CryoSat-SMOS Merged Sea Ice Thickness

ⓘ Main Improvements and changes in v206

We updated the CS2SMOS processing to the latest input versions of the source data (SMOS L3C sea ice thickness v3.3 & CryoSat-2 L2P sea ice thickness v2.6)

CryoSat-2 version 2.6 update

- Reprocessing with CryoSat-2 ICE Level-1b algorithm baseline-E (in v2.5, baseline-E data was only used since Oct 2020).
- Use the OSI-SAF / C3S sea ice type (interim) climate data record. Notable changes in sea ice type information in the first half of October.
- Resolved issues´:
    - There have been cases of incomplete CryoSat-2 near real-time L1B data on the production system in v2.5. The latency of near real-time production has been increased from 36h to 48h

(full change log)

CS2SMOS algorithm changes

- None

ⓘ Main Improvements and changes in v205

We updated the CS2SMOS processing to the latest input versions of the source data (SMOS L3C sea ice thickness v3.3 & CryoSat-2 L2P sea ice thickness v2.5)

CryoSat-2 version 2.5 update

- New surface type classification (sea ice / lead / open ocean discrimination)
- New flag indicating surface wave / swell influence in the marginal ice zone
- Resolved issues:
    - Waveform shape parameter computation used for surface type (lead, sea ice) discrimination incorrect for noisy waveforms
    - Not all orbit segments from different files were connected correctly

(full change log)

CS2SMOS algorithm changes

- Apply CryoSat-2 marginal ice zone filter flag in CS2SMOS data merging

ⓘ Main Improvements and changes in v204

We updated the CS2SMOS processing to the latest input versions of the source data (SMOS L3C sea ice thickness v3.3 & CryoSat-2 L2P sea ice thickness v2.4)

CryoSat-2 version 2.4 update

- Latest CryoSat-2 L1B data version (ICE baseline-E from Oct. 2021 and later, ICE baseline-D until April 2021)
- latest version of OSI-SAF sea ice concentration and sea ice type auxiliary data,
- change of sea ice concentration mask from 70% to 15%)

(full change log)

SMOS version 3.3 update

- Latest SMOS L1C data version (v724)
- Grid: NSIDC Sea Ice Polar Stereographic North (EPSG:3411) has been replaced by WGS 84 / NSIDC Sea Ice Polar Stereographic North (EPSG:3413)

(full change log)

CS2SMOS file format changes

- Minor update of global attributes

ⓘ

Links

Product description document

Read-me-first technical note

ESA Websites:

ESA EO Mission CryoSat

ESA EO Mission SMOS

Visualization of NetCDF data:

Panoply

Points of Contacts

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Responsible Scientists

Lars Kaleschke

Stefan Hendricks

Xiangshan Tian-Kunze

Robert Ricker (now at NORCE)

> **ⓘ Main Improvements and changes in v203**
>
> - We adapted the CS2SMOS processing to changes due to the update to CryoSat-2 sea ice thickness product version v2.3.

> **ⓘ Main Improvements and changes in v202**
>
> - The time coverage resolution has been changed from 7 days to 1 day, meaning that the weekly averaged product is updated every day from now on.
> - We adapted the CS2SMOS processing to changes due to the update to CryoSat-2 sea ice thickness product version v2.2.
> - We adapted the CS2SMOS processing to changes due to the update to SMOS sea ice thickness product version v3.2, which is now processed and provided by AWI.
> - An ocean mask is applied to allow for a consistent land/ocean mask throughout the entire data record in order to overcome inconsistencies due to switches of the land masks in the OSI SAF ice concentration products.
> - We now use different sea ice concentration products for the operational mode and for the reprocessing mode. In the operational mode, we use the operational OSI-401 ice concentration product, while in the reprocessing mode, the reprocessed OSI -430-b ice concentration product is used. Both are provided by OSI SAF.
> - Changes in the NetCDF variable names, fulfilling CF 1.6 conventions.

Version	Date	Comments
v205	09.11.2022	System and algorithm update
v204	25.10.2021	System update
v203	07.10.2020	System update
v202	01.10.2019	System and algorithm update
v201	10.01.2019	Official ESA release

Product Description Overview

Parameter	Sea ice thickness
Spatial covergae	N: 90°, S:16.6°, E:180°, W:-180°
Spatial Resolution	25 km x 25 km
Temporal coverage of the data record:	November 2010 to present
Time coverage resolution	1 day
Time coverage duration	7 days
Data Format(s)	NetCDF
Platforms	CryoSat-2, SMOS
Version	v204

File naming convention

NetCDF files are named using the following convention:

<convention-prefix>_<regional code>- <institution>,<platform(s)>,<grid>_<time>_<mode>_<product version>_<file version>.nc

convention-prefix	World Meteorological Organization: W
regional code	European: XX
institution	European Space Agency: ESA
processing level/parameter	level 4 sea ice thickness: l4sit
Platform(s)	satellites: SMOS, CS2
grid	25 km EASE2 grid, Northern Hemisphere: NH_25KM_EASE2
time	time span: yyyymmdd - yyyymmdd
mode	reprocessing: r, operational: o
product version	version 2.0.4: v204
file version	version 1: 01

Example NetCDF naming for operationally processed data:

`W_XX-ESA,SMOS_CS2,NH_25KM_EASE2_20190304_20190310_o_v204_01_l4sit.nc`

Example NetCDF naming for reprocessed data:

`W_XX-ESA,SMOS_CS2,NH_25KM_EASE2_20190304_20190310_r_v204_01_l4sit.nc`

File Format

The weekly grids are given in standardized binary data format (Network common data form: NetCDF v4). Global attributes are given in Table 1. The variables are given as grid arrays, see Table 2. NetCDF files are formatted according to CF conventions: CF-1.6 ACDD-1.3. We use a scaling factor of 10^{-3} and a fillvalue = -2147483647.

Table 1: Global attributes from an example NetCDF file, covering the week from March 04 to March 10, 2019.

Attribute	Value
title	Sea Ice Thickness derived from merging CryoSat-2 and SMOS ice thickness
description	Weekly Arctic sea-ice thickness derived from CryoSat-2 and SMOS using an optimal interpolation scheme
summary	Weekly Arctic sea-ice thickness derived from CryoSat-2 and SMOS using an optimal interpolation scheme
keywords	Cryosphere > Sea Ice > Sea Ice Thickness
product_version	204
processing_mode	r
time_of_creation	Fri Oct 11 09:04:06 2019
history	Fri Oct 11 09:04:06 2019 creation
Conventions	CF-1.6
spatial_resolution	25.0 km grid spacing
geospatial_lat_min	16.623929977416992
geospatial_lat_max	90.0

geospatial_lon_min	-180.0
geospatial_lon_max	180.0
geospatial_vertical_min	0.0
geospatial_vertical_max	0.0
time_coverage_start	2019-03-04T00:00:00Z
time_coverage_end	2019-03-11T00:00:00Z
time_coverage_duration	P7D
time_coverage_resolution	P1D
platform	CryoSat-2, SMOS
project	CS2SMOS PDS: SMOS & CryoSat-2 Sea Ice Data Product Processing and Dissemination Service
institution	Alfred-Wegener-Institut Helmholtz Zentrum für Polar und Meeresforschung (AWI), http://www.awi.de
creator_name	Alfred-Wegener-Institut Helmholtz Zentrum für Polar und Meeresforschung (AWI), http://www.awi.de
creator_type	institution
creator_url	www.awi.de
contributor_name	Robert Ricker, Stefan Hendricks, Xiangshan Tian-Kunze, Lars Kaleschke
contributor_role	PrincipalInvestigator, Author, Author, Author
publisher_email	cs2smos-support@awi.de
publisher_url	https://spaces.awi.de/confluence/x/DwVmEQ
references	Ricker, R., Hendricks, S., Kaleschke, L., Tian-Kunze, X., King, J., and Haas, C.: A weekly Arctic sea-ice thickness data record from merged CryoSat-2 and SMOS satellite data, The Cryosphere, 11, 1607-1623, https://doi.org/10.5194/tc-11-1607-2017, 2017.
_CoordSysBuilder	ucar.nc2.dataset.conv.CF1Convention

Table 2: NetCDF file content. Note, that we use a scaling factor of 10^-3 and a fillvalue = -2147483647.

Variable	Description	Unit	Type	Dimension
Lambert_Azimuthal_Grid	proj4_string: +proj=laea +lon_0=0 +datum=WGS84 +ellps=WGS84 +lat_0=90.0	-	int	-
time_bnds	start and end time of the weekly retrieval	seconds since 1978-01-01 00:00:00	double	2
analysis_sea_ice_thickness	CS2SMOS weekly merged sea ice thickness	m	int	1,432,432
background_sea_ice_thickness	background field, interpolation using CS2 and SMOS sea ice thickness data	m	int	1,432,432
weighted_mean_sea_ice_thickness	weighted mean of weekly CS2 and SMOS ice thickness retrievals	m	int	1,432,432
innovation	difference between background and analysis ice thickness	m	int	1,432,432
sea_ice_concentration	sea ice concentration	%	int	1,432,432
sea_ice_type	sea ice type	-	int	1,432,432
correlation_length_scale	correlation length scale of background ice thickness	m	int	1,432,432
analysis_sea_ice_thickness_unc	uncertainty of the merged sea ice thickness	m	int	1,432,432
smos_sea_ice_thickness	weekly averaged SMOS ice thickness	m	int	1,432,432
cryosat_sea_ice_thickness	weekly averaged CryoSat-2 ice thickness	m	int	1,432,432
time	reference time of product (middle of the week)	seconds since 1978-01-01 00:00:00	double	1
xc	x coordinate of projection (eastings)	km	float	432
yc	y coordinate of projection (northings)	km	float	432
lon	longitude coordinate	degrees_north	float	432,432
lat	latitude coordinate	degrees_east	float	432,432

Grid

All grids are projected onto the 25 km EASE2 Grid, which is based on a polar aspect spherical Lambert azimuthal equal-area projection (Brodzik et al., 2012). The grid dimension is 5400 km x 5400 km, equal to a 432 x 432 grid. The grid is centered on the geographic Pole, meaning that the Pole is located at the intersection of center cells (Figure 1).
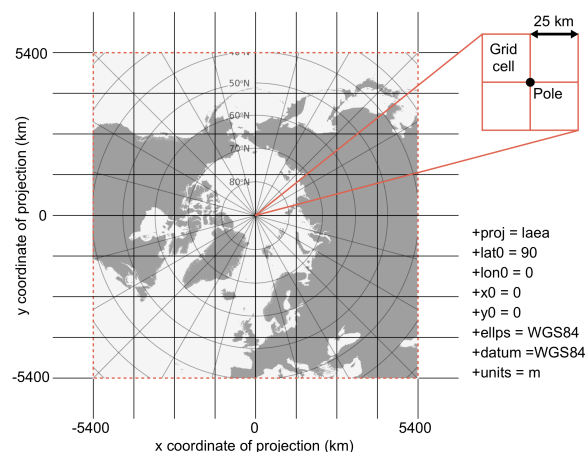

Figure1: Specifications of the EASE2 25 km grid, which is used for the merged product.