Ocean & Sea Ice SAF

Product User Manual for OSI SAF Global Sea Ice Concentration

Product OSI-401-b

Version 1.4

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Documentation Change Record

Document version	Software version	Date	Change	Description
V 0.9 (1)	V 1.0	14.10.2011		First Version. Based on the Sea Ice Product PUM osisaf_ss2_pum_ice-conc-edge-type_v3p11
V 1.0 draft	V 1.0	05.02.2015		Update. For ORR review.
V 1.0	V1.0	29.04.2015		Updates after ORR review
V 1.1	V 1.1	04.10.2015		Changes in NetCDF file and new variable description.
V 1.2	V 1.1	15.01.2015		Modifications of the mask are described.
V 1.3	V 1.2	29.04.2016		Updated NetCDF header in Appendix C, as F18 instrument now replaces F17
V 1.4	V 1.2	02.06.2016		Updated the filename conventions

The software version number gives the corresponding version of the OSI SAF High Latitude software chain which was used to produce the sea ice concentration product OSI-401-b.

(1) The present document is a continuation of the previous Product User Manual for OSI-401a, OSI-402a and OSI-403a, version 3.11, September 2014.

CONTENTS

1. Introduction

1.1 The EUMETSAT Ocean and Sea Ice SAF

For complementing its Central Facilities capability in Darmstadt and taking more benefit from specialized expertise in Member States, EUMETSAT created Satellite Application Facilities (SAFs), based on co-operation between several institutes and hosted by a National Meteorological Service. More on SAFs can be read from www.eumetsat.int.

The Ocean and Sea Ice Satellite Application Facility (OSI SAF) is producing on an operational basis a range of air-sea interface products, namely: wind, sea ice characteristics, Sea Surface Temperatures (SST), Surface Solar Irradiance (SSI) and Downward Longwave Irradiance (DLI). The sea ice products include sea ice concentration, the sea ice emissivity, sea ice edge, sea ice type and sea ice drift and sea ice surface temperature (from mid 2013).

The OSI SAF consortium is hosted by Météo-France. Sea ice products are produced at the OSI SAF High Latitude processing facility (HL centre), operated jointly by the Norwegian and Danish Meteorological Institutes. Resulting sea ice fields are available daily within 6 hours after the last satellite data acquisition. This means within 06 UTC each day. The sea ice products are delivered with global coverage on two files, one for the Northern and one for the Southern Hemisphere. In addition a separate product for the Atlantic part of the northern Hemisphere is produced.

1.2 Ownership and copyright of data

The OSI SAF sea ice concentration data have been produced under the responsibility of Norwegian Meteorological Institute and Danish Meteorological Institute.
The ownership and copyrights of the data set belong to EUMETSAT. The data is distributed freely, but EUMETSAT must be acknowledged when using the data. EUMETSAT's copyright credit must be shown by displaying the words "copyright (year) EUMETSAT" for each of the products used. User feedback to the OSI SAF project team is highly valued. The comments we get from our users is important argumentation when defining development activities and updates. We welcome anyone to use the data and provide feedback.

1.3 Scope

This document is dedicated to the OSI SAF product users and describes organization and layout of the sea ice concentration product (OSI-401-b).

1.4 Sea ice concentration algorithm

Since the start of the operational production of sea ice products in 2002 users have requested a longer sea ice concentration record specifically processed with the stability which is required for climate studies. It was therefore decided to reprocess historical passive microwave data extending the OSI SAF sea ice data set. This effort was started in 2006. The OSI SAF project team and these two Visiting Scientist projects initiated the OSI SAF reprocessing and produced a first version of the data set. Later further improvements have been ingested before the current version. The intention with the reprocessing project was also to further develop and update the sea ice concentration algorithm which is used for the day-to-day processing. The Algorithm Theoretical Basis Document (ATBD) [RD.2] describes the first step towards unifying the day to day and the

reprocessing sea ice concentration algorithms. Compared to the old day to day algorithm this new algorithm adjusts to the actual water and ice signatures and ensures inter-sensor calibration using dynamical tie-points. This step will further ease and speed-up the implementation of new microwave radiometer sensors and enable the estimation of uncertainty estimates.

This product fulfils the requirement OSI-PRD-PRO-205 in the OSI SAF Product Requirement Document [RD.1]. The sea ice concentration algorithm is presented in the algorithm theoretical basis document [RD.2]. No data or validation results are presented in this document. The validation results of the methodology are presented in the validation report [RD.3].
This product is delivered in GRIB, HDF5 and NetCDF formats through the OSI SAF Sea Ice FTP server and EUMETSAT EUMETCast service.

1.5 Definitions, acronyms and abbreviations

AMSR	Advanced Microwave Scanning Radiometer
ATBD	Algorithm Theoretical Basis Document
CMS	Centre de Météorologie Spatiale
CDL	network Common data form Description Language
CDOP	Continuous Development and Operations Phase (OSI SAF project)
CF	Climate and Forecast (Metadata Conventions)
DMI	Danish Meteorological Institute
ECMWF	European Centre for Medium range Weather Forecasts
FTP	File Transfer Protocol
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
GCMD	Global Change Master Directory
met.no	Norwegian Meteorological Institute
NASA	National Aeronautics and Space Administration
NetCDF	Network Common Data Form
NSIDC	National Snow and Ice Data Center
NWP	Numerical Weather Prediction
OSI SAF	Ocean and Sea Ice Satellite Application Facility
RTM	Radiative Transfer Model
SAR	Synthetic Aperture Radar
SMMR	Scanning Multichannel Microwave Radiometer
SSM/I	Special Sensor Microwave/Imager
SSMIS	Special Sensor Microwave Imager Sounder
Tb	Brightness temperature

1.6 Reference Documents

[RD.1] OSI SAF CDOP2 Product Requirement Document, v3.0.

[RD.2] OSI SAF Sea Ice Concentration Algorithm Theoretical Basis Document, v1.2.

[RD.3] OSI SAF Sea Ice Concentration Product Validation Report, v1.1.

2. Input data

This chapter describes the SSMIS satellite data which is processed by the OSI SAF sea ice concentration algorithm. The algorithm is flexible and it can process other types of microwave radiometer data such as SSM/I, SMMR, and AMSR. Further, the algorithm uses numerical weather prediction (NWP) data from ECMWF for correction of the brightness temperatures prior to calculating the sea ice concentration. The NWP parameter fields are briefly described in section 2.2.

2.1 The SSMIS constant incidence angle scanning microwave radiometer satellite data

The SSMIS is a polar orbiting conically scanning radiometer with constant incidence angle around 50deg 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. The SSMIS temperature sounding channels 1-4 near 50 GHz vertical polarisation penetrate into the lower troposphere and partially to the surface since the atmosphere is not totally opaque at those channels (Kunkee et al., 2008). The OSI SAF sea ice concentration algorithm uses brightness temperature swath data as input, using the 19V, the 37V and the 37H channel data.

2.2 NWP data and radiative transfer model correction

The brightness temperatures (Tb) are corrected explicitly for air temperature, wind roughening over open water and water vapour in the atmosphere prior to the calculation of ice concentration. The correction uses a radiative transfer model function (RTM) and NWP data. Over areas with both ice and water the influence of open water roughness on the Tb's and the ice emissivity is scaled linearly with the ice concentration. The emissivity of ice is given by standard tie-point emissivities (Comiso et al. 1997). The correction procedure is described in the ATBD and in Andersen et al. (2006B). The NWP model grid points are co-located with the satellite swath data in time and space and a correction to the Tb's is applied.

The representation of atmospheric liquid water column in the NWP data is not suitable to use for Tb correction (see Andersen et al., 2006B). The Tb's are therefore not corrected for the influence of liquid water. It is constrained to zero in the RTM. The RTM is described in Wentz (1997) and this specific implementation is described in the ATBD.

3. Processing scheme

This section describes the processing steps in the OSI SAF sea ice concentration processing scheme. The processing goes from level 2 swath data to level 3 re-sampled ice concentrations.

3.1 Level 2 processing

This main step contains all processing done on the original swath data, without re-sampling or averaging. Numerical weather prediction data from ECMWF were interpolated in time and space to the position of each brightness temperature swath grid point.

3.2 Dynamical tie-points

With the channels featured by the SSMIS in combination with the radiative characteristics of sea ice, it is possible to distinguish Arctic multiyear and first-year ice concentrations during winter. In order to achieve this it is necessary to provide typical emissivities or brightness temperatures called tie-points, of ice and open water. Errors and inconsistencies in the estimated ice concentrations may arise when deviations from the tie-point emissivities occur over time due to e.g. melting, snow cover effects and wind roughening of the ocean surface as well as spatially due to geographical differences in chemical and physical conditions. Nevertheless, tie-point sets, supplied with the various sea ice concentration algorithms, are usually hemispheric and constant in time, although Comiso et al. (1997) has defined sets to cover the summer period for the Bootstrap algorithm. Finally, it is usual to define the water tie-point based on minimum observed brightness temperatures, corresponding to a minimum atmospheric influence. However, due to the average atmospheric contribution, this results in an undesirable bias over open water and frequent spurious ice concentrations.
In order to improve on this, here we use dynamical tie-points based on the actual mean signatures of ice and of open water. The dynamical tie-point method described in the ATBD [RD.2] uses principal component analysis to determine clusters of sea ice and open water.

Every swath brightness temperature is corrected for the atmospheric influence. The swath data for one day is collected and using the NASA Team ice concentration for selection of signatures of 100% sea ice the following parameters are computed:

- The number of near 100% sea ice brightness temperature data points
- The number of open water (near the ice edge) brightness temperature data points
- Using a principal component analysis:
  - the coordinates of the open water tie-point
  - the vector describing the ice line

A weighted hemispheric mean over the last 30 days is computed based on the daily information. The 30 day mean is then used as the tie-point in the sea ice concentration algorithm.

3.3 Estimation of sea ice concentration

The analysis of atmospheric sensitivity in Andersen et al. (2006B) showed that the Bootstrap frequency mode algorithm (Comiso, 1986) had the lowest sensitivity to atmospheric noise over open water. Conversely, the comparison to high resolution SAR imagery in Andersen et al. (2007) revealed that of the algorithms using the low frequency channels (i.e. below 85 GHz), the Bristol

algorithm gave the best agreement. Consequently a hybrid algorithm has been established as a smooth combination of two of the tested algorithms, the Bristol algorithm and the Bootstrap frequency mode algorithm. To ensure an optimum performance over both marginal and consolidated ice, and to retain the virtues of each algorithm, the Bristol algorithm is given little weight at low concentrations up to 40%, while the Bootstrap algorithm is given little weight at concentrations over 40%. The algorithm is described in the ATBD [RD.2].

3.4 Level 3 processing

The ice concentration is calculated using the Bristol/Bootstrap sea ice concentration algorithm as described above with SSMIS tie-points for each observation during the analysis interval of 1 day. In the second step, the multi pass analysis, these results are analysed on the 10 km OSI SAF grid. Several SSMIS observation nodes, with estimated concentrations, influence each analysis grid point. The radius of influence, *r,* for each SSMIS observation is 75 km. The weight assigned to each SSMIS observation in the analysis is dependent on a Gaussian weighting scaled with the footprint size. Data is missing for the North and South pole pixels.

3.5 Climatology mask
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.

Particular regions with curved coastlines which contain large amounts of land spill over are masked out. In particular, regions of the Baltic are masked out.

Ice is only calculated on the lakes for months1, 2, 3, 4 and 12, otherwise the ice concentration is set to zero over the regions of the lakes that are not masked out. (See Section 3.6 for more details.)

3.6 The land mask and coastal zone

Measurements near the shore are a mixture of land, coast and sea emission. The coastline 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 land masks and a mask based on inspection of recent VIS-IR imagery developed by S. Kern, University of Hamburg. The mask 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.

Areas near the coast in the Baltic Sea and around Denmark have be masked out. This due to a large amount of land-spillover in that region.

All the lakes have been masked out, with the exception of central regions of lakes with sufficient large dimension to have low spill over noise in their centres. Lakes Superior, Michigan and Huron. Here, the sea ice algorithm has been applied to fresh water, so these measurements should be applied with caution, and only indicative of the presence of ice.

3.7 Sea ice concentration uncertainties

Uncertainty estimates are needed when the ice concentration data are compared to other data sets or when the ice concentrations are assimilated into numerical models. The mean precision of some of the more common algorithms, used to compute ice concentration from SSM/I data, such as NASA Team and Bootstrap are reported to be 1-6 % in winter (Andersen et al., 2006A). This is also achieved with the OSI SAF algorithm measured as the standard deviation of the difference relative

to a reference (open water or 100% ice).

The polar atmosphere is generally transparent for microwave radiation in the sounding channels called the atmospheric windows. When computing the ice concentration using the atmospheric window channels, the atmospheric emission and scattering is an error source. The tie-points are typical ice and water signatures representative on a hemispheric scale. Deviations from the typical surface emission signatures result in ice concentration uncertainties.

The SSMIS instrument has large footprints on the ground, and the algorithms with the lowest sensitivity to both atmospheric and surface emissivity variability use Tb's at different frequencies with different footprint size. Representing these large footprints on a finer, predefined grid results in a representativeness error. This is sometimes called smearing. Additional sources of error are the geo-location error, sensor noise, drift, and sea ice variability over the sampling period.

The representativeness error is computed as a function of ice concentration using a model. The tie-point uncertainty, including residual atmospheric noise, sensor noise and ice surface emissivity variability, is derived from measurements. The total uncertainty is the sum of the different uncertainties squared:

$$\varepsilon_{total}^2 = \varepsilon_{algorithm}^2 + \varepsilon_{smearing}^2$$

where the algorithm uncertainty is the inherent uncertainty of the concentration algorithm and the smearing uncertainty is the uncertainty due to re-sampling to a grid where the sensor footprint covers more than one pixel. These are the three uncertainties given in the ice concentration product. The sea ice concentration uncertainty algorithm is described in detail in the ATBD [RD.2]

4. Validation and quality control

The validation is described in the validation report [RD.3].

5. Product description

This chapter gives a description of the product specification, metadata, data formats and product distribution.

5.1 Product specification

The product consists of these major fields:
•sea ice concentration
•uncertainties: total, algorithm and smearing
•confidence level

Sea ice concentration
Sea ice concentration indicates the fraction of a given ocean grid point covered by ice. It is given as a real number, with range from 0-100%.

Uncertainties
The algorithm uncertainty, the smearing uncertainty and the resulting total uncertainty of each sea ice concentration grid cell value are given in three separate fields. The uncertainties are given in percentages, with a range from 0-100%. The algorithm is described in the ATBD.

Confidence level
The confidence level is based on the daily standard deviation within each gridcell, i.e. the grid cell standard deviation going from L2 to L3.

The confidence level is defined using the calculated standard deviation (SD) of the sea ice concentration going from L2 to L3. The confidence levels are defined as follows:
•nominal processing, excellent quality: SD 0 – 10
•nominal processing, good quality: SD 10 – 20
•nominal processing, acceptable quality: SD 20 – 30
•processed but to be used with care: SD > 30
•computation failed: Erroneous
•not processed, no input data: No data.

The confidence level is given a guide only. The user is advised to use the total uncertainty to estimate the quality of the data, rather that the confidence level. The confidence level is subject to elimination in future product versions.

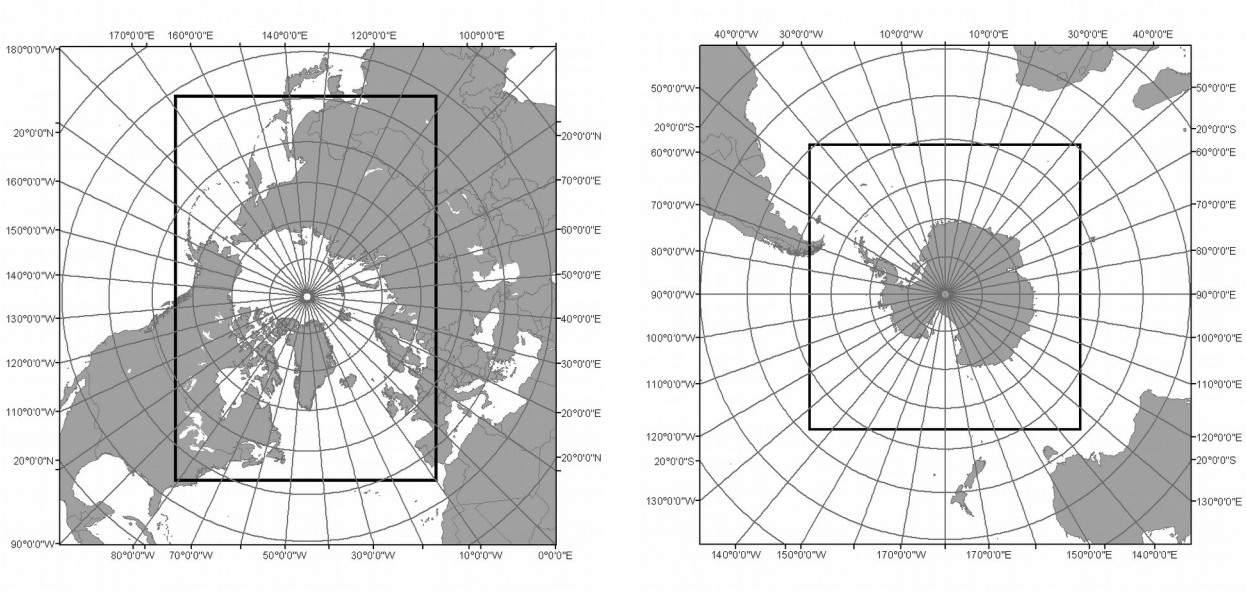
5.2 Grid specification

The product grids are adapted from the 25 km resolution Goddard Space Flight Center projections used to disseminate various SSM/I 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).

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

Geographical definition for Northern Hemisphere Grid, NH	
Projection:	Polar stereographic projection true at 70°N
Resolution:	10 km
Size:	760 columns, 1120 lines
Central Meridian:	45°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, SH	
Projection:	Polar stereographic projection true at 70°S
Resolution:	10 km
Size:	790 columns, 830 lines
Central Meridian:	0°
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



Northern Hemisphere **Southern Hemisphere**

Figure 1: Coverage of the Northern and Southern grids are shown by the black, thick boxes (from NSIDC).

5.3

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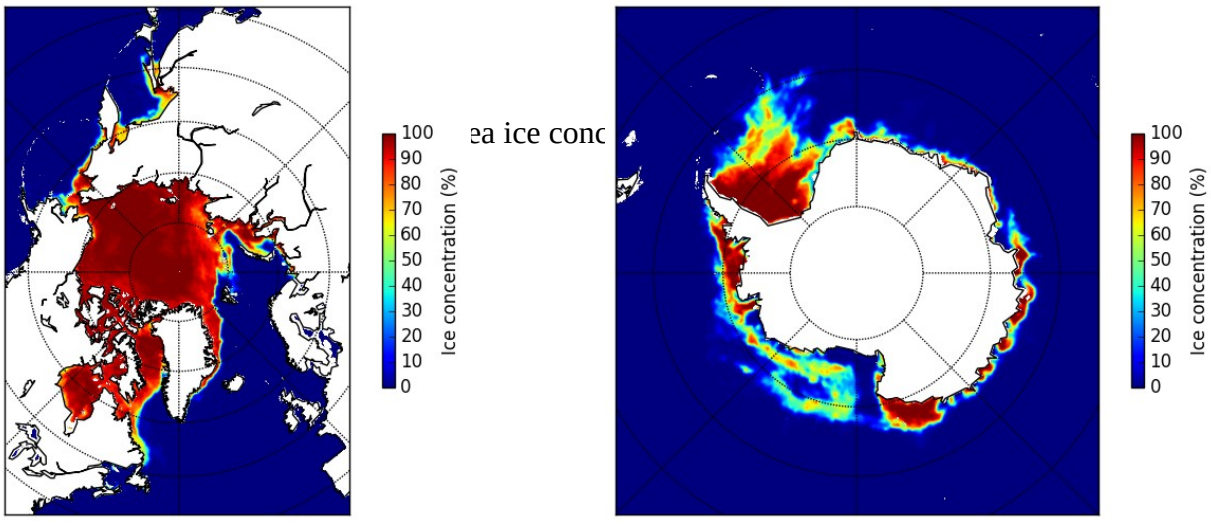

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Figure 2: The ice concentration for 05 January 2016 at the Northern (left) and Southern (right) Hemispheres.

5.4 File formats

The products are available under WMO GRIB format, NCSA HDF5 format and Unidata NetCDF format. More information about the OSI SAF sea ice data formats can be found at [http://saf.met.no] under Data formats.

GRIB format
A complete description of the GRIB format can be found in WMO publication No 306, Manual on Codes. A few parameters are encoded in the GRIB header. This manual is available at:
http://library.wmo.int/pmb_ged/wmo_306-v1-1-2015_en.pdf

The header sections of the GRIB files contain the metadata for the OSI SAF products, and these are described in Appendix A. Due to limitations in the GRIB format, there are fewer metadata in the GRIB files than in the HDF5 and NetCDF files.

HDF5 format
The HDF5 format is a public format. Documentation is found at:
http://www.hdfgroup.org/HDF5/doc

The metadata are stored in HDF5 attributes. Appendix B describes the HDF5 attributes defined for the sea ice concentration data products.

NetCDF3 format
The NetCDF3 format is a public format, with documentation available at:
http://www.digitalpreservation.gov/formats/fdd/fdd000330.shtml

The OSI SAF sea ice products use the CF 1.0 standard for metadata in the NetCDF3 files. The metadata in the NetCDF3 files are described in Appendix C. More metadata have been added to the NetCDF files compared to the HDF5 files.

5.5 Data distribution

There are two main sources for obtaining the OSI SAF Sea Ice products; by FTP or through EUMETCast. In addition the products can be delivered through the Regional Meteorological Data Communication Network (RMDCN) on request.

At the OSI SAF Sea Ice FTP server [ftp://saf.met.no/prod/ice] the products are available in GRIB and HDF5 format. Here products from the last month are available. In addition there is a separate directory with an archive of all previously produced sea ice products (up to the last available product) at [ftp://saf.met.no/archive/ice]. The file name convention for these products is given in the table below.
Through the EUMETSAT EUMETCast service the OSI SAF Sea Ice products are available in the GRIB format. 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 products are disseminated through EUMETCast. More information about the EUMETCast service can be found at [http://www.eumetsat.int].

5.6 Filename convention

The following table gives the file name convention used on the OSI SAF FTP server.

File name convention for NH and SH files on OSI SAF FTP and LDAP server	
Sea Ice Product	
NetCDF3, GRIB and HDF5	
Ice concentration	ice_conc_<hemisphere>_polstere-100_multi_<date12>.<filetype>

<hemisphere>: NH for Northern Hemisphere products, SH for Southern Hemisphere.
<date12>: Date and time of the product on format YYYYMMDDHOMI, e.g. 201501011200.
<filetype>: “grb” for GRIB files, “hdf5” for HDF5 files, “nc” for NetCDF files.

The following table gives the file name convention used for the products disseminated through EUMETCast.

File name convention for NH and SH files through EUMETCast	
Sea Ice Product	
GRIB	
Ice concentration	S-OSI_-DMI_-MULT-GL_<hemisphere>_CONC__-<date12>Z.grb.gz

References

Andersen, S., L. Toudal Pedersen, G. Heygster, R. Tonboe, and L Kaleschke, Intercomparison of passive microwave sea ice concentration retrievals over the high concentration Arctic sea ice. *Journal of Geophysical Research* 112, C08004, doi10.1029/2006JC003543, 2007.

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Andersen, S., R. Tonboe, S. Kern, and H. Schyberg. Improved retrieval of sea ice total concentration from spaceborne passive microwave observations using Numerical Weather Prediction model fields: An intercomparison of nine algorithms. *Remote Sensing of Environment104, 374-392*, 2006B.

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Smith, D. M. Extraction of winter sea ice concentration in the Greenland and Barents Seas from SSM/I data. *International Journal of Remote Sensing 17*(13), 2625-2646, 1996.

Wentz, F. J. A well-calibrated ocean algorithm for SSM/I. *Journal of Geophysical Research* 102(C4), 8703-8718, 1997.

Appendix A: Limited description of the GRIB file header

The GRIB files are written using the EMOS library, developed at ECMWF. Internally, the data are stored using the GRIB bitmap convention, which means that missing value elements are marked and removed. The user should be aware that on retrieval, these elements will be assigned a user defined value that should be set to the missing value for the given field. This is -32767.0 for ice concentration data.

The parameters in sections 1, 2 and 3 of the GRIB files, which are specific to the OSI SAF Sea Ice products, are given in the following table. The parameter names or values with an asterisk (*) refer to tables given in WMO publication No 306 - Manual on Codes. Note that the Earth figure used cannot be adequately coded following the GRIB standard. The earth figure implied in the component flags bitmask of section 2 octet 17 is not meaningful. For convenience the two earth radii and latitude of true scale have been stored as vertical components in section 2. Due to the floating point representation used in GRIB the earth radii are accurate only to the nearest meter; however this has no practical significance. This deviation from the standard has been marked by double asterisks (**).

Octet	Content	Value
Section 1		
1-3	Length in octets of Section 1	
4	Version number	3
5	Center identifier	88 for met.no Oslo
6	Process identifier	1 for met.no Oslo
7	grid definition	255 (grid defined in Section 2)
8	flag section 2 and 3	128* for the quality index fields (TBC) 192* for the other fields (TBC)
9	Parameter	91* for sea ice concentration 230 for sea ice concentration quality index
10	type of level	1*
11-12	Level	0*
13-17, 25	Reference time	
18	time unit indicator	2*
19	P1*	0
20	P2*	0
21	time range indicator	0
22-23	Number of products included	number of hourly fields (or orbits) actually included in the product
24	Number of products missing	number of missing hourly fields (or orbits)
27-28	Decimal scale factor	0*
29	Local use flag	0* (no local use)
Section 2		
1-3	Length in octets of Section 2	
4	Number of vertical coordinate parameters	3**
5	Location of the list of vertical coordinate parameters	255* (not present)
6	data representation type	5 (Polar stereographic projection grid)
7-8	Number of points along x-axis	760 for NH, 790 for SH
9-10	Number of points along y-axis	1120 for NH, 830 for SH
11-13	Latitude of first grid point	33975 for NH, -41502 for SH
14-16	Longitude of first grid point	-80730 for NH, -135000 for SH

17	Resolution and component flags	00000000*
18-20	Longitude of the meridian parallel to y-axis	-45000 for NH, 0 for SH
21-23	x-direction grid length	10000
24-26	y-direction grid length	10000
27	Projection centre flag	0* (North pole on the projection plane) for NH 128* (South pole on the projection plane) for SH
28	Scanning mode flags	01000000*
33-36	Major axis	6378273** for NH and SH
37-40	Minor axis	6356890** for NH and SH
41-44	Latitude of true scale	70.0 for NH**, -70.0 for SH**
Section 3		
1-3	Length in octets of Section 3	
4	Number of unused bits at the end of Section 3	
5-6	Bitmap flag	1* for the quality index field 0* for the other fields

Appendix B: The OSIHDF5 format

The sea ice products are stored in a local implementation of the HDF5 format, which is called the OSIHDF5 format. More details about this format are presented at the OSI SAF Sea Ice web portal [http://saf.met.no], under Documents. The information presented here describes all the metadata in the product files.

The tables in this appendix give the description of the parameters and the content of the fixed parameters for each sea ice product.

OSI SAF Sea Ice products HDF5 format		
Object	Element	Contents
Header	source	Source of product, “OSI_SAF_HL” for all products.
	product	Type of product.
	area	Name of product grid area.
	projstr	PROJ-4 string for product projection.
	iw	Image width.
	ih	Image height.
	z	Number of fields in file, “1” for all products.
	Ax	Pixel size in x and y-direction.
	Ay	
	Bx	x and y-position of upper left corner of upper left pixel in UCS coordinates.
	By	
	year	Date and time of product.
	month	
	day	
	hour	
	minute	
data[00]	description	Description of data field.
	osi_dtype	Data value type.

Values for fixed Header parameters for the hree product grids			
Parameter	NH grid	SH grid	
area	“OSISAF_NH”	“OSISAF_SH”	
projstr	(see tables under 'Grid Specification' for values)		
iw	760	790	
ih	1120	830	
Ax	10.0	10.0	
Ay	10.0	10.0	
Bx	-3850.0	-3950.0	
By	5850.0	4350.0	

Values for fixed parameters for each Sea Ice product			
Sea Ice Product	Header/“product”	data/”description”	data/”osi_dtype”
Ice concentration	“Ice Conc”	“Ice Conc”	OSI_FLOAT
Ice concentration quality index	“Ice Conc QF”	“Ice Conc QF”	OSI_UINT

Appendix C: Sea Ice products in NetCDF format

The OSI SAF Sea Ice products have been made available on NetCDF format.
Below is an example of the NetCDF header of a sea ice concentration file.

```
netcdf ice_conc_sh_polstere-100_multi_201604281200 {
dimensions:
	time = 1 ;
	nv = 2 ;
	xc = 790 ;
	yc = 830 ;
variables:
	int Polar_Stereographic_Grid ;
		Polar_Stereographic_Grid:grid_mapping_name = "polar_stereographic" ;
		Polar_Stereographic_Grid:false_easting = 0. ;
		Polar_Stereographic_Grid:false_northing = 0. ;
		Polar_Stereographic_Grid:semi_major_axis = 6378273. ;
		Polar_Stereographic_Grid:semi_minor_axis = 6356889.44891 ;
		Polar_Stereographic_Grid:straight_vertical_longitude_from_pole = 0. ;
		Polar_Stereographic_Grid:latitude_of_projection_origin = -90. ;
		Polar_Stereographic_Grid:standard_parallel = -70. ;
		Polar_Stereographic_Grid:proj4_string = "+proj=stere +a=6378273
+b=6356889.44891 +lat_0=-90 +lat_ts=-70 +lon_0=0" ;
	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 in Cartesian system" ;
		xc:standard_name = "projection_x_coordinate" ;
	double yc(yc) ;
		yc:axis = "Y" ;
		yc:units = "km" ;
		yc:long_name = "y coordinate in Cartesian system" ;
		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" ;
	short ice_conc(time, yc, xc) ;
		ice_conc:_FillValue = -999s ;
		ice_conc:long_name = "The sea ice concentration on the southern
hemisphere" ;
		ice_conc:standard_name = "sea_ice_area_fraction" ;
		ice_conc:units = "%" ;
		ice_conc:valid_min = 0s ;
		ice_conc:valid_max = 10000s ;
		ice_conc:grid_mapping = "Polar_Stereographic_Grid" ;
		ice_conc:coordinates = "lat lon" ;
		ice_conc:scale_factor = 0.01f ;
		ice_conc:add_offset = 0.f ;
	byte confidence_level(time, yc, xc) ;
		confidence_level:long_name = "confidence level" ;
		confidence_level:valid_min = 0b ;
		confidence_level:valid_max = 5b ;
		confidence_level:grid_mapping = "Polar_Stereographic_Grid" ;
```

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              confidence_level:coordinates = "lat lon" ;
              confidence_level:flag_values = 0b, 1b, 2b, 3b, 4b, 5b ;
              confidence_level:flag_meanings = "unprocessed, erroneous, unreliable,
acceptable, good, excellent" ;
              confidence_level:flag_descriptions = "\n",
                     "0 -> not processed, no input data\n",
                     "1 -> computation failed\n",
                     "2 -> processed but to be used with care\n",
                     "3 -> nominal processing, acceptable quality\n",
                     "4 -> nominal processing, good quality\n",
                     "5 -> nominal processing, excellent quality" ;
       byte status_flag(time, yc, xc) ;
              status_flag:_FillValue = -1b ;
              status_flag:units = "1" ;
              status_flag:long_name = "status flag for concentration of sea ice retrieval"
;
              status_flag:standard_name = "sea_ice_area_fraction status_flag" ;
              status_flag:valid_min = 0b ;
              status_flag:valid_max = 102b ;
              status_flag:grid_mapping = "Polar_Stereographic_Grid" ;
              status_flag:coordinates = "lat lon" ;
              status_flag:flag_values = 0b, 2b, 10b, 14b, 100b, 101b, 102b ;
              status_flag:flag_meanings = "nominal lake background type_mask land missing
unclassified" ;
              status_flag:flag_descriptions = "\n",
                     "  0 -> nominal value from algorithm used\n",
                     "  2 -> sea ice algorithm applied over lake\n",
                     " 10 -> background data was used for setting the value\n",
                     " 14 -> value set using an ice type mask\n",
                     "100 -> missing value due to over land\n",
                     "101 -> missing value due to missing data\n",
                     "102 -> unclassified pixel" ;
       float total_uncertainty(time, yc, xc) ;
              total_uncertainty:_FillValue = -1.e+10f ;
              total_uncertainty:least_significant_digit = 3 ;
              total_uncertainty:units = "1" ;
              total_uncertainty:long_name = "The sea ice concentration uncertainty on the
southern hemisphere" ;
              total_uncertainty:coordinates = "lat lon" ;
              total_uncertainty:grid_mapping = "Polar_Stereographic_Grid" ;
       float smearing_uncertainty(time, yc, xc) ;
              smearing_uncertainty:_FillValue = -1.e+10f ;
              smearing_uncertainty:least_significant_digit = 3 ;
              smearing_uncertainty:units = "1" ;
              smearing_uncertainty:long_name = "The sea ice concentration smearing
uncertainty on the southern hemisphere" ;
              smearing_uncertainty:coordinates = "lat lon" ;
              smearing_uncertainty:grid_mapping = "Polar_Stereographic_Grid" ;
       float algorithm_uncertainty(time, yc, xc) ;
              algorithm_uncertainty:_FillValue = -1.e+10f ;
              algorithm_uncertainty:least_significant_digit = 3 ;
              algorithm_uncertainty:units = "1" ;
              algorithm_uncertainty:long_name = "The sea ice concentration algorithm and
tie-point uncertainty on the southern hemisphere" ;
              algorithm_uncertainty:coordinates = "lat lon" ;
              algorithm_uncertainty:grid_mapping = "Polar_Stereographic_Grid" ;

// global attributes:
              :title = "Daily Sea Ice Concentration Analysis from OSI SAF EUMETSAT" ;
              :product_id = "OSI-401" ;
              :product_name = "osi_saf_ice_conc" ;
              :product_status = "operational" ;
              :abstract = "The daily analysis of sea ice concentration is obtained from
operation satellite images of the polar regions. It is based on atmospherically corrected
signal and a carefully selected sea ice concentration algorithm. This product is freely
available from the EUMETSAT Ocean and Sea Ice Satellite Application Facility (OSI
SAF)." ;
              :topiccategory = "Oceans Climatology Meteorology Atmosphere" ;
              :keywords = "Sea Ice Concentration, Sea Ice, Oceanography, Meteorology,
```

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Climate, Remote Sensing" ;
              :gcmd_keywords = "Cryosphere > Sea Ice > Sea Ice Concentration\n",
                     "Oceans > Sea Ice > Sea Ice Concentration\n",
                     "Geographic Region > Northern Hemisphere\n",
                     "Vertical Location > Sea Surface\n",
                     "EUMETSAT/OSISAF > Satellite Application Facility on Ocean and Sea
Ice, European Organisation for the Exploitation of Meteorological Satellites" ;
              :activity_type = "Space borne instrument" ;
              :easternmost_longitude = 180. ;
              :westernmost_longitude = -180. ;
              :northernmost_latitude = -39.23089 ;
              :southernmost_latitude = -90. ;
              :area = "Southern Hemisphere" ;
              :instrument_type = "Multi-sensor analysis" ;
              :platform_name = "Multi-sensor analysis" ;
              :start_date = "2016-04-28 00:00:00" ;
              :stop_date = "2016-04-29 00:00:00" ;
              :project_name = "EUMETSAT OSI SAF" ;
              :institution = "EUMETSAT OSI SAF" ;
              :PI_name = "Rasmus Tonboe" ;
              :contact = "osisaf-manager@met.no" ;
              :distribution_statement = "Free" ;
              :copyright_statement = "Copyright 2016 EUMETSAT" ;
              :references = "OSI SAF Sea Ice Product Manual, Eastwood S. (editor)\n",
                     " v3.9, October 2013\n",
                     " http://osisaf.met.no\n",
                     " http://www.osi-saf.org" ;
              :history = "2016-04-29 creation" ;
              :product_version = "3.0" ;
              :software_version = "5.0.1" ;
              :netcdf_version = "3.6.3" ;
              :Conventions = "CF-1.4" ;
}
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