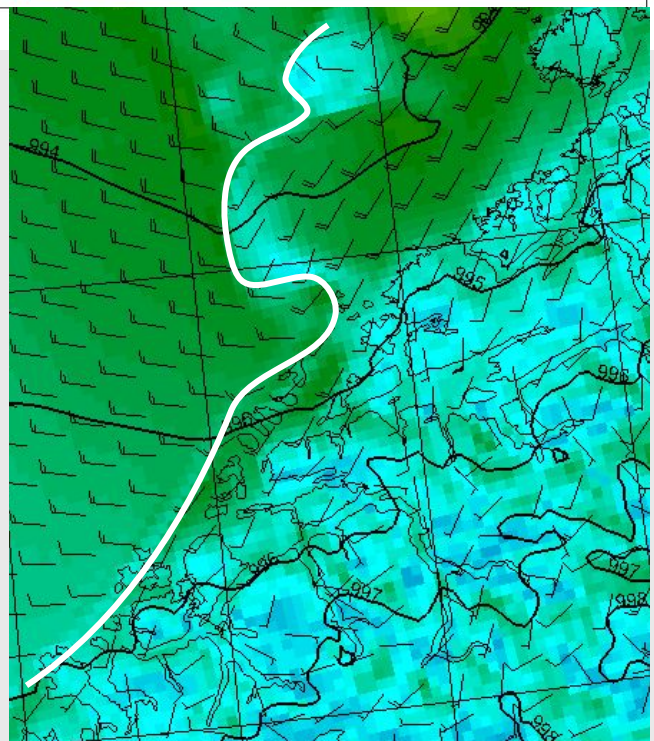


Wind speed from Sentinel level-2 OCN OWI product

Wind direction from Sentinel level-2 OCN OWI product





AROME 2.5km forecast (+5 hr)

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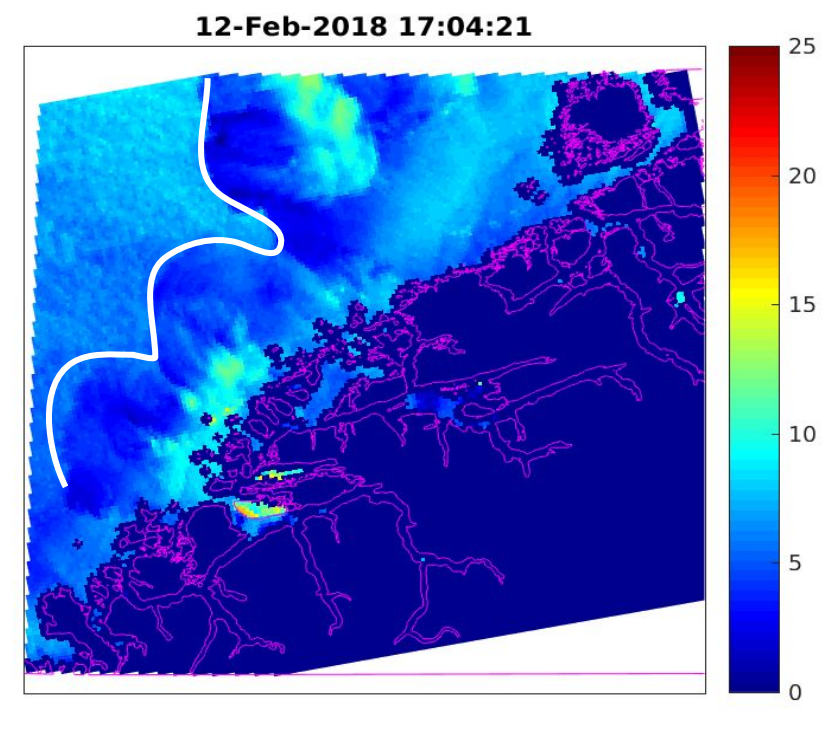
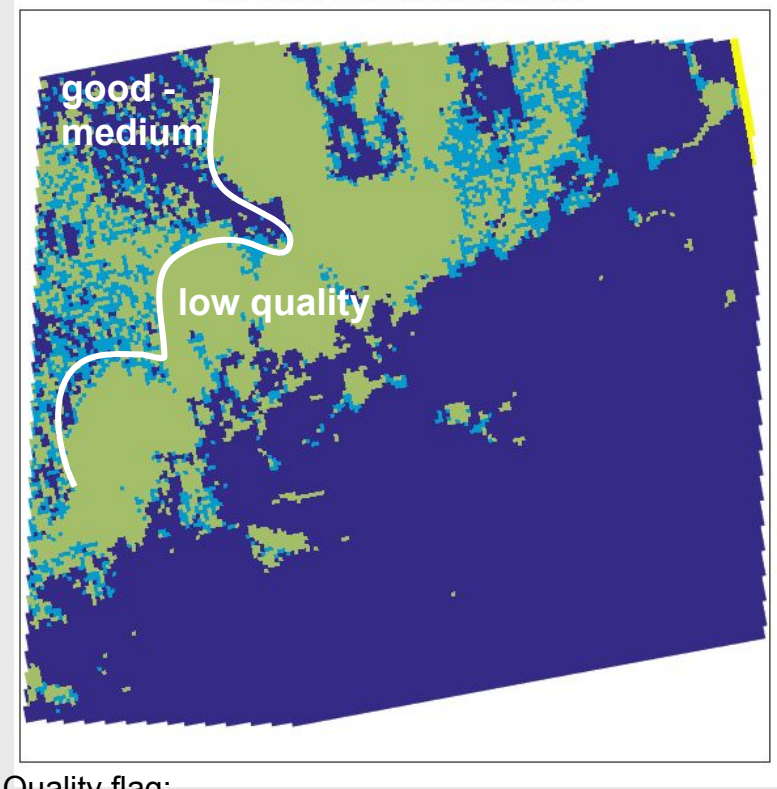


Wind speed from Sentinel level-2 OCN OWI product



Quality flag:
consistency_between_wind_inverted_and_NRCS_
and_Doppler_measured'
flag_values = [0 1 2 3]
flag_meanings = 'good medium low poor'

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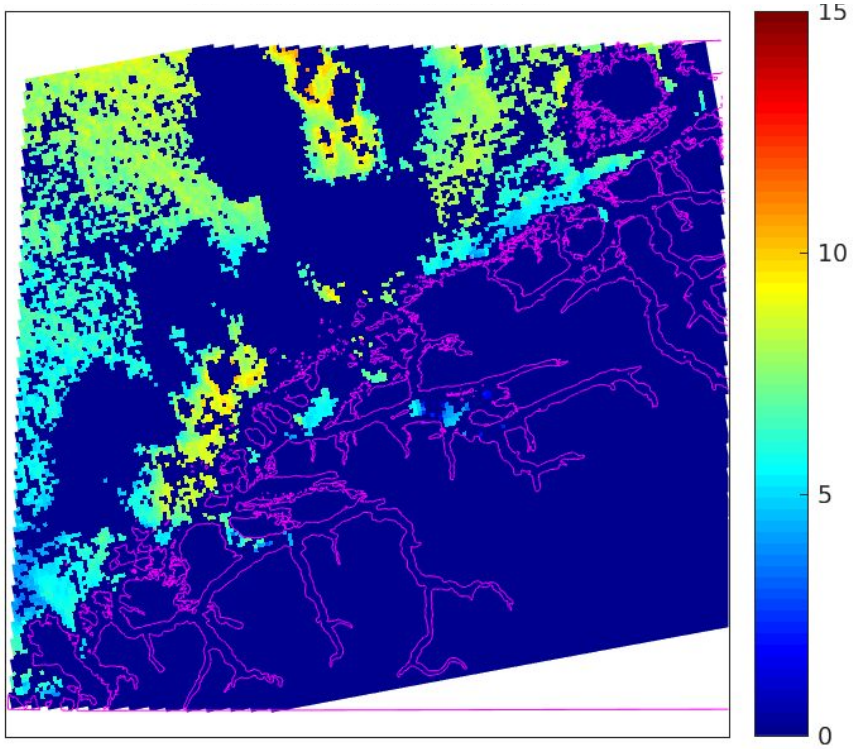
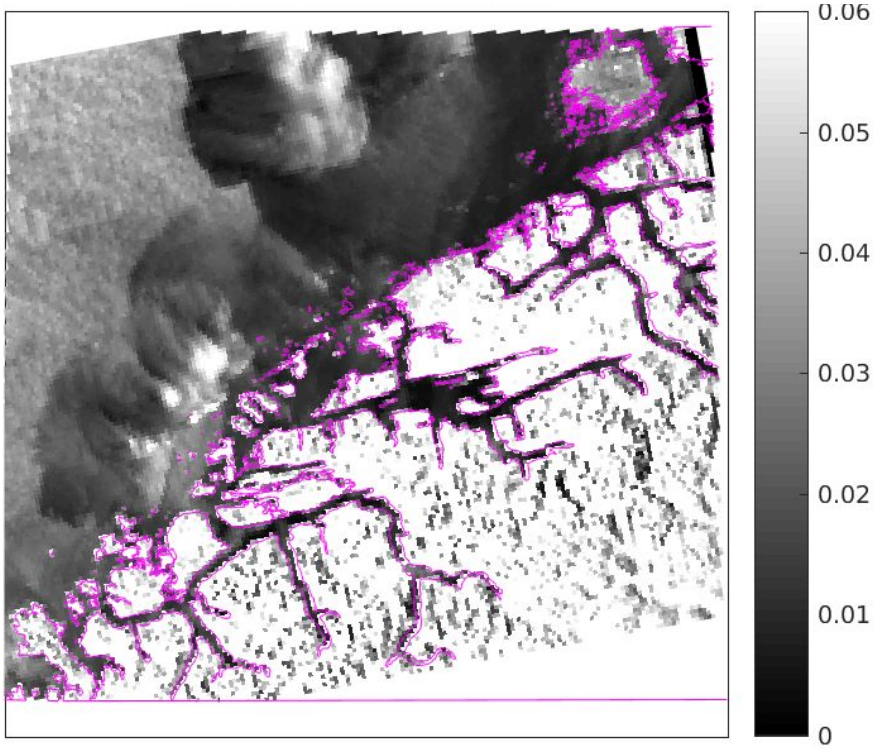
Operational use: wind speed and backscatter

Wind speed (medium-good quality)



Normalised radar cross section (NRCS)



SAR backscatter can not be properly interpreted to wind speed without wind direction and antenna look direction

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Summary

Testing of three different SAR wind products:

More frequent 5-9m/s winds in SAR in NERSC/MET product

Geolocation errors in NERSC/MET and DTU products

Sentinel level-2 OCN wind product with quality flag and bright target removal is promising. Coarser resolution of 1km.

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