PRODUCT USER MANUAL

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For Regional High Resolution Sea Ice Charts
Svalbard and Greenland Region
SEAICE_ARC_SEAICE_L4_NRT_OBSERVATIONS_011_002

Issue: 2.9

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CHANGE RECORD

Issue	Date	§	Description of Change	Author	Validated By
1.0	16.09.2011	All	Creation of the document	Frode Dinessen	Lars-Anders Breivik
2.0	28.10.2011	layout	Adaptation to new template		
2.1	17-11-2011		Update Nomenclature of file	L. Crosnier WP17	
2.2	2014.05.15	II	Add MFTP download mechanism	Bruce Hackett	Lars-Anders Breivik
2.3	2015.01.30	III	Transition to Sentinel-1, Corrected SUBS download nomenclature	Frode Dinessen, Bruce Hackett	L. Crosnier
2.4	2015.05.20	all	Change format to fit CMEMS graphical rules		L. Crosnier
2.5	2015.09.20	all	Finish CMEMS rebranding	Frode Dinessen, Bruce Hackett	
2.6	2016.09.30	All	Sentinel-1B data included in service	Frode Dinessen	B. Hackett
2.7	2018.01.15	All	Updated description Rebranding from OSI to SI TAC	Frode Dinessen	C. Wettre
2.8	2019.12.06	All	Greenland datasets (former _011_003) product) information included.	Matilde B. Kreiner	C. Wettre
2.9	2020.09.09	All	Updated with information of new Greenland datasets.	Matilde B. Kreiner	C. Wettre

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GLOSSARY AND ABBREVIATIONS

TAC	Thematic Assembly Centre
SI	Sea Ice
MET Norway	Norwegian Meteorological Institute
NetCDF	Network Common Data Form
CF	Climate Forecast (convention for NetCDF)
DMI	Danish Meteorological Institute
RMS	Root mean square
SDN	SeaDataNet (climatology)
PC	Production Center
PU	Production Unit
FTP	Protocol to download files
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)
Sigrid-3	Sea Ice GeoReferenced Information and Data, version 3
Subsetter	CMEMS service tool to download a NetCDF file of a selected geographical box using values of longitude an latitude, and time range
Directgetfile	CMEMS service tool (FTP like) to download a NetCDF file
WMO	World Meteorological Organization



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INTRODUCTION

I.1 Summary

This guide describes the regional sea ice product SEAICE_ARC_SEAICE_L4_NRT_OBSERVATIONS _011_002 from the CMEMS Sea Ice Thematic Ensemble Centre (SI TAC), what data services are available, how to access them and how to use the files and services.

This products datasets are produced at MET Norway and DMI and disseminated by MET Norway. They are high resolution sea ice chart products covering the regions around Greenland, around Svalbard and from the Barents Sea region to Novaya Zemlya.

The data are freely available under the CMEMS data license.

I.2 History of changes

- ➤ <u>Since October 2014</u>, Sentinel-1(A) data has gradually been incorporated into the service and this satellite has now replaced most of the RADARSAT data.
- ➤ <u>Since June 2016</u>, Sentinel-1B data have been incorporated into the service. Both Sentinel-1A and -1B are now fully integrated into the product production.



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II HOW TO DOWNLOAD A PRODUCT

II.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.

II.2 Download a product through the CMEMS Web Portal Directgetfile 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#5 will guide you on How to download a product through the CMEMS Web Portal Directgetfile Service.

II.3 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.



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III DESCRIPTION OF THE PRODUCT SPECIFICATION

III.1 General Description

The operational sea ice services at MET Norway and at DMI produces sea ice concentration charts based on a manual interpretation of satellite data.

The satellite data used are Synthetic Aperture Radar (SAR) data from Envisat (until its failure in April 2012) and Radarsat. Since October 2014, Sentinel-1 data has gradually been incorporated into the service and is now the dominant input data source. In addition to the SAR data, visual and infrared data from Sentinel-2, Sentinel-3, MODIS and NOAA-AVHRR, are used.

The Sentinel-1 data are in Extended Wide (EW) mode dual polarization. Sentinel-1 data in Interferometric Wide swath mode (IW) is also used when available. Each EW scene covers an area of 400×400 km and is resampled to a spatial horizontal resolution of 80×80 meter. An IW scene covers an area of 250×250 km. The Sentinel-1 data covers most of the MET Norway and DMI ice charting areas. The Radarsat data are in Scansar Wide mode dual polarization. Each scene covers an area of 500×500 km and is resampled to a spatial horizontal resolution of 50×500 meter. The MODIS and NOAA data cover the charting area several times each day and are resampled to a horizontal resolution of 1000×1000 meter.

The operator uses the latest available satellite data and draws the ice chart in an ArcGIS production system.

The Svalbard and Greenland datasets have different temporal frequency: The Svalbard dataset is distributed on working days before 15.00 UTC. The Greenland overview ice chart dataset is produced twice weekly and summarizes ice conditions based on satellite data acquired within the last 1-3 days. The Greenland regional ice chart dataset coverage and frequency depends on season, ship routes and data availability. Normally one regional ice chart is produced on the basis of one Sentinel-1 image and the individual scenes/ice charts cover a subset of the DMI ice charting area of Greenland waters. The ice charts are thus snapshot interpretations of the ice conditions at the time of the Sentinel-1 image acquisition.

All the gridded sea ice chart products are available at a spatial resolution of 1000 meter.

III.2 General Information

Product Lines	SEAICE_ARC_SEAICE_L4_NRT_OBSERVATIONS_011_002	
Geographical coverage	Svalbard area 80°W-80°E; 60°N-85°N, Greenland area 80°W-10°E, 55°N-85°N	
Variables	Svalbard dataset: Total ice concentration Greenland datasets: total and partial ice concentrations, stage of	



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	development, floe size.	
Analysis	Yes	
Forecast	No	
Available time series	Svalbard ice chart: From 4 January 2010 – on going	
	Greenland regional ice charts: From 5 January 2009 – ongoing	
	Greenland overview ice charts: From 2 March 2011 – ongoing	
Temporal resolution	Svalbard ice charts: daily on weekdays.	
	Greenland regional ice charts: When ice charts are produced (0 - more times per day).	
	Greenland overview ice charts: produced on Sundays and Wednesdays.	
Target delivery time Svalbard ice charts: Daily on working days before 15 UTC		
	Greenland regional ice charts: Within 18 hours after satellite data acquisition.	
	Greenland overview ice charts: 14:00 UTC next day (Mondays and Thursdays).	
Horizontal resolution	Svalbard ice chart: 1.0 deg	
	Greenland ice charts: ~1-5km, gridded at 1 km grid	
Number of vertical levels	Surface parameter	
Format	NetCDF CF1.4	

Table 1 - SEAICE_ARC_SEAICE_L4_NRT_OBSERVATIONS_011_002 Product Specification

Detailed information on the systems and products are on CMEMS web site: http://marine.copernicus.eu/



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III.3 Details of datasets

The MET Norway and DMI ice chart datasets follow the World Meteorological Organization (WMO) code for sea ice. The Svalbard and Greenland datasets are listed in the table below.

DATASETS	VARIABLES AND UNIT	NAME OF VARIABLES
		IN THE NETCDF FILE
METNO-ARC- SEAICE CONC-L4-	Ice concentration [%]	"sea_ice_area_fraction"
NRT-OBS	Concentration range [%]	"concentration_range"
cmems_obs-	Ice concentration [%]	"sea_ice_area_fraction"
si_arc_physic_nrt_1 km-grl_P1WT3D-m	Concentration range [%]	"concentration_range"
KIII 611_1 1W135 III	Reference ids for rasterized sea-ice-polygons	"ice_poly_id_grid"
	IDs corresponding to sea-ice-polygon reference IDs	"polygon_id"
	Total concentration*	"CT"
	Partial concentration of thickest ice*	"CA"
	Partial concentration of second thickest ice*	"CB"
	Partial concentration of the third thickest ice*	"CC"
	Stage of development of thickest ice*	"SA"
	Stage of development of second thickest Ice*	"SB"
	Stage of development of third thickest ice*	"SC"
	Form of thickest ice*	"FA"
	Form of second thickest ice*	"FB"
	Form of third thickest ice*	"FC"
	Stage of development of ice thicker than SA but with concentration less than 1/10*	"CN"
	Stage of development of any remaining class of ice*	"CD"
	Predominant and secondary forms of ice*	"CF"
	General polygon surface type [I=Ice, W=Water]	"poly_type"
	* Coded in Sigrid-3. See Table 3 - Table 6.	



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cmems_obs-	Ice concentration [%]	"sea_ice_area_fraction"
si_arc_physic_nrt_1 km-grl P1D-irr	Concentration range [%]	"concentration_range"
6 <u>.</u> . 12	Reference ids for rasterized sea-ice-polygons	"ice_poly_id_grid"
	IDs corresponding to sea-ice-polygon reference IDs	"polygon_id"
	Total concentration*	"CT"
	Partial concentration of thickest ice*	"CA"
	Partial concentration of second thickest ice*	"CB"
	Partial concentration of the third thickest ice*	"CC"
	Stage of development of thickest ice*	"SA"
	Stage of development of second thickest Ice*	"SB"
	Stage of development of third thickest ice*	"SC"
	Form of thickest ice*	"FA"
	Form of second thickest ice*	"FB"
	Form of third thickest ice*	"FC"
	Stage of development of ice thicker than SA but with concentration less than 1/10*	"CN"
	Stage of development of any remaining class of ice*	"CD"
	Predominant and secondary forms of ice*	"CF"
	General polygon surface type [I=Ice, W=Water]	"poly_type"
	* Coded in Sigrid-3. See Table 3 - Table 6.	

Table 2 - List of the datasets

Svalbard dataset:

For the Svalbard dataset, METNO-ARC-SEAICE_CONC-L4-NRT-OBS, the concentration classes are defined by concentration intervals:

♦ Fast ice: 10/10

♦ Very Close Drift Ice: 9-10/10

♦ Close Drift Ice: 7-8/10

♦ Open Drift Ice: 4-6/10

♦ Very Open Drift Ice: 1-3/10

♦ *Open Water:* < 1/10

These concentration intervals are converted to fixed concentration values in the gridded product described by the "sea_ice_area_fraction" variable:



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Fast ice: 100

♦ Very Close Drift Ice: 95

♦ Close Drift Ice: 75

♦ Open Drift Ice: 50

♦ Very Open Drift Ice: 20

♦ Open Water: 5

To reflect the WMO concentration intervals the "concentration_range" variable is given in the product defined by a +- concentration value for each grid point.

Greenland datasets:

The DMI datasets follow the World Meteorological Organization (WMO) code for sea ice with concentration classes defined by concentrations in 10ths, and the total ice concentration variable <code>sea_ice_are_fraction</code> gives concentration in 10ths, from 0 (open water) to 100% ice (landfast ice). To reflect the concentration intervals the <code>concentration_range</code> variable is given in the product defined by a +- concentration value for each grid point. Concentration intervals are now rarely used in the DMI ice charts.

Note: The ice concentrations are seldom homogeneously distributed inside the drawn polygons down to the scale of the gridding, so whereas the average concentrations of the polygons are considered correct for the polygon, each individual 1 x 1 km grid cell may deviate substantially from this average value.

In addition to the total ice concentration variable <code>sea_ice_are_fraction</code> and the concentration interval variable <code>concentration_range</code> the DMI datasets contain all additional sea ice variables from the WMO egg code, see Figure 1, in SIGRID-3 code from the DMI overview and regional ice charts. The SIGRID-3 ice codes consists of a total ice concentration for the polygon (CT), concentrations of up to 3 different ice types/forms specified by their partial concentration (CA, CB and CC), their stage of development (SA, SB and SC) and their form (FA, FB and FC). These are explained in the following Table 3 - Table 6 (extracted from JCOMM Expert Team on Sea Ice, 2014).

When converting the original ice chart format into the dataset netCDF format, each polygon is given an ID number, see variable *ice_poly_id_grid* and *polygon_id*, and all ice chart variables (*CT, CA, CB, CC, SA,* ...) for that polygon is described in the netCDF file organized by this ID number.

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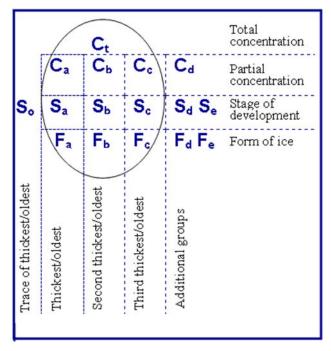


Figure 1 - Overview of ice egg code variables: The World Meteorology Organization (WMO) system for sea ice symbology is referred to as the "Egg Code" due to the oval shape of the symbol. Overview of ice egg code variables - See also code tables later in this section. (Source: nsidc.org).

Definition, concentration	Sigrid3 code (CT, CA, CB and CC)
Ice Free	00
Less than 1/10 (open water)	01
Bergy water	02
1/10	10
2/10	20
3/10	30
4/10	40
5/10	50
6/10	60
7/10	70
8/10	80
9/10	90
10/10	92

Table 3 - Concentration codes for variable identifiers CT, CA, CB, and CC (Specific concentrations).



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Chara of Davidson and	Thickness	Sigrid3 code for variables	
Stage of Development		SA, SB, SC, CN and CD	
Ice Free		00	
No stage of development		80	
New Ice	< 10 cm	81	
Nilas, Ice Rind	< 10 cm	82	
Young Ice	10 - 30 cm	83	
Grey Ice	10 - 15 cm	84	
Grey – White Ice	15 - 30 cm	85	
First Year Ice	30 - 200 cm	86	
Thin First Year Ice	30 - 70 cm	87	
Thin First Year Ice Stage 1	30 - 50 cm	88	
Thin First Year Ice Stage 2	50 - 70 cm	89	
Medium First Year Ice	70 - 120 cm	91	
Thick First Year Ice	> 120 cm	93	
Old Ice		95	
Second Year Ice		96	
Multi-Year Ice		97	
Glacier Ice		98	

Table 4 - Stage of development codes and thickness of ice for variable identifiers SA, SB, SC, CN, and CD.

Form	Size/ concentration	Sigrid3 code for variables FA, FB, FC and CF
Pancake Ice	30 cm – 3 m	00
Shuga / Small Ice Cake, Brash Ice	< 2 m across	01
Ice Cake	< 20 m across	02
Small Floe	20 – 100 m across	03
Medium Floe	100 – 500 m across	04
Big Floe	500 m – 2 km across	05
Vast Floe	2 – 10 km across	06
Giant Floe	> 10 km across	07
Fast Ice		08
Growlers, Floebergs or Floebits		09



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Icebergs		10
Strips and Patches	Concentrations 1/10	11
Strips and Patches	Concentrations 2/10	12
Strips and Patches	Concentrations 3/10	13
Strips and Patches	Concentrations 4/10	14
Strips and Patches	Concentrations 5/10	15
Strips and Patches	Concentrations 6/10	16
Strips and Patches	Concentrations 7/10	17
Strips and Patches	Concentrations 8/10	18
Strips and Patches	Concentrations 9/10	19
Strips and Patches	Concentrations 10/10	20
Level Ice		21
Unknown		99

Table 5 - Form of ice codes for variable identifiers FA, FB, FC, and CF.

Description	poly_type
Water – sea ice free	L
Ice – of any concentration	W
No Data	N

Table 6 - List of the variable Poly_type character variables.

III.4 Additional information about products

The ice charts are originally produced for navigational purposes and consists of manually drawn polygons with fairly homogenous ice conditions. The ice charts contains a number of ice parameters, of which the total ice concentration is dominant. The ice concentrations are not always homogenously distributed inside the polygons down to the 1 kilometer scale of the gridding, so whereas the average concentrations of the polygons are considered correct for the polygon, each individual 1km grid cell may deviate substantially from this average value.



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IV NOMENCLATURE OF FILES

The nomenclature of the downloaded files differs on the basis of the chosen download mechanism **Subsetter** or **Directgetfile** or **CMEMS FTP** service.

File name convention:

ice_conc_svalbard_<yyyymmddhhmm>.nc
ice_conc_greenland_<yyyymmddhhmm>.nc
ice_conc_overview_greenland_<yyyymmddhhmm>.nc

The file naming convention is relevant when downloading by **Directgetfile** and **CMEMS FTP**.

IV.1 Nomenclature of files when downloaded through the CMEMS Web Portal <u>Subsetter</u> Service

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 MOTU.

The scheme is: datasetname-nnnnn.nc

where:

- .datasetname is a character string within one of the following:
 - · ice_conc_svalbard_aggregated
 - · cmems_obs-si_arc_physic_nrt_1km-grl_P1WT3D-m
 - · cmems_obs-si_arc_physic_nrt_1km-grl_P1D-irr
- . nnnnnn: 6 digit transaction identifier corresponding to the unique request number in MOTU.
- .nc: standard NetCDF filename extension.

Example:

ice_conc_svalbard_aggregated_130346.nc

IV.2 Nomenclature of files when downloaded through the CMEMS Web Portal <u>Directgetfile</u> or <u>CMEMS FTP</u> Service

When downloading through the CMEMS DirectGetFile service you will get a file named datasetname_nnnnn.zip where the datasetname and nnnnnn are as explained for Subsetter.

The files in the Directgetfile zip package follow the file naming convention shown at the beginning of Ch. IV.



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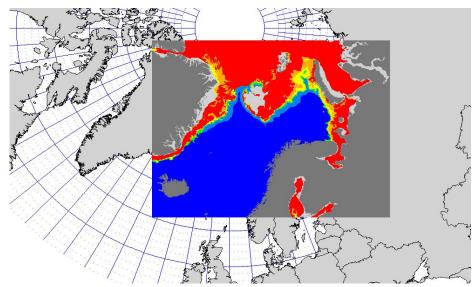
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IV.3 Grid type and Geographical Projection

The products datasets are gridded in a regular grid of 1000x1000 meter covering the areas shown in the figures below. The projection used is polar-stereographic with the following projection parameters:

Polarstereographic (proj=stere lat_0=90.0 lat_ts=90.0 lon_0=0.0 R=6371000)

IV.4 Domain coverage (includes image of domain + projection used if any)



V Figure 2 - Example of full Svalbard dataset spatial coverage (produced on every weekday).

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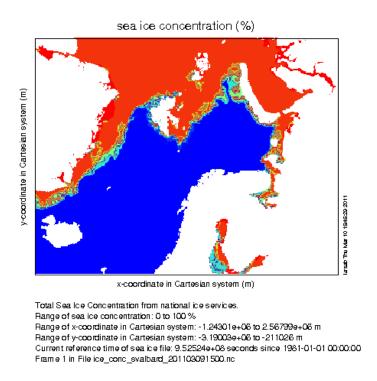


Figure 3 - Spatial coverage of the SIW-METNO-ARC-SEAICE_HR-OBS product

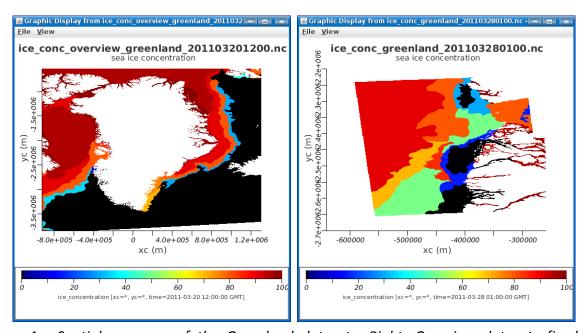


Figure 4 - Spatial coverage of the Greenland datasets. Right: Overview datasets fixed coverage (produced twice a week). Left: Example of regional 'NRT' dataset coverage (produced at varying frequencies for different areas).



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V.1 Update Time

Svalbard dataset:

• updated every weekday at 4 pm.

Greenland datasets:

- Regional ice chart dataset: updated up to several times every weekday within 18 hrs of satellite data acquisition.
- Overview ice chart dataset: updated every Monday and Thursday by 14:00 UTC.

The Greenland datasets may not be updated on public Danish holidays, but updated the day after.

V.2 Temporal extend of analysis and forecast stored on delivery mechanism

Svalbard dataset:

stored since 1. January 2010.

Greenland datasets:

- Regional ice chart dataset, cmems_obs-si_arc_physic_nrt_1km-grl_P1D-irr: available from 15 December 2020 -.
- Overview ice chart dataset, cmems_obs-si_arc_physic_nrt_1km-grl_P1WT3D-m: available from 15 December 2020 -.
- Regional ice chart dataset, DMI-ARC-SEAICE_CONC-L4-NRT-OBS: available from 5 January 2009 15 February 2021.
- Overview ice chart dataset, DMI-ARC-SEAICE_CONC_OVERVIEW-L4-NRT-OBS: available from 3 March 2011 15 February 2021.

V.3 Other information: mean centre of Products, land mask value, missing value

Ref: CMEMS-SI-PUM-011-002

Land mask values are defined as value -99



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VI FILE FORMAT

VI.1 Netcdf

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.

Ref: CMEMS-SI-PUM-011-002

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

VI.2 Structure and semantic of NetCDF maps files

Svalbard dataset, METNO-ARC-SEAICE_CONC-L4-NRT-OBS, example:

```
dimensions:
    time = 1;
    xc = 3812;
    yc = 2980;

variables:
    int time(time);
        time:long_name = "reference time of sea ice file";
        time:units = "seconds since 1981-01-01 00:00:00";
    float yc(yc);
        yc:axis = "Y";
        yc:long_name = "y-coordinate in Cartesian system";
yc:units = "m";
```



float xc(xc);

PUM for SI TAC regional Arctic sea ice product

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```
xc:axis = "X";
                 xc:long_name = "x-coordinate in Cartesian system";
                 xc:units = "m";
        float lat(yc, xc);
                lat:long_name = "latitude";
                 lat:units = "degrees north";
        float lon(yc, xc);
                 lon:long_name = "longitude";
                 lon:units = "degrees_east";
        char crs;
                 crs:grid_mapping_name = "polar_stereographic";
                 crs:straight_vertical_longitude_from_pole = 0.f;
                 crs:latitude of projection origin = 90.f;
                 crs:standard parallel = 90.f;
                 crs:false_easting = 0.f;
                 crs:false northing = 0.f;
                 crs:proj4 string = "+proj=stere lon 0=0.0 lat ts=90.0 lat 0=90.0 a=6371000.0 b=6371000.0";
        short ice_concentration(time, yc, xc);
                 ice_concentration:long_name = "sea ice concentration" ;
                 ice_concentration:standard_name = "sea_ice_area_fraction" ;
                 ice_concentration:units = "%";
                 ice concentration:coordinates = "lon lat";
                 ice concentration:grid mapping = "crs";
                 ice_concentration:source = "MET Norway";
                 ice_concentration:_FillValue = -99s;
                 ice_concentration:scale_factor = 1.f;
                 ice_concentration:add_offset = 0.f;
        short concentration_range(time, yc, xc);
                 concentration_range:long_name = "concentration range";
                 concentration range:units = "%";
                 concentration_range:coordinates = "lon lat";
                 concentration_range:grid_mapping = "crs";
                 concentration range: FillValue = -99s;
                 concentration range:comments = "Range of the analyized ice consentration value";
// global attributes:
                 :title = "Total Sea Ice Concentration from national ice services.";
                 :Conventions = "CF-1.4";
                 :netcdf version id = "3.6.2-beta6";
                 :creation date = "2011-03-09T14:11:19Z";
                 :produced_date = "2011-03-09T14:00:00Z";
                 :valid_date = "2011-03-09T14:00:00Z";
                 :product_version = "1.0";
                 :software_version = "1.0";
                 :comment = "The ice concentration is based on a manual interpretation of different satellite
data. For more information about the the product contact the national ice service";
                 :satellite = "Radarsat";
                 :sensor = "ASAR";
                 :spatial resolution latitude = 1000.f;
                 :spatial_resolution_longitude = 1000.f;
                 :southernmost latitude = 54.36565f;
```



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SEAICE_ARC_SEAICE_L4_NRT_OBSERVATIONS_011_002

```
:northernmost_latitude = 88.10237f;
:westernmost_longitude = -80.36474f;
:easternmost_longitude = 85.30225f;
:field_type = "daily";
:institution = "MET Norway";
:institution_references = "http://www.retro.MET Norway";
:contact = "iceservice@MET Norway";
:operational_status = "operational";
}
```

Greenland dataset: cmems_obs-si_arc_physic_nrt_1km-grl_P1WT3D-m, example:

```
netcdf file:ice_conc_overview_greenland_202009061200.nc {
dimensions:
 time = 1;
 yc = 3318;
 xc = 2232;
  polygon_reference = 1000;
variables:
 int time(time=1);
   :long_name = "reference time of sea ice file";
   :units = "seconds since 1981-01-01 00:00:00";
   :calendar = "standard";
  float yc(yc=3318);
   :axis = "Y";
   :long_name = "y-coordinate in Cartesian system";
   :units = "m";
  float xc(xc=2232);
   :axis = "X";
   :long_name = "x-coordinate in Cartesian system";
   :units = "m";
  float lat(yc=3318, xc=2232);
   :long_name = "latitude";
   :units = "degrees north";
   :_ChunkSizes = 1106U, 744U; // uint
  float lon(yc=3318, xc=2232);
   :long name = "longitude";
   :units = "degrees_east";
   :_ChunkSizes = 1106U, 744U; // uint
  char crs;
   :straight_vertical_longitude_from_pole = -45L; // long
   :latitude_of_projection_origin = 90L; // long
   :standard_parallel = 90L; // long
   :grid_mapping_name = "polar_stereographic";
   :false_easting = 0.0f; // float
   :false_northing = 0.0f; // float
```



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SEAICE_ARC_SEAICE_L4_NRT_OBSERVATIONS_011_002

```
:proj4_string = " +proj=stere +lon_0=-45 +lat_ts=90 +lat_0=90 +a=6371000 +b=6371000";
short ice_concentration(time=1, yc=3318, xc=2232);
 :long name = "sea ice concentration";
 :standard_name = "sea_ice_area_fraction";
 :units = "%";
 :coordinates = "lon lat";
 :grid_mapping = "crs";
 :source = "DMI";
 :_FillValue = -99S; // short
 :scale_factor = 1.0f; // float
 :add_offset = 0.0f; // float
 :_ChunkSizes = 1U, 1659U, 1116U; // uint
short concentration range(time=1, yc=3318, xc=2232);
 :long_name = "concentration range";
 :units = "%";
 :coordinates = "lon lat";
 :grid_mapping = "crs";
 :_FillValue = -99S; // short
 :comments = "Range of the analyized ice consentration value";
 :_ChunkSizes = 1U, 1659U, 1116U; // uint
short ice_poly_id_grid(time=1, yc=3318, xc=2232);
 :_FillValue = -99S; // short
 :long_name = "Reference ids for rasterized sea-ice-polygons";
 :units = "1";
 :coordinates = "lon lat";
 :grid_mapping = "crs";
 :source = "DMI";
 :scale factor = 1.0; // double
 :add offset = 0.0; // double
 :_ChunkSizes = 1U, 1659U, 1116U; // uint
short polygon id(time=1, polygon reference=1000);
 :long_name = "Ids corresponding to sea-ice-polygon reference ids";
 :units = "1";
 :source = "DMI";
 :nodata_value = "-9";
 :_ChunkSizes = 1U, 1000U; // uint
short CT(time=1, polygon_reference=1000);
 :long_name = "Total concentration (SIGRID3-code)";
 :standard_name = "sea_ice_area_fraction";
 :units = "1";
 :source = "DMI";
 :nodata value = "-9";
 :_ChunkSizes = 1U, 1000U; // uint
short CA(time=1, polygon_reference=1000);
 :source = "DMI";
 :nodata value = "-9";
```



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SEAICE_ARC_SEAICE_L4_NRT_OBSERVATIONS_011_002

```
:units = "1";
 :long_name = "Partial concentration of thickest ice (SIGRID3-code)";
 :standard_name = "sea_ice_area_fraction";
 :_ChunkSizes = 1U, 1000U; // uint
short SA(time=1, polygon_reference=1000);
 :long name = "Stage of development of thickest ice (SIGRID3-code)";
 :standard_name = "sea_ice_classification";
 :units = "1";
 :source = "DMI";
 :nodata_value = "-9";
 :_ChunkSizes = 1U, 1000U; // uint
short FA(time=1, polygon reference=1000);
 :standard name = "sea ice classification";
 :source = "DMI";
 :nodata_value = "-9";
 :long name = "Form of thickest ice (SIGRID3-code)";
 :units = "1";
 :_ChunkSizes = 1U, 1000U; // uint
short CB(time=1, polygon_reference=1000);
 :long_name = "Partial concentration of second thickest ice (SIGRID3-code)";
 :units = "1";
 :source = "DMI";
 :nodata_value = "-9";
 :standard_name = "sea_ice_area_fraction";
 :_ChunkSizes = 1U, 1000U; // uint
short SB(time=1, polygon_reference=1000);
 :long name = "Stage of development of second thickest Ice (SIGRID3-code)";
 :standard name = "sea ice classification";
 :units = "1";
 :source = "DMI";
 :nodata_value = "-9";
 :_ChunkSizes = 1U, 1000U; // uint
short FB(time=1, polygon_reference=1000);
 :nodata_value = "-9";
 :standard_name = "sea_ice_classification";
 :units = "1";
 :source = "DMI";
 :long_name = "Form of second thickest ice (SIGRID3-code)";
 :_ChunkSizes = 1U, 1000U; // uint
short CC(time=1, polygon_reference=1000);
 :long_name = "Partial concentration of the third thickest ice (SIGRID3-code)";
 :standard_name = "sea_ice_area_fraction";
 :units = "1";
 :source = "DMI";
 :nodata_value = "-9";
 : ChunkSizes = 1U, 1000U; // uint
```



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SEAICE_ARC_SEAICE_L4_NRT_OBSERVATIONS_011_002

```
short SC(time=1, polygon_reference=1000);
   :long_name = "Stage of development of third thickest ice (SIGRID3-code)";
   :standard name = "sea ice classification";
   :units = "1";
   :source = "DMI";
   :nodata value = "-9";
   :_ChunkSizes = 1U, 1000U; // uint
  short FC(time=1, polygon_reference=1000);
   :long_name = "Form of third thickest ice (SIGRID3-code)";
   :standard_name = "sea_ice_classification";
   :source = "DMI";
   :nodata value = "-9";
   :units = "1";
   :_ChunkSizes = 1U, 1000U; // uint
  short CN(time=1, polygon reference=1000);
   :standard_name = "sea_ice_classification";
   :source = "DMI";
   :nodata value = "-9";
   :long_name = "Stage of development of ice thicker than SA but with concentration less than 1/10 (SIGRID3-
code)";
   :units = "1";
   :_ChunkSizes = 1U, 1000U; // uint
  short CD(time=1, polygon_reference=1000);
   :long_name = "Stage of development of any remaining class of ice (SIGRID3-code)";
   :standard_name = "sea_ice_classification";
   :units = "1";
   :source = "DMI";
   :nodata_value = "-9";
   :_ChunkSizes = 1U, 1000U; // uint
  short CF(time=1, polygon reference=1000);
   :standard_name = "sea_ice_classification";
   :units = "1";
   :source = "DMI";
   :nodata_value = "-9";
   :long_name = "Predominant and secondary forms of ice (SIGRID3-code)";
   : ChunkSizes = 1U, 1000U; // uint
  char POLY_TYPE(time=1, polygon_reference=1000);
   :long_name = "General surface type: I=Ice, W=Water, (L=Land - not used by DMI)";
   :source = "DMI";
   :nodata_value = "N";
   :_ChunkSizes = 1U, 1000U; // uint
// global attributes:
:title = "Arctic Sea Ice Greenland Overview";
:Conventions = "CF-1.4";
:netcdf version id = "4.6.0";
```



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SEAICE_ARC_SEAICE_L4_NRT_OBSERVATIONS_011_002

```
:creation date = "2020-09-08T21:20:16Z";
:produced_date = "2020-09-06T12:00:00Z";
:valid_date = "2020-09-06T12:00:00Z";
:product_version = "1.0";
:software_version = "1.0";
:comment = "The ice concentration is based on a manual interpretation of different satellite data. For more
information about the the product contact the national ice service";
:satellite = "NA";
:sensor = "SAR";
:spatial_resolution_latitude = 1000.0f; // float
:spatial_resolution_longitude = 1000.0f; // float
:southernmost_latitude = 54.629f; // float
:northernmost_latitude = 85.239235f; // float
:westernmost longitude = -105.15334f; // float
:easternmost longitude = 22.95248f; // float
:field_type = "daily";
:institution = "DMI";
:institution references = "http://www.dmi.dk";
:contact = "iskort@dmi.dk";
:operational_status = "operational";
```

Ref: CMEMS-SI-PUM-011-002

Greenland dataset: cmems_obs-si_arc_physic_nrt_1km-grl_P1D-irr, example:

```
netcdf file: ice_conc_greenland_202009082105.nc {
dimensions:
 time = 1;
 yc = 3318;
 xc = 2232;
  polygon reference = 1000;
variables:
 int time(time=1);
   :long name = "reference time of sea ice file";
   :units = "seconds since 1981-01-01 00:00:00";
   :calendar = "standard";
  float yc(yc=3318);
   :axis = "Y";
   :long_name = "y-coordinate in Cartesian system";
   :units = "m";
  float xc(xc=2232);
   :axis = "X";
   :long_name = "x-coordinate in Cartesian system";
   :units = "m";
  float lat(yc=3318, xc=2232);
   :long name = "latitude";
   :units = "degrees north";
   :_ChunkSizes = 1106U, 744U; // uint
```



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SEAICE_ARC_SEAICE_L4_NRT_OBSERVATIONS_011_002

```
float lon(yc=3318, xc=2232);
 :long_name = "longitude";
 :units = "degrees_east";
 : ChunkSizes = 1106U, 744U; // uint
char crs;
 :straight vertical longitude from pole = -45L; // long
 :latitude_of_projection_origin = 90L; // long
 :standard_parallel = 90L; // long
 :grid_mapping_name = "polar_stereographic";
 :false_easting = 0.0f; // float
 :false_northing = 0.0f; // float
 :proj4_string = " +proj=stere +lon_0=-45 +lat_ts=90 +lat_0=90 +a=6371000 +b=6371000";
short ice concentration(time=1, yc=3318, xc=2232);
 :long_name = "sea ice concentration";
 :standard_name = "sea_ice_area_fraction";
 :units = "%";
 :coordinates = "lon lat";
 :grid_mapping = "crs";
 :source = "DMI";
 :_FillValue = -99S; // short
 :scale_factor = 1.0f; // float
 :add offset = 0.0f; // float
 :_ChunkSizes = 1U, 1659U, 1116U; // uint
short concentration_range(time=1, yc=3318, xc=2232);
 :long_name = "concentration range";
 :units = "%";
 :coordinates = "lon lat";
 :grid mapping = "crs";
 : FillValue = -99S; // short
 :comments = "Range of the analyized ice consentration value";
 :_ChunkSizes = 1U, 1659U, 1116U; // uint
short ice_poly_id_grid(time=1, yc=3318, xc=2232);
 :_FillValue = -99S; // short
 :long_name = "Reference ids for rasterized sea-ice-polygons";
 :units = "1";
 :coordinates = "lon lat";
 :grid mapping = "crs";
 :source = "DMI";
 :scale_factor = 1.0; // double
 :add_offset = 0.0; // double
 :_ChunkSizes = 1U, 1659U, 1116U; // uint
short polygon_id(time=1, polygon_reference=1000);
 :long_name = "Ids corresponding to sea-ice-polygon reference ids";
 :units = "1";
 :source = "DMI";
 :nodata_value = "-9";
 : ChunkSizes = 1U, 1000U; // uint
```



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SEAICE_ARC_SEAICE_L4_NRT_OBSERVATIONS_011_002

```
short CT(time=1, polygon_reference=1000);
 :long name = "Total concentration (SIGRID3-code)";
 :standard_name = "sea_ice_area_fraction";
 :units = "1";
 :source = "DMI";
 :nodata value = "-9";
 :_ChunkSizes = 1U, 1000U; // uint
short CA(time=1, polygon_reference=1000);
 :source = "DMI";
 :nodata_value = "-9";
 :units = "1";
 :long name = "Partial concentration of thickest ice (SIGRID3-code)";
 :standard name = "sea ice area fraction";
 :_ChunkSizes = 1U, 1000U; // uint
short SA(time=1, polygon reference=1000);
 :long_name = "Stage of development of thickest ice (SIGRID3-code)";
 :standard_name = "sea_ice_classification";
 :units = "1";
 :source = "DMI";
 :nodata_value = "-9";
 : ChunkSizes = 1U, 1000U; // uint
short FA(time=1, polygon_reference=1000);
 :standard_name = "sea_ice_classification";
 :source = "DMI";
 :nodata_value = "-9";
 :long_name = "Form of thickest ice (SIGRID3-code)";
 :units = "1";
 : ChunkSizes = 1U, 1000U; // uint
short CB(time=1, polygon_reference=1000);
 :long name = "Partial concentration of second thickest ice (SIGRID3-code)";
 :units = "1";
 :source = "DMI";
 :nodata value = "-9";
 :standard_name = "sea_ice_area_fraction";
 :_ChunkSizes = 1U, 1000U; // uint
short SB(time=1, polygon_reference=1000);
 :long_name = "Stage of development of second thickest Ice (SIGRID3-code)";
 :standard_name = "sea_ice_classification";
 :units = "1";
 :source = "DMI";
 :nodata value = "-9";
 :_ChunkSizes = 1U, 1000U; // uint
short FB(time=1, polygon reference=1000);
 :nodata_value = "-9";
 :standard name = "sea ice classification";
```



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SEAICE_ARC_SEAICE_L4_NRT_OBSERVATIONS_011_002

```
:units = "1";
   :source = "DMI";
   :long_name = "Form of second thickest ice (SIGRID3-code)";
   :_ChunkSizes = 1U, 1000U; // uint
  short CC(time=1, polygon_reference=1000);
   :long name = "Partial concentration of the third thickest ice (SIGRID3-code)";
   :standard_name = "sea_ice_area_fraction";
   :units = "1";
   :source = "DMI";
   :nodata_value = "-9";
   :_ChunkSizes = 1U, 1000U; // uint
  short SC(time=1, polygon reference=1000);
   :long name = "Stage of development of third thickest ice (SIGRID3-code)";
   :standard name = "sea ice classification";
   :units = "1";
   :source = "DMI";
   :nodata value = "-9";
   :_ChunkSizes = 1U, 1000U; // uint
  short FC(time=1, polygon_reference=1000);
   :long_name = "Form of third thickest ice (SIGRID3-code)";
   :standard name = "sea ice classification";
   :source = "DMI";
   :nodata_value = "-9";
   :units = "1";
   :_ChunkSizes = 1U, 1000U; // uint
  short CN(time=1, polygon_reference=1000);
   :standard name = "sea ice classification";
   :source = "DMI";
   :nodata_value = "-9";
   :long_name = "Stage of development of ice thicker than SA but with concentration less than 1/10 (SIGRID3-
code)";
   :units = "1";
   :_ChunkSizes = 1U, 1000U; // uint
  short CD(time=1, polygon_reference=1000);
   :long_name = "Stage of development of any remaining class of ice (SIGRID3-code)";
   :standard name = "sea ice classification";
   :units = "1";
   :source = "DMI";
   :nodata_value = "-9";
   :_ChunkSizes = 1U, 1000U; // uint
  short CF(time=1, polygon_reference=1000);
   :standard_name = "sea_ice_classification";
   :units = "1";
   :source = "DMI";
   :nodata_value = "-9";
   :long name = "Predominant and secondary forms of ice (SIGRID3-code)";
```



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SEAICE_ARC_SEAICE_L4_NRT_OBSERVATIONS_011_002

```
:_ChunkSizes = 1U, 1000U; // uint
  char POLY_TYPE(time=1, polygon_reference=1000);
   :long_name = "General surface type: I=Ice, W=Water, (L=Land - not used by DMI)";
   :source = "DMI";
   :nodata value = "N";
   : ChunkSizes = 1U, 1000U; // uint
// global attributes:
:title = "Arctic Sea Ice Greenland";
:Conventions = "CF-1.4";
:netcdf_version_id = "4.6.0";
:creation_date = "2020-09-09T09:00:06Z";
:produced date = "2020-09-08T21:05:00Z";
:valid date = "2020-09-08T21:05:00Z";
:product_version = "1.0";
:software version = "1.0";
:comment = "The ice concentration is based on a manual interpretation of different satellite data. For more
information about the the product contact the national ice service";
:satellite = "NA";
:sensor = "SAR";
:spatial_resolution_latitude = 1000.0f; // float
:spatial_resolution_longitude = 1000.0f; // float
:southernmost latitude = 54.629f; // float
:northernmost_latitude = 85.239235f; // float
:westernmost_longitude = -105.15334f; // float
:easternmost_longitude = 22.95248f; // float
:field_type = "daily";
:institution = "DMI";
:institution_references = "http://www.dmi.dk";
:contact = "iskort@dmi.dk";
:operational status = "operational";
Greenland dataset: DMI-ARC-SEAICE_CONC-L4-NRT-OBS, example:
netcdf ice_conc_greenland_201103280100 {
dimensions:
    time = 1;
    xc = 2232;
    yc = 3318;
```

Ref: CMEMS-SI-PUM-011-002

int time(time);

float yc(yc);

float xc(xc);

yc:axis = "Y";

yc:units = "m";

xc:axis = "X";

time:long_name = "reference time of sea ice file"; time:units = "seconds since 1981-01-01 00:00:00";

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

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

variables:



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SEAICE_ARC_SEAICE_L4_NRT_OBSERVATIONS_011_002

```
xc:units = "m";
    float lat(yc, xc);
        lat:long_name = "latitude";
        lat:units = "degrees_north";
    float lon(yc, xc);
        lon:long_name = "longitude";
        lon:units = "degrees east";
    char crs;
        crs:grid_mapping_name = "polar_stereographic";
        crs:false easting = 0.f;
        crs:false_northing = 0.f;
        crs:proj4_string = " +a=6371000 +b=6371000 +lat_ts=90 +lon_0=-45 +proj=stere +lat_0=90"
    short ice concentration(time, yc, xc);
        ice concentration:long name = "sea ice concentration";
        ice_concentration:standard_name = "sea_ice_area_fraction";
        ice concentration:units = "%";
        ice_concentration:coordinates = "lon lat";
        ice_concentration:grid_mapping = "crs";
        ice_concentration:source = "DMI";
        ice concentration: FillValue = -99s;
        ice_concentration:scale_factor = 1.f;
        ice_concentration:add_offset = 0.f;
    short concentration range(time, yc, xc);
        concentration_range:long_name = "concentration range";
        concentration_range:units = "%";
        concentration_range:coordinates = "lon lat";
        concentration_range:grid_mapping = "crs";
        concentration_range:_FillValue = -99s;
        concentration_range:comments = "Range of the analyized ice consentration value";
// global attributes:
        :title = "Total Sea Ice Concentration from national ice services.";
        :Conventions = "CF-1.4";
        :netcdf version id = "3.6.2-beta6";
        :creation_date = "2011-03-28T23:31:33Z";
        :produced_date = "2011-03-28T01:00:00Z";
        :valid date = "2011-03-28T01:00:00Z";
        :product_version = "1.0";
        :software version = "1.0";
        :comment = "The ice concentration is based on a manual interpretation of different sate
llite data. For more information about the the product contact the national ice service";
        :satellite = "NA";
        :sensor = "SAR";
        :spatial_resolution_latitude = 1000.f;
        :spatial_resolution_longitude = 1000.f;
        :southernmost_latitude = 54.629f;
        :northernmost_latitude = 85.23923f;
        :westernmost longitude = -105.1533f;
        :easternmost longitude = 22.95248f;
        :field_type = "daily";
        :institution = "DMI";
```



SEAICE_ARC_SEAICE_L4_NRT_OBSERVATIONS_011_002

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```
:institution_references = "http://www.dmi.dk";
:contact = "iskort@dmi.dk";
:operational_status = "operational";
```

Greenland dataset: DMI-ARC-SEAICE_CONC_OVERVIEW-L4-NRT-OBS, example:

```
netcdf ice_conc_overview_greenland_201105221200 {
dimensions:
        time = 1;
        xc = 2232;
        yc = 3318;
variables:
        int time(time);
                time:long name = "reference time of sea ice file";
                time:units = "seconds since 1981-01-01 00:00:00";
        float yc(yc);
                yc:axis = "Y";
                yc:long_name = "y-coordinate in Cartesian system";
                yc:units = "m";
        float xc(xc);
                xc:axis = "X";
                xc:long name = "x-coordinate in Cartesian system";
                xc:units = "m":
        float lat(yc, xc);
                lat:long_name = "latitude";
                lat:units = "degrees_north";
        float lon(yc, xc);
                lon:long_name = "longitude";
                lon:units = "degrees_east";
        char crs;
                crs:grid_mapping_name = "polar_stereographic";
                crs:false easting = 0.f;
                crs:false northing = 0.f;
                crs:proj4_string = " +a=6371000 +b=6371000 +lat_ts=90 +lon_0=-45 +proj=stere +lat_0=90";
        short ice_concentration(time, yc, xc);
                ice_concentration:long_name = "sea ice concentration";
                ice_concentration:standard_name = "sea_ice_area_fraction" ;
                ice_concentration:units = "%";
                ice_concentration:coordinates = "lon lat";
                ice concentration:grid mapping = "crs";
                ice_concentration:source = "DMI";
                ice_concentration:_FillValue = -99s;
                ice concentration:scale factor = 1.f;
                ice_concentration:add_offset = 0.f;
        short concentration_range(time, yc, xc);
                concentration_range:long_name = "concentration range";
                concentration_range:units = "%";
                concentration range:coordinates = "lon lat";
                concentration_range:grid_mapping = "crs";
                concentration range: FillValue = -99s;
                concentration range:comments = "Range of the analyized ice consentration value";
```



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SEAICE_ARC_SEAICE_L4_NRT_OBSERVATIONS_011_002

```
// global attributes:
                 :title = "Total Sea Ice Concentration from national ice services.";
                 :Conventions = "CF-1.4";
                 :netcdf version id = "3.6.2-beta6";
                 :creation_date = "2011-05-23T23:16:47Z";
                 :produced_date = "2011-05-22T12:00:00Z";
                 :valid date = "2011-05-22T12:00:00Z";
                 :product_version = "1.0";
                 :software_version = "1.0";
                 :comment = "The ice concentration is based on a manual interpretation of different satellite
data. For more information about the the product contact the national ice service";
                 :satellite = "NA";
                 :sensor = "SAR";
                 :spatial resolution latitude = 1000.f;
                 :spatial resolution longitude = 1000.f;
                 :southernmost_latitude = 54.629f;
                 :northernmost latitude = 85.23923f;
                 :westernmost longitude = -105.1533f;
                 :easternmost_longitude = 22.95248f;
                 :field_type = "daily";
                 :institution = "DMI";
                 :institution_references = "http://www.dmi.dk";
                 :contact = "iskort@dmi.dk";
                 :operational status = "operational";
}
```

Ref: CMEMS-SI-PUM-011-002

VI.3 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...