PRODUCT USER MANUAL

For Arctic Sea Ice observations

Sea Ice Concentration and Sea Ice Type

SEAICE_ARC_PHY_AUTO_L4_NRT_011_015

Issue: 1.0

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CHANGE RECORD

Issue	Date	§	Description of Change	Author	Validated By
1.0	2020.09.04	All	Initial version	F. Dinessen, A. Korosov C. Wettre	C. Wettre

TABLE OF CONTENTS

GLOSSARY AND ABBREVIATIONS

CF	Climate Forecast (convention for NetCDF)
CMEMS	Copernicus Marine Environment Monitoring Service
DGF	Direct Get File (FTP-like CMEMS service tool to download a NetCDF file)
FTP	Protocol to download files
GLO	Global
NetCDF	Network Common Data Form
PUM	Product User Manual
QUID	Quality Information Document
Subsetter	CMEMS service tool to download a NetCDF file of a selected geographical box and time range
OpenDAP	Open-Source Project for a Network Data Access Protocol. Protocol to download subset of data from a n-dimensional gridded dataset (ie: 4 dimensions: lon-lat,depth,time)
SIC	Sea Ice Concentration
SI-type	Sea Ice Type
EUMETSAT	European Organization for the Exploitation of Meteorological Satellites
OSISAF	Ocean and Sea Ice Satellite Application Facility
NWP	Numerical Weather Prediction
TB	Temperature Brightness

I INTRODUCTION

I.1 Summary

This document is the user manual for the CMEMS product SEAICE_ARC_PHY_AUTO_L4_NRT_011_015 disseminated as part of the CMEMS Sea Ice Thematic Ensemble Centre. The product covers the Arctic with focus on the European part of the Arctic. It is automatic generated in NRT based on the latest available satellite data. The product comprises of two datasets:

- cmems_obs-si_arc_phy-siconc_nrt_L4-auto_P1D

A high-resolution sea ice concentration product produced from a combination of satellite data from Sentinel-1 Synthetic Aperture Radar (SAR) and Advanced Microwave Scanning Radiometer 2 (AMSR2). This dataset contains three sub-datasets:

- Sea Ice concentration
- Confidence given as probability of correct classification
- Status_flag, indication land, coastal areas and satellites used in different areas.

- cmems_obs-si_arc_phy-icetype_nrt_L4-auto_P1D

A high-resolution sea ice type (stage of development) product produced based on Sentinel-1 Synthetic Aperture Radar (SAR). This dataset contains two sub-datasets:

- Sea Ice Type (stage of development) separated into open water, young ice, first-year ice, multi-year ice.
- Confidence given as probability for correct classification

The datasets are updated as follows every day:

- Starting from midnight the satellite data servers are checked for new data at regular intervals.
- All new satellite images are processed individually.
- Around noon, the individual analysis is merged into a netCDF mosaic and made available for dissemination.

The product is published on the CMEMS dissemination server after automatic quality controls. Product is available on-line and disseminated through the CMEMS Information System. Files downloaded are in NetCDF format and follow CF-1.4 convention.

More detailed information can be obtained from the CMEMS Service Desk (servicedesk.cmems@mercator-ocean.eu).

I.2 History of changes

15/01/2021	First version of document

II PRODUCT DESCRIPTION

II.1 General Description

This product covers the European Arctic areas and is produced daily based on the latest available satellite data covering the relevant areas. Two different datasets are included in the product and are described in more detail below:

II.2 Sea Ice Concentration

The Sea Ice Concentration product is a multisensor product generated from merging SIC derived from passive microwave AMSR-2 data and SAR data from Sentinel-1.

II.2.1 AMSR-2 Sea Ice Concentration

The AMSR-2 sea ice concentration processing operational processed using the OSI SAF / ESA CCI+ Hybrid Dynamic (OSHD). The procedures for processing the level 2 swath sea ice concentration products are schematically presented in Figure 1

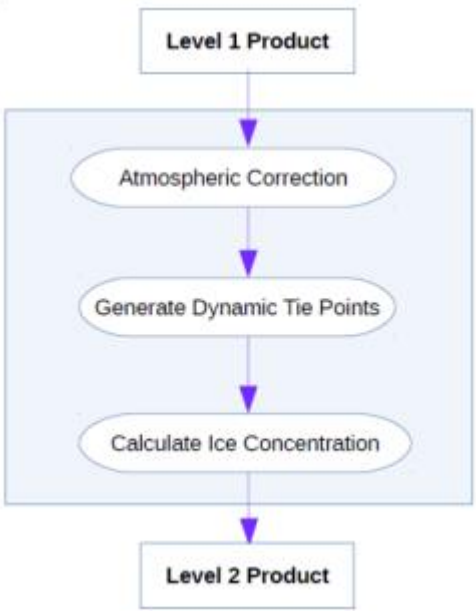


Figure 1: Processing flow chart for level 2 production.

The AMSR-2 instrument is a dual-polarized (V/H polarization), conically scanning, microwave radiometer. The conically scanning radiometer has a constant incidence angle of approximately 55

degree on the ground and a swath width of approximately 1450 km. The channels used in the computation of the ice concentration fields are given in Table 1.

Nominal Band (GHz)	Band(GHz)	Polarizaton	Spatial Resolution(km x km)
19	18.70	V	22 x 14
37	36.50	V,H	12 x 7
89	89.00	V,H	5 x 3

Table 1: The AMSR-2 instrument channels used for computation of the ice concentration product and their spatial resolution.

The high-frequency sea ice concentration algorithm uses the two high frequency channels (89H and 89V), thus providing a spatial resolution of ~5 km. A sea-ice concentration at lower resolution (and lower noise) computed from the 18.7 and 36.5 GHz channels is also used as part of the RTM correction (first-guess).

In Level 2 processing, atmospheric correction is first applied to the AMSR-2 Level 1 global swath brightness temperatures (Tb) using RTM and NWP data and the first-guess sea-ice concentration estimate. Secondly, the daily dynamic tie-points for the ice concentration algorithms are determined. With the inputs from the above two steps (Figure 1), the final ice concentration is calculated using a high-frequency / high-resolution algorithm (near90 GHz).

The atmospheric water vapour content and wind roughening of the open sea surface can sometimes be problematic for sea ice concentration retrievals. Here, the brightness temperatures (Tb) are corrected explicitly for wind roughening over open water and water vapour in the atmosphere prior to the calculation of the high-frequency ice concentration. The correction is using an 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 a first-guess ice concentration, computed from the 18.7 and 36.5 GHz imagery.
The emissivity of ice is determined from standard tie-point emissivities. The correction procedure was introduced in Andersen et al. (2006B) and further refined in Lavergne et al. (2019).

Sea-ice concentration algorithms using passive microwave observations use tie-points. Tie-points are the typical Tb signature of two extreme sea-ice cover conditions: 0% SIC (open water -OW- tie-point) and 100% SIC (closed-ice -CI- tie-point). As in the OSI SAF / ESA CCI approach, we use dynamic tie-points, that are changed on a daily basis.

The high-frequency sea-ice concentration algorithm is the “near 90 GHz linear” algorithm (Ivanova et al. 2015), but adapted to make use of dynamic tie-points (see section above). In practice, the equation of the CI line in the x=89V, y=89H Tb space is known from the dynamic Tb training samples, and the OW tie-point is a point in that same Tb space diagram.

Given a new observed Tb (a 2d point in the 89V, 89H space), the SIC by the near-90 GHz linear is estimated as the ratio of distances between the OW and the observed Tb point to the distance between the OW point and the CI line:

$$C(T_b) = \frac{v(T_b - \langle T^{OW} \rangle)}{v(\langle T^{CI} \rangle - \langle T^{OW} \rangle)}$$

where v is a unit vector perpendicular to the CI ice line (the coordinates of v are derived from the equation of the CI ice line).

The computed ice concentration estimates in swath projection for each swaths available in the area of interest are concatenated and gridded onto the multisensor grid as a daily level 3 product. An example of a daily product is shown in Figure 2.

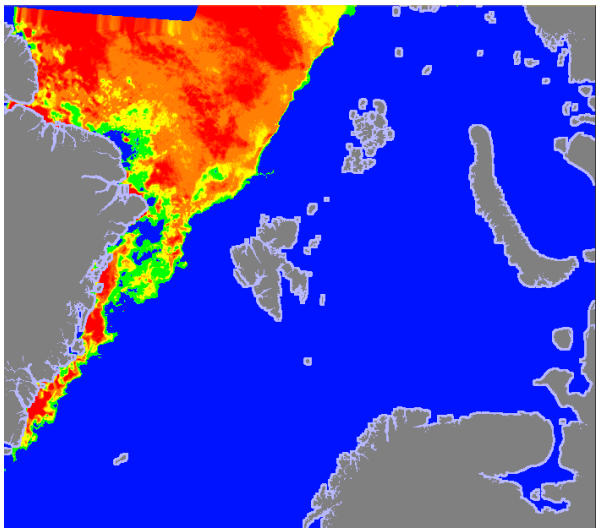


Figure 2: AMSR2 sea ice concentration from 24. August 2020

II.2.2 Sentinel-1 Sea Ice concentration

The SAR data used are Sentinel-1 dual-polarized (HH/HV polarization combination) recorded in Extra wide swath mode with a swath width of 410km and a spatial resolution of 93x87 m (pixel spacing of 40x40m). First, the data are classified into ice/water pixels by a Bayesian classification method before the sea ice concentration is estimated based on area of ice cover within an area of ~1x1km. ***Figure 3*** shows the main steps of the Sentinel-1 SIC processing:

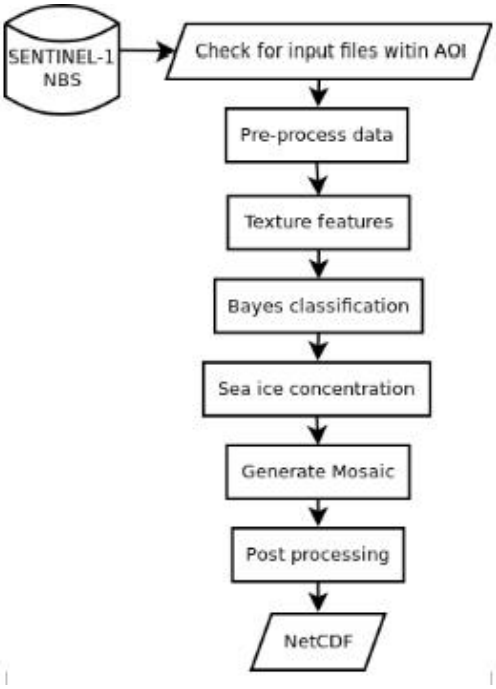


Figure 3: Sentinel-1 processing flow

In the pre-processing the Senitnel-1 backscatter data are absolute calibrated into sigma nought values (σ^0) for each pixel. The thermal noise is then removed from the signal before speckling filtering. From the cross-polarization (HV-pol), texture features for entropy and variance are calculated. The four features co- and cross-polarization, entropy and variance are then used as input to a Bayesian classification where the individual pixels are classified into sea ice or water. An example of the features used as input to the Bayesian classification is shown in Figure 4***Figure 4*** where backscatter from HH and HV are to the left and variance and entropy are to the right.

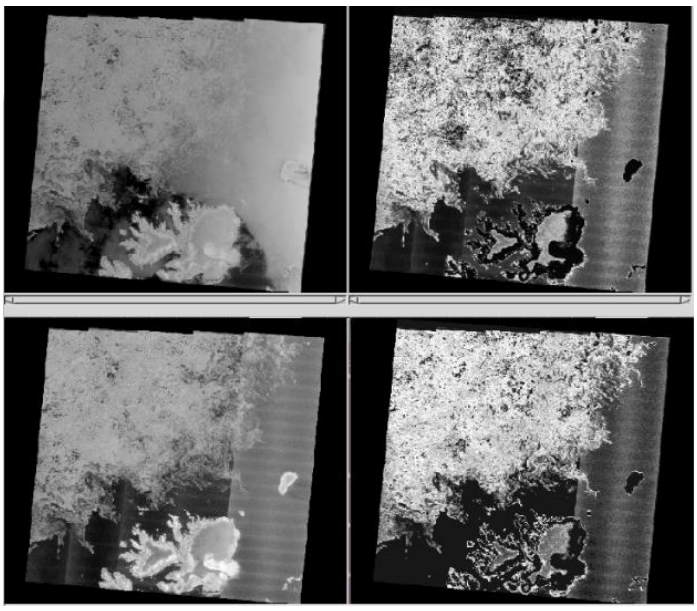


Figure 4: Example of features used as input in the Bayesian classification. Upper left is the backscatter of HH-polarization while HV-polarization is shown in lower left. Upper right are the variance and lower right are the entropy.

After separation into ice/water the concentration is calculated from area covered by ice inside a 1x1 km area. All available Sentinel-1 classified images are then projected to a polar stereographic projection and merged into a mosaic file. The mosaic file is a two layer product containing sea ice concentration and probability of correct classification. An example of the Sentinel-1 mosaic from 12. January 2021 is shown in Figure 5.

One of the challenges when classifying SAR into ice or water is backscatter ambiguity when strong wind generate capillary waves over open water. This may produce a backscattering signal similar to sea ice giving rise to a misclassification of the data. To avoid these errors to appear in the final multisensor product a wind filter is applied to the SAR SIC product. The filter increases the uncertainties of the SAR SIC products in areas where wind speed is above 10 m/s. Information about the wind speed is extracted form a NWP model running at MET-Norway.

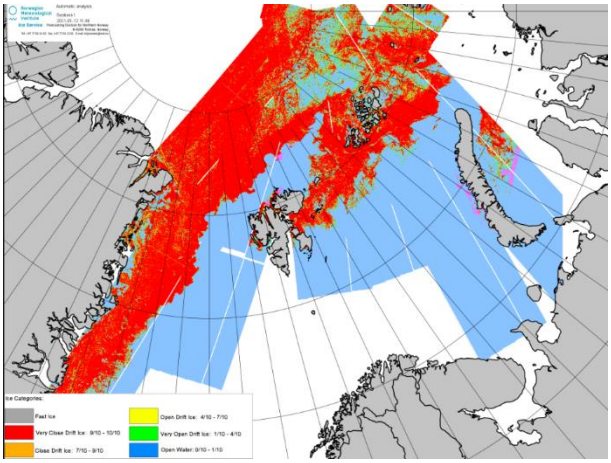


Figure 5: Sentinel-1 sea ice concentration from 12. January 2021

II.2.3 Multisensor sea ice concentration

After the processing of SAR and AMSR2 based sea ice concentration the two products are merged into a multisensor sea ice concentration product using a variation analysis. The method used is based on similar methods used in data assimilation in meteorological models where we try to minimize a cost-function. The cost-function is formed as a sum of costs from the different satellite SIC products and a contribution from result of the previous data analysis. The uncertainty of each satellite observation is based on the probability of correct classification of the SAR and AMSR2 and is used as a weighting of the different observations in the merging. Figure 6 shows an example where SAR and AMSR2 based sea ice concentration are merged with the previous analysis into a multisensor sea ice concentration product.

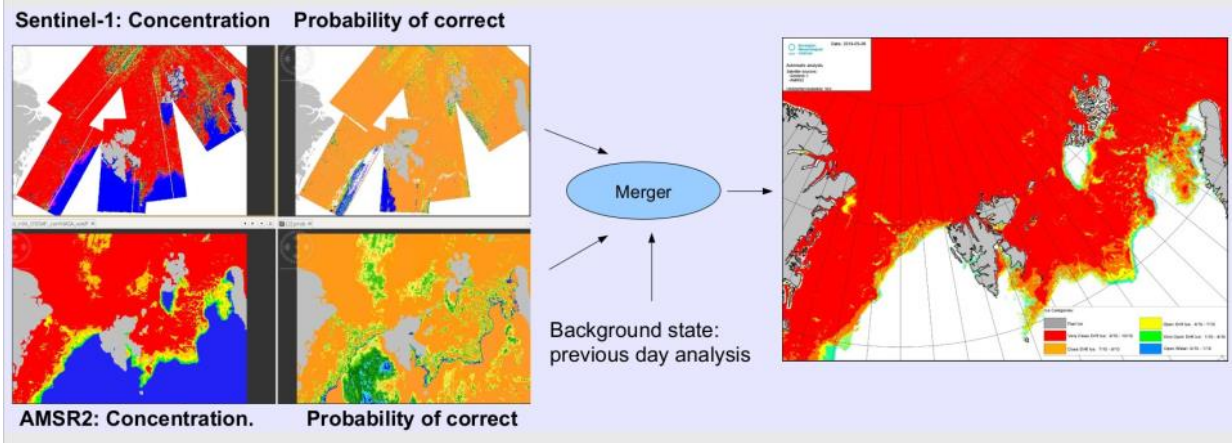


Figure 6: Example of merging satellite analysis of sea ice concentration into a multisensory product. The weighting of the different analyses is given by the probability of correct classification

The final multisensor product is a netCDF file contains tree dataset layers, sea ice concentration, probability of correct classification and status flag. An example of a multisensor analysis from 12. January 2021 is shown in ***Figure 7***

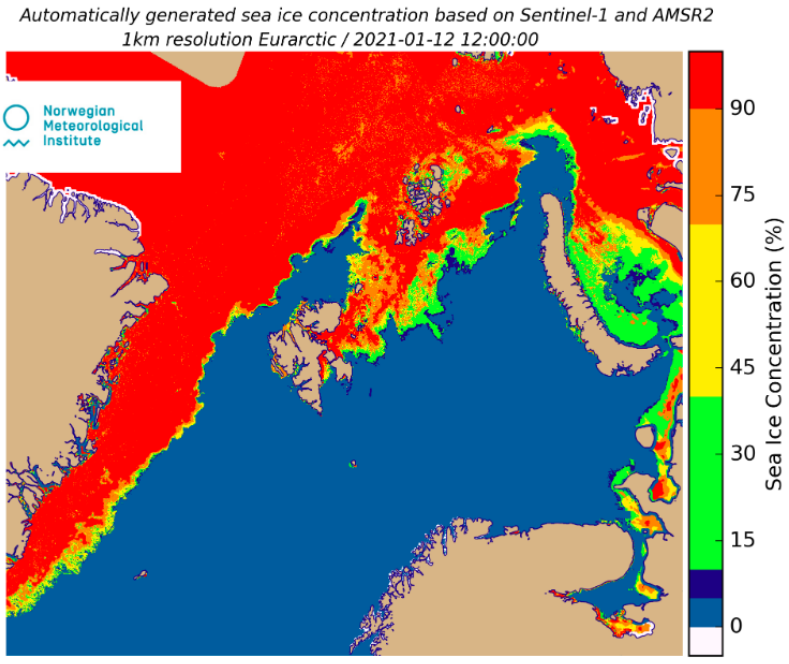


Figure 7: Multisensor analysis based on Sentinel-1 and AMSR2 data from 11. January 2021

II.2.4 Sea ice type

The high-resolution automatic sea ice type (stage of development) product is derived from Sentinel-1 SAR data using a convolutional neural network (CNN) (Boulze et al., 2020). It provides pixel-by-pixel classification of SAR data into four different types: open water, young ice, first-year ice, multi-year ice. The CNN was trained on manual ice charts prepared by the National Ice Center NOAA. CNN also provides probability of classification, which can be used as a measure of uncertainty.

Product name	SEAICE_ARC_PHY_AUTO_L4_NRT_011_015		
Geographical coverage	European part of the Arctic		
Variables	Sea Ice concentration Sea Ice Concentration Probability Sea ice Concentration status_flag Sea Ice Type Sea Ice Type Classification Probability		
Analysis / Update frequency	**yes**	**daily**	
Multi-Year/Update Frequency	NRT product only		
Available time series	From 1. May 2021 – on going		
Target delivery time	Analysis : Daily at 14pm UTC		
Temporal resolution	daily		
Horizontal resolution	1 km (polar-stereographic grid)		
Number of vertical levels	surface only		
Format	NetCDF CF1.4		
Delivery mechanisms	Subsetter	DGF	FTP

II.3 Details of the dataset

SEAICE_ARC_PHY_AUTO_L4_NRT_011_015
cmems_obs-si_arc_phy-siconc_nrt_L4-auto_P1D contains
conc[%] Sea ice concentration merged from SAR and AMSR2 concentration products. sea_ice_area_fraction
confidence[%] probability for correct classification

status_flag[1] status flag for sea ice concentration retrieval
cmems_obs-si_arc_phy-icetype_nrt_L4-auto_P1D
ice_type [1] sea ice type sea_ice_classification
confidence [%] probability of correct classification

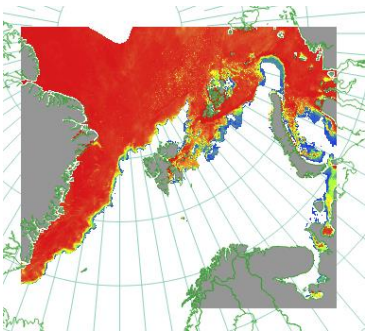
II.4 Details on sea ice concentration and sea ice type

SIC	Sea ice concentration in percent (%) [0-100],
confidence	Uncertainty of SIC given as probability of correct from 0 to 100 % The values are derived from output of the classification algorithms.
status_flag	Status flag indicating: 1 - land, 2 - coastal area, 4 - AMSR2 data used, 8 - SAR data used, 12 - AMSR-2 + SAR data used
SI Type	Classification of SAR imagery into four types: 0 - open water, 1 - young ice, 2 - first-year ice, 3 - multi-year ice.
confidence	Uncertainty of CNN classification from 0 (absolutely uncertain) to 1 (absolutely certain)

II.5 Product System Description

The operational satellite analysis products for sea ice concentration and sea ice type are produced on a daily basis providing 1km gridded products in a polar stereographic projection. The production is set up to regularly check for new available satellite images covering the European Arctic area. Any new data is downloaded to MET-Norway and automatically processed. At noon all the analysed satellite images are merged into a mosaic product and made available for dissemination through the CMEMS dissemination unit.

Domain	southernmost_latitude = 62.656956602401 ; northernmost_latitude = 89.9956640593935 ; westernmost_longitude = -179.481491219432 ; easternmost_longitude = 179.513645207052 ;

Resolution and grid	Resolution : 1.0 km Polar-stereographic: "+proj=stere +lat_0=90n +lon_0=0e +lat_ts=90n +r=6371000"
Geographic coverage	

II.6 Processing information

II.6.1 Update Time

Regular checking and analysing new satellite data made available between 00 UTC to 12 UTC. The individual satellite data are then merged into a polar-stereographic grid. A daily gridded product is disseminated at 14:00 UTC.

II.6.2 Time coverage

An archive of analysis since 1st May 2021 up to real-time is available.

II.6.3 Time averaging

III HOW TO DOWNLOAD A PRODUCT

III.1 Download a product through the CMEMS Web Portal Subsetter Service

You first need to register. Please find below the registration steps: http://marine.copernicus.eu/web/34-products-and-services-faq.php#1

Once registered, the CMEMS FAQ http://marine.copernicus.eu/web/34-products-and-services-faq.php#3 will guide you on How to download a product through the CMEMS Web Portal Subsetter Service.

III.2 Download a product through the CMEMS FTP Service

You first need to register. Please find below the registration steps: http://marine.copernicus.eu/web/34-products-and-services-faq.php#1

Once registered, the CMEMS FAQ http://marine.copernicus.eu/web/34-products-and-services-faq.php#8 will guide you on How to download a product through the CMEMS Web Portal FTP Service.

III.3 Download a product through the CMEMS Web Portal Direct Get File Service

You first need to register. Please find below the registration steps: http://marine.copernicus.eu/web/34-products-and-services-faq.php#1

Once registered, the CMEMS FAQ http://marine.copernicus.eu/web/34-products-and-services-faq.php will guide you on how to download a product through the CMEMS Web Portal Direct Get File Service.

IV NOMENCLATURE AND FORMAT

IV.1 Nomenclature of files when downloaded through through the Subsetter Service

SEAICE_ARC_PHY_AUTO_L4_NRT_011_015 files nomenclature when downloaded through the CMEMS Web Portal Subsetter is based on product dataset name and a numerical reference related to the request date on the portal.

The scheme is: **datasetname_nnnnnnnnnnnnn.nc**

where:

- **datasetname**: as described previously
- **nnnnnnnnnnnnn**: 13 digit integer corresponding to the current time (download time) in milliseconds since January 1, 1970 midnight UTC.
- **.nc**: standard NetCDF filename extension.

Example: cmems_obs-si_arc_phy-siconc_nrt_L4-auto_P1_1303461772348.nc

IV.2 Nomenclature of files when downloaded through the DGF and CMEMS FTP Services

SEAICE_ARC_PHY_AUTO_L4_NRT_011_015 files nomenclature when downloaded through the CMEMS Web Portal Subsetter is based on product filename convention:

File name convention:

name_date.nc

where:

- **name**: dataset filename (multisensorSeaIce / s1_icetype_mosaic)
- **date**: integer (format YYYYMMDDhhmm) corresponding to valid date e
- **.nc**: standard NetCDF filename extension.

Example:

cmems_obs-si_arc_phy-siconc_nrt_L4-auto_P1D: **multisensorSeaIce_202012100600.nc**

cmems_obs-si_arc_phy-icetype_nrt_L4-auto_P1D:**s1_icetype_mosaic_202012100600.nc**

IV.3 FILE FORMAT

The products are stored using the NetCDF format.

NetCDF (network Common Data Form) is an interface for array-oriented data access and a library that provides an implementation of the interface. The NetCDF library also defines a machine-independent

format for representing scientific data. Together, the interface, library, and format support the creation, access, and sharing of scientific data. The NetCDF software was developed at the Unidata Program Center in Boulder, Colorado. The NetCDF libraries define a machine-independent format for representing scientific data.

Please see Unidata NetCDF pages for more information, and to retrieve NetCDF software package.

NetCDF data is:

* Self-Describing. A netCDF file includes information about the data it contains.

* Architecture-independent. A NetCDF file is represented in a form that can be accessed by computers with different ways of storing integers, characters, and floating-point numbers.

* Direct-access. A small subset of a large dataset may be accessed efficiently, without first reading through all the preceding data.

* Appendable. Data can be appended to a NetCDF dataset along one dimension without copying the dataset or redefining its structure. The structure of a NetCDF dataset can be changed, though this sometimes causes the dataset to be copied.

* Sharable. One writer and multiple readers may simultaneously access the same NetCDF file.

IV.4 File size

DATASET NAME	FILE NAME	DIMENSION [GB]	
		Compressed	**Uncompressed**
cmems_obs-si_arc_phy-siconc_nrt_L4-auto_P1D	multisensorSeaIce_${date}.nc	0.041	0.041
cmems_obs-icetype_arc_phy-siconc_nrt_L4-auto_P1D	s1_icetype_mosaic_${date}.nc	0.021	0.021

IV.5 Remember: scale_factor & add_offset / missing_value / land mask

Dataset: cmems_obs-si_arc_phy-siconc_nrt_L4-auto_P1D

Real_Value = Display_Value

The missing value for this dataset is: -1

Land masks are equal to “_FillValue” (see variable attribute on NetCDF file).

Dataset: cmems_obs-si_arc_phy-icetype_nrt_L4-auto_P1D

Real_Value = Display_Value

The missing value for this dataset is equal to "_FillValue" : -127

Land masks: -1.

IV.6 Reading Software

NetCDF data can be browsed and used through a number of software, like:

- ✔ ncBrowse: http://www.epic.noaa.gov/java/ncBrowse/,
- ✔ NetCDF Operator (NCO): http://nco.sourceforge.net/
- ✔ IDL, Matlab, GMT…

Useful information on UNIDATA: http://www.unidata.ucar.edu/software/netcdf/

IV.7 Structure and semantic of netCDF maps files

Sea Ice Concentration:

netcdf multisensorSeaIce_202012100600 {

dimensions:

time = UNLIMITED ; // (1 currently)

y = 2500 ;

x = 2800 ;

variables:

int time(time) ;

time:axis = "T" ;

time:standard_name = "time" ;

time:calendar = "standard" ;

time:long_name = "reference time of product" ;

time:units = "days since 1970-01-01 00:00:00" ;

float y(y) ;

y:axis = "Y" ;

y:long_name = "y-coordinate in Cartesian system" ;

y:standard_name = "projection_y_coordinate" ;

y:units = "m" ;

float x(x) ;

x:axis = "X" ;

x:long_name = "x-coordinate in Cartesian system" ;

x:standard_name = "projection_x_coordinate" ;

x:units = "m" ;

float lat(y, x) ;

lat:long_name = "latitude coordinate" ;

lat:units = "degrees_north" ;

lat:standard_name = "latitude" ;

float lon(y, x) ;

lon:long_name = "longitude coordinate" ;

lon:units = "degrees_east" ;

char crs ;

crs:grid_mapping_name = "polar_stereographic" ;

crs:straight_vertical_longitude_from_pole = 0. ;

crs:latitude_of_projection_origin = 90. ;

crs:standard_parallel = 90. ;

crs:false_easting = 0. ;

crs:false_northing = 0. ;

crs:semi_major_axis = 6371000LL ;

crs:semi_minor_axis = 6371000LL ;

crs:proj4_string = "+proj=stere +lat_0=90.0 +lon_0=0.0 +lat_ts=90.0 +R=6.371e+06 +units=m +no_defs" ;

byte conc(time, y, x) ;

conc:long_name = "Sea ice concentration merged from SAR and AMSR2 concentration products" ;

conc:comment = "This field contains a multisensor sea ice product based on sea ice concentration derrived from Sentinel-1 SAR and AMSR2 data. Valid values are Concentration=[0:100], Land=-127, NoData=-1" ;

conc:units = "%" ;

conc:standard_name = "sea_ice_area_fraction" ;

conc:grid_mapping = "crs" ;

conc:coordinates = "lon lat" ;

conc:fill_value = -127LL ;

byte confidence(time, y, x) ;

confidence:long_name = "probability for correct classification" ;

confidence:grid_mapping = "crs" ;

confidence:units = "%" ;

confidence:coordinates = "lon lat" ;

confidence:fill_value = -127LL ;

byte status_flag(time, y, x) ;

status_flag:long_name = "status flag for sea ice concentration retrieval" ;

status_flag:standard_name = "sea_ice_classification status_flag" ;

status_flag:grid_mapping = "crs" ;

status_flag:coordinates = "lon lat" ;

status_flag:fill_value = -127LL ;

status_flag:flag_values = 1b, 2b, 4b, 8b, 12b ;

status_flag:flag_meanings = "land costal_zone SAR_data AMSR2_data SAR_and_AMSR2_data" ;

status_flag:flag_descriptions = "1 -> land\n 2 -> costal_zone\n 4 -> SAR data used\n 8 -> AMSR2 data used\n 12 -> SAR + AMSR2 data used\n" ;

// global attributes:

:title = "Daily automatic ice analysis." ;

:product_status = "operational" ;

:abstract = "The daily analysis of sea ice concentration is based on satellite data from AMSR2 and Sentinel-1, \n which is combined in an optimal interpolation merging.\n Sea ice concnetration from passive microvave AMSR2 data are produced from the 89GHz channel giving a spatial resolution of 5x5km\n SAR data from the Sentinel-1 are first classified into ice/water at a 40x40m pixel resoluton before concentration is estimated from ice area within 1x1km\n The two concentrations products are then subsampled to the same 1x1km spatial resolution and merged in an optimal interpolation" ;

:activity_type = "Space borne instrument" ;

:area = "Eurarctic" ;

:instrument_type = "Multi-sensor analysis" ;

:source = "Sentinel-1 EW HH/HV-polarization, AMSR2 89GHz v,h" ;

:references = "unknown" ;

:history = "2020-12-08T15:14:56Z created" ;

:Conventions = "CF-1.4" ;

:netcdf4_version_id = "4.4.0" ;

:netcdf4_format = "NETCDF4" ;

:product_version = "1.0" ;

:software_version = "1.0" ;

:comment = "This is an automatic generated product based on satellite data." ;

:spatial_resolution_latitude = 1000. ;

:spatial_resolution_longitude = 1000. ;

:southernmost_latitude = 62.5587477158913 ;

:northernmost_latitude = 89.9956445992833 ;

:westernmost_longitude = -179.481491219432 ;

:easternmost_longitude = 179.513645207052 ;

:institution = "MET Norway" ;

:institution_reference = "http://www.met.no" ;

:contact = "froded@met.no" ;

:start_date = "2020-12-10T00:00:00Z" ;

:stop_date = "2020-12-10T15:00:00Z" ;

Sea Ice Type:

netcdf s1_icetype_mosaic_20201210 {

dimensions:

time = 1 ;

yc = 2500 ;

xc = 2800 ;

variables:

int time(time) ;

time:long_name = "reference time of satellite image" ;

time:units = "days since 1970-01-01 00:00:00" ;

time:calendar = "standard" ;

time:axis = "T" ;

float yc(yc) ;

yc:axis = "Y" ;

yc:long_name = "y-coordinate in Cartesian system" ;

yc:units = "m" ;

yc:standard_name = "projection_y_coordinate" ;

float xc(xc) ;

xc:axis = "X" ;

xc:long_name = "x-coordinate in Cartesian system" ;

xc:units = "m" ;

xc:standard_name = "projection_x_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" ;

char crs ;

crs:grid_mapping_name = "polar_stereographic" ;

crs:straight_vertical_longitude_from_pole = 0. ;

crs:latitude_of_projection_origin = 90. ;

crs:standard_parallel = 90. ;

crs:false_easting = 0. ;

crs:false_northing = 0. ;

crs:proj4_string = "+proj=stere +lat_0=90n +lon_0=0e +lat_ts=90n +r=6371000" ;

byte ice_type(time, yc, xc) ;

ice_type:_FillValue = -127b ;

ice_type:long_name = "sea ice type" ;

ice_type:standard_name = "sea_ice_classification" ;

ice_type:coordinates = "lon lat" ;

ice_type:grid_mapping = "crs" ;

ice_type:flag_values = -1b, 0b, 1b, 2b, 3b ;

ice_type:flag_meanings = "land open_water young_ice first_year_ice multi_year_ice" ;

ice_type:flag_descriptions = "\n -1 -> land \n 0 -> no ice or very open ice \n 1 -> young ice\n 2 -> fist year ice\n 3 -> ice that survived a summer melt\n" ;

ice_type:source = "MET Norway" ;

ice_type:fill_value = -127LL ;

byte confidence(time, yc, xc) ;

confidence:_FillValue = -127b ;

confidence:long_name = "confidence level" ;

confidence:units = "%" ;

confidence:coordinates = "lon lat" ;

confidence:grid_mapping = "crs" ;

confidence:source = "MET Norway" ;

confidence:fill_value = -127LL ;

// global attributes:

:_NCProperties = "version=2,netcdf=4.6.2,hdf5=1.10.4" ;

:title = "Automatic ice analysis from national ice services." ;

:Conventions = "CF-1.4" ;

:netcdf4_version_id = "4.6.2" ;

:netcdf4_format = "NETCDF4" ;

:creation_date = "2020-12-10T13:32:59Z" ;

:start_date = "2020-12-10T01:00:00Z" ;

:stop_date = "2020-12-10T13:00:00Z" ;

:product_version = "1.0" ;

:software_version = "1.0" ;

:abstract = "This is an automatic generated sea ice type product from Sentinel-1 Syntetic Aperature Radar (SAR) data. The product by MET-Norway based on software developed by The Nansen Environmental and Remote Sensing Center. A more detailed description of the product can be found in the paper: https://www.mdpi.com/2072-4292/12/13/2165" ;

:spatial_resolution_latitude = 1000. ;

:spatial_resolution_longitude = -1000. ;

:southernmost_latitude = 62.656956602401 ;

:northernmost_latitude = 89.9956640593935 ;

:westernmost_longitude = -179.481491219432 ;

:easternmost_longitude = 179.513645207052 ;

:institution = "MET Norway" ;

:institution_reference = "http://www.met.no" ;

:references = "https://doi.org/10.3390/rs12132165" ;