European Space Agency

# WP 5100
# Open Ocean Study
## Description of validation approach and expected outputs

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# WP5100 ASSESSMENT OBJECTIVES

- **To assess the Sentinel-3 processing**
- **To describe the validation approaches for assessing the innovative methods performances regarding :**
  - The continuity from LRM to SAR modes (this will be done by comparing SARM with PLRM considered as a reference)
  - The noise reduction performance
  - Detection of dependencies
    - Focus on wavelength scales greater than 50 km
    - Sentivity to radial velocity, SWH, wind speed, …
  - The ability to resolve fine scale ocean features and consistency of mesoscale and large-scale signals
  - Analysis of parameters wrt to coastal distance, attack angle to the coast-line, bathymetry
  - The consistency of the geophysical corrections (WTC from Uporto)

# WP5100 Performance specification and Product Validation Plan

| | | |
|---|---|---|
| **Partners** | CLS, TU Delft | |
| **Key Objectives** | **- To fully characterize the performances of the existing Sentinel-3 altimetry processing (SAR and PLRM) in open ocean,**<br>**- To perform a Product Validation Plan (PVP) for the validation of the innovative algorithms.** | |
| **Activities** | - Description of the validation strategy with performance metrics documented in the PVP [**CLS**] | T0 + 4 |
| | - Evaluation of Sentinel-3 reference performances in SAR [**CLS**] and RDSAR [**TU Delft**] | T0 + 12 |
| **Input** | - L2 Test data sets (Phase1) | |
| **Output** | - Product Validation Plan, D2.4<br>- Product Validation Report (Phase 1), D2.5 | |
| **Risks** | Non-sufficient amount of processed data to allow robust statistical analyses and efficient assessment of S-3 reference performances | |

## Product Validation Plan D2.4 contains

- **Description of the methodologies adopted :**
  - To characterize the reference dataset (current Sentinel-3 processing in SAR mode and PLRM)
  - To assess the innovative algorithms and the WTC solution from U.Porto
- **List of performance metrics and diagnoses used for the assessment**

## Methodologies

- **Phase 1: Assessment of the Sentinel-3 data sets**
  - **Sentinel-3 PLRM dataset** will be assessed by analyzing the continuity with LRM at the SARM boxes border
  - Cross comparing with Jason-2 (or Jason-3) mission through along-track and cross-overs analyses
  - **Sentinel-3 SAR mode** dataset will be then assessed by comparison with reference PLRM that are perfectly collocated and time tagged (properly removing any oceanic signal)
  - Large amount of observations will permit to make a deep assessment with reliable statistic

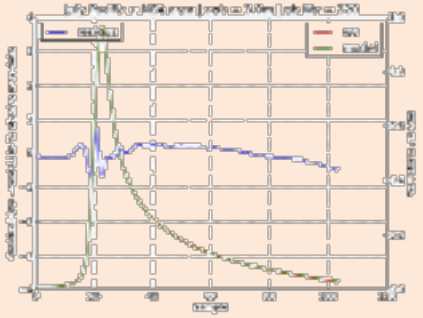
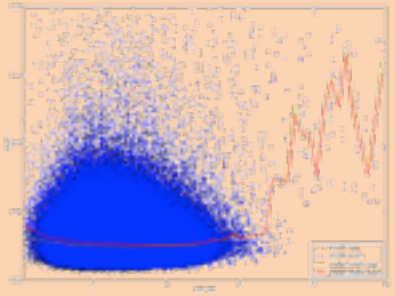
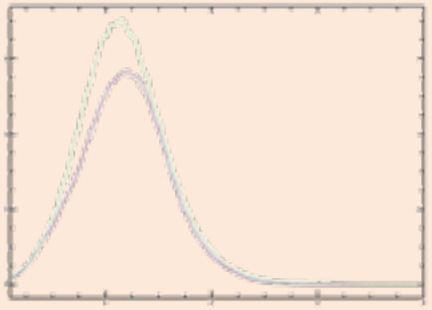
# Methodologies

- **Phase 2: Innovative algorithms assessment**
  - **Comparison between the new SAR mode datasets and the Sentinel-3 reference ones** through the use of a “retracking test bench” (as done in CP4O)
  - **Comparison between the enhanced WTC solution and the reference WTC derived from ECMWF model**
  - Analyses done at 1-Hz (after compression) to enable direct comparison between SAR mode and PLRM data sets
    - Limiting the time of processing
    - Reducing the impact of noise level which could help to detect potential anomalies between the studied and the reference data sets
    - Specific 20-Hz analyses (spectral analyses and waveform fitting) are also considered

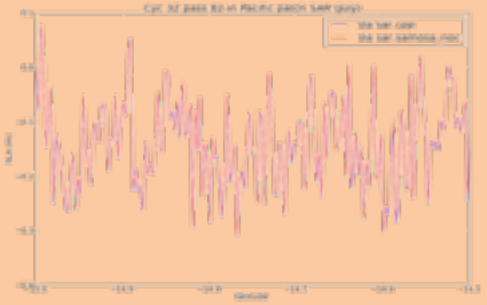
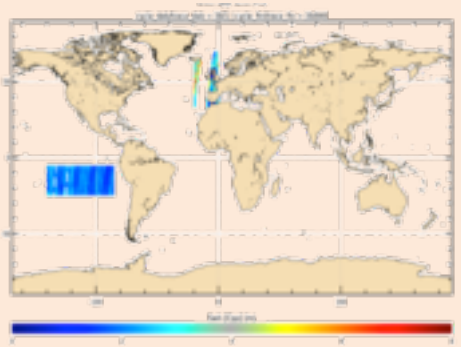
## Methodologies

- **Data editing to remove measurements of low accuracy**
  - Only valid ocean data are selected
    - removing data corrupted by sea ice and rain
    - specific editing criteria are applied, based on thresholds on different parameters
  - The comparison of the results derived from editing could provide first order relevant information about performances of a solution
- **Iteration with algorithm experts**
  - First, an inter-comparaison and validation reported is generated
  - Then iterations with the algorithm expert/responsible are planned to validate the content of this report or for further investigation

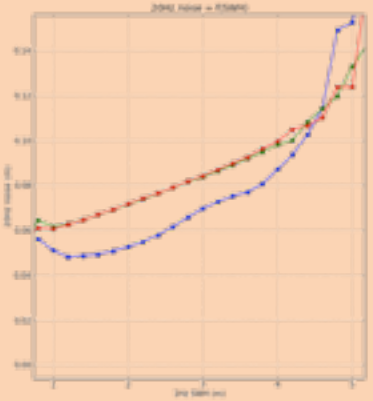
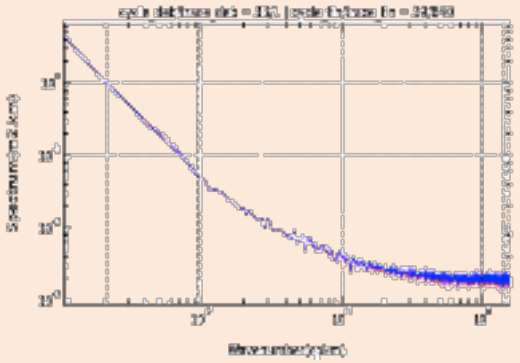
# WP5100 PRODUCT VALIDATION PLAN

| Diagnosis | Parameters | comment | Illustration | Applicable / WorkPackage |
|---|---|---|---|---|
| Residual between model and data (20Hz) | SARM Waveforms / model | This diagnosis allows to detect potential fitting anomalies and to identify on which part of the waveforms they are located |  | - Sentinel-3a Delay Doppler reference dataset (WP5100)<br>-Innovative algorithm data sets (WP5400) |
| Misfit against SWH (20Hz or 1Hz) | Waveforms misfit | This diagnosis performed on the misfit allows to characterize the retracking performances |  | - Sentinel-3a Delay Doppler reference dataset (WP5100)<br>-Innovative algorithm data sets (WP5400) |
| Histogram (1Hz) | SLA and their Differences<br>SWH and their Differences<br>Wind Speed and their differences<br>Misfits | Histograms of estimated parameters and their differences to characterise accurately global bias (drift not visible) and point out potential shape differences |  | - Sentinel-3a Delay Doppler reference dataset (WP5100)<br>-Innovative algorithm data sets (WP5400)<br>- GPD WTC (WP5400) |

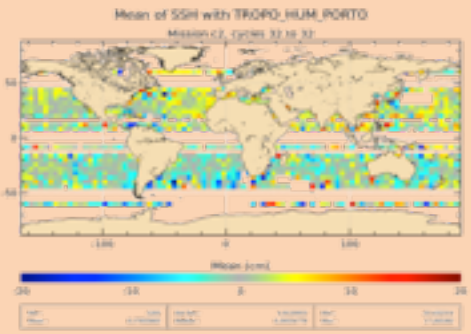
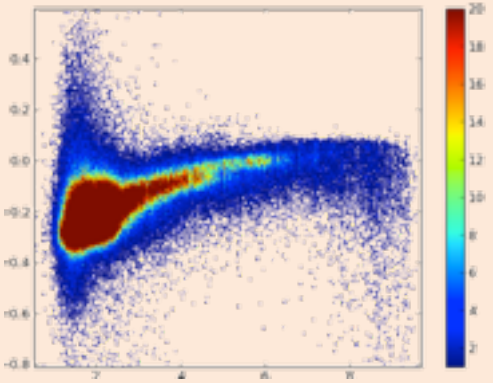
# WP5100 PRODUCT VALIDATION PLAN

| Diagnosis | Parameters | comment | Illustration | Applicable / WorkPackage |
|---|---|---|---|---|
| AT temporal evolutions (1Hz) | SLA mean and std<br>SWH mean and std<br>Wind speed mean and std | Temporal evolution of along-track estimated parameters and their differences averaged per days to characterize potential drift. |  | ntinel-3a Delay Doppler reference dataset (WP5100)<br>-Innovative algorithm data sets (WP5400)<br>- GPD WTC (WP5400) |
| Maps (1Hz) | SLA and their differences<br>SWH and their differences<br>Wind Speed and their differences<br>Misfits and their differences<br>Maps of edited measurements | Maps of the most part of parameters (estimated parameters + misfit + WTC ...) and their differences to visualize geographically potential correlated discrepancies. |  | ntinel-3a Delay Doppler reference dataset (WP5100)<br>-Innovative algorithm data sets (WP5400)<br>- GPD WTC (WP5400) |

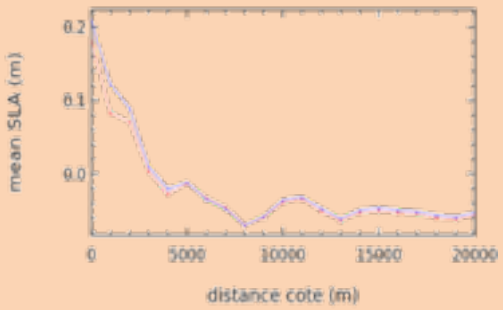
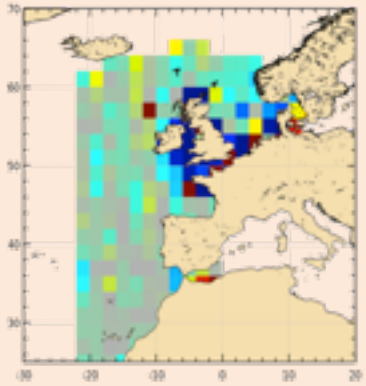
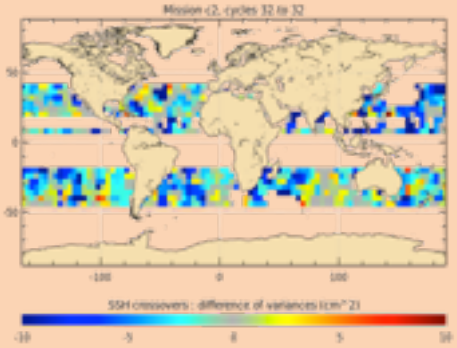
# WP5100 PRODUCT VALIDATION PLAN

| Diagnosis | Parameters | comment | Illustration | Applicable / WorkPackage |
|---|---|---|---|---|
| Noise (more precisely: 20Hz standard deviation) against SWH (1Hz) | 20Hz Range standard deviation<br>20Hz SWH standard deviation | The analysis of the 20Hz standard deviation derived from compression process as function of SWH allows to characterise the processing performances |  | ntinel-3a Delay Doppler reference dataset (WP5100)<br>-Innovative algorithm data sets (WP5400) |
| Wavenumber spectra (20Hz) | SLA<br>SWH | The Spectral analysis of SLA and SWH allows to point out discrepancies and/or performances of given processing separating the different spatial scales of the signal |  | ntinel-3a Delay Doppler reference dataset (WP5100)<br>-Innovative algorithm data sets (WP5400) |

# WP5100 PRODUCT VALIDATION PLAN

| Diagnosis | Parameters | comment | Illustration | Applicable / WorkPackage |
|---|---|---|---|---|
| Crossovers (1Hz) | SSH | Differences of SSH at crossovers allows to assess the reliability of altimeter measurements between ascending and descending passes. |  | ıtinel-3a Delay Doppler reference dataset (WP5100)<br>- GPD WTC (WP5400) |
| Dependency analysis / Dispersion diagrams (1Hz) | Range differences as function of several parameters | y=f(x) and z = f(x,y) diagrams allow to assess the dependencies between parameters. These diagnoses will be applied on estimated parameters and their differences. |  | ıtinel-3a Delay Doppler reference dataset (WP5100)<br>-Innovative algorithm data sets (WP5400) |
| | SWH differences as function of several parameters | | | |
| | Wind speed differences as function of several parameters | | | |
| | Misfit differences as function of several parameters | | | |

# WP5100 PRODUCT VALIDATION PLAN

| Diagnosis | Parameters | comment | Illustration | Applicable / WorkPackage |
|---|---|---|---|---|
| Coastal comparisons (20Hz) | SLA<br>Sigma0/wind speed | This work will not be redundant with WP6000 since no external metrics will be used. Plots of estimated parameter and their differences as function of the coastal distance and angle will be performed. |  | -Innovative algorithm data sets (WP5400)<br>- GPD WTC (WP5400) |
| Along-track gain of variance (1Hz) | SLA | This diagnoses is used to compare the along -track variability of the SLA using two different geophysical corrections (in this case DComb / ECMWF WTC).<br>Var(slaDcomb) - Var(slaECMWF) |  | - GPD WTC (WP5400) |
| Crossovers gain of variance (1Hz) | SSH | This diagnoses allows to determined if the studied geophysical correction (compared to the reference one) allows to reduce or not errors at crossovers.<br>Var(diffSSH1) - Var(diffSSH2)<br>SSH1 and SSH2 being computed with different WTC. |  | - GPD WTC (WP5400) |

# WP5100 PERFORMANCE METRICS

| Technique | Parameter(s) |
|---|---|
| Residuals between model and data | waveforms |
| misfit against wave height misfit | misfit, SWH |
| Histograms | SLA, SWH, wind speed |
| Parameter profiles as a function of time | SLA, SWH, wind speed |
| Cartography | SLA, SWH, wind speed, radial velocity, mispointings, rejected data |
| noise against wave height | SLA, SWH, wind speed |
| wavenumber spectra | SLA, SWH, wind speed |
| Cross over C2/C2 | SLA, SWH, wind speed |
| Cross over C2/J2 | SLA, SWH, wind speed |

+ comparison with PLRM data to check the consistency between two modes
+ other metrics: separating ascending and descending passes, distance to coast, attack angle,..

**Apply at 1-Hz (eventually at 20-Hz where it is required)**

# WP5400 SARM PERFORMANCE METRICS

| Technique | Parameter(s) |
|---|---|
| Residuals between model and data | waveforms |
| misfit against wave height misfit | misfit, SWH |
| biases and trends | difference of parameters (SLA, SWH, wind speed) from alternative approaches |
| Histograms | difference of parameters (SLA, SWH, wind speed) |
| Dispersion diagrams | difference of parameters (SLA, SWH, wind speed) as a function of mispointings, radial velocity, SWH |
| Parameter profiles as function of time | difference of parameters (SLA, SWH, wind speed) |
| Cartography | difference of parameters (SLA, SWH, wind speed), gained or rejected data |
| noise against wave height | SLA, SWH, wind speed |
| wavenumber spectra | SLA, SWH, wind speed |
| Cross over C2/C2 | SLA, SWH, wind speed |
| Cross over C2/J2 | SLA, SWH, wind speed |

**Apply at 1-Hz (eventually at 20-Hz where it is required)**

# WP5400 WTC PERFORMANCE METRICS

| Technique | Parameter(s) |
|---|---|
| Along track differences (mean and standard deviation) | WTC |
| Along track difference as funtion of the latitude and coacstal distance | WTC |
| Along track gain of variance | SLA |
| Along track gain of variance as as function of the latitude and coastal distance | SLA |
| Cross over difference | SSH |
| Cross over gain of variance | SSH |
| Cross over gain of variance as function of the latitude and coastal distance | SSH |
| Along track analysis | SLA |

**Apply at 1-Hz (eventually at 20-Hz where it is required)**

# WP5100 Synthesis and Risks/Recommendations

## Input data

- WP4000 Phase 1 Test Data Sets (L2, waveforms, models, auxiliary data)
- WP3000/WP4000 PSD and IODD
- Other EO satellite data (J2, Saral, J3 ?) and geophysical corrections from CLS database
- L2 RADS, CPP SAR/PLRM/LRM ?

## Deliverables

- Product Validation Plan, D2.4 – **Draft issued**
- Product Validation Report (Phase 1), D2.5

## Risks

- Not enough data to assess each algorithm
- No clear conclusion coming out from this assessment

## Recommendations

- To coordinate with WP5000 team for the selection of the periods (and geographical zones) of the Test Data Sets