sea state cci

System Verification Report (SVR)

version 3.0, 10 February 2022

Contents

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Issue	Date	Comments
1.0	27/11/2019	First version submitted to ESA
2.0	22/09/2021	Version 2 reworked for latest system verification approach
3.0	10/02/2022	Version 3 reworked for latest system verification approach (added unitary test description for community tools)

List of Acronyms

CCI	Climate Change Initiative
CLS	Collecte Localisation Satellite
CMEMS	Copernicus Marine Environment Monitoring Service
CPU	Central Processing Unit
ECV	Essential Climate Variable
ESA	European Space Agency
GDR	Geophysical Data Record
GFO	Geosat Follow On
HPC	High Performance Computing
L1A	Level 1A
L1B	Level 1B
L4	Level 4
LRM	Low Rate Measurement
RA	Radar Altimeters
RR	Round Robin
S3A	Sentinel-3A
S3B	Sentinel-3B
SAR	Synthetic Aperture Radar
SMOS	Soil Moisture and Ocean Salinity satellite
SSH	Secure Shell
SVR	System Verification Report
SWH	Significant Wave Height
WV	Wave (mode for SAR)

1. Introduction

Overview

This document presents the System Verification Report (SVR) for **Sea_State_cci**, deliverable 3.3 of the project. This is the third version prepared at the end of the project with updates on the system verification approach.

The first version of this report gave a synthetic view of the test activities performed on the CCI Sea State prototype which has ensured the generation of the first version (V1.1) of required Sea State ECV data products, covering the period 1992 to 2019 for altimeter only.

Mission	Altimeter	Selected band	Source product
GFO	GFO-RA	Ku	GDR/POE [NOAA]
TOPEX/Poseidon	TOPEX, POSEIDON-1	Ku	MGDR [CNES]
ERS-1	RA	Ku	OPR [ESA/F-PAF]
ERS-2	RA	Ku	OPR [ESA/F-PAF]
Envisat	RA-2	Ku	GDR v2.1 [ESA/F-PAC]
Jason-1	POSEIDON-2	Ku	GDR version E (MLE4 retracker for SWH, MLE3 for sigma0) [Aviso]
Jason-2	POSEIDON-3	Ku	GDR version D (MLE4 retracker for SWH, MLE3 for sigma0) [Aviso]
Jason-3	POSEIDON-3B	Ku	GDR version D (MLE4 retracker for SWH, MLE3 for sigma0) [Aviso]
Cryosat-2	SIRAL	Ku	IGDR [NOAA]
SARAL	AltiKa	Ka	GDR [Aviso]

Table 1: Level 2 GDR altimeter data used as input data of the Sea State Dataset v1.1

In September 2021, an updated version V2.0.6 of the Sea State ECV data (covering the 2002-2020 period) was produced with the same CCI Sea State system of production but with additional algorithms for processing altimeter from Level 1 (SGDR) and introducing SAR.

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 [Aviso]	15-Jan-2002 to 3-Mar-2012
Jason-2	POSEIDON-3	Ku	SGDR version D [Aviso]	4-Jul-2008 to 17-May-2017
Jason-3	POSEIDON-3B	Ku	SGDR version D [Aviso]	17-Feb-2016 to 1-Jun-2019
Cryosat-2	SIRAL	Ku	SIR LRM L1B version D [ESA]	16-Jul-2010 to 8-Jul-2020
Saral	AltiKa	Ka	SGDR version T [Aviso]	14-Mar-2013 to 11-Nov-2019

Table 2: Level 1 SGDR altimeter data used as input data of the Sea State Dataset v2.0.6

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

Table 3: Level 1 SAR data used as input data of the Sea State Dataset v2.0.6

The remainder of this System Verification Report contains two further sections:

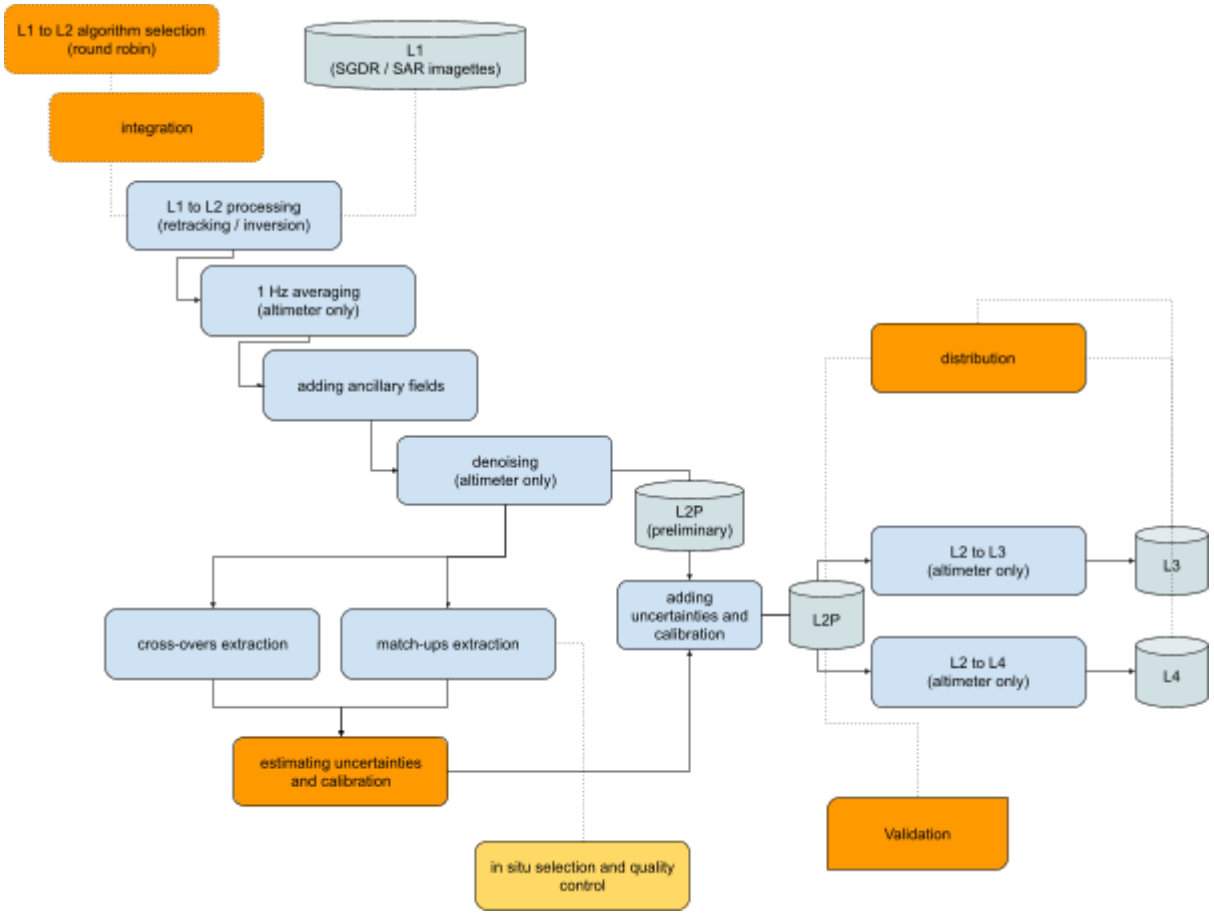
- Section 2: Overview of the Processing Chain
- Section 3: Overview of System Verification

Reference documents

ATBD	Algorithm Theoretical Basis Document (ATBD) version 1.1, 7 November 2019
RRFR	Round Robin: Final selection and ranking of algorithms version 1.1, 20 January 2020
PVASR	Product Validation and Algorithm Selection Report version 1.1, 25 November 2019
RRDP-1	Altimeter Round Robin Data Package
RRDP-2	SAR Round Robin Data Package
ISDBR	In Situ Database Report version 1.0, 23 September 2020
E3UB	End-to-end ECV Uncertainty Budget version 1.1, 20 September 2019
PVP	Product Validation Plan version 1.1, 25 November 2019
PVIR	Product Validation and Intercomparison Report version 1.0, 22 June 2020
CAR	Climate Assessment Report version 1.0, 14 July 2020
IHCstudy	Supporting Study: Regional Extreme Wave Climate Analysis (IH Cantabria) version 1.1, 5 August 2020
WPR	Supporting Study: Wave Power Report, Uni Galati version 1.1, 3 July 2020

2. Overview of the Processing Chain

The following diagram describes the overall workflow for the generation of CCI Sea State Datasets.



The processing steps are broken down into, in light blue, purely computational steps and, in orange, expertise and analysis steps requiring interaction among the partners.

More details on each processing step can be found in the System Specification Document [SSD].

3. System Verification

The processing framework used in the Sea State CCI project is mainly based on the Ifremer / CERSAT production system hosted in Ifremer *Datarmor* supercomputer, continuously maintained in an operational condition for both NRT and reprocessing production activities. Test and verification of the production elements are therefore performed as part of CERSAT service.

As for processing elements, many elements are also maintained in the context of CERSAT activities such as some of the python packages to read and enrich data with ancillary information, generate multi-mission cross-overs and match-ups, etc…, which include unitary and integration test suites.

However, new algorithms dedicated to the CCI Sea State project have been selected and implemented in the production system. These new algorithms, described in the Algorithm Theoretical Basis Document (ATBD), have been selected during a round-robin intercomparison over selected altimeter and SAR tracks (Round Robin Data Package), after comparison with other reference standards through a validation process. The assessment results have been presented during the Algorithm Selection Meeting and are listed in Round Robin: Final selection and ranking of algorithms (RRFR). The final reprocessed dataset was evaluated through Product Validation and Intercomparison Report (PVIR), from climate perspective in Climate Assessment Report (CAR) and dedicated assessment supporting studies.

The different specific verification steps are summarized in the following table:

Altimeter Retracking verification	Altimeter Round-Robin (RR) intercomparison framework ● performed over a selection of Jason-3 LRM and Sentinel-3A SAR tracks (RRDP-1) against reference (buoy and model) data ● assessment in *Product Validation and Algorithm Selection Report* (PVASR) and *Round Robin: Final selection and ranking of algorithms* [RRFR] ● selected algorithm described in *Algorithm Theoretical Basis Document* (ATBD)
SAR Retracking verification	SAR Round-Robin (RR) intercomparison framework ● performed over a selection of Sentinel-1 tracks (RRDP) against reference (buoy) data [RRDP-2] ● assessment in a *Round-Robin Final Report* [RRFR] ● selected algorithm described in *Algorithm Theoretical Basis Document* (ATBD)
Integration	Integration of the selected RR algorithm prior to reprocessing ● comparison of a selection of tracks for each mission, processed both at original prototype's provider and on the CCI reprocessing platform

L1 to L2 processing	ad hoc tools developed to verify: ● completeness of the reprocessed archive wrt input data ● integrity of the output files ● completeness of each variable's content (in particular for ancillary information which come from different sources)
1 Hz Averaging	● unitary tests to verify averaging method(s)
Adding ancillary data	● verification of the completeness of each variable's content (in particular for ancillary information which come from different sources)
denoising	● unitary test ● comparison with original matlab prototype by Y.Quilfen
In Situ data selection and QC	● verification of CMEMS In Situ TAC data quality and identification of the "best" buoys presented in PM8 ● selected buoys traced in In Situ Database Report (ISDBR)
Cross-over extraction	● community tool (**naiad**) used in multiple projects (https://gitlab.ifremer.fr/naiad/naiad) ● unitary test (see below)
Match-up extraction	● community tool (**felyx**) used in multiple projects (https://gitlab.ifremer.fr/felyx/felyx_processor) ● unitary test (see below)
Uncertainties and calibration estimation	● analysed and reported in End-to-end ECV Uncertainty Budget (E3UB)
Adding uncertainties and calibration	
L2 to L3 processing	● verification of completeness ● integrity of the output files ● completeness of each variable's content
L2 to L4 processing	
Validation	● methodology described in the Product Validation Plan (PVP) ● reported results in Product Validation and Intercomparison Report (PVIR) ● climate assessment of CCI dataset in Climate Assessment Report (CAR) ● assessment supporting studies ○ Supporting Study: Regional Extreme Wave Climate Analysis (IH Cantabria) ○ Supporting Study: Wave Power Report (WPR), Uni Galati
Distribution	● access & download rate tested by different project

	partners before data release

felyx unit tests

The following table provides the list of tests passed for *felyx* match-up extraction tool.

Test identifier	**Main functions or subsystems tested**	**Description**
test_extraction_swath_s3a_wst.py	Match-up extraction and assembling from swath feature	Extraction of child products from a full WST orbit, over virtual buoy locations calculated on the WST data grid at regular sampling space.
test_colocation_trajectory.py	Match-up extraction from trajectory feature	Extraction of child products from a full altimetry orbit, over virtual buoy locations calculated on the data grid at regular sampling space. Assembling from pre-extracted child products or manifest indices. Assembling in one of multiple products.
test_extraction_cciseastate_cmems.py	Match-up extraction from trajectory feature	Extraction of child products from a collection of altimetry files over wave measuring buoys.
test_convert_csv_to_parquet.py	In situ formatting	Conversion of CMEMS buoy data from old csv to new parquet format
test_configuration.py	Argument reading	Reading processing configuration from a config file passed as an argument
test_extraction_static.py	Child product extraction for swath feature	Extraction of child products over static sites from a WST full orbit.
test_get_coverage.py	get_coverage	Extraction from Elasticsearch of the temporal time frames of child product collections.
test_import_parquet_insitu.py	Import in Elasticsearch of in situ data	Import into (and removal from) Elasticsearch of CMEMS TAC wave buoy data stored in parquet.

test_metrics_ds.py	Import in Elasticsearch of metrics	Import into (and removal from) Elasticsearch of metrics data stored in json.
test_miniprods_ds.py	Import in Elasticsearch of child products metadata	Import into (and removal from) Elasticsearch of child products metadata from manifest files.
test_sites.py	get_raws get_trajectories	Export of insitu data from Elasticsearch
test_wipe_miniprods.py	wipe_miniprods	Removal of miniprods and associated metrics from Elasticsearch over a time frame.

naiad

The following table provides the list of tests passed for *naiad* satellite cross-over extraction tool.

Test identifier	**Main functions or subsystems tested**	**Description**
pytest_connection_args.py	indexing engine (Elasticsearch7 - ES7)	testing the connection to spatial data indexing engine (ES7)
pytest_multisearch_es7.py	data search	testing a bulk search over a list of times and locations
pytest_register_es7.py	indexing	testing the indexing of spatial data into the indexing engine
pytest_search_swath_es7_multiple.py	data search	
pytest_create_es7.py	indexing	testing the creation of an index of spatial data into the indexing engine (ES7)
pytest_register_es7_swi_l2anad.py	indexing	testing the indexing of nadir altimetry data into the indexing engine
pytest_search_swath_es7.py	data search	testing the spatio-temporal search of swath type data
pytest_inquire_es7.py	data search	searching for the properties of an indexed granule
pytest_register_es7_multiple.py	data search	testing multiple indexing options
pytest_search_es7.py	data search	testing the spatio-temporal search of along-track altimetry data

pytest_colocation_es7.py	colocation	testing the detection of cross-overs between two altimetry platforms