EUMETSAT

OSI SAF

OCEAN AND SEA ICE

Product User Manual for the Global Sea-Ice Edge and Type Product

GBL SIED OSI-402-d and GBL SITY OSI-403-d

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2.3	5.2	May 2018	SAA, SE	Since 04-04-2018, GRIB and HDF5 formats are no longer produced. Products are accessible on NetCDF format only. Included date of release for OSI-402/403-c.
2.4	5.3	Sep 2020	SAA, SE	Using new version of sea ice concentration product (OSI-401-b) for dynamical PDFs.
3.0	5.3	02/12/2020	SAA	Major revision of the document related to the introduction of Metop-C, introduction of Southern Hemisphere sea-ice type product, and introduction of uncertainty estimates and upgraded flag information.
3.1	5.2	09/02/2021	SAA, EJD, SE	Amended according to review comments. Removal of "confidence_level" flag; major re-definition of flag variables; pluss editorial. Affected sections: 1.2, 1.4, 2.1.2, 3.2, 3.3, 4.1.3–4.1.6, A.

The software version number gives the corresponding version of the OSI SAF High Latitude software chain for which the product manual is valid.

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Glossary

AMSR	Advanced Microwave Scanning Radiometer.
AMSR2	Advanced Microwave Scanning Radiometer 2.
ASCAT	Advanced Scatterometer.
ATBD	Algorithm Theoretical Basis Document.
AVHRR	Advanced Very High Resolution Radiometer.
C3S	Copernicus Climate Climate Service.
DMI	Danish Meteorological Institute.
DMSP	Defense Meteorological Satellite Program.
ECMWF	European Center for Medium-Range Weather Forecasts.
EDC	EUMETSAT Data Center.
EUMETSAT	European Organization for the Exploitation of Meteorological Satellites.
FTP	File Transfer Protocol.
GCOM-W	Global Change Observation Mission for Water.
GW1	GCOM-W1.
HL	High Latitude.
HYR	Half Yearly operations Report.
JAXA	Japan Aerospace Exploration Agency.
MET-Norway	Norwegian Meteorological Institute.
Metop	Meteorological Operational polar satellite program.
NH	Northern Hemisphere.
NSIDC	National Snow and Ice Data Center.
NWP	Numerical Weather Prediction.
OSI SAF	Ocean and Sea Ice Satellite Application Facility.
OSI-401	OSI SAF Sea-Ice Concentration product.
OSI-402	OSI SAF Sea-Ice Edge product.

OSI-403	OSI SAF Sea-Ice Type product.
OSI-405	OSI SAF Low resolution Sea-Ice Drift product.
PDF	Probability Density Function.
PMW	Passive MicroWave.
PUM	Product User's Manual.
RTM	Radiative Transfer Model.
SAF	Satellite Application Facility.
SAR	Synthetic Aperture Radar.
SH	Southern Hemisphere.
SICO	Sea-Ice Concentration.
SIDR	Sea-Ice Drift.
SIED	Sea-Ice Edge.
SITY	Sea-Ice Type.
SMMR	Scanning Multichannel Microwave Radiometer.
SSM/I	Special Sensor Microwave/Imager.
SSMIS	Special Sensor Microwave Imager/Sounder.
SVR	Scientific Validation Report.
T2m	2m Air Temperature.
TB	Brightness Temperature.
TCWV	Total Column Water Vapour.
THREDDS	Thematic Real-time Environmental Distributed Data Services.

1. Introduction

1.1 The EUMETSAT Ocean and Sea Ice SAF

The Satellite Application Facilities (SAFs) are dedicated centres of excellence for processing satellite data - hosted by a National Meteorological Service - which utilise specialist expertise from institutes based in Member States. EUMETSAT created Satellite Application Facilities (SAFs) to complement its Central Facilities capability in Darmstadt. The Ocean and Sea Ice Satellite Application Facility (OSI SAF) is one of eight EUMETSAT SAFs, which provide users with operational data and software products. More on SAFs can be read at www.eumetsat.int.

The objective of the OSI SAF is the operational near-real-time production and distribution of a coherent set of information, derived from earth observation satellites, and characterising the ocean surface and the energy fluxes through it: sea surface temperature, radiative fluxes, wind vector, and sea-ice characteristics. For some variables, the OSI SAF is also aiming at providing long term data records for climate applications, based on reprocessing activities.

The sea-ice products include sea-ice concentration, the sea-ice emissivity at 50 GHz, sea-ice edge, sea-ice type, sea-ice drift, and sea-ice surface temperature (from mid-2014).

The sea-ice processing is performed at the High Latitude processing facility (HL centre), operated jointly by the Norwegian and Danish Meteorological Institutes.

1.2 Disclaimer

All intellectual property rights of the OSI SAF products belong to EUMETSAT. The use of these products is granted to every interested user, free of charge. If you wish to use these products, EUMETSAT's copyright credit must be shown by displaying the words "Copyright © <YYYY> EUMETSAT" or the OSI SAF logo on each of the products used.

Note : The comments that we get from our users is an important input when defining development activities and updates, and user feedback to the OSI SAF project team is highly valued. Users are welcome to send a direct email to osisaf-manager@met.no. See also Section 4.5 for more contact information.

Acknowledgment and citation

Use of the product(s) should be acknowledged with the following citations (product specific):

- OSI-402 : EUMETSAT Ocean and Sea Ice Satellite Application Facility, Global Sea-Ice Edge Near-Real-Time product - Multimission (2020), OSI-402-d, (Data extracted from OSI SAF FTP server/EUMETSAT Data Center: (<extracted period>,) (<extracted domain>,)) accessed <download date>

- OSI-403 : EUMETSAT Ocean and Sea Ice Satellite Application Facility, Global Sea-Ice Type Near-Real-Time product - Multimission (2020), OSI-403-d, (Data extracted from OSI SAF FTP server/EUMETSAT Data Center: (<extracted period>,) (<extracted domain>,)) accessed <download date>

1.3 Scope of this document

This document is dedicated to the OSI SAF product users and describes organization and layout of the OSI SAF Global Sea-Ice Edge (OSI-402) and Type (OSI-403) products.

1.4 Overview

The global Sea-Ice Edge and Type products are classification products that distinguish between the following classes:

- Sea-Ice Edge (OSI-402 series) – distinguish between open water, open sea ice, and closed sea ice
- Sea-Ice Type (OSI-403 series) – distinguish between first-year ice and multiyear ice.

Both products are multi-sensor products derived from passive and active microwave remote sensing data combined in a Bayesian approach. They are computed for both hemispheres on the standard OSI SAF grid with 10 km spatial resolution.

The products are delivered in NetCDF, format through FTP, THREDDS, EUMETCast, and EUMETSAT Data Center. See https://osisaf-hl.met.no for real-time examples of the products and updated information.

Below is given a short timeline of the main upgrades and developments up to the present time. Note, that due to these regular upgrades, the near-real-time products should not be used for climate studies. For climate consistent products, we recommend checking out the related sea-ice edge and type products from the Copernicus Climate Change Service (C3S): https://cds.climate.copernicus.eu

1.4.1 Timeline of developments

Satellite-derived Passive MicroWave data (PMW) over the ocean has been the backbone of large-scale sea-ice monitoring since the late 1970s. The SMMR on Nimbus-7 operated from 1978 until 1987, followed up by the SSM/I onboard the DMSP satellites monitoring since 1987. Data from SSM/I was the primary satellite data used in the OSI SAF sea-ice products when operational production started in 2005.

In 2009, ASCAT scatterometer data from Metop-A was introduced and supplemented the PMW data in a multi-sensor approach of the operational products of Sea-Ice Edge (OSI-402) and Sea-Ice Type (OSI-403).

In 2013, the SSM/I was replaced by its follower, the SSMIS from DMSP-F17, and the products thereby changed ID-label to OSI-402-a and OSI-403-a, respectively [Aaboe et al., 2013]. The data from F17 stopped being used in April 2016 due to calibration problems, and F18 has therefore been used in the operational products since then.

The two sea-ice products improved in 2015 by the introduction of a dynamical tuning of the algorithm with daily updated training data (OSI-402-b, OSI-403-b). In 2016, AMSR2 from JAXA's GCOM-W1 was introduced as an additional PMW sensor with higher spatial resolution than the SSMIS (OSI-402-c, OSI-403-c). In the same upgrade, ASCAT data from Metop-B was included to supplement Metop-A, hereby contributing to better coverage of scatterometer data over the lower latitude sea ice regions.

On 23.09.2020 there was a small change to the processing chain for these products. The input sea-ice concentration product used in the dynamical PDF generation was changed, giving a small improvement in the product quality. The change had no impact on product format or product delivery.

Recently, since the beginning of 2021, the product upgrades include for the first time an ice-type classification in Southern Hemisphere, and all sea-ice fields are accompanied by uncertainty fields and upgraded production flags (OSI-402-d, OSI-403-d). In addition, ASCAT data from Metop-C is introduced to operate in parallel with Metop-B. Due to drift of Metop-A and its limited lifetime left (*status*-information for Metop-C on https://www.wmo-sat.info/oscar/satellites), Metop-C is replacing Metop-A instead of operating all three Metop satellites in parallel.

1.5 Reference and applicable documents

Detailed information on the algorithm and the processing of the products are to be found in the Algorithm Theoretical Basis Document (ATBD) [1]. Results from validation against navigational ice charts and monitoring are gathered in the associated Scientific Validation Report (SVR) [2]. In addition, Half Yearly operations Report (HYR) and on-line quality information are found on https://osisaf-hl.met.no.

1.5.1 Reference documents

[1] EUMETSAT OSI SAF
Algorithm Theoretical Basis Document for the Global Sea-Ice Edge (OSI-402-d) and Type (OSI-403-d)
SAF/OSI/CDOP3/MET-Norway/SCI/MA/379, version 3.2, December 2020

[2] EUMETSAT OSI SAF
Validation Report for the Global Sea-Ice Edge (OSI-402-d) and Type (OSI-403-d)
SAF/OSI/CDOP3/MET-Norway/SCI/RP/224, version 3.0, December 2020

[3] EUMETSAT OSI SAF
Algorithm Theoretical Basis Document for the Sea-Ice Concentration (OSI-401-b)
SAF/OSI/CDOP/DMI/SCI/MA/189, version 1.5, April 2016

1.5.2 Applicable documents

[4] EUMETSAT OSI SAF
Product Requirements Document
SAF/OSI/CDOP3/MF/MGT/PL/2-001, version 1.4, 20/12/2018

[5] EUMETSAT OSI SAF
Service Specification Document
SAF/OSI/CDOP3/MF/MGT/PL/003, version 1.8, 08/07/2019

2. Input data

This section describes the satellite data used in the multi-sensor retrieval as well as other auxiliary data such as numerical weather prediction (NWP) data used for atmospheric correction of the PMW brightness temperature. The channel specifications for all sensors included in the OSI SAF sea-ice edge and type products are given in Table 1.

2.1 Passive microwave data

The PMW imaging systems used in the retrieval are all polar-orbiting conically scanning radiometers. They measure the upwelling surface microwave brightness temperature (TB), which is linearly related to the physical surface temperature: TB $= \epsilon$T, where ϵ is the microwave emissivity of the surface material, and T is the physical surface temperature. The multi-sensor retrieval uses one primary PMW source which since 2016 is the AMSR2 due to its higher spatial resolution. The SSMIS data is used as gap-filling or backup solution where AMSR2 fails. For the Southern Hemisphere, sea-ice type is only using AMSR2 data.

2.1.1 SSMIS data

The Special Sensor Microwave Imager/Sounder (SSMIS) onboard DMSP-F18 is a polar-orbiting conically scanning radiometer with a constant incidence angle around 53.1° and a swath width of about 1700 km. It has window channels near 19, 37, 91, and 150 GHz and sounding channels near 22, 50, 60, and 183 GHz. All channels are available in both horizontal (H) and vertical (V) polarization. The algorithm is using swath TB data as input. It uses the 19 (V,H), the 37 (V), and the 91 (V,H) channel data.

2.1.2 AMSR2 data

The Advanced Microwave Scanning Radiometer 2 (AMSR2) onboard the GCOM-W1 (GW1) satellite is similar to SSMIS but with the crucial difference of having a higher spatial resolution than SSMIS, see Table 1. The conically scanning radiometer has a constant incidence angle around 55° and a swath width of approximately 1450 km. It operates at seven different frequencies (including the very low frequency at 6.9 GHz) which for the retrieval is used only the 19 (V,H), the 37 (V) and the 89 (V,H) channel data.

At the time of writing, the prospects are good for a follow-up (AMSR3) mission, but it is not clear if a gap between AMSR2 and AMSR3 can be avoided.

Note, that for the three selected frequency channels used in the retrieval, the highest frequency differs between the PMW sensors (91 GHz for SSMIS and 89 GHz for AMSR2) and will in the following be referred to as the *near 90* GHz or in short *N90*. For the two lower frequencies, the difference between the sensors is negligible and they are referred to as *19* and *37* GHz.

Sensor	Platform	Channels [GHz]	pol.	Sampling [km]	Footprint size [km]	Last active date
AMSR2	GCOM-W1	18.7 36.5 89.0	V,H V,H V,H	10 10 5	14x22 7x12 3x5	Active
SSMIS	DMSP-F18	19.35 37.0 91.655	V,H V,H V,H	25 25 12.5	42x70 27x44 13x14	Active
ASCAT	Metop-B/ Metop-C	C-band	VV	12.5	(25-34)x (25-34)	Active

Table 1: Characteristics of the different sensors and channels used in the OSI SAF Sea-Ice Edge and Type products.

2.1.3 Atmospheric corrections

Contamination arising from atmospheric water vapor content and wind roughening of the open water surface is a common problem in the remote sensing of sea ice from passive microwave observations. To mitigate this problem, a correction is computed using the radiative transfer model (RTM) by Wentz [1997] extended with a scheme developed by Kern [2004] for the 85 GHz channels, with numerical weather prediction (NWP) input from ECMWF model fields of surface wind, 2m air temperature T2m and atmospheric water content TCWV. This correction is subsequently applied to the measured TBs as part of the OSI SAF sea-ice concentration algorithm (OSI-401) prior to the calculation of the sea-ice edge and type, so more details on the RTM is found in the OSI-401 ATBD [3] . Given a mixture of weather contamination and low ice concentrations, such as often experienced in the marginal ice zone, the widely used threshold-based weather filtering methods such as described by Cavalieri et al. [1995] tend to either remove the ice completely or leave it untouched. The NWP model-based correction method will tend to only remove the weather-induced part and give more accurate concentration estimates. Note, that this method works directly on TB and is therefore well suited for use in both the ice edge and type products as well as for the ice concentration product.

2.2 Scatterometer data

The scatterometer instrument measures the microwave backscatter, σ_0, which has been averaged and re-sampled by using either a Hamming window or a boxcar filtering across and along the viewing swath in order to achieve spatial resolution and to reduce measurement noise [ASCAT Product Guide, 2017]. The backscatter from the ocean surface depends on the surface roughness, caused by for example the wind-induced gravity/capillary waves over the ocean or a cover of sea ice. The variation in backscatter measurements due to the viewing geometry of the instrument can be utilized to detect sea ice, following Cavanie et al. [1993], and is the basis for the method developed for ice/water discrimination under the OSI SAF (see more details in the ATBD [1]).

2.2.1 ASCAT data

The Advanced SCATterometer (ASCAT) onboard the Metop satellites (A,B,C) is a real aperture radar, emitting microwave radiation at 5.255 GHz (C-band) towards the Earth and measuring the backscatter. It uses only vertically (VV) polarized antennas. Two sets of three antennas are used to generate radar beams oriented at 45°, 90° and 135° with respect to the satellite's flight direction, on both sides of the satellite ground track. Each of the beams covers 550 km-wide swaths, separated by a 700 km gap, as the satellite moves along its orbit. Sampling resolution is 25 km or 12.5 km which divides each swath into 21 or 42 cells, respectively. For each cell, three independent backscatter measurements, $\sigma_{0,fore}$, $\sigma_{0,mid}$, and $\sigma_{0,back}$, are obtained using the different viewing directions from the three antennas. The forward and backward-pointing antennas are viewing the same cell on the ground with different viewing azimuths, but with the same incident angle. The mid antenna is viewing with a steeper incident angle.

2.3 Auxiliary data

Atmospheric NWP data is used in masking of the Sea-ice Edge and Type product, as well as for the correction of the brightness temperatures for atmospheric contribution, as described in Section 2.1.3. Data of sea-ice concentration is used when selecting training data for different ice classes in the algorithm. And for the retrieval of sea-ice type in the Southern Hemisphere is used a backtracking tool based on sea-ice drift data. In Table 2 is listed the auxiliary data used for the Sea-ice Edge and Type processing.

Auxiliary Product Type	**Description**	**Source**
Wind speed, T2m, TCWV	ECMWF operational forecasts	ECMWF
Sea Ice Concentration (SICO)	OSI-401-b: Global Sea Ice Concentration (SSMIS)	EUMETSAT OSI SAF www.osi-saf.org/?q=content/global-sea-ice-concentration-ssmis
Sea Ice Drift (SIDR)	OSI-405-b: Global Low Resolution Sea Ice Drift	EUMETSAT OSI SAF www.osi-saf.org/?q=content/global-low-resolution-sea-ice-drift-c

Table 2: Auxiliary datasets and their sources for the Sea-ice Edge and Type processing.

3. Processing scheme

This section briefly describes the processing steps in the retrieval algorithm for the sea-ice edge and type. The process can be divided into three sub-steps: The processing on original swath data (level 1 and 2). This step includes a pre-processing carried out as part of the OSI-401 level 2 processing chain [3] and handles the NWP data and the atmospheric correction of TB's. Calculation of the ice-class probabilities from single sensors is also done on swath data. The second step is the daily-average gridding to level 3 fields; and the final step involves the Bayesian multi-sensor analysis and final masking of sea-ice edge and type (level 3). An overview of these three steps is shown in Figure 1, and the scope of each step is presented briefly in the following sections. A more detailed description of the steps and the science behind can be found in the ATBD [1].

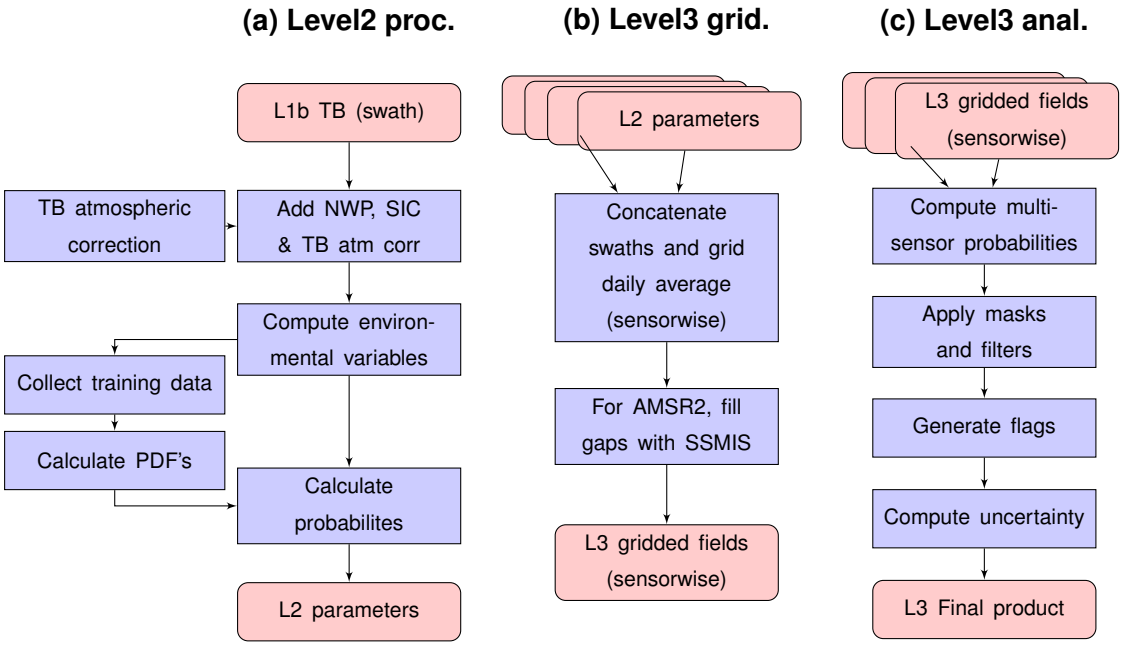


Figure 1: The main processing elements in the daily calculations of sea-ice edge and type divided into 3 sub-routines: (a) Level2, (b) Level3 gridding, and (c) Level3 analysis. The red boxes with rounded corners represent data input and output, the blue boxes represent the processing steps. The outputs from Level2 go as input to Level3, and the Level3 gridded fields as input to the Level3 analysis.

3.1 Level 1 and 2 processing

The steps in Level 1 (L1) and Level 2 (L2) contain all processing done on the original swath data and is performed successively as the data arrive. It includes the pre-processing with adding the auxiliary data by collocation of NWP data with sensor data, and the RTM correction of the brightness temperatures for influence from the atmosphere.

The environmental classification parameters, that are used in the algorithm to distinguish between ice and water and different ice types, are calculated from the corrected PMW brightness temperatures and the scatterometer data.

Finally, the probabilities for each of the ice classes (closed ice, open ice, open water, first-year ice and multiyear ice) are calculated on each observation point in satellite projection. The L2 probability calculations are performed for each environmental variable and are later to be combined in the multi-sensor approach in the L3 analysis (Section 3.3.

The single-sensor probabilities are tuned by the dynamical PDF's derived from a continuously updated training dataset of the environmental variables.

3.2 Level 3 gridding and daily averaging

The gridding of the swath data to daily fields loads all satellite observation, and derived probabilities, within 24 hours, centered on 12:00 UTC, and grid these to the final output grids. The gridding is carried out for the Northern Hemisphere and the Southern Hemisphere, individually.

In addition, ancillary data are given on the same OSI SAF grid and used to mask away land and coast and correct erroneous ice. The uses of the ancillary data are marked as a flag for each grid point in the processing flags, see Section 4.1.4.

Land-sea-coast: contains land, coast, and sea occurrences. It has been derived on the OSI SAF grids from the World Vector Shoreline. In the Southern Hemisphere, information on ice shelf coverage has been added from the NASA AMSR-E landmasks and a mask based on inspection of recent VIS-IR imagery developed by S. Kern, University of Hamburg. The atlas includes 3 types of pixels: "land", "coast" and "sea". Sea-ice calculations are done over the sea pixels. The coast pixels are pixels within a fixed distance from the coastline over sea areas. This fixed distance is chosen in accordance with the size of the footprint of the SSMIS data. Observations within these pixels are not processed since they are most likely contaminated by land. These pixels are given the value "unclassified" in the data products. For those interested, the land-sea-coast masks are available here: ftp://osisaf.met.no/docs/tools in two separate files *lmask_nh_stere_100.nc* and *lmask_sh_stere_100.nc* for Northern and Southern Hemisphere, respectively.

Sea-ice climatology: contains monthly fields of maximum sea-ice extent (Ocean Masks) provided by NSIDC (see http://nsidc.org for details). This dataset is based on data from SMMR and SSM/I spanning the period from 1979 through 2002.

Background data: To make the product more useful for automatic use, obviously erroneous classified sea ice is removed by the use of background information derived from the NWP model. The parameter chosen for this purpose is the NWP temperature analysis field at 2 m (T2m). A spurious ice filtering is implemented by setting all grid points with T2m > 8.0°C to open water. Experience shows that the value, T2m > 8.0°C, is high enough to account for uncertainty in the NWP analysis and ensure proper distance from the ice edge. The value is however tunable and given as an input parameter. To avoid the erroneous removal of extreme ice extents, the NSIDC climatological maximum sea-ice edge is expanded towards open water by 50 km before being added to the NWP background data.

Ice type mask: To reduce noise in the ice type products an ice type mask is defined. Areas where multiyear ice never occurs, e.g. the Bay of Bothnia are set to first-year ice. This mask is used to overrule the erroneous classification and ensure first-year ice.

Ice drift mask: In a separate processing chain, an ice type classification of the Southern Hemisphere sea ice is derived based on Lagrangian backtracking of ice parcels. It is based on the OSI SAF sea-ice drift product (OSI-405, see Table 2). An ice parcel is classified as multiyear ice if it can be traced back to a location with ice at the time of the minimum sea-ice extent in February/March. Conversely, the ice parcel is classified as first-year ice when the ice parcel is traced back to open water before the minimum extent. This valuable independent information is used to mask erroneously classified multiyear ice from the Bayesian approach. So, sea ice is masked as first-year ice whenever there is a disagreement where the Bayesian approach results in multiyear ice while the backtracking classification gives first-year ice. Read more on the backtracking classification used for the Southern Hemisphere sea-ice type in the corresponding ATBD [1].

3.3 Level 3 sea-ice classification analysis

The core of the sea-ice classification is based on the Bayesian multi-sensor approach. The Bayesian approach describes the *probability of occurrence* of the most likely surface class. Therefore, the final surface class in a grid point is defined as the class with the highest probability. The probability estimate itself is in addition an indicator of the statistical uncertainty of the classification. The higher the probability, the less uncertain the resulting classification. And the lower the probability, the more uncertain the result. The product uncertainty for both Sea-Ice Edge and Type is therefore defined directly from the Bayesian probabilities and normalized to be a unitless parameter between 0 and 1:

$$uncertainty = \frac{1 - (probability/100\%)}{0.5}. \tag{3.1}$$

Note, that the probability in Eq. 3.1 is the probability of the final classification. For a classification between two classes, the highest uncertainty is when the probability is 50% corresponding to the two classes being equally likely to occur. This explains the normalization factor of 0.5 in Eq. 3.1.

The uncertainty field completely replaces the *confidence level* flag which has been provided as the only quality information in previous versions of the products. The new uncertainty field gives the same information but with more details.

The final step in the sea-ice analysis involves convenient filters to remove or flag suspicious sea-ice over open water and correction of obviously wrong classifications. The status in each pixel of the retrieval process and the applied filters are logged in a *status flag* field which is included in each daily product file together with the ice field (see Section 4.1.4).

3.4 Validation and quality control

The quality assessment of the OSI SAF Global Sea-Ice Edge (OSI-402-d) and Type (OSI-403-d) is done first just before becoming an operational/pre-operational product distributed by the OSI SAF. This first assessment is presented in this Scientific Validation Report (SVR) [2]. Then continuous monitoring of the product quality is done by the OSI SAF team and presented in the half-yearly operations reports available on the OSI SAF website project documentation.

The quality assessment of the OSI SAF Sea-Ice Edge and Type is done against the target accuracy requirement defined in the OSI SAF Product Requirement Document [4].

Sea-Ice Edge Accuracy
Threshold acc. : NH : 30 km (yearly average); SH : 70 km (yearly average)
Target acc. : NH : 20 km (yearly average); SH : 45 km (yearly average)

Sea-Ice Type Accuracy
Threshold acc. : 200,000 km^2 monthly std.dev. in difference from running mean.
Target acc. : 100,000 km^2 monthly std.dev. in difference from running mean.

The target accuracy corresponds to the desired performance level (the breakthrough accuracy). If the values are not compliant with the target accuracy requirement, we consider that the product is still useful/usable as long as the values are compliant to the threshold requirement.

Validation and assessments of the Sea-Ice Edge product are based on both objective and subjective comparisons with high-quality navigational sea-ice analyses produced at the operational Sea Ice Services at DMI and MET-Norway. These navigational ice charts have requirements very different from the OSI SAF products. They are to a large extent based on subjective interpretation of high-resolution SAR and AVHRR data. However, in areas where SAR or AVHRR data are not available for subjective analysis, the sea-ice analysts might use PMW data and OSI SAF products. However, only navigational ice charts that are based on subjective interpretation of high resolution SAR, MODIS and AVHRR data are used in the evaluation of the OSI SAF products.

Validation of the Sea-Ice Type product is an assessment of the product's stability. With the assumption that the area of multiyear ice is not experiencing large or rapid changes on a daily time scale, the validation is based on a monitoring of the daily multiyear ice area and its standard deviation variability.

4. Product description

This section gives a describtion of the OSI SAF Sea-Ice Edge and Type products, including the product specification, availability and limitations. Information on the instruments and the auxiliary data used in the retrieval process is found in Section 2, and a brief description of the processing steps is found in Section 3.

4.1 Product specification

The Sea-Ice Edge and Type are delivered in individual, daily files. The daily product files contain one main sea-ice variable and 6 related variables (in addition to the position and time variables):

Sea-Ice Edge

- sea-ice edge (`ice_edge`)
- uncertainty (`uncertainty`)
- status flag (`status_flag`)
- data used in processing (`param_used`)
- number of orbits used in processing per sensor:
  - AMSR2, principal PMW sensor (`orbit_num_amsr`)
  - SSMIS, secondary PMW sensor (`orbit_num_ssmis`)
  - ASCAT (`orbit_num_ascat`)

Sea-Ice Type

- sea-ice type (`ice_type`)
- uncertainty (`uncertainty`)
- status flag (`status_flag`)
- data used in processing (`param_used`)
- number of orbits used in processing per sensor:
  - AMSR2, principal PMW sensor (`orbit_num_amsr`)
  - SSMIS, secondary PMW sensor (`orbit_num_ssmis`)
  - ASCAT (`orbit_num_ascat`)

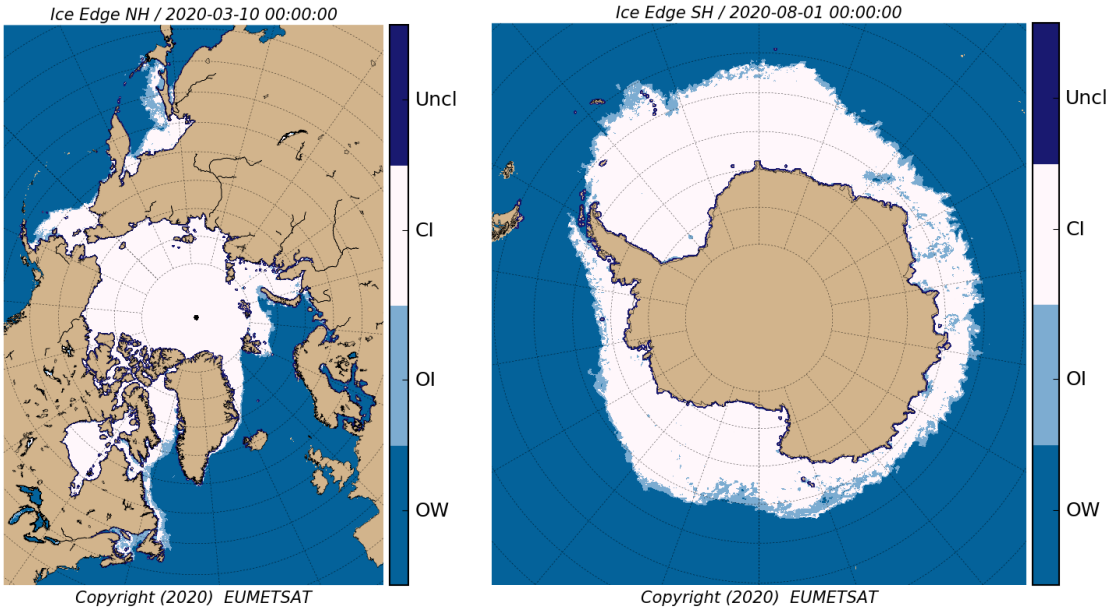
The definitions of each of these fields are given in the sections below.

4.1.1 Sea-ice edge

Sea-ice edge, SIED, is a classification product (unitless) separating the ocean surface into three classes. The definition of each class and its assigned integer code are given below, and examples are seen in Figure 2 for Northern Hemisphere and Southern Hemisphere, respectively.

- 1: open water (sea-ice concentration $< 30\%$)
- 2: open ice ($30\% \leq$ sea-ice concentration $< 70\%$)
- 3: closed ice ($70\% \leq$ sea-ice concentration)
- -1: Fillvalue (unclassified pixel due to e.g. land, near the coast or missing data)

The sea-ice edge product resembles in many ways the products of sea-ice concentration. However, the major differences of the edge product are: different retrieval methods, the inclusion of both passive and active microwave data, and the inclusion of both lower and higher PMW frequencies. In addition, the threshold at 30% ice concentration for defining the sea-ice edge differs from the sea-ice concentration products which most often maps lower concentrations as well.



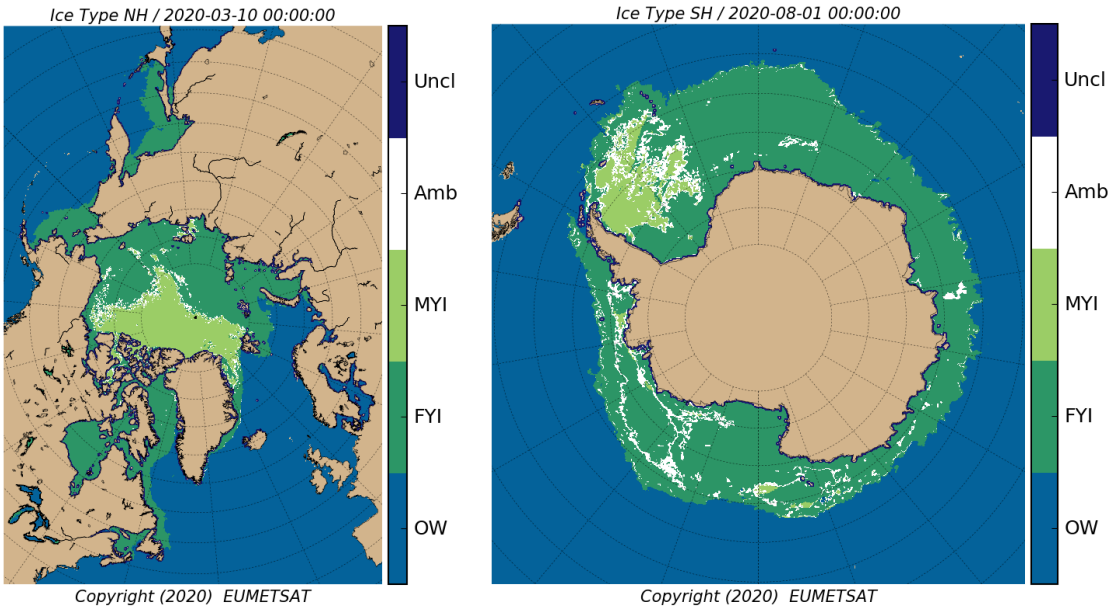
(a) NH SIED (b) SH SIED

Figure 2: Example of sea-ice edge classes (OW = open_water, OI = open_ice, CI = closed_ice, Uncl = unclassified). (a) Northern Hemisphere, March 10, 2020. (b) Southern Hemisphere, August 1, 2020.

4.1.2 Sea-ice type

Sea-ice type, SITY, is a classification product (unitless) separating the sea-ice surface into the two classes of *first-year ice* (seasonal ice that has formed after last melting season) and *multiyear ice* (older ice that has survived at least one melting season). Each class represents the dominant ice type within that region. An example of the sea-ice type product is seen in Figure 3. The definition of each class and its assigned integer code is given below:

- 1: open water (sea-ice concentration $< 30\%$. Adopted from Sea-Ice Edge.)
- 2: first-year ice (ice_concentration $\geq 30\%$)
- 3: multiyear ice (ice_concentration $\geq 30\%$)
- 4: ambiguous (probability $< 75\%$)
- -1: Fillvalue (unclassified pixel due to e.g. land, near the coast or missing data)



(a) NH SITY (b) SH SITY

Figure 3: Example of sea-ice type classes (OW = open_water, FYI = first-year_ice, MYI = multiyear_ice, Amb = ambiguous, Uncl = classified). (a) Northern Hemisphere, March 10, 2020. (b) Southern Hemisphere, August 1, 2020.

As seen in the list, the sea-ice type includes also the class *Ambiguous* which is representing where and when the ice type classification is not to be relied on. The classification will be set to ambiguous in the following cases:

- **Ambiguous pixels**: Ice classification is defined as *ambiguous* where the highest probability is less than 75%.
- **Ambiguous period**: In the summer period the ice type classification becomes unreliable and all ice is classified as *ambiguous*. This is mainly due to melting at the ice surface so that the microwave signature of the surface loses its ability to differ between

first-year ice and multiyear ice. The ice is set to *ambiguous* in the defined summer periods per hemisphere:

- Northern Hemisphere: May – September
- Southern Hemisphere: October – Februar

4.1.3 Uncertainty

The uncertainty is a unitless estimate between 0 and 1 that represents the significance of the statistical classification in each pixel (see Eq. 3.1). The uncertainty estimates are overwritten by fixed values in pixels where a mask has been activated. Replacement values for flagged pixels are shown in Table 3. Uncertainty values towards 1 indicate a non-significant separation of the classes, whereas low values toward 0 indicate that the Bayesian classification is significant. During mid-winters, the uncertainty field is often close to zero everywhere else than in the transition zones between the classes. Approaching the melting season the uncertainty values will increase over larger areas. Figure 4 shows examples of the mid-winter uncertainty estimates for both sea-ice edge and type in Northern Hemisphere and Southern Hemisphere, respectively.

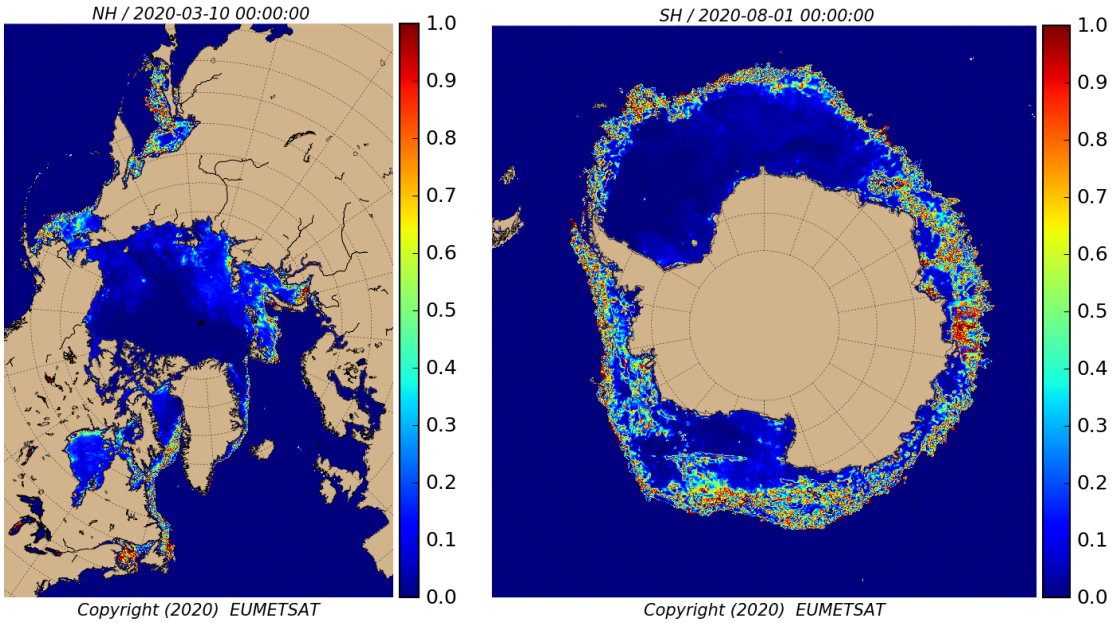
Flag value	**Activated masks**	**Uncertainty**
	Open water	0
1	Land	0
16	T2m	0
128	Climatology	0
256	Geographical ice type mask	0
512	Seasonal ambiguous ice type	1
1024	Ice drift mask	0.5
2048	Statistical filter	0
4096	Unclassified	0
8192	Missing	0

Table 3: Fixed uncertainty for masked pixels. The flag value, in the first column, refers to the Status flag values in Table 4.

Note, that for the Sea-Ice Type product the uncertainty only represents the classification over ice and does not include the classification uncertainty between sea ice and the class of *open water*. Instead, the ice edge uncertainty is represented in the Sea-Ice Edge product.

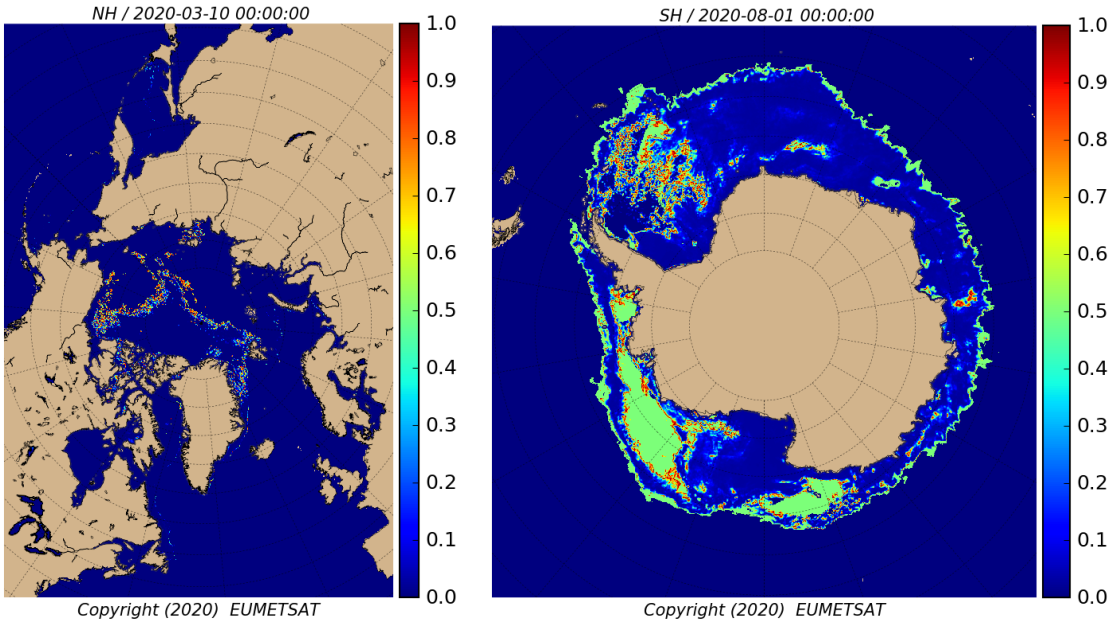
4.1.4 Status flag

In the final step of the processing (see Figure 1c, Section 3.3), several maskings are applied for correcting the classification or removing erroneous sea ice. Every pixel with an activated mask is registered in the status flag.



(a) NH SIED uncertainty

(b) SH SIED uncertainty



(c) NH SITY uncertainty

(d) SH SITY uncertainty

Figure 4: Example of uncertainty field (Eq. 3.1). (a) Northern Hemisphere sea-ice edge uncertainty, March 10, 2020, (b) Southern Hemisphere sea-ice edge uncertainty, August 1, 2020, (c) Northern Hemisphere sea-ice type uncertainty, March 10, 2020, (d) Southern Hemisphere sea-ice type uncertainty, August 1, 2020.

The status flag is coded as a flag_mask variable according to the CF convention[1]. The different values are described in Table 4 and example status flag fields are shown for both

[1] https://cfconventions.org/Data/cf-conventions/cf-conventions-1.7/build/ch03s05.html

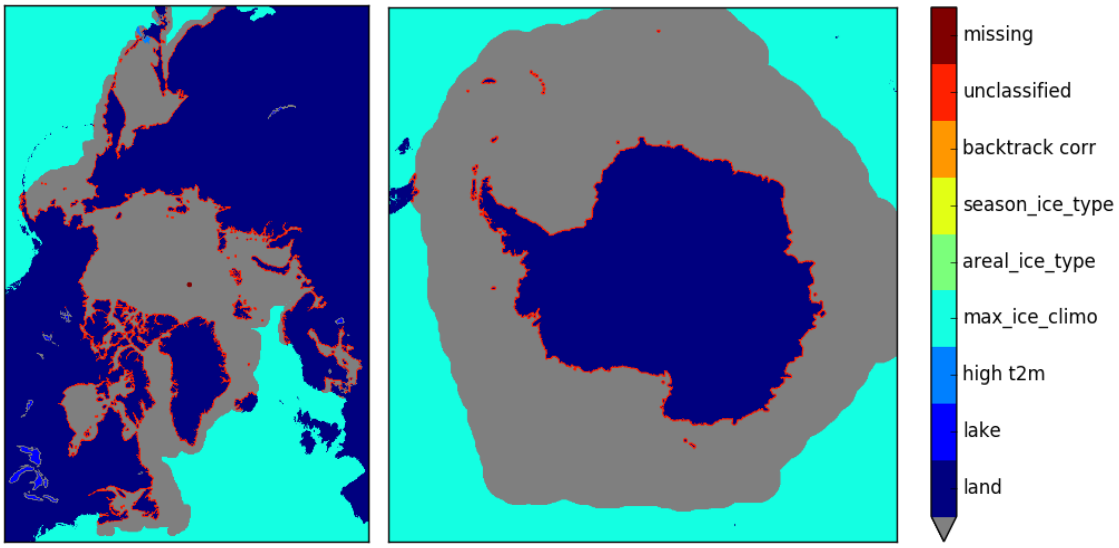
sea-ice edge and type in Figure 5.

Bit Nr	Value	Definition
1	1	Position is over land
2	2	Position is lake
3	4	- (*Not in use. Kept for later usage.*)
4	8	- (*Not in use. Kept for later usage.*)
5	16	Sea ice is set to *no ice* since the 2m air temperature is high at this position
6	32	- (*Not in use. Kept for later usage.*)
7	64	- (*Not in use. Kept for later usage.*)
8	128	Sea ice is set to *no ice* since position is outside maximum sea ice climatology
9	256	Sea ice type is set to *first-year ice* by the geographical ice type mask
10	512	Sea ice type is set to *ambiguous* due to season
11	1024	Sea ice type is set to *first-year ice* by the ice drift mask
12	2048	Sea ice type is set to *first-year ice* by the statistical filter
13	4096	Unclassified pixel
14	8192	Missing value due to missing data

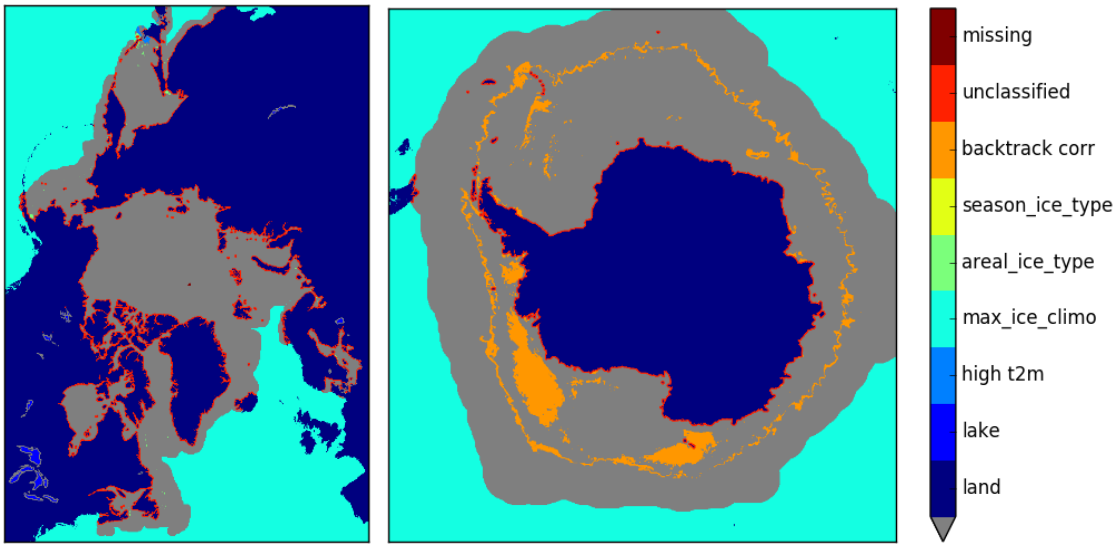
Table 4: Definition of status flag bits

This flag is a bit array with each bit representing a different status, so grid cell values can be a combination of several statuses. Most combinations of flags are theoretically possible, with the exception of the eight (outside maximum climatology), the tenth (seasonal ambiguity in ice type) and the first (land) bits which override other flags in the grid cells.

One example of a possible combination is the status flag "18" which represents a pixel in a lake (2) which was originally classified as ice but has been set as water due to warm surface temperature (16).



(a) NH SIED status flag (b) SH SIED status flag



(c) NH SITY status flag (d) SH SITY status flag

Figure 5: Example of status flag fields (only activated flags are shown). For the binary code description, see Table 4. (a) Northern Hemisphere sea-ice edge status flag for 20200310 (b) Southern Hemisphere sea-ice edge status flag for 20200801 (c) Northern Hemisphere sea-ice type status flag for 20200310 (d) Southern Hemisphere sea-ice type status flag for 20200801

4.1.5 Flag `param_used`

The `param_used` flag contains information about which channel combinations or parameters (also called the environmental variables in Figure 1a) were used in the algorithm for creating the final ice product. It is coded as a flag_mask variable according to the CF convention[2], with size signed byte, and the different values are described in Table 5.

This flag is a bit array with each bit representing a different parameter, so grid cell values can be a combination of several flags. For example, the param_used "26" is a combination of PRn90 (2), PR19-GR3719V (8) and anisFMB (16), see Table 5.

Note, that the flag maps the specific parameters used in the computation and do not specify from which sensor or satellite. So, in order to get information on e.g. what PMW data is used in the example above, this param_used information should be supplemented by the `orbit_num` flag-variables, see Section 4.1.6. Also note, that param_used includes the low frequency variable *PR19-GR3719V* which is used as a filter in the Bayesian calculation of the sea-ice edge (see more details in the ATBD [1]).

Bit Nr	Value	Definition
1	1	PR37 data used
2	2	PRn90 data used
3	4	GR3719V data used
4	8	PR19-GR3719V data used
5	16	anisFMB data used
6	32	BScatt data used

Table 5: Definition of param_used bits

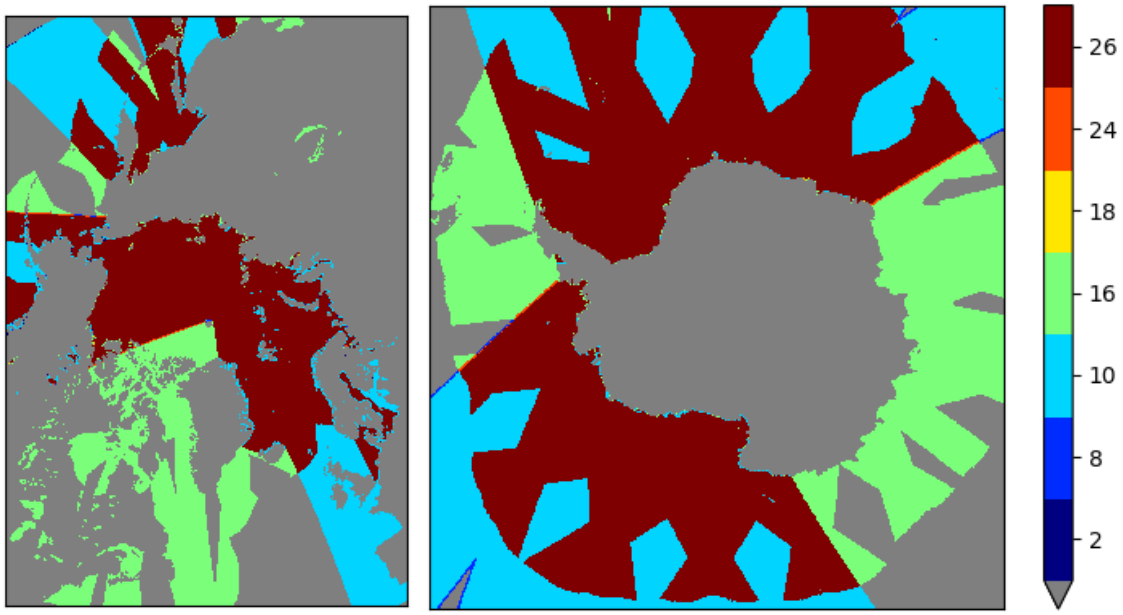
Examples of the param_used flag related to the sea-ice edge product are shown in Figure 6 for both Northern Hemisphere and Southern Hemisphere. The examples are for illustrative reasons picked for October 22, 2019, where there is a larger gap in the PMW data.

4.1.6 Orbit number variables

For each of the sensors AMSR2, SSMIS, and ASCAT (aboard different satellites) there is an `orbit_num_<satellite>` variable which gives the number of orbital passes used in the algorithm to create the final ice product. It is coded as a signed byte. Note that for ASCAT this is an accumulation of orbits from the different satellites like Metop-B and Metop-C. Also note that for SSMIS this is not necessarily the total number of orbits available from the satellite. Since SSMIS is currently used to gap-fill AMSR2 data the `orbit_num_ssmis` variable will only include number of orbits where `orbit_num_amsr` is zero.

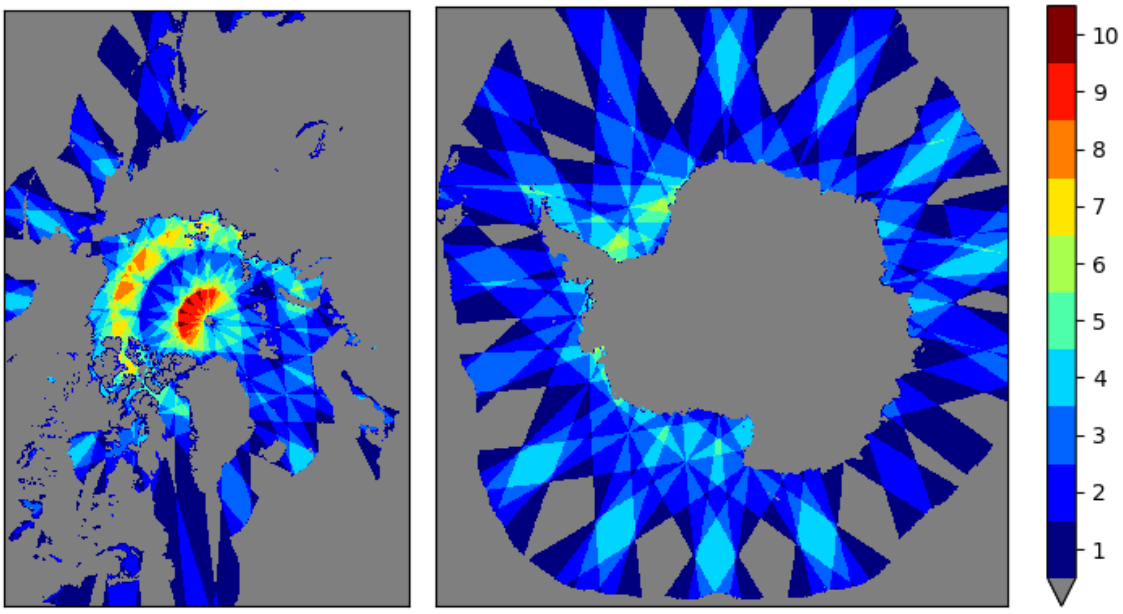
An example of `orbit_num_ascat` is shown for sea-ice edge for both hemispheres in Figure 7. `orbit_num_amsr` and `orbit_num_ssmis` will in general be similar.

[2] https://cfconventions.org/Data/cf-conventions/cf-conventions-1.7/build/ch03s05.html



(a) NH SIED param_used (b) SH SIED param_used

Figure 6: Example of param_used flag field for sea-ice edge, 20191022. (a) Northern Hemisphere, (b) Southern Hemisphere. For the binary code description, see Table 5.



(a) NH SIED orbit_num_ascat (b) SH SIED orbit_num_ascat

Figure 7: Example of orbit_num_ascat field for sea-ice edge, 20191022. (a) Northern Hemisphere, (b) Southern Hemisphere.

4.2 Grid characteristics

The product grids are adapted from the 25 km resolution Goddard Space Flight Center projections used to disseminate various SSM/I and SSMIS based products available at the National Snow and Ice Data Center (see http://nsidc.org for details). There is one grid for the Northern Hemisphere product (NH) and one grid for the Southern Hemisphere product (SH), as seen in Figure 8.

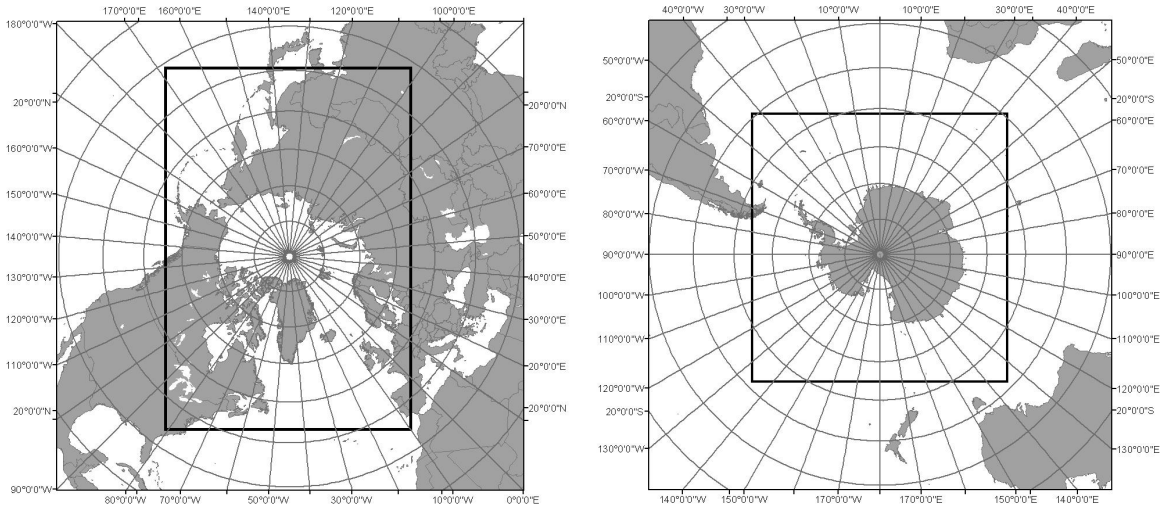


Figure 8: Coverage of the Northern (left) and Southern (right) Hemisphere grids, marked with the black box (from NSIDC).

Below are given the details of the grid definitions and approximate maps of the grid extents, corner coordinates are referenced to pixel center. Projection definitions in the form of PROJ-4 initialization strings are also given (see http://trac.osgeo.org/proj/ for details).

Geographical definition for Northern Hemisphere Grid, NH	
Projection:	Polar stereographic projection true at 70°N
Grid cell size:	10 km
Size:	760 columns, 1120 lines
Central Meridian:	45°W
Center coordinate for corner grid points:	
Upper left grid point	31.0294°N, 168.3380°E
Upper right grid point	31.4141°N, 102.3516°E
Lower right grid point	34.3960°N, 9.9828°W
Lower left grid point	33.9755°N, 80.7299°W
Radius of Earth:	6378273 x 6356889.44891 m
PROJ-4 string:	+proj=stere +a=6378273 +b=6356889.44891 +lat_0=90 +lat_ts=70 +lon_0=-45
Geographical definition for Southern Hemisphere Grid, NH	
Projection:	Polar stereographic projection true at 70°S
Grid cell size:	10 km
Size:	790 columns, 830 lines
Central Meridian:	0
Center coordinate for corner grid points:	
Upper left grid point	39.2845°S, 42.2376°W
Upper right grid point	39.2845°S, 42.2376°E
Lower right grid point	41.5015°S, 135.0000°E
Lower left grid point	41.5015°S, 135.0000°W
Radius of Earth:	6378273 x 6356889.44891 m
PROJ-4 string:	+proj=stere +a=6378273 +b=6356889.44891 +lat_0=-90 +lat_ts=-70 +lon_0=0

Table 6: Definition of NH and SH grids.

4.3 File formats

The OSI-402-d and OSI-403-d sea ice edge and type products are available in Unidata NetCDF4 format. The NetCDF4 (Network Common Data Form) format is a public format, with documentation available at: http://www.unidata.ucar.edu/software/netcdf. These products use the CF 1.7 standard for metadata. The metadata in the NetCDF files is described in Appendix A.

4.4 Product dissemination

For users that wants the latest OSI SAF sea-ice products within the timeliness requirement, the products can be accessed through FTP, EUMETCast and THREDDS. In addition, the product archive is available from the EUMETSAT Data Center (EDC), FTP and THREDDS.

4.4.1 Sea Ice FTP server and THREDDS server

At the OSI SAF Sea-Ice FTP server the products of sea-ice edge and type are available (under the sub-directories *edge* or *type*, respectively). Here products from the last month can be collected. In addition, there is a separate directory with an archive of all previously produced sea-ice products (up to the most recent available product), see the FTP addresses below.

The same NetCDF files are also available on the THREDDS server (through the OpenDAP protocol):

FTP product : ftp://osisaf.met.no/prod/ice
FTP archive : ftp://osisaf.met.no/archive/ice
THREDDS : http://thredds.met.no/thredds/osisaf.html

The filename convention for these products is given in Table 7. More information about THREDDS is available here: http://www.unidata.ucar.edu/software/thredds/current/tds/TDS.html

4.4.2 EUMETCast dissemination and archiving at EDC

Through the EUMETSAT EUMETCast service, the OSI SAF Sea Ice products (NetCDF) are available. The distributed files have been compressed with gzip. Different file name conventions have been chosen for the sea-ice products at EUMETCast since many different other products are disseminated through EUMETCast, see Table 7. More information about the EUMETCast service can be found at www.eumetsat.int. The product files are archived at the EUMETSAT Data Center (EDC), which can be accessed through this link:

EDC : http://www.eumetsat.int/website/home/Data/DataDelivery/EUMETSATDataCentre/index.html

4.4.3 File name convention

The following table gives the file name convention used at the OSI SAF FTP and THREDDS servers, and on EUMETCast.

Sea Ice NetCDF4 files on FTP and THREDDS	
Sea-Ice Edge	ice_edge_<area>_polstere-100_multi_<date12>.nc
Sea-Ice Type	ice_type_<area>_polstere-100_multi_<date12>.nc
Sea Ice NetCDF4 files on EUMETCast	
Sea-Ice Edge	S-OSI_-NOR_-MULT-GL_<area>_EDGEn__-<date12>.nc.gz
Sea-Ice Type	S-OSI_-NOR_-MULT-GL_<area>_TYPEn__-<date12>.nc.gz

Table 7: File name convention for the sea-ice files on the OSI SAF FTP server and on EUMETCast.

where

<area> : nh for Northern Hemisphere products, sh for Southern Hemisphere.
<date12> : Date and time of the product on format YYYYmmddHHMM, e.g. 200701221200.

4.5 Helpdesk information

Users are welcomed and encouraged to contact the OSI SAF in case of questions to or problems with OSI SAF products, and OSI SAF will support the users as best possible. Please use the helpdesk form available on the OSI SAF website:

OSI SAF : www.osi-saf.org

Note, that you might need to register on the web site to send the form.

We also recommend users to subscribe to OSI SAF service messages (specific to the products used) to be aware of any production anomaly and of product upgrades. This is done on the OSI SAF web site (above) and you need to be registered to receive service messages.

A. Sea-ice products on NetCDF format

Below is given an example of the NetCDF header of a sea-ice edge file. The header parameters are similar for sea-ice type.

```
netcdf ice_edge_nh_polstere-100_multi_202001011200 {
dimensions:

time = 1 ;
nv = 2 ;
xc = 760 ;
yc = 1120 ;

variables:

int Polar_Stereographic_Grid ;
  Polar_Stereographic_Grid:grid_mapping_name = "polar_stereographic" ;
  Polar_Stereographic_Grid:straight_vertical_longitude_from_pole = -45.f ;
  Polar_Stereographic_Grid:latitude_of_projection_origin = 90.f ;
  Polar_Stereographic_Grid:standard_parallel = 70.f ;
  Polar_Stereographic_Grid:false_easting = 0. ;
  Polar_Stereographic_Grid:false_northing = 0. ;
  Polar_Stereographic_Grid:semi_major_axis = 6378273.f ;
  Polar_Stereographic_Grid:semi_minor_axis = 6356890.f ;
  Polar_Stereographic_Grid:proj4_string = "+a=6378273 +b=6356889.44891
         +lat_ts=70 +lon_0=-45 +proj=stere +lat_0=90" ;

double time(time) ;
  time:axis = "T" ;
  time:long_name = "reference time of product" ;
  time:standard_name = "time" ;
  time:units = "seconds since 1978-01-01 00:00:00" ;
  time:calendar = "standard" ;
  time:bounds = "time_bnds" ;

double time_bnds(time, nv) ;
  time_bnds:units = "seconds since 1978-01-01 00:00:00" ;

double xc(xc) ;
  xc:axis = "X" ;
  xc:units = "km" ;
  xc:long_name = "x coordinate of projection (eastings)" ;
  xc:standard_name = "projection_x_coordinate" ;

double yc(yc) ;
  yc:axis = "Y" ;
  yc:units = "km" ;
  yc:long_name = "y coordinate of projection (northings)" ;
  yc:standard_name = "projection_y_coordinate" ;
```

```
float lat(yc, xc) ;
  lat:long_name = "latitude coordinate" ;
  lat:standard_name = "latitude" ;
  lat:units = "degrees_north" ;

float lon(yc, xc) ;
  lon:long_name = "longitude coordinate" ;
  lon:standard_name = "longitude" ;
  lon:units = "degrees_east" ;

byte ice_edge(time, yc, xc) ;
  ice_edge:_FillValue = -1b ;
  ice_edge:long_name = "sea ice edge" ;
  ice_edge:standard_name = "sea_ice_classification" ;
  ice_edge:valid_min = 1b ;
  ice_edge:valid_max = 3b ;
  ice_edge:grid_mapping = "Polar_Stereographic_Grid" ;
  ice_edge:coordinates = "lat lon" ;
  ice_edge:flag_values = 1b, 2b, 3b ;
  ice_edge:flag_meanings = "open_water open_ice close_ice" ;
  ice_edge:flag_descriptions =
    " 1 -> no ice or very open ice\n",
    " 2 -> open ice cover (4 to 7 tens)\n",
    " 3 -> close, very close and fast ice\n",
    "" ;

short status_flag(time, yc, xc) ;
  status_flag:_FillValue = -1s ;
  status_flag:long_name = "status flag for sea ice edge retrieval" ;
  status_flag:standard_name = "status_flag" ;
  status_flag:valid_min = 0s ;
  status_flag:valid_max = 16384s ;
  status_flag:grid_mapping = "Polar_Stereographic_Grid" ;
  status_flag:coordinates = "lat lon" ;
  status_flag:flag_masks = 1s, 2s, 4s, 8s, 16s, 32s, 64s, 128s, 256s,
          512s, 1024s, 2048s, 4096s, 8192s ;
  status_flag:flag_meanings = "land lake not_in_use not_in_use high_t2m not_in_use not_in_use
          max_ice_climo areal_ice_type_masked seasonal_ice_type_masked backtrack_corrected
  threshold_corrected unclassified missing" ;
  status_flag:flag_descriptions = "1 -> Position is over land\n",
    " 2 -> Position is lake\n",
    " 4 -> Flag value is not in use\n",
    " 8 -> Flag value is not in use\n",
    " 16 -> Sea ice is set to \'no ice\' since the 2m air temperature is high at
          this position\n",
    " 32 -> Flag value is not in use\n",
    " 64 -> Flag value is not in use\n",
    " 128 -> Sea ice is set to \'no ice\' since position is outside maximum sea ice
          climatology\n",
    " 256 -> Sea ice type is set to \'first-year ice\' by the geographical ice type mask\n",
    " 512 -> Sea ice type is set to \'ambiguous\' due to season\n",
    " 1024 -> Sea ice type is set to \'first-year ice\' by the ice drift mask\n",
    " 2048 -> Sea ice type is set to \'first-year ice\' by the statistical filter\n",
    " 4096 -> Unclassified pixel\n",
    " 8192 -> Missing sea ice classification due to missing data\n",
    "" ;
```

```
float uncertainty(time, yc, xc) ;
  uncertainty:_FillValue = -1.e+10f ;
  uncertainty:long_name = "uncertainty in ice edge calculation" ;
  uncertainty:valid_min = 0.f ;
  uncertainty:valid_max = 1.f ;
  uncertainty:grid_mapping = "Polar_Stereographic_Grid" ;
  uncertainty:coordinates = "lat lon" ;

byte param_used(time, yc, xc) ;
  param_used:_FillValue = -1b ;
  param_used:long_name = "parameters used in processing edge" ;
  param_used:valid_min = 0b ;
  param_used:valid_max = 64b ;
  param_used:grid_mapping = "Polar_Stereographic_Grid" ;
  param_used:coordinates = "lat lon" ;
  param_used:flag_masks = 1s, 2s, 4s, 8s, 16s, 32s ;
  param_used:flag_meanings = "pr37_used prn90_used gr3719v_used pr19_gr3719v_used
                              anisFMB_used bscatt_used" ;
  param_used:flag_descriptions = "1 -> PR37 data used\n",
    " 2 -> PRn90 data used\n",
    " 4 -> GR3719V data used\n",
    " 8 -> PR19-GR3719V data used\n",
    " 16 -> anisFMB data used\n",
    " 32 -> BScatt data used\n",
    "" ;

byte orbit_num_ascat(time, yc, xc) ;
  orbit_num_ascat:_FillValue = -1b ;
  orbit_num_ascat:long_name = "number of orbits of ascat used in processing" ;
  orbit_num_ascat:valid_min = 0b ;
  orbit_num_ascat:valid_max = 127b ;
  orbit_num_ascat:grid_mapping = "Polar_Stereographic_Grid" ;
  orbit_num_ascat:coordinates = "lat lon" ;

byte orbit_num_amsr(time, yc, xc) ;
  orbit_num_amsr:_FillValue = -1b ;
  orbit_num_amsr:long_name = "number of orbits of amsr used in processing" ;
  orbit_num_amsr:valid_min = 0b ;
  orbit_num_amsr:valid_max = 127b ;
  orbit_num_amsr:grid_mapping = "Polar_Stereographic_Grid" ;
  orbit_num_amsr:coordinates = "lat lon" ;

byte orbit_num_ssmi(time, yc, xc) ;
  orbit_num_ssmi:_FillValue = -1b ;
  orbit_num_ssmi:long_name = "number of orbits of ssmi used in processing" ;
  orbit_num_ssmi:valid_min = 0b ;
  orbit_num_ssmi:valid_max = 127b ;
  orbit_num_ssmi:grid_mapping = "Polar_Stereographic_Grid" ;
  orbit_num_ssmi:coordinates = "lat lon" ;

// global attributes:

:title = "Daily Sea Ice Edge Analysis from OSI SAF EUMETSAT" ;
:product_id = "OSI-402-d" ;
:product_name = "osi_saf_ice_edge" ;
:product_status = "operational" ;
:abstract = "The daily analysis of sea ice edges and extent is obtained
            from operation satellite images, of the polar regions. It
            is based on atmospherically corrected signal and a Bayesian,
```

```
             merging approch to estimate sea ice class probabilities.
             This product is freely available, from the EUMETSAT Ocean
             and Sea Ice Satellite Application Facility (OSI SAF).;
:topiccategory = "Oceans ClimatologyMeteorologyAtmosphere" ;
:keywords = "Sea Ice Edge,Sea Ice,Oceanography,Meteorology,Climate,Remote Sensing" ;
:gcmd_keywords = "Cryosphere > Sea Ice > Ice Edges\\
                  Oceans > Sea Ice > Ice Edges\\
                  Cryosphere > Sea Ice > Ice Extent\\
                  Oceans > Sea Ice > Ice Extent\n",
                  "Vertical Location > Sea Surface\n",
                  "EUMETSAT/OSISAF > Satellite Application Facility on Ocean
                  and Sea Ice, European Organisation for the Exploitation of
                  Meteorological Satellites" ;
:northernmost_latitude = 89.936676764302 ;
:southernmost_latitude = 31.0781878972477 ;
:easternmost_longitude = 179.986696767411 ;
:westernmost_longitude = -179.938703698359 ;
:activity_type = "Space borne instrument" ;
:area = "Northern Hemisphere" ;
:instrument_type = "Multi-sensor analysis" ;
:platform_name = "Multi-sensor analysis" ;
:start_date = "2020-01-01 00:00:00" ;
:stop_date = "2020-01-02 00:00:00" ;
:project_name = "EUMETSAT OSI SAF" ;
:institution = "EUMETSAT OSI SAF" ;
:PI_name = "Signe Aaboe" ;
:contact = "osisaf-manager@met.no" ;
:license = "All intellectual property rights of the Ocean and Sea Ice SAF
            products belong to EUMETSAT. The use of these products is granted
            to every user, free of charge.
            If users wish to use these products, EUMETSAT\'s copyright credit
            must be shown by displaying the words \'Copyright EUMETSAT\'
            under each of the products shown.
            EUMETSAT offers no warranty and accepts no liability in respect of
            the Ocean and Sea Ice SAF products. EUMETSAT neither commits to nor
            guarantees the continuity, availability, or quality or suitability
            for any purpose of, the Ocean and Sea Ice SAF products." ;
:copyright_statement = "Copyright 2020 EUMETSAT" ;
:references = "OSI SAF Product User\'s Manual for the Global Sea Ice Edge and Type, Aaboe, S.,
              "http://www.osi-saf.org" ;
:history = "2020-11-25 creation" ;
:product_version = "5.0" ;
:software_version = "5.2" ;
:netcdf_version = "4.4.1.1" ;
:Conventions = "CF-1.7" ;
}
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