Bayesian sea-ice detection in the ASCAT Wind Data Processor

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Outline

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

2012 IOVWST

Ice measurements are clustered around red iceline.

Measurement space, WVC=29

Blue: double wind cone

Ice measurements are clustered around red iceline.
Bayesian Sea-ice discrimination in the ASCAT processor

ASCAT sea ice GMF per WVC

Strong for wind GMF
Weak for sea ice GMF

WVC20
WVC14
WVC8
WVC2

SIDE view
Sea ice looks like along-track wind

Inner swath
Mid-inner swath
Mid-outer swath
Outer swath

TOP view

Ice line outside the wind cone
Ice line on wind cone
Ice line inside the wind cone

Reduced discrimination for inner mid swath WVCs
Sea-ice coordinate system
- 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 $\sigma^0 = \text{GMF}(a, \theta)$
Bayesian sea ice probability

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

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

\[
p(ice \mid x) = \frac{P(ice) p(x \mid ice)}{P(ice) p(x \mid ice) + P(water) p(x \mid water)}
\]

Prior probability

Posterior probability

distribution of wind MLE
ASCAT sea ice probability on a red-to-blue scale
7 September 2011

- Rather sharp edge in melting conditions
Sea ice area comparison

Sea ice area Northpole

Bayesian Sea-ice discrimination in the ASCAT processor
2012 IOVWST
Quality flag occurrence

arctic area

antarctic area

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
Sea ice model details

- 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)

- \( c_{\text{mix}} \) 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

Bayesian Sea-ice discrimination in the ASCAT processor

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

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

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

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

Bayesian Sea-ice discrimination in the ASCAT processor
2012 IOVWST

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
Quality flags

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
Aquamarine: inversion failed
Purple: 2d var failed
Dark green: GMF distance too large
Red: ice
White: missing data
Quality flags

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
Aquamarine : inversion failed
Purple : 2d var failed
Dark green : GMF distance too large
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