



Royal Netherlands
Meteorological Institute
*Ministry of Infrastructure and the
Environment*

Bayesian sea-ice detection in the ASCAT Wind Data Processor

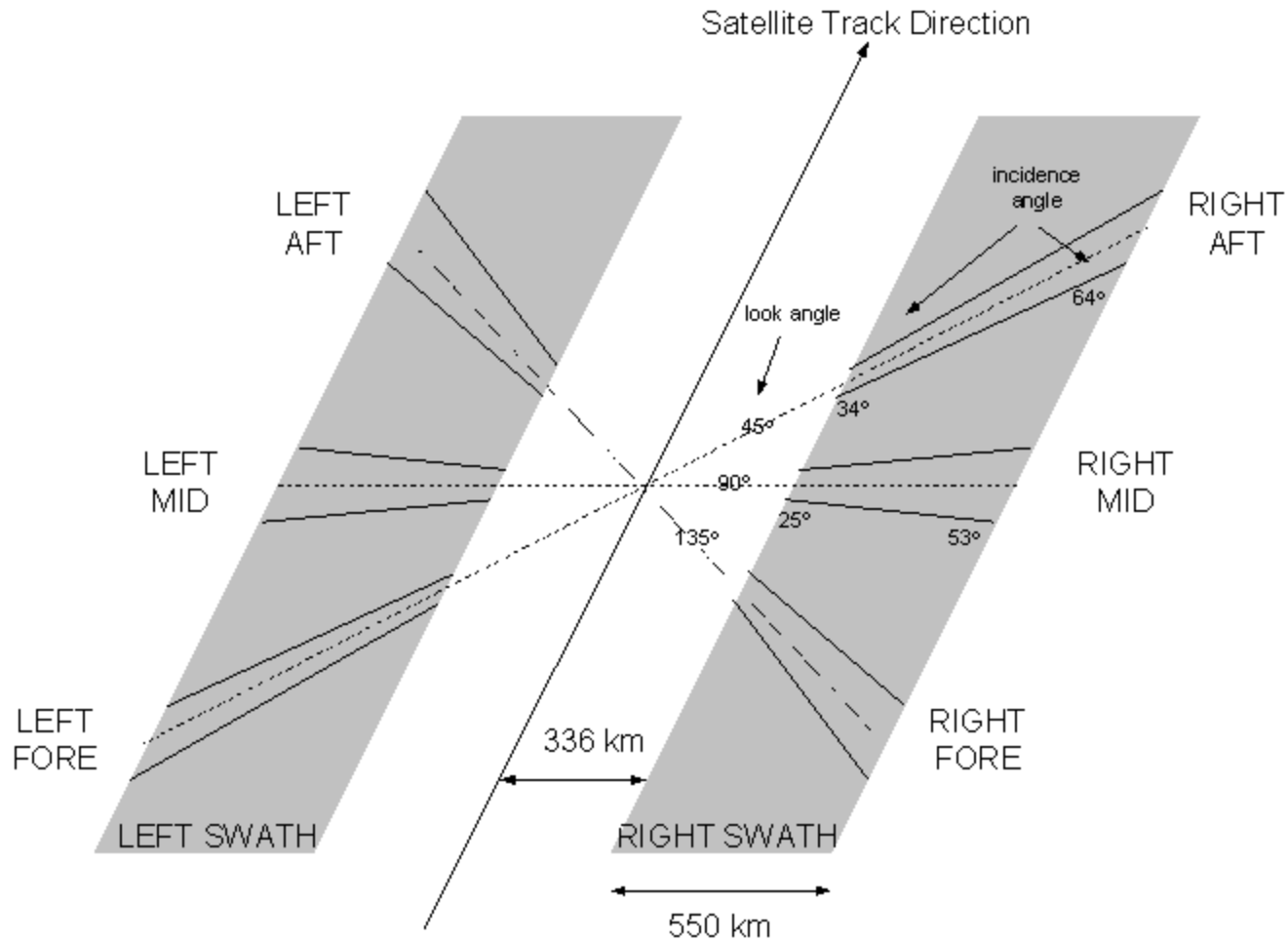
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- Maria Belmonte
- Ad Stoffelen
- Anton Verhoef

- KNMI scatterometer team
- EUMETSAT OSISAF

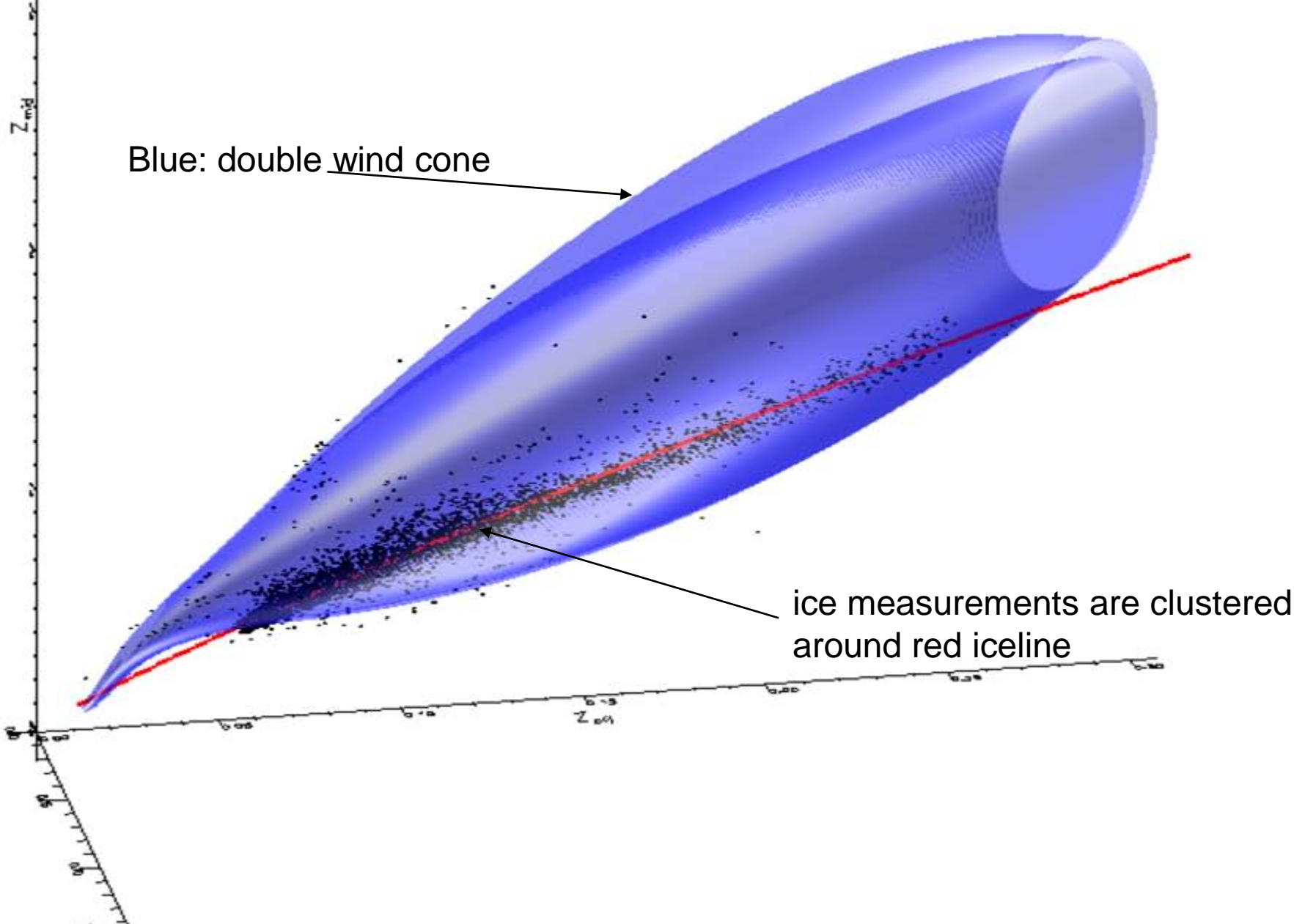


- ASCAT GMF in measurement space
- Bayesian sea ice probability update
- Water / sea ice discrimination performance
- Sea ice map movies
- Conclusions

ASCAT swath geometry



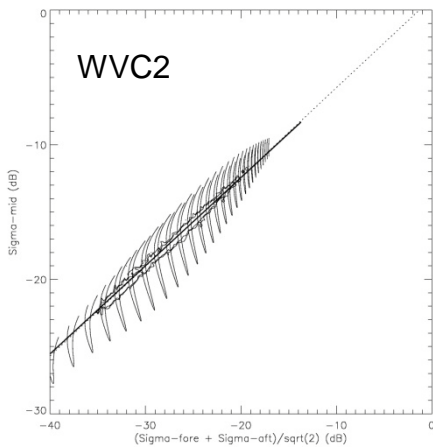
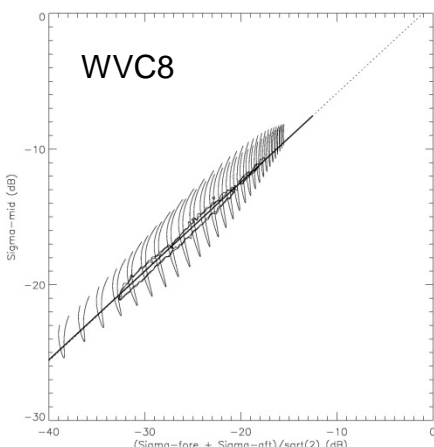
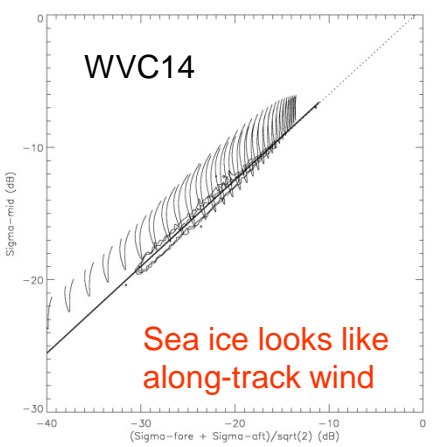
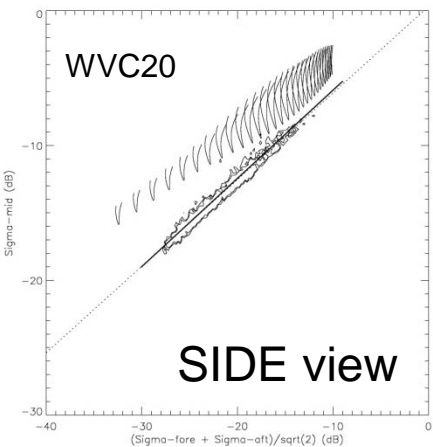
Measurement space, WVC=29



ASCAT sea ice GMF per WVC



Strong for wind GMF
Weak for sea ice GMF

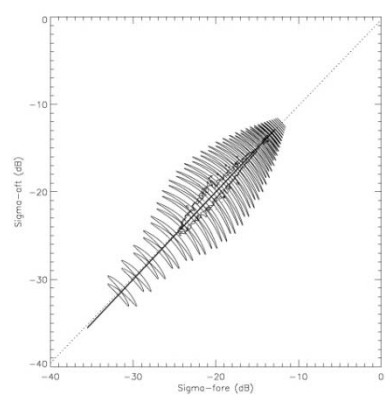
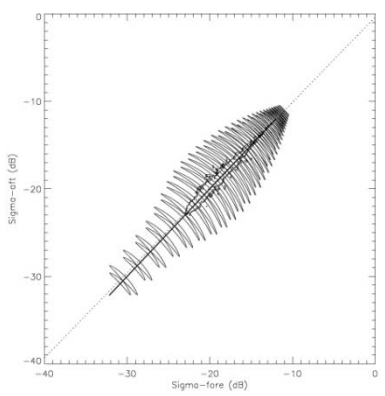
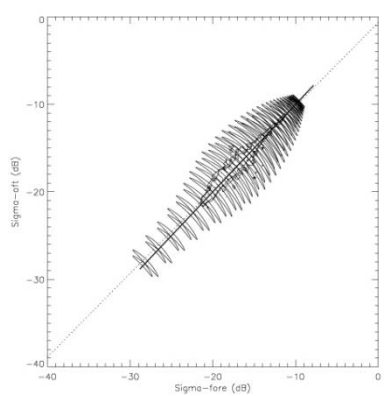
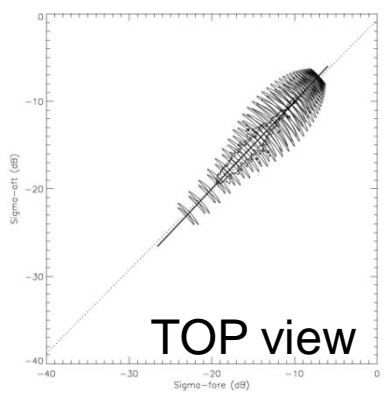


Inner swath

Mid-inner swath

Mid-outer swath

Outer swath



Ice line **outside** the wind cone

Ice line **on** wind cone

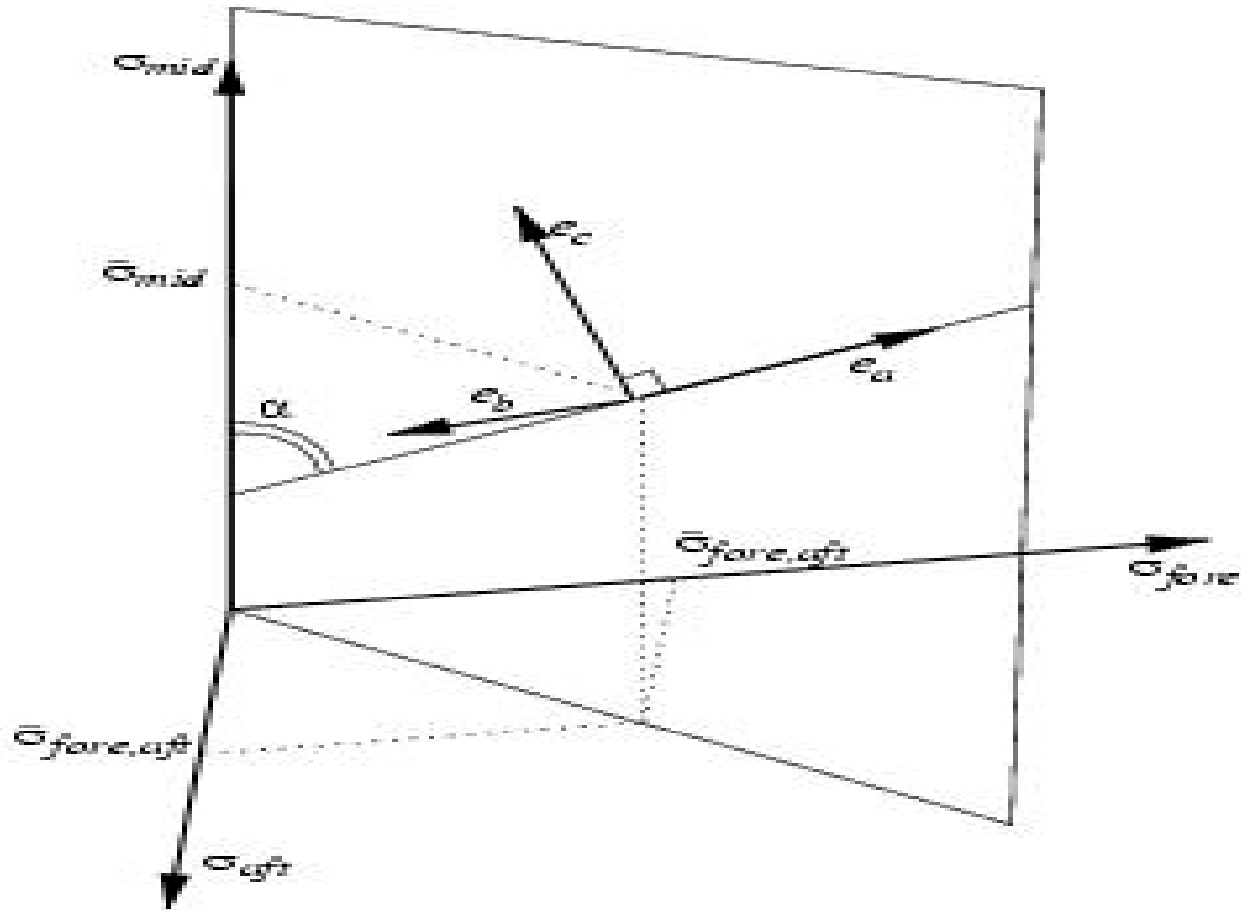
Ice line **inside** the wind cone



Reduced discrimination for inner mid swath WVCs

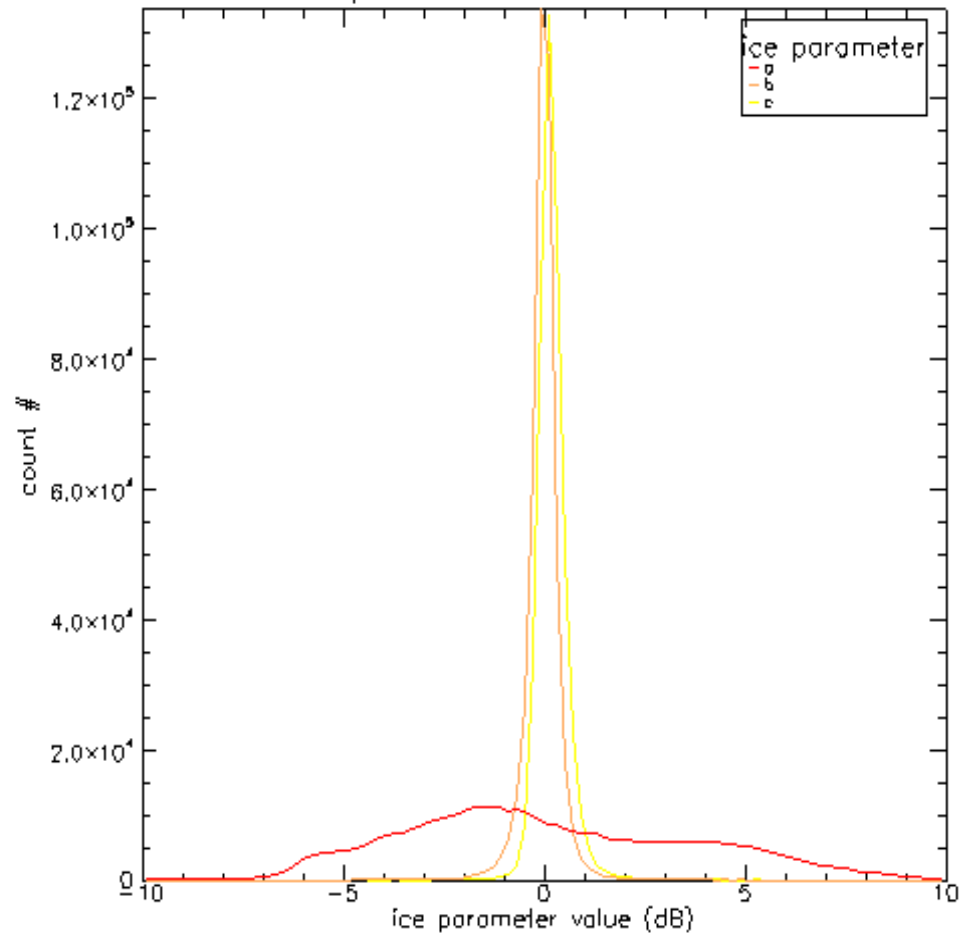
tion in the ASCAT processor

Sea-ice coordinate system





Ice parameter distribution



- Along-ice-line coordinate a has a geophysical meaningful interpretation (ice age; first-year sea ice/multi-year sea ice)
- Perpendicular coordinates b and c are measure for $p(x|\text{ice})$
- From a large (sea-ice) dataset:
 - a is mapped (average and SD) to mid-swath reference WVC
 - b and c are scaled with their respective SD per WVC
- Scaling of the sea ice parameter a makes it independent of WVC and allows a sea ice GMF definition of $\sigma^0 = \text{GMF}(a, \theta)$



Two classes: ice and water: $P(ice) + P(water) = 1$

Measurement $\mathbf{x} = f(\sigma^0)$ used to calculate new posterior probability

$$p(ice | \mathbf{x}) = \frac{P(ice) p(\mathbf{x} | ice)}{P(ice) p(\mathbf{x} | ice) + P(water) p(\mathbf{x} | water)}$$

from normal distribution in b and c

Posterior probability

Prior probability

distribution of wind MLE

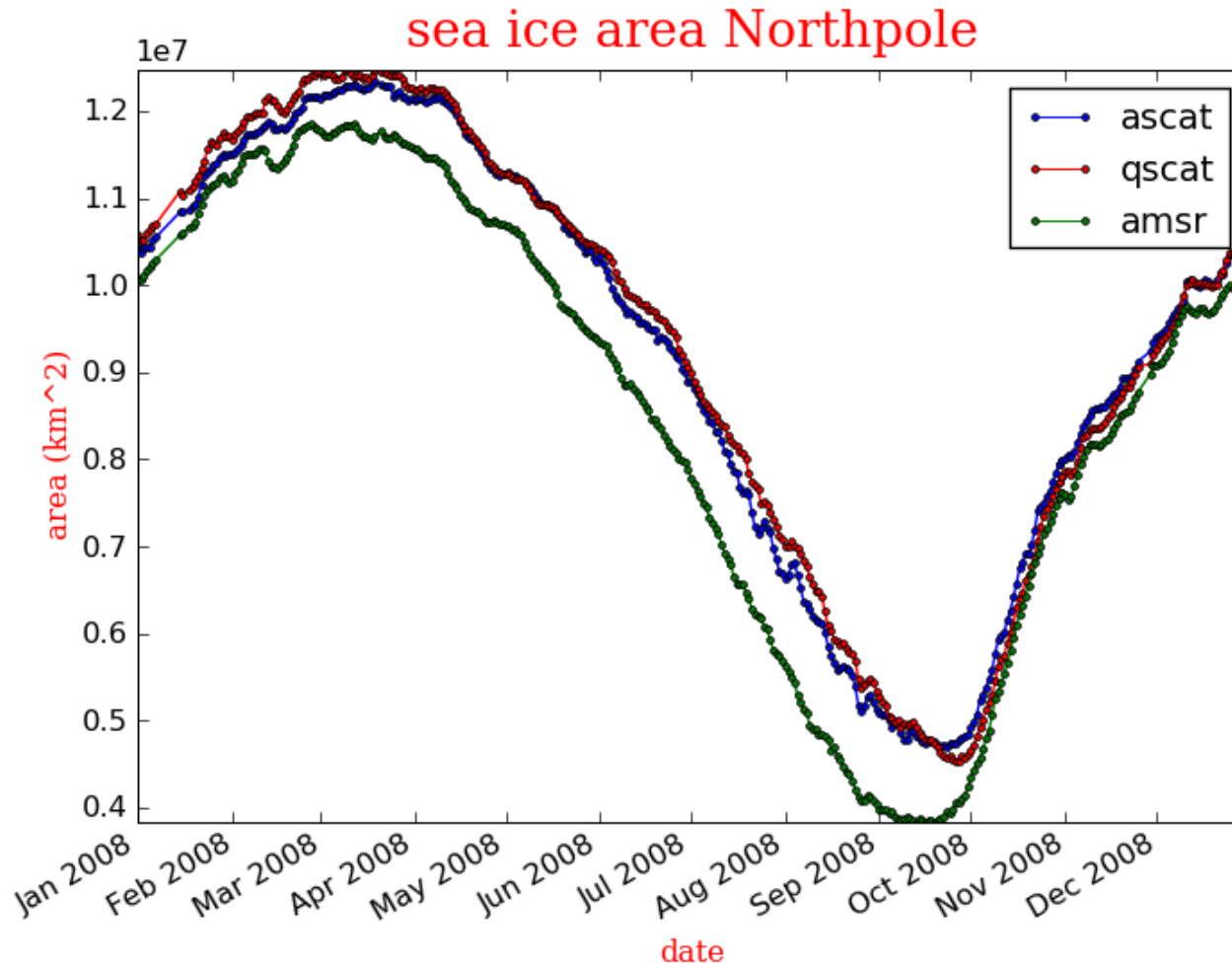
ASCAT sea ice probability



**ASCAT sea ice probability
on a red-to-blue scale
7 September 2011**

- Rather sharp edge in melting conditions

Sea ice area comparison

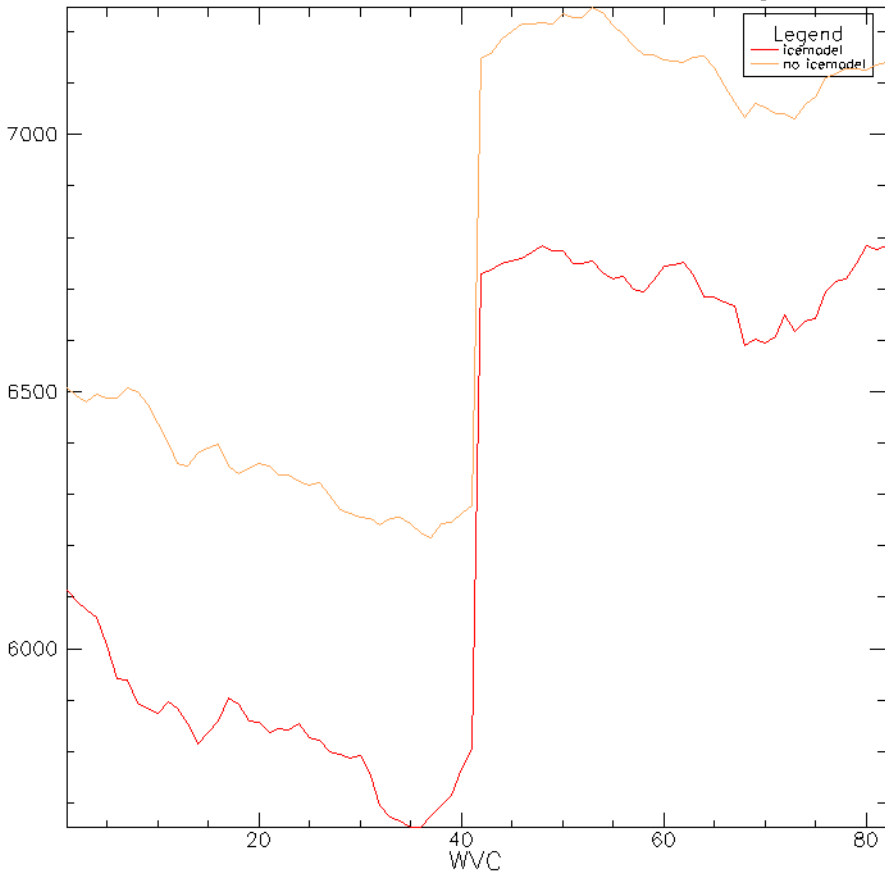


Quality flag occurrence



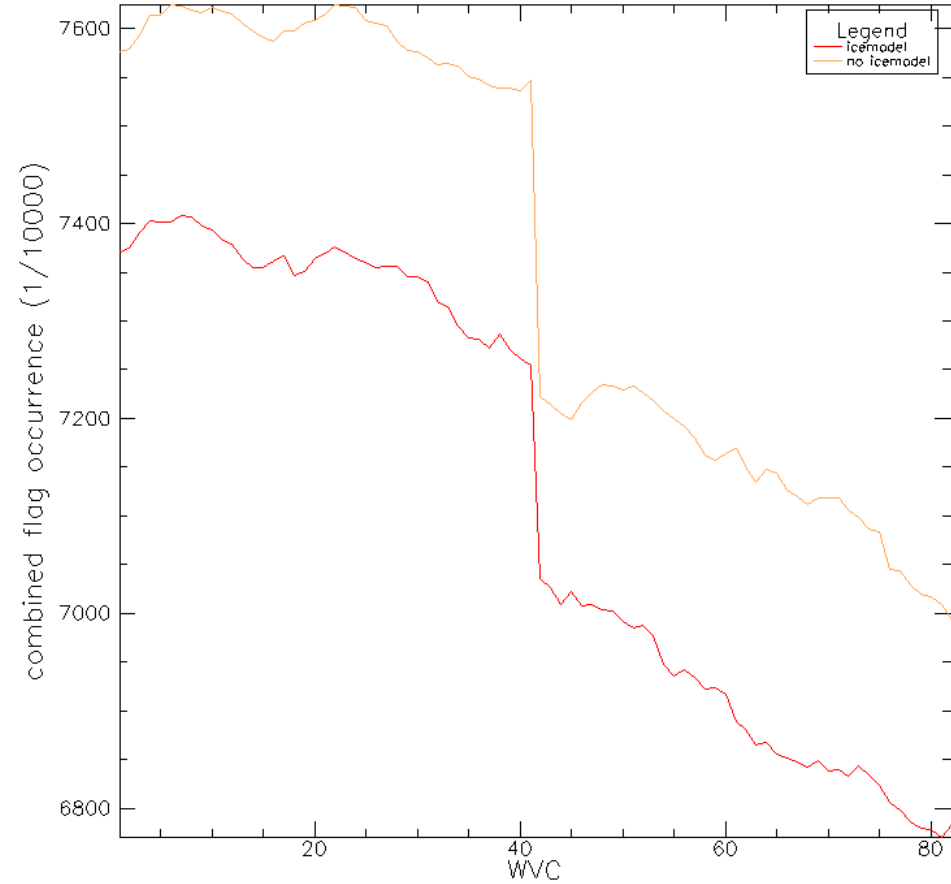
arctic area

%ice OR %land OR %knmi_lqc OR %qual_sigma0



antarctic area

%ice OR %land OR %knmi_lqc OR %qual_sigma0



Much more winds in sea ice margin with ASCAT sea ice discrimination



ice map movies...

Conclusions

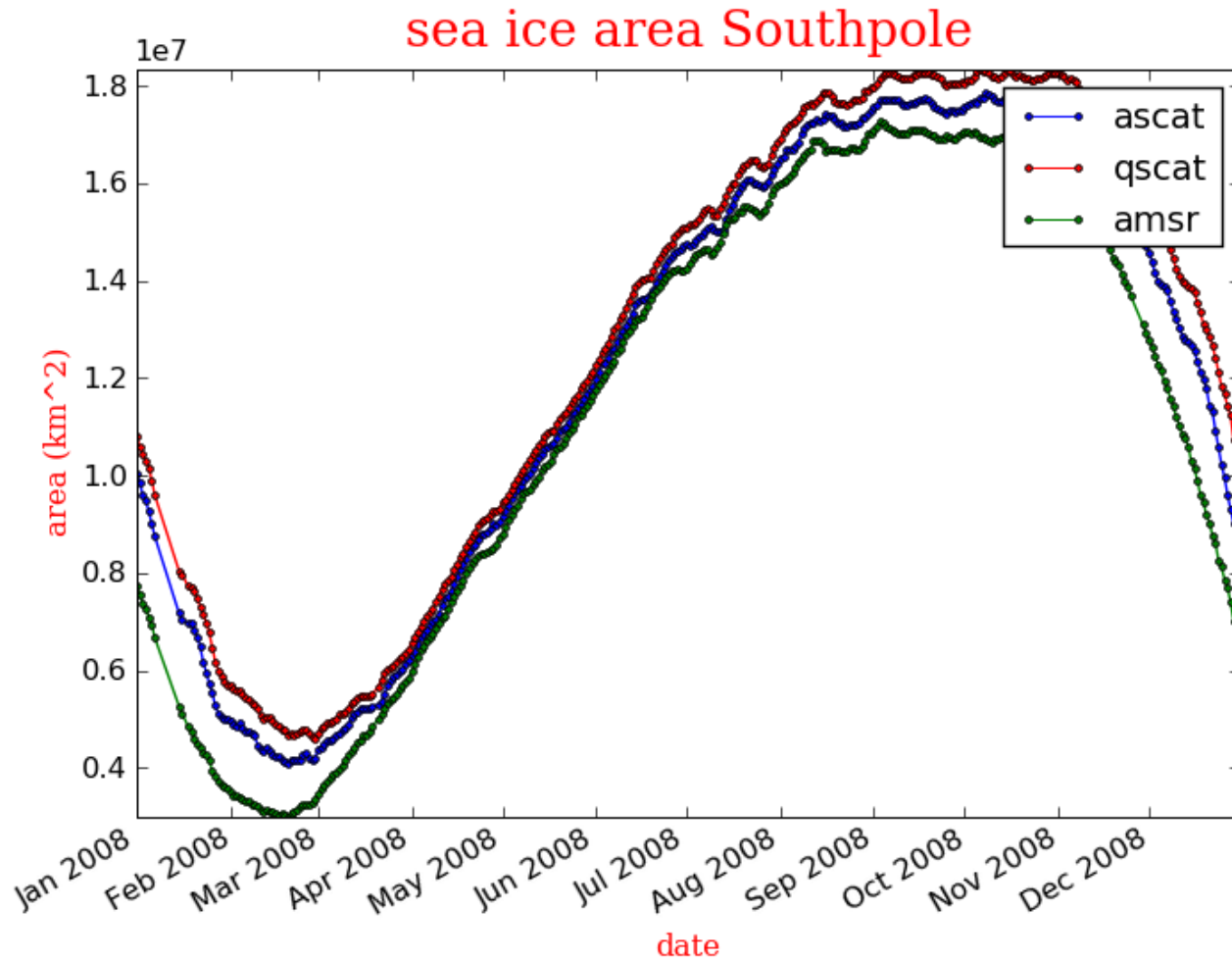


- ASCAT sea ice discrimination provides good results (12.5 km and 25.0 km)
- Many optional settings:
 - c_mix parameter (for tuning over the seasons)
 - threshold probability for wind/sea-ice discrimination
 - spatial and temporal averaging (smoothing of prior)
 - prior: use of wind vector difference (scatterometer-NWP)
 - use of prior SST data
- ASCAT results compare well with other satellite products
- Use of ASCAT sea ice discrimination increases the fraction of valid wind WVCs / reduces number of sea ice WVCs
- Launch of METOP-B will increase spatial coverage and reduce time intervals between measurements
- After calibration METOP-A+B data can be combined for an improved sea ice product

Extra slides



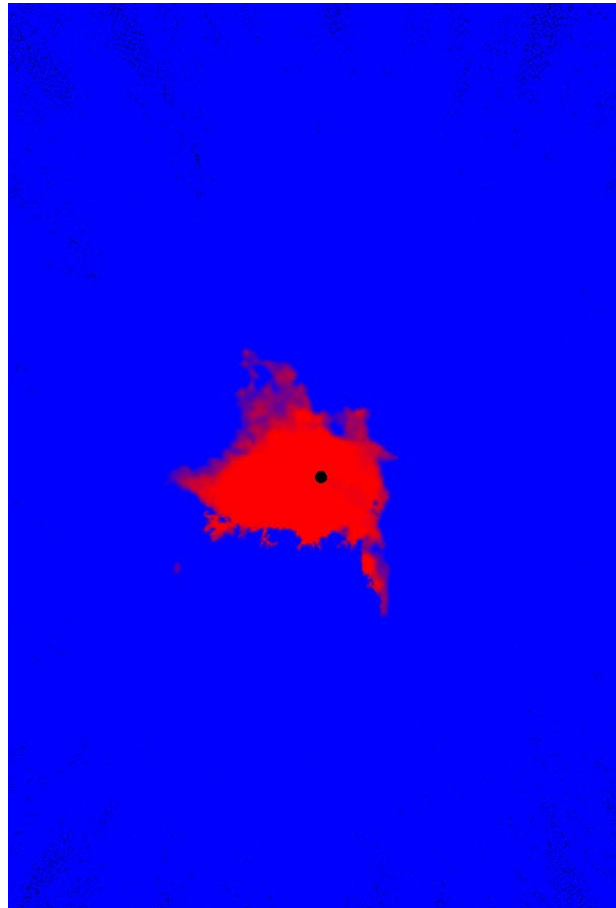
Sea ice area comparison





- Sea ice probability stored on a grid (12.5 km spacing) for North pole and South pole region
- Both 25.0 km and 12.5 km WVC spacing input data can be handled
- Sea ice map updated on each satellite overpass of METOP satellite
- Space and time averaging is performed for reliable wind/ice discrimination (for grid points with new ASCAT data only)
- c_{mix} parameter scales distance to ice line and therefore probability
- Sea ice age, ice probability and ice QC flag are written to BUFR output

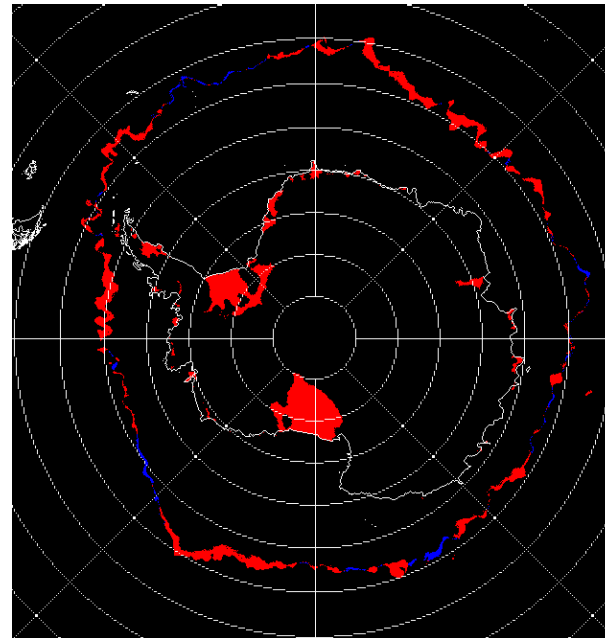
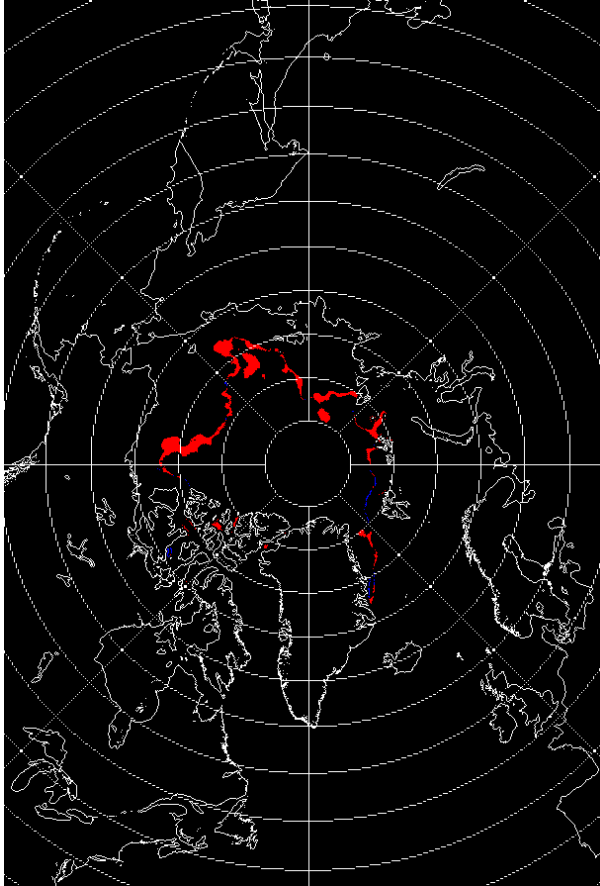
OSISAF multi-sensor product



**ice concentration
on a red-to-blue scale
7 September 2011**

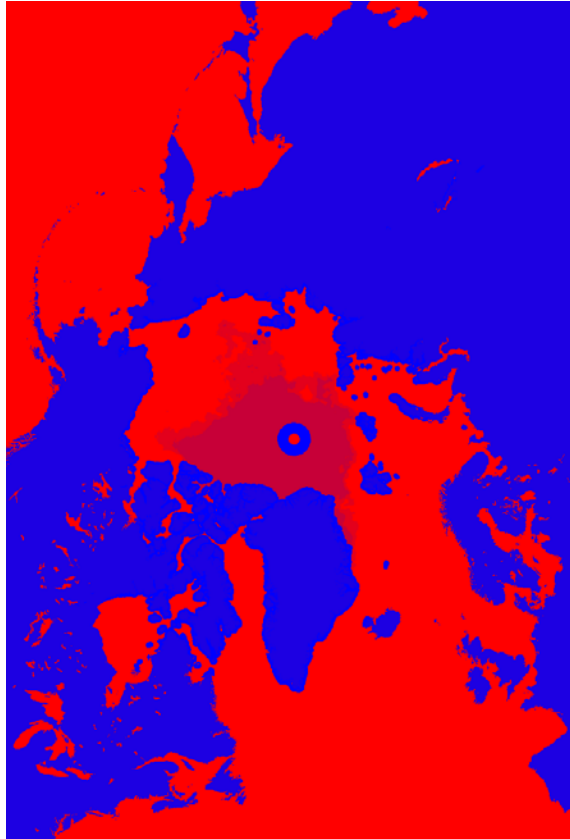
**OSISAF@15% ice concentration
KNMI@50% ice probability**

**KNMI sea ice area larger than in
OSISAF multi-sensor product**

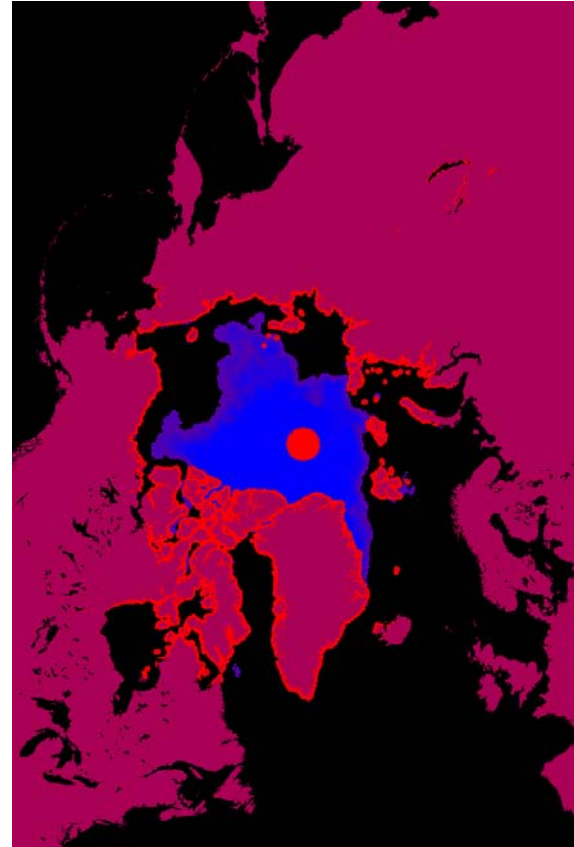


Red - ASCAT=ice and OSISAF=not ice
Blue - ASCAT=not ice and OSISAF=ice

Sea ice from SSMI



light red : water
medium red : open ice
dark red : closed ice



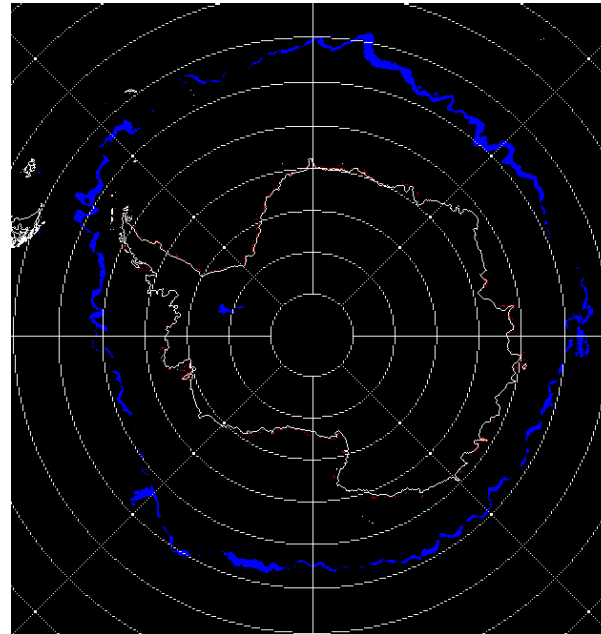
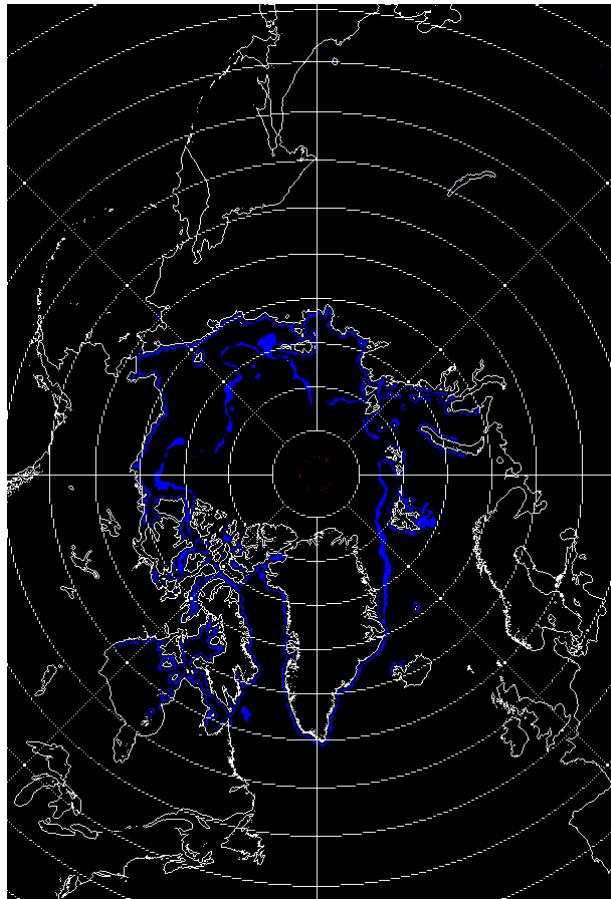
sea ice concentration
0-100% on a blue scale

SSMI – ASCAT

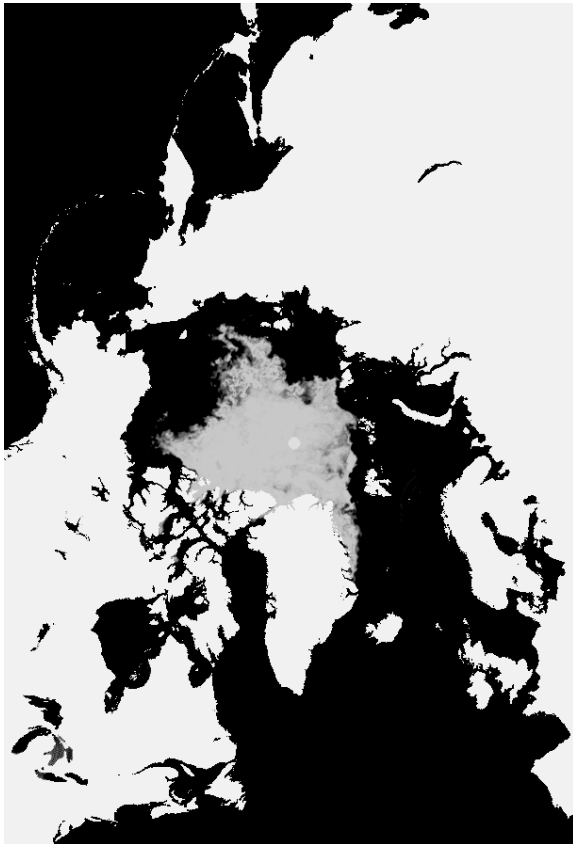


**SSMI@15% ice concentration
ASCAT@50% ice probability**

**ASCAT sea ice area smaller than
OSISAF SSMI product**



Red - ASCAT=ice and SSMI=not ice
Blue - ASCAT=not ice and SSMI=ice



**sea-ice concentration
0-100% on a gray scale**

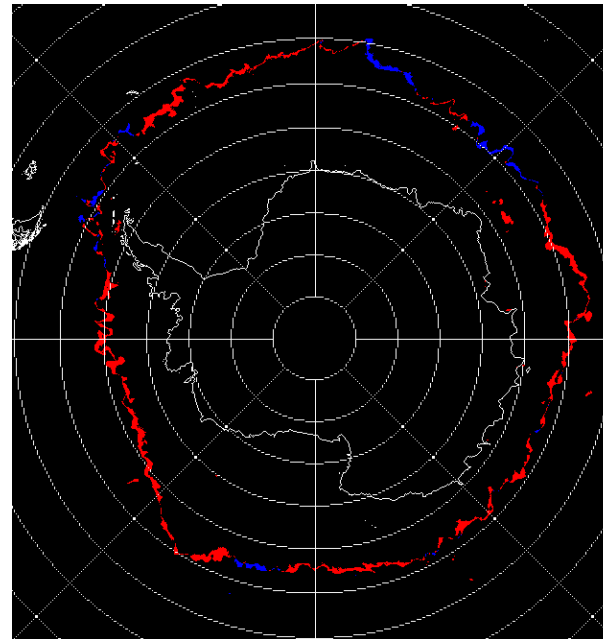
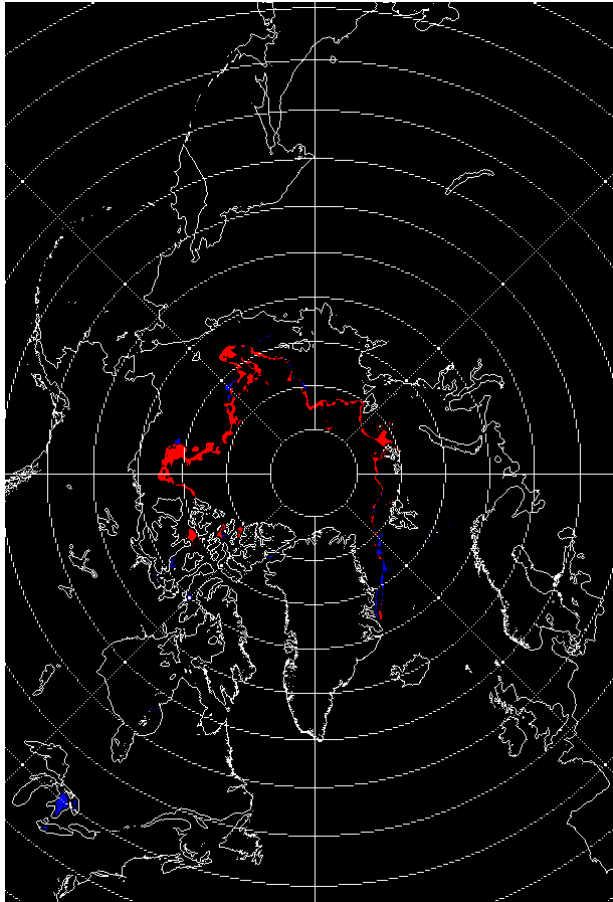


15% sea-ice concentration level

AMSR sea ice



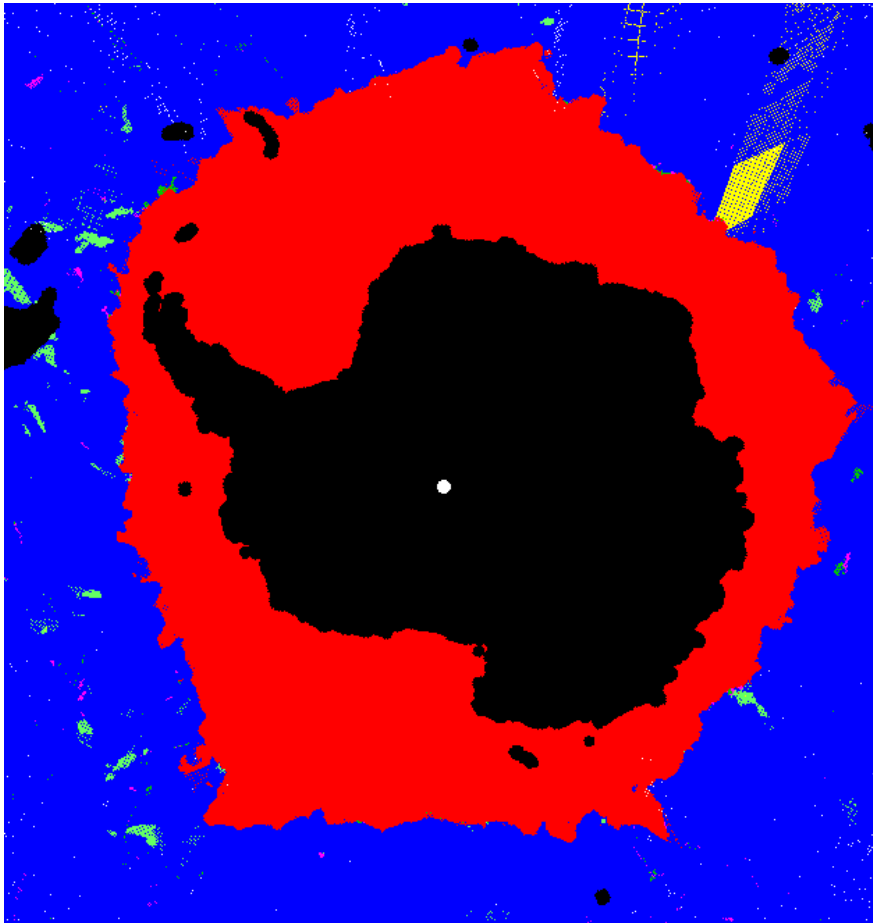
AMSR @15% ice concentration
ASCAT @50% ice probability



Red - ASCAT=ice and AMSR=not ice
Blue - ASCAT=not ice and AMSR=ice



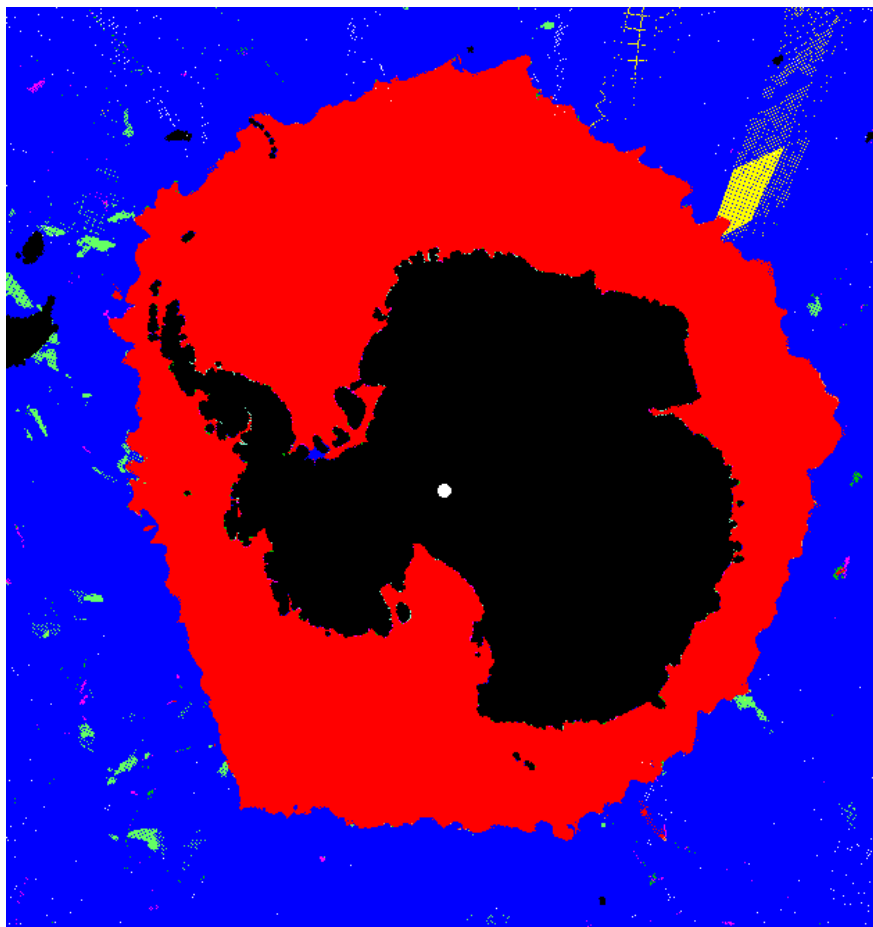
ice flagging based on SST



- Blue : sea (scat wind solution present)
- Yellow : level 1 flags for sigma0 quality and azimuth
- Light green : kp flag, large wind, small wind
- Aquamarin : inversion failed
- Purple : 2d var failed
- Dark green : GMF distance too large
- Red : ice
- White : missing data



ice flagging based on sea ice model



- Blue : sea (scat wind solution present)
- Yellow : level 1 flags for sigma0 quality and azimuth
- Light green : kp flag, large wind, small wind
- Aquamarin : inversion failed
- Purple : 2d var failed
- Dark green : GMF distance too large
- Red : ice
- White : missing data