Sea Ice Climate Change Initiative: Phase 1

Sea Ice Concentration (SIC) Round Robin Data Package

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1 Introduction

1.1 Purpose and Scope

This document describes the Round Robin datasets (RRDP) for the Sea Ice Concentration Essential Climate Variables products to be produced in ESA's Climate Change Initiative.

The RRDP is a set of comma separated ASCII files which contain independent ice concentrations and co-located satellite TBs extracted from the SMMR, SSMI and AMSR-E swath datasets to be used to produce the final ECV product.

The dataset should be easy to use by reading the files line by line, calculate SIC from the given TBs and compare with the given reference SIC.

1.2 Document Structure

The document includes the RRDP description for Sea Ice Concentration, including information about how the dataset was generated and the choices made.

1.3 Document Status

This is a first formal issue of the RRDP. More background information on the validation procedures can be found in the PVP document (Product Validation Plan).

1.4 Applicable Documents

The following table lists the Applicable Documents that have a direct impact on the contents of this document.

Acronym	Title	Reference	Issue
AD-1	Sea Ice ECV Project Management Plan	ESA-CCI_SICCI_PMP_D6.1_v1.1	1.1
AD-2	Sea Ice ECV Product Validation Plan	ESA-CCI_SICCI_PVP	
AD-3	Sea Ice ECV Data Access and Requirements Document	ESA-CCI_SICCI_DARD	

Table 1-1: Applicable Documents

1.5 Applicable Standards

Acronym	Title	Reference	Issue

Table 1-2: Applicable Standards

1.6 Acronyms and Abbreviations

Acronym	Meaning
ACDD	Attribute Convention for Dataset Discovery
AMSR-E	Advanced Microwave Scanning Radiometer aboard EOS
AO	Announcement of Opportunity
ASCII	American Standard Code for Information Interchange
ASIRAS	Airborne Synthetic Aperture and Interferometric Radar Altimeter System
ATBD	Algorithm Theoretical Basis Document
CF	Climate and Forecasting
CM-SAF	Climate Monitoring Satellite Application Facility
DMSP	Defence Meteorological Satellite Program
DWD	Deutscher Wetterdienst
EASE	Equal Area Scalable Earth-Grid
ECV	Essential Climate Variable
Envisat	Environmental Satellite
EO	Earth Observation
ERS	European Remote Sensing Satellite
ESA	European Space Agency
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
FB	Freeboard
FCDR	Fundamental Climate Data Record
FOC	Free of Charge
FOV	Field-of-View
FTP	File Transfer Protocol
GB	GigaByte
GCOM	Global Change Observation Mission
GHRSST	Group for High Resolution Sea Surface Temperature
H	Horizontal polarization
H+V	Horizontal and vertical polarization
IDL	Interactive Data Language
Matlab	Matrix Laboratory
MB	MegaByte
MIZ	Marginal ice zone
MODIS	Moderate Resolution Imaging Spectroradiometer
n.a.	Not applicable
NetCDF	Network Common Data Format
NH	Northern hemisphere
NSIDC	National Snow and Ice Data Center
OIB	Operation Ice Bridge
OSI-SAF	Ocean and Sea Ice Satellite Application Facility
PDGS	Payload Data Ground System
PI	Principal Investigator

Acronym	Meaning
PMW	Passive Microwave
PRF	Pulse Repetition Frequency
RA	Radar altimeter
RADAR	Radio Detection and Ranging
SAR	Synthetic Aperture Radar
SIC	Sea Ice Concentration
SIRAL	SAR/Interferometric Radar Altimeter
SIT	Sea Ice Thickness
SH	Southern hemisphere
SMMR	Satellite Multichannel Microwave Radiometer
SMOS	Soil Moisture and Ocean Salinity
SSM/I	Special Sensor Microwave / Imager
SSM/IS	Special Sensor Microwave / Imager+Sounder
TB	TeraByte
TBD	To be defined
TM	Thematic Mapper
ULS	Upward Looking Sonar
URD	User Requirements Document
URL	Uniform Resource Locator
V	Vertical polarization

Table 1-3: Acronyms

2 Round Robin Data Package (RRDP) (SIC)

The purpose of the RRDP is to collect a reference dataset of brightness temperatures and validated ice concentrations that allow evaluation of sea ice concentration algorithms and understanding of the error contributions from different sources of errors.

The database consists of TB data measured by:

- AMSR-E,
- SMMR and
- SSMI microwave radiometers (DARD: ID 1.01 and 1.02);
- Simulated data;

  Using MEMLSI;

  Using modified Wentz models (RTM).

The format of the RRDP is a set of data files in simple ASCII csv format with a number of columns containing:

- The source of the TB data (time, sensor, dataset, model, model version etc);
- The actual TBs (different number of columns for the different source datasets;
- Associated ice parameters (including total ice concentration, snow parameters (if known), ice type, ice thickness etc. if available);
- Associated environmental parameters (atmosphere from ECMWF reanalysis closest 6h analysis in some datasets (DARD: ID 2.01)).

2.1 Validation database from SAR and VIS/IR data

For the validation and algorithm selection a Round Robin Data Package (aka a "match-up data base") has been created following the specifications given in the validation protocol. The RRDP is hereby made available for users in the sea ice and passive microwave science community. The RRDP consists of data based on:

- Data from areas of ~100% ice from quantification of convergence and divergence areas in ENVISAT ASAR ice drift data (DTU/DMI). Use convergence from ASAR ice drift in high concentration ice areas as detection of 100% ice. Produce Antarctic and Arctic validation dataset from these SAR convergence maps. Perform subsequent quality control of 100% conc. Generate validation dataset for open water near ice for various seasons and regions.
- Data from high latitude areas of 0% ice concentration identified from ice charts, climatology and classified satellite images (DARD: ID 2.02)

- High quality validation dataset of large areas of ca. 100% thin ice (areas in the order of 100x100km) from SMOS (DARD: 2.19)

- Validation data set of daily melt-season ice concentration and melt-pond cover fraction derived from MODIS imagery (selected periods from 2000-present) (DARD: ID 2.08 and 2.09);

- SAR discrimination between water and ice (DARD: ID 2.10);

All data are collocated with available PMR data (brightness temperatures).

We have developed the necessary collocation processing system (See chapter 3) based on satellite effective fields of view.

2.2 Collocation methods (SIC)

For the algorithm selection procedure a simpler version of the collocation has been applied for time constraint reasons. Since we only use data from larger areas of homogenous ice conditions, we will average a number of satellite footprints in order to secure approximately the same resolution in all relevant channels. The target resolution will be that of the 18/19 GHz channels which are the coarsest that will be used in the algorithms to be tested. For completeness and eventual future use co-location data may be produced also for coarser resolution channels of the SMMR and AMSR-E but due to the coarse resolution these are not expected to meet user requirements for spatial resolution.

The collocation processing system takes high quality/high resolution ice concentration data from data producers and calculates weighted averages corresponding to SSMI footprints and grids at different resolutions. The methodology is considered applicable in WP4000 validation as well.

2.3 Methods for deriving independent ice concentrations

2.3.1 ASAR convergence method (SIC=100%)

The main method for identifying areas of 100% ice will be based on the PolarView / MyOcean ice drift dataset from ENVISAT ASAR. This dataset will be processed to find areas of ~100x100 Km with convergence in the ice drift pattern between two consecutive days. During winter this will correspond to areas of total ice cover (assuming that we start on day 1 with near 100% ice). Eventual openings will after 1 day of convergence be either frozen or removed due to ridging/rafting. Since the areas are of the order of 100 Km we will subsequently find corresponding PMR data that we will average to similar resolution at all channels and where the resulting resolution cell is completely inside the 100x100 Km convergence area.

In the following, the method derived and the methods used for the identification of nominal 100% sea ice is described.

2.3.1.1 AOI (Area Of Interest) cell grid description

The extent of the geographical areas of interest covers for the northern hemisphere 55N to 90N and to the North Pole, and for the southern hemisphere 55S to 80S as only sea ice is relevant.

To facilitate the identification of nominal 100% ice a special AOI grid has been devised.

The sea covering areas are divided into round AOI grid cells each with a diameter of 100km and evenly spaced with approximately 50% overlap and at least 50km from land. The 50km distance is chosen to ensure that the antenna footprint of any available passive microwave measurement sample with a centre position inside an AOI cell does not cover any land.

2.3.1.2 Identification of nominal 100%

To identify locations with nominal100% ice cover, the transport of ice is examined directly in the form of the DTU MyOcean SAR based sea ice drift product.

It is believed that an observed area which conforms to specific set of criteria with respect to area changes indicates 100% ice cover. The observed area must decrease slightly from day to day, as large are increase indicated leads and large decreases indicates to little ice .

Furthermore the observations must cover the AOI cell well.

The requirements set up as follows

2.3.1.3 Compression zone identification

All drift observations for a given day are ordered in groups of 4 neighbors and the area change calculated using a free 3rd party tool called Planimeter available from http://geographiclib.sourceforge.net/ in the package GeographicLib.

The area-change observations from a period of 48hrs are then sorted into the AOI grid, so that one AOI cell keeps track of all available area observations that falls within its boundaries.

During this process the area observations are flagged at either 'good' or 'bad' depending on their characteristics.

For a single drift observation to be considered 'good' the area change must lie within certain limits, these have been loosely chosen to be 90%-103%, to account for the round-off uncertainty associated with the 300m resolution of the SAR data on which the sea ice drift product is based.

For an AOI cell full of observations to enter the RRDP, it must contain 40 or more 'good'

2.3.2 No ice near ice boundary (SIC=0%)

From icecharts we will identify the limit of all ice and select areas in the order of 100 Km away from the ice edge in the open water region. These areas will provide the open water test data, and collocation with PMR data will be done in the same manner as above for the 100% ice areas.

Table 1. Location and valid period for open water data points

Northern hemisphere		Southern hemisphere	
January and February	August and September	January, February,March, April	August, September, October,November
58N 52W	65N 56W	64S 80W	60S 80W
63.5N 35W	63.5N 35W	63S 170W	58S 170W
70N 0E	70N 0E	59S 90E	55S 90E
73N 30E	75N 40E	64S 10E	50S 10W
55N 180	70N 170W	58.5S 20W	

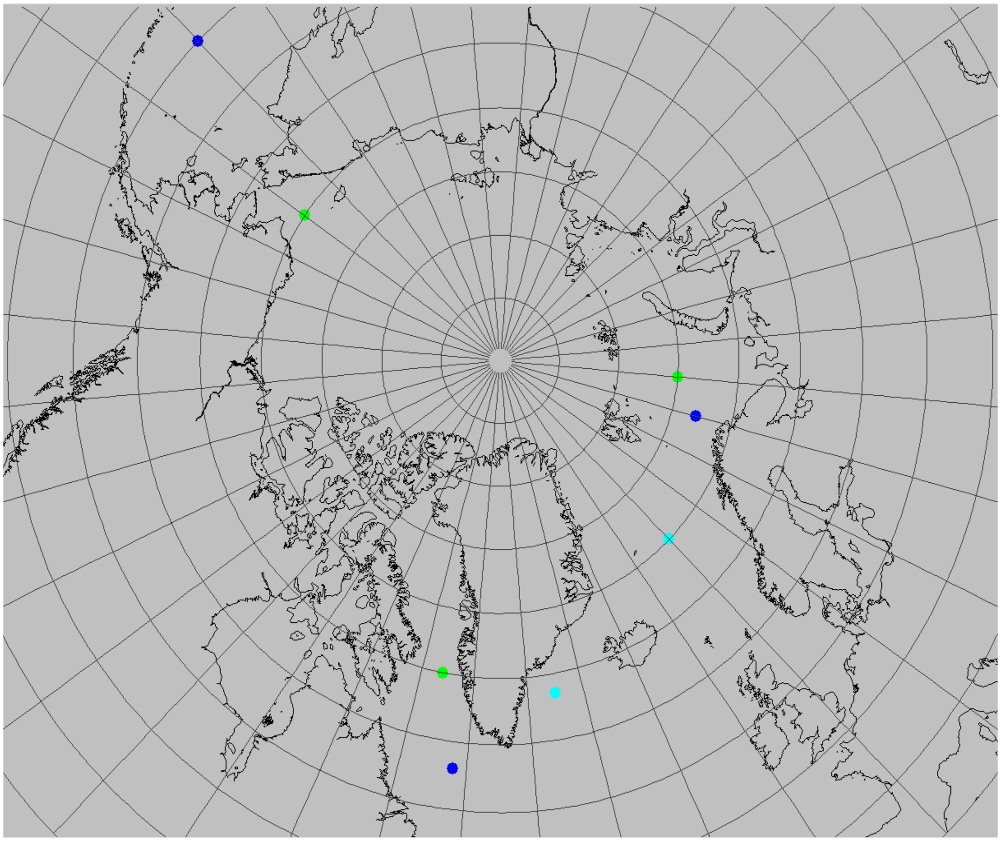

Figure 1. Location of areas for SIC=0 validation.Green are summer points, blue are winter points and cyan are points used all year.

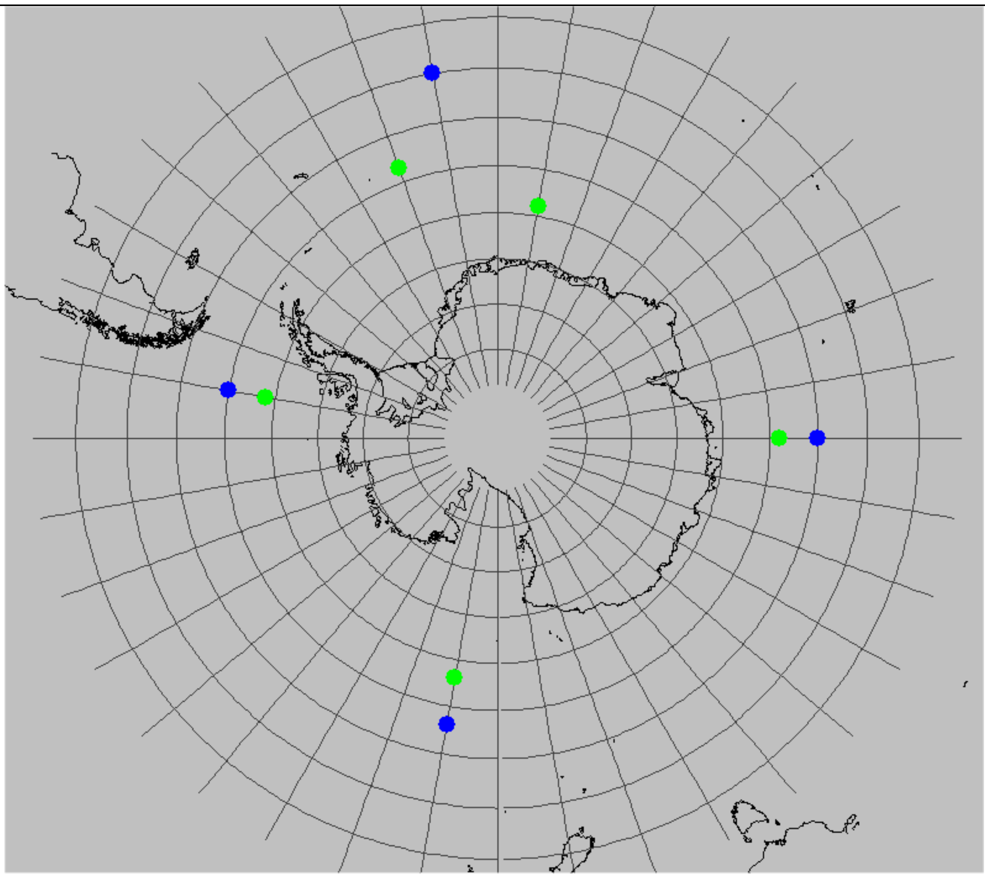

Figure 2. Location of SIC=0 areas for the SOuthern Hemisphere. Green are Austral Summer locations and Blue are Austral Winter locations.

2.3.3 Thin ice collocation

ESA's L-band sensor SMOS is intended to observe soil moisture and ocean salinity (name). Because of its long wavelength the observations are also suitable to retrieve the thickness of thin sea ice data. Two algorithms have been suggested, one based on intensity and incidence angles below 40° [1], and one based on simultaneously using both intensity and polarization difference at incidence angles above 40° [2]. Here, the latter procedure is applied to observations of the Arctic in the period of October to December 2010, the first Arctic freezing season which was observed by SMOS.

All processing is based on SMOS L1C version 3.46 data. These data are organized in Discrete Global Grid (DGG) cells of 9 km spacing in an Icosahedral Snyder Equal Area projection with aperture 4 and resolution 9 (ISEA 4H9). The grid cells have a size of about 15x15 km2. Observations nearer than 50 km from land have been excluded. All SMOS snapshots containing one or more pixels with brightness temperature higher than 300 K are considered RFI contaminated and excluded.

The mere retrieval is organized in four steps:

1. convert observations of the four Stokes components from the instrument reference frame to the surface reference frame,

2. averaging of all observations of one day within one DGG and incidence angle range of 40° to 50°
3. retrieval of ice thickness based on intensity of polarization difference values
4. interpolate results to polar stereographic projection of 12.5 km (NSIDC grid).

Subsequently, regions of homogeneous sea ice thickness have been identified by selecting regions of limited local standard deviation. For this purpose, the resulting sequence of sea ice maps is considered as a 3-d data cube with two horizontal dimensions and one time dimension. The local standard deviation is calculated using convolution operations of variable size in horizontal direction in units of 12.5x12.5 km^2 pixels and in time direction in units of days. A (7,7,3) window (x,y,t) has been selected in order to guarantee sufficient homogeneity in a region larger than the footprint of the lowest involved SSM/I channel (19 GHz, 70x43 km^2). In addition, the days before and after are included when calculating the standard deviation in order to exclude regions of strong change from one day to the next.

As period of largest extent of Arctic thin ice, the 18 days from 2 to 19 November 2010 have been identified. After a set of tests, the data fulfilling the following conditions were selected:

- ice thicknesses from 2 to 30 cm to avoid open water and noisy retrievals
- ice thickness standard deviation below 2 cm.

With this procedure, in total 4784 pixels were identified, each resulting in one data set for which the following parameters were extracted for the Round Robin exercise: latitude, longitude, x-position, y-position, thickness, standard deviation, date

Figure 3 shows the map of all extracted positions and the histogram of sea ice thickness.

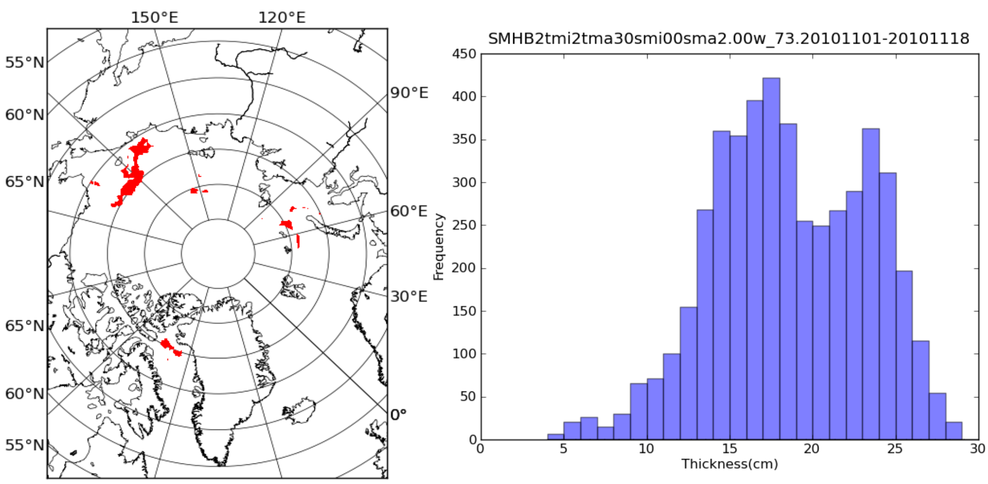

Figure 3: Left: map of identified thin ice regions. Right: histogramme of thicknesses distribution for the included datapoints.

Kaleschke, L., X. Tian-Kunze, N. Maaß, M. Mäkynen, and M. Drusch, Sea ice thickness retrieval from SMOS brightness temperatures during the Arctic *freeze-up period, Geophys. Res. Lett., 39, L05501, doi:10.1029/2012GL050916, 2012*

Heygster,G., M. Huntemann, H. Wang 2012: Polarization-based SMOS sea ice thickness retrieval algorithm (Algorithm Theoretical Basis Document (ATBD)). Technical Report, Institute of Environmental Physics, University of Bremen.

2.3.4 Summer melt collocation

Gridded independent SIC estimates from MODIS will be collocated with the coincident melt pond cover fraction (DARD: ID 2.08 and 2.09) and SICCI SIC products to investigate the impact of melt ponds and the performance of the algorithm in such melt-pond cover infested areas [Roesel et al., 2012b].

Reflectances measured by bands 1, 3, and 4 of the MODIS sensor and provided by NASA as *MODIS Surface Reflectance 8-Day L3 Global 500m SIN Grid V005"* - product (MOD09A1) and *"MODIS Surface Reflectance daily L2G Global 500 m and 1 km"* - product (MOD09GA) are projected onto a polar-stereographic grid with 500 m grid resolution, applying land, cloud and other flags provided with the original MODIS product. The analysis is limited to tiles covering the Arctic Ocean, i.e. north of 60°N. A spectral un-mixing process is applied together with an artificial neural network to classify the reflectances of each grid cell into the three surface classes: open water, melt ponds, and snow / ice. For the final melt pond fraction product, surface class distributions are interpolated onto a 12.5 km grid resolution polar-stereographic grid; resulting netCDF files contain melt pond fraction (MPF), number of valid (non-flagged) 500 m grid cells per 12.5 km grid cell (N), standard deviation of MPF according to N (MPF-SD), and the open water fraction (OWF). This is the standard product available via ICDC (http://icdc.zmaw.de).

The RRDP requires high quality, high ice concentration data at 100 km grid resolution. For the RRDP product, 8x8 12.5 km grid cell averages are computed for MPF, MPF-SD, and OWF. For this a binary mask is produced, comprising 12.5 km grid cells with above 90% ice concentration (computed as 100% - OWF) and with clear-sky conditions (100% valid grid cells). This mask is applied and 100 km grid resolution average values are computed for those 8x8 grid-cell boxes where at least 90% of the cells belong to the binary mask.

For the grid cells selected this way, the RRDP contains 8-day composite MPF data for years 2000-2011 for the entire Arctic and daily MPF data for the Kara Sea and the area North of Greenland for 2009; the period for the latter subset was chosen in accordance with melt pond retrieval activities at FMI.

For the RRDP a special 1-day dataset has been produced in order to enable accurate collocation in time with satellite PMR data.

2.3.5 Validation database from simulated microwave radiometer data

Using climatological datasets from Arctic regions we have produced a set of simulated TBs using a thermodynamic snow model and the MEMLSI

(Microwave Emissivity Model for Layered Snowpacks with Sea Ice) and the Wentz radiative transfer models for the atmosphere. The simulated data will be used to shed more light on the actual background for the algorithm performance.

Simulated data from a combined thermodynamic and emission model is used to generate the 100% sea ice data points and corresponding brightness temperatures at 6 hour intervals during the cold season from freeze-up to melt onset. The thermodynamic model is forced with ECMWF ERA 40 meteorological data input at selected locations in the Arctic and Antarctica. The sea ice emission model relate physical snow and ice properties such as density, temperature, snow crystal and brine inclusion size from the thermodynamic model to microwave attenuation, scattering and reflectivity. The emission model used here is a sea ice version of MEMLS (Wiesmann and Mätzler, 1999) described in Mätzler et al. (2006). The simulated surface emissivity and corresponding effective temperature at 19GHz is together with the atmospheric cloud water and water vapor used as input to an atmospheric model. We are using a three different atmospheric models for simulating the top of the atmosphere emission for SMMR (Wentz, 1983), SSMI (Wentz, 1997) and AMSR (Wentz and Meissner, 2000).

3 SIC RRDP data format

We have produced a set of simple to use ASCII (csv) flat files. Each line records information for a unique (validation data, collocated PM) pair. The latitude, longitude, time, source/institution, "true" SIC value (+a confidence level) are obviously part of the information to be recorded. Follow the latitude, longitude, time, instrument (<instr>-<platform>, e.g. ssmi-f15) full PM record (at least 8 channels: 19V, 19H, 37V, 37H, 22V, 22H, N90V, N90H). The data format (e.g. order of the columns, number of decimals, format for the date-time string) was not decided upon. This simple format should enable easy exchange between the partners and reading from any programming language or data-analysis tools.

Below we present a detailed description of the data columns in each type of RRDP files.

3.1 SIC=0 and SIC=1 reference data

The following tables contain information about the columns in each type of RRDP files.
Each line of each file contains a reference part and an observation part. All values/IDs are separated by commas ","

3.1.1 SMMR files, 1978-1987

	Reference part:
1	latitude [degrees]
2	longitude [degrees]
3	time (UTC)
4	reference ID (sensor/method and producer ex ICECHART_DMI)
5	nominal seaice concentration (SIC)
	Observation part:
6	latitude [degrees]
7	longitude [degrees]
8	time (UTC)
9	sensor ID (sensor and producer here SMMR_NSIDC)
10	resampled 6Ghz H-polarisation brightness temperature [Kelvin]
11	resampled 6Ghz V-polarisation brightness temperature [Kelvin]
12	resampled 10Ghz H-polarisation brightness temperature [Kelvin]
13	resampled 10Ghz V-polarisation brightness temperature [Kelvin]
14	resampled 18Ghz H-polarisation brightness temperature [Kelvin]
15	resampled 18Ghz V-polarisation brightness temperature [Kelvin]
16	resampled 21Ghz H-polarisation brightness temperature [Kelvin]
17	resampled 21Ghz V-polarisation brightness temperature [Kelvin]
18	resampled 37Ghz H-polarisation brightness temperature [Kelvin]
19	resampled 37Ghz V-polarisation brightness temperature [Kelvin]
20	upstream file name
21	sample s/n
22	reference area s/n
23	number of samples per mean
24	mean scanline of swath
25	mean scanpos of swath
26	std of resampled 6Ghz H-polarisation brightness temperature [Kelvin]
27	std of resampled 6Ghz V-polarisation brightness temperature [Kelvin]
28	std of resampled 10Ghz H-polarisation brightness temperature [Kelvin]
29	std of resampled 10Ghz V-polarisation brightness temperature [Kelvin]
30	std of resampled 18Ghz H-polarisation brightness temperature [Kelvin]
31	std of resampled 18Ghz V-polarisation brightness temperature [Kelvin]
32	std of resampled 21Ghz H-polarisation brightness temperature [Kelvin]
33	std of resampled 21Ghz V-polarisation brightness temperature [Kelvin]
34	std of resampled 37Ghz H-polarisation brightness temperature [Kelvin]

35	std of resampled 37Ghz V-polarisation brightness temperature [Kelvin]
36	Filter profile used for resampling (CLAMP is simple mean of values inside 25km radius)
	Please contact: rs@space.dtu.dk for more information

3.1.2 SSMI part, 1987-2009

	Reference part:
1	latitude [degrees]
2	longitude [degrees]
3	time (UTC)
4	reference ID (sensor/method and producer ex ICECHART_DMI)
5	nominal seaice concentration (SIC)
	Observation part:
6	latitude [degrees]
7	longitude [degrees]
8	time (UTC)
9	sensor ID (sensor and producer here SSMI_CMSAF)
10	resampled 19Ghz V-polarisation brightness temperature [Kelvin]
11	resampled 19Ghz H-polarisation brightness temperature [Kelvin]
12	resampled 22Ghz V-polarisation brightness temperature [Kelvin]
13	resampled 37Ghz V-polarisation brightness temperature [Kelvin]
14	resampled 37Ghz H-polarisation brightness temperature [Kelvin]
15	resampled 85Ghz V-polarisation brightness temperature [Kelvin]
16	resampled 85Ghz H-polarisation brightness temperature [Kelvin]
17	upstream file name
18	sample s/n
19	reference area s/n
20	number of samples per mean
21	mean scanline of swath
22	mean scanpos of swath
23	std of resampled 19Ghz V-polarisation brightness temperature [Kelvin]
24	std of resampled 19Ghz H-polarisation brightness temperature [Kelvin]
25	std of resampled 22Ghz V-polarisation brightness temperature [Kelvin]
26	std of resampled 37Ghz V-polarisation brightness temperature [Kelvin]
27	std of resampled 37Ghz H-polarisation brightness temperature [Kelvin]
28	std of resampled 85Ghz V-polarisation brightness temperature [Kelvin]
29	std of resampled 85Ghz H-polarisation brightness temperature [Kelvin]
30	Filter profile used for resampling (CLAMP is simple mean of values inside 25km radius)
	Please contact: rs@space.dtu.dk for more information

3.1.3 AMSR-E files, 2003-2011

The AMSR-E TB data are extracted from a dataset provided by the National Snow and Ice Data Center in Boulder, Colorado: AMSR-E/Aqua L2A Global Swath Spatially-Resampled Brightness Temperatures. The Advanced Microwave Scanning Radiometer - Earth Observing System (AMSR-E) instrument on the NASA Earth Observing System (EOS) Aqua satellite provides global passive microwave measurements of terrestrial, oceanic, and atmospheric variables for the investigation of global water and energy cycles.

	Reference part:
1	latitude [degrees]
2	longitude [degrees]
3	time (UTC)
4	reference ID (sensor/method and producer ex ICECHART_DMI)
5	nominal seaice concentration (SIC)
	Observation part:
6	latitude [degrees]
7	longitude [degrees]
8	time (UTC)
9	sensor ID (sensor and producer here AMSR_NSIDCWENTZ)
10	resampled 6.9Ghz V-polarisation brightness temperature [Kelvin]
11	resampled 6.9Ghz H-polarisation brightness temperature [Kelvin]
12	resampled 10.7Ghz V-polarisation brightness temperature [Kelvin]
13	resampled 10.7Ghz H-polarisation brightness temperature [Kelvin]
14	resampled 18.7Ghz V-polarisation brightness temperature [Kelvin]
15	resampled 18.7Ghz H-polarisation brightness temperature [Kelvin]
16	resampled 23.8Ghz V-polarisation brightness temperature [Kelvin]
17	resampled 23.8Ghz H-polarisation brightness temperature [Kelvin]
18	resampled 36.5Ghz V-polarisation brightness temperature [Kelvin]
19	resampled 36.5Ghz H-polarisation brightness temperature [Kelvin]
20	resampled 89.0Ghz V-polarisation brightness temperature [Kelvin]
21	resampled 89.0Ghz H-polarisation brightness temperature [Kelvin]
22	upstream file name
	Please contact: rs@space.dtu.dk for more information

The AMSR-E Level-2A product (AE_L2A) contains brightness temperatures at 6.9 GHz, 10.7 GHz, 18.7 GHz, 23.8 GHz, 36.5 GHz, and 89.0 GHz. Data are resampled to be spatially consistent, and therefore are available at a variety of resolutions that correspond to the footprint sizes of the observations such as 56 km, 38 km, 24 km, 21 km, 12 km, and 5.4 km, respectively. Each swath is packaged with associated geolocation fields. Data are stored in Hierarchical Data Format - Earth Observing System (HDF-EOS) format and are available from 19 June 2002 to the present via FTP.

P. Ashcroft and F. Wentz. 2003. *AMSR-E/Aqua L2A Global Swath Spatially-Resampled Brightness Temperatures*. Version 2. Boulder, Colorado USA: National Snow and Ice Data Center.

http://nsidc.org/data/ae_l2a.html

3.2 Thin ice data derived from SMOS

3.2.1 AMSR data from 2010 with SMOS thin ice thickness

	Each line contains a reference part and an observation part as comma separated values: **Reference part:**
1	latitude [degrees]
2	longitude [degrees]
3	time (UTC)
4	reference ID (sensor/method and producer ex ICECHART_DMI)
5	nominal seaice concentration (SIC)
6	SMOS based 'thinice' ice thickness [m]
7	std of SMOS based 'thinice' ice thickness
	Observation part:
8	latitude [degrees]
9	longitude [degrees]
10	time (UTC)
11	sensor ID (sensor and producer here AMSR_NSIDCWENTZ)
12	resampled 6.9Ghz V-polarisation brightness temperature [Kelvin]
13	resampled 6.9Ghz H-polarisation brightness temperature [Kelvin]
14	resampled 10.7Ghz V-polarisation brightness temperature [Kelvin]
15	resampled 10.7Ghz H-polarisation brightness temperature [Kelvin]
16	resampled 18.7Ghz V-polarisation brightness temperature [Kelvin]
17	resampled 18.7Ghz H-polarisation brightness temperature [Kelvin]
18	resampled 23.8Ghz V-polarisation brightness temperature [Kelvin]
19	resampled 23.8Ghz H-polarisation brightness temperature [Kelvin]
20	resampled 36.5Ghz V-polarisation brightness temperature [Kelvin]
21	resampled 36.5Ghz H-polarisation brightness temperature [Kelvin]
22	resampled 89.0Ghz V-polarisation brightness temperature [Kelvin]
23	resampled 89.0Ghz H-polarisation brightness temperature [Kelvin]
24	upstream file name
	// Further more the University of Bremen (UB) SMOS Thinice files contains ice thickness (less than 1 meter) and thinice std. Please contact: rs@space.dtu.dk for more information

3.3 Summer data with melt pond fraction

3.3.1 SSMI data with MODIS melt pond fraction

Note: At the moment no meltpond data with colocated SSMI are available since the CM-SAF SSMI dataset ends at the end of 2008 and the MODIS melt-pond fraction dataset is from 2009, so no overlap in time.

	Reference part:
1	latitude [degrees]
2	longitude [degrees]
3	time (UTC)
4	reference ID (sensor/method and producer ex MODISMELTPONDFRACTION_UHAM)
5	calculated seaice concentration (SIC)
6	std of calculated SIC
7	meltpond fraction
8	std of meltpond fraction
	Observation part:
9	latitude [degrees]
10	longitude [degrees]
11	time (UTC)
12	sensor ID (sensor and producer here SSMI_CMSAF)
13	resampled 19Ghz V-polarisation brightness temperature [Kelvin]
14	resampled 19Ghz H-polarisation brightness temperature [Kelvin]
15	resampled 22Ghz V-polarisation brightness temperature [Kelvin]
16	resampled 37Ghz V-polarisation brightness temperature [Kelvin]
17	resampled 37Ghz H-polarisation brightness temperature [Kelvin]
18	resampled 85Ghz V-polarisation brightness temperature [Kelvin]
19	resampled 85Ghz H-polarisation brightness temperature [Kelvin]
20	upstream file name
21	sample s/n
22	reference area s/n
23	number of samples per mean
24	mean scanline of swath
25	mean scanpos of swath
26	std of resampled 19Ghz V-polarisation brightness temperature [Kelvin]
27	std of resampled 19Ghz H-polarisation brightness temperature [Kelvin]
28	std of resampled 22Ghz V-polarisation brightness temperature [Kelvin]

29	std of resampled 37Ghz V-polarisation brightness temperature [Kelvin]
30	std of resampled 37Ghz H-polarisation brightness temperature [Kelvin]
31	std of resampled 85Ghz V-polarisation brightness temperature [Kelvin]
32	std of resampled 85Ghz H-polarisation brightness temperature [Kelvin]
33	Filter profile used for resampling (CLAMP is simple mean of values inside 25km radius)
	Please contact: rs@space.dtu.dk for more information

3.3.2 AMSR-E data with MODIS melt pond fraction

	Reference part:
1	latitude [degrees]
2	longitude [degrees]
3	time (UTC)
4	reference ID (sensor/method and producer ex ICECHART_DMI)
5	calculated seaice concentration (SIC)
6	std of calculated SIC
7	meltpond fraction
8	std of meltpond fraction
	Observation part:
9	latitude [degrees]
10	longitude [degrees]
11	time (UTC)
12	sensor ID (sensor and producer here AMSR_NSIDCWENTZ)
13	resampled 6.9Ghz V-polarisation brightness temperature [Kelvin]
14	resampled 6.9Ghz H-polarisation brightness temperature [Kelvin]
15	resampled 10.7Ghz V-polarisation brightness temperature [Kelvin]
16	resampled 10.7Ghz H-polarisation brightness temperature [Kelvin]
17	resampled 18.7Ghz V-polarisation brightness temperature [Kelvin]
18	resampled 18.7Ghz H-polarisation brightness temperature [Kelvin]
19	resampled 23.8Ghz V-polarisation brightness temperature [Kelvin]
20	resampled 23.8Ghz H-polarisation brightness temperature [Kelvin]
21	resampled 36.5Ghz V-polarisation brightness temperature [Kelvin]
22	resampled 36.5Ghz H-polarisation brightness temperature [Kelvin]
23	resampled 89.0Ghz V-polarisation brightness temperature [Kelvin]
24	resampled 89.0Ghz H-polarisation brightness temperature [Kelvin]
25	upstream file name
	Please contact: rs@space.dtu.dk for more information

3.4 Simulated data from ice growth during winter season

The purpose of including the simulated data in the RRDP is to get insight into which environmental parameters are responsible for which part of the ice concentration errors. We recognize that the simulated data may not represent perfectly satellite observations, so they will not be used to determine algorithm selection.

3.4.1 Format of data files with simulated SMMR data

	Each line contains a simulated datapoint as comma separated values:
1	latitude [degrees]
2	longitude [degrees]
3	date time (UTC)
4	reference ID (sensor/method and producer ex SIMULATEDAMSR_DMI)
5	nominal seaice concentration ex 1 for 100% ice cover (SIC)
6	Tb6v including atmospheric contribution
7	Tb6h including atmospheric contribution
8	Tb10v including atmospheric contribution
9	Tb10h including atmospheric contribution
10	Tb19v including atmospheric contribution
11	Tb18h including atmospheric contribution
12	Tb21v including atmospheric contribution
13	Tb21h including atmospheric contribution
14	Tb36v including atmospheric contribution
15	Tb36h including atmospheric contribution
16	e6v excluding atmospheric contribution
17	e6h excluding atmospheric contribution
18	e10v excluding atmospheric contribution
19	e10h excluding atmospheric contribution
20	e18v excluding atmospheric contribution
21	e18h excluding atmospheric contribution
22	e21v excluding atmospheric contribution
23	e21h excluding atmospheric contribution
24	e36v excluding atmospheric contribution
25	e36h excluding atmospheric contribution
26	Teff6v excluding atmospheric contribution
27	Teff6h excluding atmospheric contribution

28	Teff10v excluding atmospheric contribution
29	Teff10h excluding atmospheric contribution
30	Teff18v excluding atmospheric contribution
31	Teff18h excluding atmospheric contribution
32	Teff21v excluding atmospheric contribution
33	Teff21h excluding atmospheric contribution
34	Teff36v excluding atmospheric contribution
35	Teff36h excluding atmospheric contribution
36	timestep (model output timestep of 6 hours)
37	Ta, 2m air temperature [K]
38	Ms, mass of precipitation within the last 6 hours [kg/m2]
39	W, total column water vapour in the atmosphere [kg/m2]
40	L, total column cloud liquid water in the atmosphere [kg/m2]
41	sfb, snow freeboard, the snow surface above the water surface [m]
42	st, snow thickness [m]
43	it, ice thickness [m]
44	Dens, density of the snow surface [kg/m3]
45	Ti, snow surface temperature [K]
46	adens, average density of the snow [kg/m3]
47	apcc, average correlation length of snow grain sizes [mm]
48	asT, average snow temperature [K]
49	asal, average ice salinity [ppt]
50	aiT, average ice temperature [K]
51	ist, snow ice interface temperature [K]
	Please contact rtt@dmi.dk for more information

3.4.2 Format of data files with simulated SSMI data

	Each line contains a simulated datapoint as comma separated values: For all sensors:
1	latitude [degrees]
2	longitude [degrees]
3	date time (UTC)
4	reference ID (sensor/method and producer ex SIMULATEDAMSR_DMI)
5	nominal seaice concentration ex 1 for 100% ice cover (SIC)
6	Tb19v including atmospheric contribution
7	Tb19h including atmospheric contribution
8	Tb22v including atmospheric contribution
9	Tb22h including atmospheric contribution
10	Tb37v including atmospheric contribution
11	Tb37h including atmospheric contribution
12	Tb89v including atmospheric contribution
13	Tb89h including atmospheric contribution
14	e19v excluding atmospheric contribution
15	e19h excluding atmospheric contribution
16	e22v excluding atmospheric contribution
17	e22h excluding atmospheric contribution
18	e37v excluding atmospheric contribution
19	e37h excluding atmospheric contribution
20	e89v excluding atmospheric contribution
21	e89h excluding atmospheric contribution
22	Teff19v excluding atmospheric contribution
23	Teff19h excluding atmospheric contribution
24	Teff22v excluding atmospheric contribution
25	Teff22h excluding atmospheric contribution
26	Teff37v excluding atmospheric contribution
27	Teff37h excluding atmospheric contribution
28	Teff89v excluding atmospheric contribution
29	Teff89h excluding atmospheric contribution
30	timestep (model output timestep of 6 hours)
31	Ta, 2m air temperature [K]
32	Ms, mass of precipitation within the last 6 hours [kg/m2]

33	W, total column water vapour in the atmosphere [kg/m2]
34	L, total column cloud liquid water in the atmosphere [kg/m2]
35	sfb, snow freeboard, the snow surface above the water surface [m]
36	st, snow thickness [m]
37	it, ice thickness [m]
38	Dens, density of the snow surface [kg/m3]
39	Ti, snow surface temperature [K]
40	adens, average density of the snow [kg/m3]
41	apcc, average correlation length of snow grain sizes [mm]
42	asT, average snow temperature [K]
43	asal, average ice salinity [ppt]
44	aiT, average ice temperature [K]
45	ist, snow ice interface temperature [K]
	Please contact rtt@dmi.dk for more information

3.4.3 Format of datafiles with simulated AMSR-E data

	Each line contains a simulated datapoint as comma separated values: For all sensors:
1	latitude [degrees]
2	longitude [degrees]
3	date time (UTC)
4	reference ID (sensor/method and producer ex SIMULATEDAMSR_DMI)
5	nominal seaice concentration ex 1 for 100% ice cover (SIC)
6	Tb6v including atmospheric contribution
7	Tb6h including atmospheric contribution
8	Tb10v including atmospheric contribution
9	Tb10h including atmospheric contribution
10	Tb18v including atmospheric contribution
11	Tb18h including atmospheric contribution
12	Tb23v including atmospheric contribution
13	Tb23h including atmospheric contribution
14	Tb36v including atmospheric contribution
15	Tb36h including atmospheric contribution
16	Tb50v including atmospheric contribution
17	Tb50h including atmospheric contribution
18	Tb52v including atmospheric contribution
19	Tb52h including atmospheric contribution
20	Tb89v including atmospheric contribution
21	Tb89h including atmospheric contribution
22	e6v excluding atmospheric contribution
23	e6h excluding atmospheric contribution
24	e10v excluding atmospheric contribution
25	e10h excluding atmospheric contribution
26	e18v excluding atmospheric contribution
27	e18h excluding atmospheric contribution
28	e23v excluding atmospheric contribution
29	e23h excluding atmospheric contribution
30	e36v excluding atmospheric contribution
31	e36h excluding atmospheric contribution
32	e50v excluding atmospheric contribution
33	e50h excluding atmospheric contribution
34	e52v excluding atmospheric contribution

35	e52h excluding atmospheric contribution
36	e89v excluding atmospheric contribution
37	e89h excluding atmospheric contribution
38	Teff6v excluding atmospheric contribution
39	Teff6h excluding atmospheric contribution
40	Teff10v excluding atmospheric contribution
41	Teff10h excluding atmospheric contribution
42	Teff18v excluding atmospheric contribution
43	Teff18h excluding atmospheric contribution
44	Teff23v excluding atmospheric contribution
45	Teff23h excluding atmospheric contribution
46	Teff36v excluding atmospheric contribution
47	Teff36h excluding atmospheric contribution
48	Teff50v excluding atmospheric contribution
49	Teff50h excluding atmospheric contribution
50	Teff52v excluding atmospheric contribution
51	Teff52h excluding atmospheric contribution
52	Teff89v excluding atmospheric contribution
53	Teff89h excluding atmospheric contribution
54	timestep (model output timestep of 6 hours)
55	Ta, 2m air temperature [K]
56	Ms, mass of precipitation within the last 6 hours [kg/m2]
57	W, total column water vapour in the atmosphere [kg/m2]
58	L, total column cloud liquid water in the atmosphere [kg/m2]
59	sfb, snow freeboard, the snow surface above the water surface [m]
60	st, snow thickness [m]
61	it, ice thickness [m]
62	Dens, density of the snow surface [kg/m3]
63	Ti, snow surface temperature [K]
64	adens, average density of the snow [kg/m3]
65	apcc, average correlation length of snow grain sizes [mm]
66	asT, average snow temperature [K]
67	asal, average ice salinity [ppt]
68	aiT, average ice temperature [K]
69	ist, snow ice interface temperature [K]
	Please contact rtt@dmi.dk for more information

4 Access the RRDP datafiles

The RRDP files are accessible from

http://sicci.seaice.dk/RRDP/

AMSR_MODIS_MELTPOND	02-10-2013 09:59	File folder
AMSR_SIC0	02-10-2013 10:00	File folder
AMSR_SIC1	02-10-2013 10:00	File folder
AMSR_SMOS_THINICE_SIC1	02-10-2013 09:54	File folder
SIMULATED_SIC0	02-10-2013 09:53	File folder
SIMULATED_SIC1	02-10-2013 09:52	File folder
SMMR_SIC0	02-10-2013 10:01	File folder
SSMI_SIC0	02-10-2013 09:57	File folder
SSMI_SIC1	02-10-2013 09:56	File folder

All are available in one zipfile (SICCI_SIC_RRDP.zip)

The datafiles are also available through the ESA CCI website.

5 References

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