Daily sea ice extent and normalized backscatter (ASCAT, ERS, QuikSCAT and Oceansat-2)

User Manual

Abstract: The sea ice extent and normalized backscatter from the ASCAT, ERS, QuikSCAT and OSCAT scatterometers result from the Bayesian discrimination of measured backscatter distances to prescribed ocean wind and sea ice geophysical model functions [Ref1, Ref2]. The sea ice product contains the Bayesian sea ice probability and a proxy age of sea ice mapped onto 12.5 km polar stereographic grids. The sea ice extent is formed when the sea ice probability crosses a certain threshold, and the proxy age of sea ice is converted to (normalized VV C-band, or HH and VV Ku-band) sea ice backscatter using the instructions detailed in this manual.

Introduction

The KNMI presents a first version of a consistent long-term record of sea ice extent and backscatter from satellite scatterometry (ERS, QuikSCAT, ASCAT and Oceansat-2) dating back from 1992 to present day. The sea ice extents from scatterometers show good agreement with the global sea ice concentration climate data records from passive microwave instruments [Ref3, Ref4] during the winter months, but present notable differences during the summer months, scatterometers being more inclusive regarding the detection of lower concentration and melting ice. The scatterometer record also monitors the evolution of sea ice backscatter, which is typically used to separate multiyear from first year ice, and informs about the physical characteristics of the most dominant sea ice types.

1. NETCDF contents

The daily sea ice products from the ERS (1992-2001), QuikSCAT (1999-2009), ASCAT (2008-2017) and Oceansat-2 (2009-2014) scatterometer missions are available on 12.5 km polar stereographic grids (608 x 896 pixels for the Artic region, and 632 x 664 pixels for the Antartic region, https://nsidc.org/data/polar-stereo/ps_grids.html) in NETCDF format. The variables names and their contents include:

- X coordinate of projection in km
- Y coordinate of projection in km
- Latitude coordinate in degrees
- Longitude coordinate in degrees
- Sea ice probability
- Sea ice age: Normalized projection of backscatter on sea ice GMF in dB
- Time of last update: Time elapsed since last update in hours (only ERS)

2. Converting sea ice probability into sea ice extent

The threshold used to define the sea ice extent from sea ice probabilities has been adjusted empirically for the different missions [Ref1, Ref2].

2.1 ERS

The sea ice condition for the Northern hemisphere is:

- From Apr 1st to Sep 1st **ice probability≥0.5** (else **ice probability≥0.4**)

The sea ice condition for the Southern hemisphere is:

- From Feb 1st to Oct 1st **ice probability≥0.4** (else **ice probability≥0.5**)

2.2 QuikSCAT, ASCAT and OSCAT

The sea ice condition for QuikSCAT, ASCAT and OSCAT is **ice probability≥0.55**

3. Converting sea ice age into normalized backscatter

The sea ice age is the normalized projection of the backscatter measurement on the sea ice GMF in dB [Ref5].

3.1 ERS and ASCAT

To transform the ERS or ASCAT sea ice age into C-band backscatter normalized to 52.8 degrees of incidence (in correspondence with backscatter collected by the fore beam of the ASCAT reference node number 10, or the fore beam of the ERS reference node number 15), proceed as:

$$SIGMA = <SIGMA> + (iceage + <a>) * U\_ice$$

Where <SIGMA> is the mean (fore beam) sea ice backscatter, <a> is the mean a-parameter, and U_ice is the fore beam component of the sea ice GMF unit vector, all evaluated at the incidence angle of the reference node (see Table 1).

Table 1 – Coefficients describing the conversion from ASCAT or ERS sea ice age to C-band VV backscatter normalized at 52.8 degrees of incidence

Parameter	Value
<SIGMA>	-17.44 (dB)
<a>	-0.42 (dB)
U_ice	0.592

Please consult with us (scat@knmi.nl) if you would like to normalize to a different incidence angle.

3.2 QuikSCAT and OSCAT

To transform the QuikSCAT and OSCAT sea ice age into Ku-band backscatter (in correspondence with the backscatter collected by the outer VV beam at 54/57 degrees of incidence, or the inner HH beam at 46/49 degrees of incidence), proceed as:

$$SIGMA\_HH = (a - <a>) * U\_ice\_HH$$

$$SIGMA\_VV = offset + (a - <a>) * U\_ice\_VV$$

Table 2 – Coefficients describing the conversion from QuikSCAT/OSCAT sea ice age to Ku-band HH (46/49 degrees) and VV (54/57 degrees) backscatter

Parameter	Val QuikSCAT	Val OSCAT
offset	-1.25 (dB)	-1.13 (dB)
<a>	14.00 (dB)	18.00 (dB)
U_ice_HH	0.69310874	0.69310874
U_ice_VV	0.72083306	0.72083306

4. Available data sets

The data can be obtained from the KNMI Data Centre, see the links on http://www.knmi.nl/scatterometer/ice_extents/.

ASCAT-A Arctic daily sea ice extent and backscatter maps
doi:10.21944/ascat_a_nh_sea_ice_v1.0

ASCAT-A Antarctic daily sea ice extent and backscatter maps
doi:10.21944/ascat_a_sh_sea_ice_v1.0

ERS-1 Arctic daily sea ice extent and backscatter maps
doi:10.21944/ers_1_nh_sea_ice_v1.0

ERS-1 Antarctic daily sea ice extent and backscatter maps
doi:10.21944/ers_1_sh_sea_ice_v1.0

ERS-2 Arctic daily sea ice extent and backscatter maps
doi:10.21944/ers_2_nh_sea_ice_v1.0

ERS-2 Antarctic daily sea ice extent and backscatter maps
doi:10.21944/ers_2_sh_sea_ice_v1.0

Oceansat-2 OSCAT Arctic daily sea ice extent and backscatter maps
doi:10.21944/oceansat2_nh_sea_ice_v1.0

Oceansat-2 OSCAT Antarctic daily sea ice extent and backscatter maps
doi:10.21944/oceansat2_sh_sea_ice_v1.0

QuikSCAT SeaWinds Arctic daily sea ice extent and backscatter maps
doi:10.21944/quikscat_nh_sea_ice_v1.0

QuikSCAT SeaWinds Antarctic daily sea ice extent and backscatter maps
doi:10.21944/quikscat_sh_sea_ice_v1.0

When referring to the data sets, citation can be done in the following way (example):

Verhoef, A., Belmonte Rivas, M., & Stoffelen, A. (2018). ERS-1, Antarctic daily sea ice extent and backscatter maps [Data set]. Royal Netherlands Meteorological Institute (KNMI). https://doi.org/10.21944/ers_1_sh_sea_ice_v1.0

References

[Ref1] Belmonte Rivas, M., Verspeek, J., Verhoef, A. and Stoffelen, A., " Bayesian Sea Ice Detection With the Advanced Scatterometer ASCAT", IEEE Transactions on Geoscience and Remote Sensing, 50(7), 2649-2657, 2012. <https://www.researchgate.net/publication/254061299_Bayesian_Sea_Ice_Detection_With_the_Advanced_Scatterometer_ASCAT>

[Ref2] Belmonte Rivas, M. and Stoffelen, A., "New bayesian algorithm for sea ice detection with Quikscat", IEEE Transactions on Geoscience and Remote Sensing 49(6), 1894-1901, 2011. <https://www.researchgate.net/publication/224216013_New_Bayesian_Algorithm_for_Sea_Ice_Detection_With_QuikSCAT>

[Ref3] Cavalieri, D. J., C. L. Parkinson, P. Gloersen, and H. J. Zwally. 1996, updated yearly. Sea Ice Concentrations from Nimbus-7 SMMR and DMSP SSM/I-SSMIS Passive Microwave Data, Version 1. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. doi: <http://dx.doi.org/10.5067/8GQ8LZQVL0VL>

[Ref4] EUMETSAT Ocean and Sea Ice Satellite Application Facility. Global sea ice concentration climate data records 1978-2015 (v1.2, 2015), [Online]. Norwegian and Danish Meteorological Institutes. <http://osisaf.met.no/p/ice/>

[Ref5] De Haan, S., Stoffelen, S., "Ice discrimination using ERS scatterometer", SAF/OSI/KNMI/TEC/TN/120, 2001. <http://projects.knmi.nl/publications/fulltexts/safosi_w_icescrknmi.pdf>