sea state cci

Climate Research Data Package (CRDP)

version 4.0, 25 April 2025

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Ifremer	PML Plymouth Marine Laboratory	ECMWF
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ESA Approval	Sarah Connors	Sarah Connors	30/07/2025

Issue	Date	Comments
2.0	22/09/2021	For the CRDP v1 the Product User Guide was accepted as the deliverable. This cover note is released for version 2 of the CRDP to formalise the deliverable, and the document version is numbered v2.0 to avoid confusion.
3.0	15/03/2022	Cover note for version 3.0 dataset
4.0	25/04/2025	Cover note for version 4.0 dataset

1. Introduction

This document presents a covering note for the Climate Research Data Package (CRDP) for **Sea_State_cci**, deliverable 4.2 of the project. This is prepared as the formal deliverable for the v4 dataset, as part of the MS2 milestone.

The remainder of this Climate Research Data Package covering note contains a summary of the data products, covering: missions included; data access; format; citation, and a description of differences with the version 1.1, version 2.0 and version 3.0 datasets.

2. Summary of Sea_State_cci Data Products version 4

2.1 Products overview

The 4th version (version 4) of CCI Sea State products provides an updated time series based on the version 3 methodology. It extends and improves the altimeter significant wave height (SWH) products with a complete new retracking (as decided in the Phase 1) including the same filtering, new intercalibration method and new uncertainty evaluations. It also improves the SAR Wave Mode measurements to the dataset. The version 4 extends the version 3 dataset up to December 2024 and fixes some minor issues or adds some additional ancillary variables.

Three kinds of products are delivered:

- L2P : Along-track products from altimetry and SAR missions separated per satellite and pass, including all measurements with flags, corrections and extra parameters from other sources. These are expert products with rich content and no data loss.
- L3 : Edited merged daily products retaining all valid and good quality measurements from all altimeters over one day (one daily file), with simplified content (only a few key parameters). This is close to what is delivered in NRT by CMEMS project.
- L4 : Gridded products averaging valid and good measurements from all available altimeters over a fixed resolution grid (1°x1°) on a monthly basis. These products are meant for statistics, and visualisation through the CCI toolbox.

Ancillary buoy data used for validation is not provided as a CCI product but can be obtained from CMEMS. On the contrary, the Sea State CCI ancillary microseism product has kept unchanged wrt version 3.

2.2 Altimeter missions

For version 2, 3 and 4, a full retracking of altimeter waveforms was performed with two different retrackers: WHALES by TUM for LRM altimeters, LRM or PRLM solution was chosen for SAR altimeters (Sentinel 3 and 6). The previous standards provided in LR-RMC from 2000 to 2020 has also been kept unchanged because no upstream dataset was made available by CNES.

As a reminder, version 3 included missions spanning from 2002 to 2021. The list of altimetry missions included in version 4 are:

Mission	Altimeter	Selected band	Source product	Temporal coverage
Envisat	RA-2	Ku	SGDR v3 [ESA]	14-May-2002 to 8-Apr-2012
Jason-1	POSEIDON-2	Ku	SGDR version E	15-Jan-2002 to 3-Mar-2012

			[Aviso]	
Jason-2	POSEIDON-3	Ku	SGDR version D [Aviso]	4-Jul-2008 to 17-May-2017
Jason-3	POSEIDON-3B	Ku	SGDR version F [Aviso]	17-Feb-2016 to present
Cryosat-2	SIRAL	Ku	SIR LRM L1B version E [ESA]	16-Jul-2010 to present
Saral	AltiKa	Ka	SGDR version T [Aviso]	14-Mar-2013 to present
ERS-1	RA	Ku	REAPER [ESA]	17-Jul-1991 to 10-Mar-2000
ERS-2	RA	Ku	REAPER [ESA]	21-Apr-1995 to 4-Jul-2011
TOPEX	NRA	Ku	GDR [NASA]	10-Aug-1992 to 18-Jan-2006
GFO	GFO-RA	Ku	GDR	10-Feb-1998 to 26-Nov-2008
Sentinel-3A	SRAL/PLRM (*)	Ku	L2 NTC [EUMETSAT]	16-Feb-2016 to now
Sentinel-3B	SRAL/PLRM (*)	Ku	L2 NTC [EUMETSAT]	25-Apr-2018 to now
CFOSAT	SWIM	Ku	L2 [CNES]	29-Oct-2018 to now
Sentinel-6 MF	POSEIDON-4/ LRM (*)	Ku	L2 NTC [EUMETSAT]	21-Nov-2020 to now

(*) The consensus is for version 4 to keep only PLRM/LRM mode for delayed doppler missions, for consistency with the other missions merged later in Level 3 and Level 4 products. However it is planned to process internally SAR mode for intercomparison and assessment.

2.3 SAR missions

SAR Image and Wave Mode data are a new addition to this CCI Sea State version 4 Dataset (all former SAR Wave Mode datasets in version 4 are replaced with newer and somewhat

different datasets), with various complementary products providing significant wave height and directional parameters for recent missions embedding a SAR.

Mission	SAR	Band	Source product	Temporal coverage
Envisat	ASAR	C	ESA WVI	10-Dec-2002 to 8 Apr-2012
Sentinel-1 A	SAR	C	S1A_WV_SLC, S1A_IW_GRD, S1A_EW_GRD	1-Dec-2014 to now
Sentinel-1 B	SAR	C	S1B_WV_SLC: S1B_IW_GRD, S1B_EW_GRD	15-Jun-2016 to 23-Dec-2021

2.5 Format

All products are in NetCDF4 Classic format. They comply to the CCI Data Standard 2.1 (See http://cci.esa.int/working-groups) and follow the CF 1.7 and ACDD conventions

The detailed format of each product is described in the following sections.

2.6 Data access, organisation and file naming

The data can be obtained from Ifremer FTP server: ftp://eftp.ifremer.fr. The login and password can be obtained upon filling the registration form at :

https://forms.ifremer.fr/lops-siam/access-to-esa-cci-sea-state-data/

The common directory structure is based on CCI recommendations and is arranged as follows:

/products/<release version>/data/<instrument type>/<type>/<mission>/<date>/

Where:

- **<release version>** is the dataset version (currently 4.0 for this dataset)
- **<instrument type>** is the type of remote sensing technique: **altimeter** or **sar**
- **<type>** : will be different for each ECV, but needs to be defined, and consistent within an ECV, here **l2** for along-track data, **l3** for edited merged products and **l4** for monthly averaged gridded products)
- **<mission>** : satellite mission (for L2P products only)

- **<date>** : <year as YYYY>/<day in the year as DDD>

The file nomenclature is based on form 2 of CCI recommendations :

ESACCI-<CCI Project>-<Processing Level>-<Data Type>-<Product String>[-<Additional Segregator>]-<IndicativeDate>[<Indicative Time>]-fv<File version>.nc

Where:

- **<CCI Project>** : SEASTATE
- **<Processing Level>** : here L2P for along-track data, L3 for edited merged product and L4 for monthly averages
- **<Data Type>** : SWH for “Significant Wave Height”, ISSP for “Integrated Sea State Parameters”
- **<Product String>** : contains the name of the mission for L2P
- **<Additional Segregator>** : optionally the name of algorithm used
- **<Indicative Date>[<Indicative Time>] :** The identifying date for this data set. Format is YYYYMMDDTHHMMSS, where YYYY is the four digit year, MM is the two digit month from 01 to 12 and DD is the two digit day of the month from 01 to 31. The date used should best represent the observation date for the data set. For along-track data it will be the time of the first measurement in the file.
- **<File version>** : File version number in the form n{1,}[.n{1,}] (That is 1 or more digits followed by optional . and another 1 or more digits.)

Examples:

L2P altimeter product:

ESACCI-SEASTATE-L2P-SWH-Jason-2-20170130T145103-fv01.nc

L3 product:

ESACCI-SEASTATE-L3-SWH-MULTI_1D-20170130-fv01.nc

L4 product:

ESACCI-SEASTATE-L4-SWH-MULTI_1M-201701-fv01.nc

Soon, data will also be added to **ESA CCI data portal**, along the previous 1.1 version, at: https://data.ceda.ac.uk/neodc/esacci/sea_state/

The data organization there is as follow:

/esacci/seastate/data/<release version>/<instrument type>/<type>/<mission>/<date>/

2.7 Dataset Citation

The dataset citation will be a DOI reference. Application is in progress and reference to be added in a future release of this document.

3. Differences between versions of datasets

3.1 Differences between versions 1 and 2 datasets

The main differences between CCI Sea State version 1 and version 2 datasets include:

- a **new retracking algorithm** (WHALES) applied consistently to all version 2 altimeter L2P products to retrieve the significant wave height (SWH) from altimeter waveforms, whereas in version 1 we were using and correcting the SWH provided by space agencies which were using different retrackers (see section 4.1.2.1 of Product User Guide)
- a **more limited coverage** (2002-2019) in version 2 for altimeter products instead of 1992-2018 in version 1; missions previously available in version 1 such as ERS-1, ERS-2, GFO and Topex are no longer available in version 2. This is due to the choice of applying a consistent retracker for all missions; additional effort and investigation are required to properly address these older missions which will be undertaken for a future release. Jason-1 and Jason-2 also have a smaller temporal coverage in version 2 than in version 1 as graveyard orbit phases were excluded from processing. They will be added in a next release.
- a **revised editing and SWH outlier removal scheme** for version 2 altimeter L2P products (see section 4.1.2.4 of Product User Guide)
- a **revised estimation of cross-mission SWH adjustment corrections** and **SWH uncertainties** for version 2 altimeter L2P products (see section 4.1.2.5 and 4.1.2.6 of Product User Guide)
- **no more cross-mission adjustment corrections to sigma0** are provided in version 2 altimeter L2P products, this will be addressed in a future release
- some **format and content changes** in version 2 altimeter L2P products:
    - added **model SWH from ERA5** as an ancillary variable (*swh_model*)
    - fixed values in **distance to coast** (distance_to_coast) now in meters (instead of km), as specified by the variable units attribute
    - ancillary **sea level variables are now taken from CMEMS** (SEALEVEL_GLO_PHY_L3_REP_OBSERVATIONS_008_062 dataset) instead of CCI Sea Level, as it is more comprehensive and more frequently updated. As a consequence, the CMEMS variables *mdt* and *sla_unfiltered* are now replacing the former CCI Sea Level *mean_sea_surface*, *sea_state_bias* and *corssh* variables.
- addition of **SAR L2P products** providing SWH and spectral wave parameters for Envisat, Sentinel-1 A and Sentinel-1 B missions (see section 5 of Product User Guide)

3.2 Differences between versions 2 and 3 datasets

The main differences between CCI Sea State version 2 and version 3 datasets include:

- Extension of the version 2 dataset up to December 2020;

- Fix of some minor issues and addition of some additional ancillary variables;
- Addition of SAR altimetry data from Sentinel-3A;
- Addition of microseism data.

3.3 Differences between versions 3 and 4 datasets

The main differences between CCI Sea State version 3 and version 4 Altimeter Level 2P datasets include:

- an **extension of the existing missions** to 2024, including also missing phases or cycles in version 3 : SARAL, Jason-3, CryoSat-2, retracked with WHALES retracker, Sentinel 3A from EUMETSAT SGDR
- a **new set of missions** added to extend the covered period from 1992 to 2024 : ERS-1, ERS-2, GFO, TOPEX, Sentinel-3 B, Sentinel-6 A, all processed from SGDR 20 Hz SWH measurements
- Sentinel-3 A & B now **processed from EUMETSAT SGDR 20 Hz SWH** measurements instead of LR-RMC retracker
- a **revised editing and SWH outlier removal scheme** for version 2 altimeter L2P products
- a **revised estimation of cross-mission SWH adjustment corrections** and **SWH uncertainties**
- cross-mission **adjustment corrections of the sigma0 for Topex, Jason-1/2/3 and Sentinel-6**
- **added consistent wind calculation** from adjusted sigma0 and SWH
- some **format and content changes**:
    - added ancillary **wave model variables from Ifremer WW3 reanalysis**
    - **fixed bathymetry** for longitudes west of 0° and **higher resolution** (15'') GEBCO 2023 bathymetry
    - **distance to coast** now calculated from OpenstreetMap coastline close in coastal areas

The main differences between CCI Sea State version 3 and version 4 SAR Level 2P datasets include:

- completely new set of retrieval algorithms
- Inclusion of image mode for Sentinel-1A and Sentinel-1B
- Inclusion of wave partition parameters (partition SWH, partition peak wavelength, partition peak direction, partition spectral spread, partition directional spread) for Sentinel-1 A WV, Sentinel-1 B WV missions (wave partition parameters for Envisat, ERS-1 and ERS-2 will be included in version 5)

	Altimetry 1Hz	**SAR DLR**	**SAR ODL**	**SAR LOBS**
contact information of the data provider	cersat@ifremer.fr	cersat@ifremer.fr	cersat@ifremer.fr	TBD
unique product version number	V4	V4	V4	V5
release date	To come: June 2025	To come: June 2025	To come: June 2025	To come: 2026
description of the file naming	ESACCI-<CCI Project>-<Processing Level>-<Data Type>-<Product String>[-<Additional Segregator>]-<IndicativeDate>[<Indicative Time>]-fv<File version>.nc as presented in part 7.1 of SSD_PUM_V4.pdf			
assigned DOIs	TBD	TBD	TBD	TBD
list of satellite instruments used	Altimeter from the following missions: TOPEX, Jason1,2,3, Sentinel6A, Sentinel3A and 3B, ENVISAT, SARAL, CRYOSAT-2, ERS1, ERS2	EW from Sentinel1A and 1B, IW from Sentinel1A and 1B		
information on processing level and whether the product is a single instrument or harmonised CDR	L2P: monomission products L3: monomission harmonised in terms of wave depending bias (intercalibration step) L4: multimission grids including all altimetric L3 values	monomission products for the moment	monomission products for the moment	
a list of all resolution and spatio-temporal sampling and time and space coverage characteristics	L2p: 1Hz 7km splitted into orbits (like L2) L3: 1Hz 7km splitted into days L4: 1°x1° monthly	L2: irregular L4: NA	L2: irregular L4: NA	
any specific product format attributes	/	/	Including partitioning	
whether the data is to be made public	Public	Public	Public but demo dataset	

or if this is an internal release only				
version history (i.e. list of major differences compared to earlier releases)	See Above	See Above	V4 is the first version of spectral partitioned data built out of SAR technology distributed for the project	

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