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1 Introduction

1.1 Scope and purpose

This document is the Data Product Definition Document (DPDD) detailing each type of product that is generated in the frame of the LOTUS project. These products are built for demonstration purposes to first prepare prototype Sentinel-3 data sets but also support the development of new potential GMES products and value-adding downstream applications for ocean and land services.

The Sentinel-3 satellite embarking a SAR altimeter will provide substantial improvements compared to the conventional radar altimeter mission (enhanced along-track resolution and better speckle noise reduction). Its along-track SAR capability is notably of great interest for coastal zones, inland water and sea-ice altimetry applications. To date, no data products based on SAR mode data are provided or used operationally. They are neither considered nor implemented in the GMES services yet.

The LOTUS project benefits from the availability of the CryoSat-2 SAR data to enable the development of demonstration products that will help in the proper exploitation of Sentinel-3 SAR data. But in order to utilize the full potential of its new data source, new processing schemes with innovative algorithms need to be developed and implemented. The primary objective of the LOTUS project is aimed precisely at defining and developing new products and processing chains to encourage and promote the take-up of data from Sentinel-3.

Several kinds of demonstration products are defined and designed in this study according to the different applications it is aimed to (for operational marine or land services) and the different users types which may be encountered (scientists or end-users may have different product levels of interest).

All these products address the different surface targets of the Sentinel-3 topography measurements:

- Sea surface heights, wave heights and wind speeds in the open oceans, coastal seas as well as in sea ice,
- In-land water in rivers and lakes,
- Soil moisture, and
- Snow water equivalent,

and meet the needs of the different users:

- New Level-2 data products, complementing the ESA Sentinel-3 L2 data products, and
- Higher level data products (Level-3 and Level-4), so that end users get an easy access to the specific higher-level information they need.

This document is designed to provide high-level information of all these different products.

1.2 Document structure

This document is structured into an introductory chapter (this section) followed by three chapters:

- Section 2 provides a view of the products generation approach,
- Section 3 provides the list and description of the demonstration products,
- APPENDIX provides the complete list of the geophysical products.

2 User Products

The definition of the LOTUS data products are provided in the following parts.

In first, a general description of the processing levels, products classification, and generation approach is given. Then the LOTUS demonstration products are described in more detail, providing information on the products organisation, contents and formats.

2.1 Processing Levels

The following Level-1BS, Level-2, Level-3 products will be generated. Level 4 products (gridded data sets) are out of scope since this kind of products is only meaningful for merging different satellites. Moreover it is important to note the limitations of these high-level satellite products when using them, since it is not taking benefit of the improvement in the along-track resolution anymore.

Level-1BS product (not disseminated to the users): The raw data acquired by the CryoSat-2 satellite in SAR mode is processed by the CryoSat Processing Prototype chain (CPP) inherited from the Sentinel-3 ground segments, to generate Level-1BS data products. This product is used internally to the LOTUS project to produce data level 2 products with refined algorithms.

It includes geo-located and calibrated radar echoes (i.e. stack of Doppler beams) with ancillary information (latitude and longitude coordinates, altitude, satellite velocity, roll and pitch mispointing angles of the antenna derived from the star tracker information, landmarks (land/water), tracker range, geophysical and environmental corrections) at high sampling rate (20-Hz). Also it should be noted that a precise orbit determination is used in the product (the reference surface for the altitude and the orbital rate of the satellite is the T/P reference ellipsoid and not WGS84).

Two kinds of Level-1BS product are generated regarding the target end applications to be considered:

- One is intended to provide relevant information to the Level-2 processing scheme for easing the extraction of high-resolution water body quantities in regions where the impact of land and ice elements having much higher brightness temperatures than water is significant (enhancing surface topography measurements in the coastal zone, sea ice regions and over in-land rivers, their tributaries and lakes).

  A weighting function (e.g. Hamming function) is applied in azimuth direction in order to limit the effect of azimuth ambiguities originating from very high scattering targets that may aliased the received signal in azimuth. This function also allows cleaning the beams pointing off-nadir from spurious signals that may originate by the spread of high levels of energy contained in the main lobe through the azimuthal impulse response. Nevertheless a side effect of the weighting is to degrade the azimuthal resolution (typically ~300m to ~450m in the CryoSat-2 configuration). A second process in the chain consists in zero padding the Doppler beam waveforms doubling their extension in order to, on the one hand, broad the leading edge of

the waveform and, on the other hand, avoid aliasing of the signal that would occur by squaring the detected signal typically over specular surfaces in polar ocean or coastal

- A Level-1BS product is dedicated to open ocean investigations for which the nominal CPP processing chain remains unchanged.

Level-2 product: It includes high-resolution along-track geophysical quantities (altimeter range, orbital altitude and geophysical corrections, with significant wave height and wind-speed information) derived from the processing of the measurements data provided into the Level-1BS product, then time-tagged, precisely located and corrected for geophysical and environmental effects (tropospheric correction, ionospheric correction, solid earth, ocean and pole tides, etc.). Different Level-2 processes are in use according to different targets and will thus generate more than one Level-2 product from the same Level-1BS product. Data at this level are used by scientists or engineers that already work in the field.

Level-3 product: It is intended to ease the use of the CryoSat-2 measurements (as the ones that will be provided by Sentinel-3 SRAL measurements) for the end users. Along-track data are ready for immediate use in applications, validated (off-record data are edited), corrected and/or inter-calibrated. Two kinds of data products are designed regarding the target end applications.

- Ocean data products take benefit of multi-mission cross-calibration processing (based on combination with Jason-like altimeter mission) to ensure that all flows from all satellites provide consistent and accurate information. Furthermore, the resolution and sampling are optimised compared to Level 2 products.
- Land data products have undergone rigorous selection and retracking processes that aim at extracting the most relevant observations on the hydrology of basins such as time series of water levels and discharge rates, which could be directly used by hydrologists for studies of regional climate variability as well as for socio-economic applications (e.g., water resources management, navigation, and flood hazards).

2.2 Water products classification

User community can access to the disseminated demonstration products from Level-2 to higher levels. In order to better serve the user community with products having geophysical information contents that are in line with their needs, but also enable faster and more effective data use, the products are divided into independent datasets based on the type of water surface they contain (e.g., open ocean, sea ice, river/lake). For each targeted test area (as defined in **[LOTUS D1.3 report, 2014]**), a specific algorithm that is relevant for the retrieval of most valuable geophysical parameters is applied.

Several water products are thus defined as follows:

- Level 2 and 3 Open oceans product,
- Level 2 Coastal seas product,
- Level 2 and 3 Polar ocean product,
- Level 2 and 3 Rivers and lakes product,
- Level 3 and 4 Soil moisture product, and
- Level 2, 3 and 4 Snow water equivalent product,

Each product dedicated to specific applications will be demonstrated in the selected case study regions.

2.3 Products generation

The CPP chain allows the generation of Level-1BS products containing stacks of co-located Doppler beams. After their acquisition in CLS database, geophysical and environmental corrections are added to these products in order to compute the SLA quantities at higher level. LOTUS partners order the Level-1BS product type to be generated according to the different processing needs (with weighting function and oversampling method applied or not) and the selected geographical zone.

The set of Level-1BS products responds to the requirements of the target application that will be studied. The Level-2 processing is then conducted individually by each partner. Higher-level products (Level-3 and Level-4 if needed) are generated afterwards and the prototype data sets disseminated to the users. In addition the LOTUS project will carry out an assessment of these products using independent data sets.

2.4 User products list

The Figure 2.1 shows an overall view of the LOTUS data production and dissemination.

The Level-1BS are used internally to the project. They are not disseminated to the user community. They include masked values that enable to discriminate measurements flagged as land or water.

The Level 2 products are along-track 1Hz and 20Hz Ku band parameters in SAR mode. The Level 3 products are along track products with different sampling and resolution which is optimised for the end users. All of these products are processed taking into account the land/sea mask.

To ease the online dissemination and the users' data handling, it is foreseen to specify in the filename of the data sets an identifiable description of the type of the data. For the ocean data collection, the filename will contain the identifier "_OCE", and for the land data products the identifier "_LAN". The identifiers of the surface target and level of processing are also indicated. For example "PO_3_OCE" designates the Level-3 Polar ocean products.

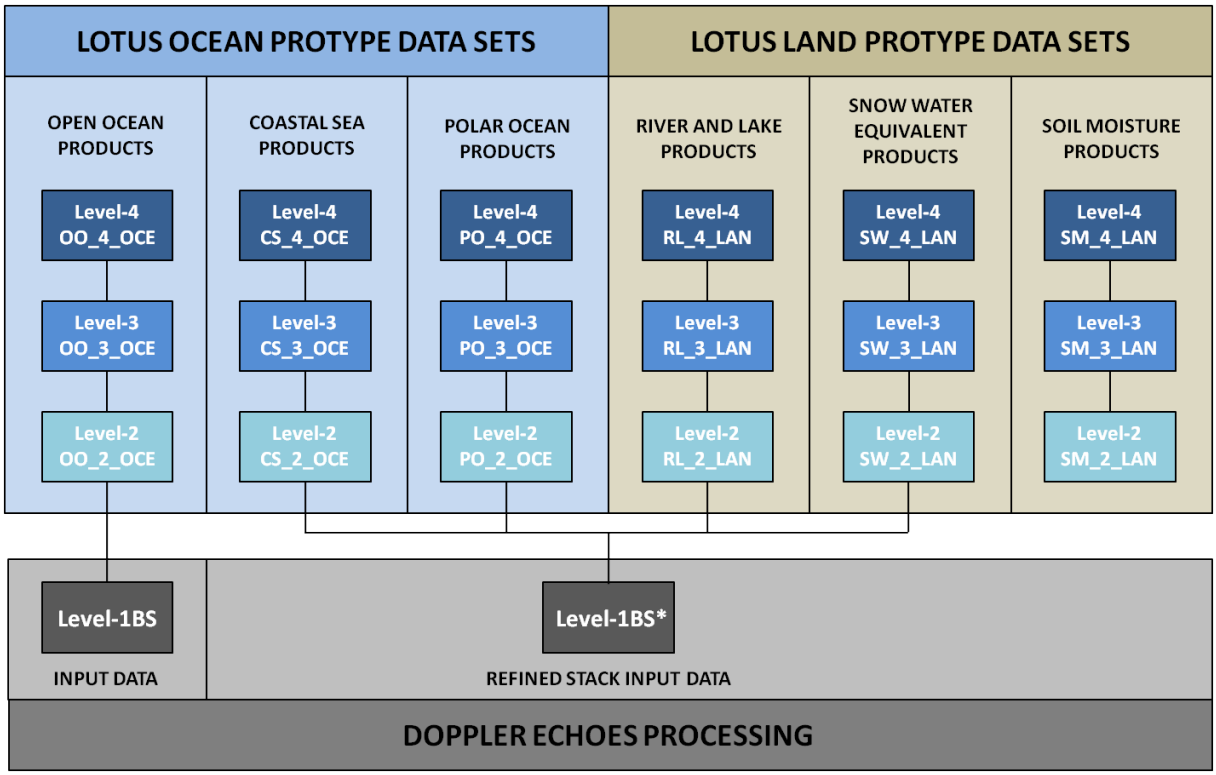

Figure 2.1: Overall view of the LOTUS user products.

The following table lists the different types of user products that are generated for each application (ocean or land topography measurements, and water surface target) and processing level (Level 2, 3, and 4 where they are applicable).

User product type	Level	Description
OO_2_OCE	2	1Hz and 20Hz SIRAL CryoSat-2 parameters (SAR/PLRM) over Open Ocean
OO_3_OCE	3	Cross-calibrated SIRAL CryoSat-2 parameters (SAR/PLRM) over Open Ocean
CS_2_OCE	2	20Hz SIRAL CryoSat-2 parameters (SAR/PLRM) over Coastal areas
PO_2_OCE	2	1Hz and 20Hz SIRAL CryoSat-2 parameters (SAR/PLRM) over Polar Ocean
PO_3_OCE	3	Cross-calibrated SIRAL CryoSat-2 parameters (SAR/PLRM) over the Polar Ocean (using global arc cross calibration)
RL_2_LAN	2	20Hz SIRAL CryoSat-2 parameters (SAR/PLRM) over in-land Rivers and Lakes
RL_3_LAN	3	Edited 20Hz SIRAL CryoSat-2 parameters (SAR/PLRM) over in-land Rivers and Lakes and time series at virtual stations
SW_2_LAN	2	Not for release
SW_3_LAN	3	20Hz filtered Snow Depth estimates (from SIRAL Cryosat-2 SAR data)
SW_4_LAN	4	Snow depth time series
SM_2_LAN	2	Not for release (data too noisy for 20Hz spatial resolution to be useful)
SM_3_LAN	3	Along-track soil moisture mean estimates (SMMEs) at spatial resolutions determined by data high frequency variation and locations bounded by DREAM extents
SM_4_LAN	4	Time series for each SMME

Table 1: User products list

3 Products description

In this section, a description of the LOTUS user products is provided.

As it is previously explained, the LOTUS products are organized into different targets and processing levels in order to implement a packaging scheme suited to archiving and dissemination to users. Each product package contains geophysical information that are retrieved by the new algorithms developed in the frame of the LOTUS project, around which associated 1Hz/20Hz auxiliary parameters (orbital information, roll/pitch mispointing, environmental/geophysical corrections, models, land/water mask) are embedded. The correction parameters and models that are necessary to compute the SLA and water level are listed in Annexe A.

These files are encoded in NetCDF-4 format.

3.1 Ocean prototype data sets

3.1.1 Open Ocean Products

3.1.1.1 *OO_2_OCE geophysical product description*

The Level-2 SIRAL CryoSat-2 prototype data sets contain the typical altimetry parameters, like the altimeter range, the sea surface height, the wind speed, significant wave height and all required geophysical corrections.

The altimeter estimates are obtained using a specific ocean retracker in PLRM and in SAR mode.

A conventional Brown ocean retracker based on unweigthed least square estimations (also known as MLE) which are traditionally used with LRM echoes, is applied to the PLRM power waveforms for estimating the different geophysical parameters. A 4-parameter estimator is considered for adequately fitting the measured waveforms with the return power model since the CryoSat-2 satellite exhibits unstable off-nadir mispointing angle in flight.

In SAR mode, a 3-parameter ocean retracker fits the numerical multilooked waveform model to one 20 Hz Level 1B SAR waveform using the LSE method and retrieve geophysical variables (range, significant wave height, backscattering coefficient) and fitting quality information.

This file contains specific geophysical parameters at different measurement rhythms (20Hz/1Hz) as follows

Parameter	Instr. Operation Mode	Description
1Hz/20Hz Surface Height	PLRM/SAR	Distance of the satellite from the reference surface, so: (corrected) Height = Altitude – Range - Corrections Where Corrections = altimeter ionospheric correction + model dry tropospheric correction + radiometer wet tropospheric correction+ sea state bias correction + solid earth tide height + geocentric ocean tide height solution1 (GOT solution) + geocentric pole tide height + combined corrections from MOG2D model The sea surface height anomaly (SSHA) is defined here as the altitude minus the corrected range minus the Mean Sea Surface (MSS) and minus known geophysical effects. Instrumental corrections are included
1Hz/20Hz Significant Wave Height	PLRM/SAR	It is the average wave height, trough to crest, of the one-third largest waves in a particular geographic location. In conventional altimetry, it is computed from the slope of the return radar pulse (the gradient of the leading edge of the radar echo, known as the leading-edge slope), after reflection on the surface.
1Hz/20Hz Backscatter coefficient	PLRM/SAR	The backscatter coefficient, sigma0, is computed from the power of the altimeter's return pulse. AGC corrections included
1Hz/20Hz Wind speed	PLRM/SAR	Wind speed is calculated from the mathematical relationship with the backscatter coefficient and the significant wave height.
1Hz/20Hz Mispointing	PLRM	Square of the off-nadir angle is derived from the waveform (deviation of boresight from nadir). Variations of this parameter can reveal actual platform mispointing, if any, but can also reveal waveform contamination by rain or by sea-ice.

Table 2: Retrieved parameters description for open ocean

3.1.1.2 *OO_3_OCE geophysical product description*

Parameter	Instr. Operation Mode	Description
Sea Level Anomaly	PLRM/SAR	Sea Level anomaly edited, filtered and sub-sampled at 5 Hz. An empirical adjustment on Jason-2 is applied to correct Cryosat-2 from long wavelength errors.

Table 3: Level-3 Geophysical parameters description for open ocean

3.1.2 Coastal Ocean Products

3.1.2.1 *The CO_2_OCE geophysical product description*

The Level-2 SIRAL CryoSat-2 prototype data sets contain the typical altimetry parameters, like the altimeter range, the sea surface height, the wind speed, significant wave height and all required geophysical corrections.

The altimeter estimates are obtained using a specific ocean retracker for SAR mode. The retracker is based in a modification of the SAMOSA model, a fully analytical waveform model, that performs the best fit to the SAR-waveform in order to simultaneously estimate the following geophysical variables: range, significant wave height, and backscattering coefficient. A Goodness of fit (GOF) parameter is also given in order to evaluate the quality of the model fit to the data.

Given that the distance to the coast is critical in this environment, two other parameters are provided within this product, i.e. the minimum distance to the coastline, and the minimum across-track distance. This is the key distance value, as it is the observation direction of the radar.

Given the requirement of high spatial resolution in coastal areas, all the estimated geophysical parameters are provided at 20 Hz.

Parameter	Instr. Operation Mode	Description
20Hz Surface Height	SAR	Distance of the satellite from the reference surface, so: (corrected) Height = Altitude – Range - Corrections Where Corrections = altimeter ionospheric correction + model dry tropospheric correction + radiometer wet tropospheric correction+ sea state bias correction + solid earth tide height + geocentric ocean tide height solution1 (GOT solution) + geocentric pole tide height + combined corrections from MOG2D model The sea surface height anomaly (SSHA) is defined here as the altitude minus the corrected range minus the Mean Sea Surface (MSS) and minus known geophysical effects. Instrumental corrections are included
20Hz Significant Wave Height	SAR	It is the average wave height, trough to crest, of the one-third largest waves in a particular geographic location. In conventional altimetry, it is computed from the slope of the return radar pulse (the gradient of the leading edge of the radar echo, known as the leading-edge slope), after reflection on the surface.
20Hz Backscatter coefficient	SAR	The backscatter coefficient, sigma0, is computed from the power of the altimeter's return pulse. AGC corrections included
20Hz Minimum Distance to Coast	SAR	Minimum distance from nadir point to coastline
20Hz Minimum Across Track Distance to Coast	SAR	Minimum across-track distance from nadir point to coastline
20Hz GOF	SAR	Goodness of fit between SAR L1b Waveform and Model, defined as GOF = sqrt(Sum(Wf(i)^2 - Model(i))^2)

Table 4: Coastal Ocean parameters description

3.1.3 Polar Ocean Products

3.1.3.1 *The PO_2_OCE geophysical product description*

The Level-2 SIRAL CryoSat-2 prototype data sets contain the typical altimetry parameters, like the altimeter range, the sea surface height, the wind speed, significant wave height and all required geophysical corrections. As the Polar Ocean is primarily under the SAR mask and as radiometer observations are frequently distorted due to the presence of sea ice, we suggest to use the following two changes with respect to the open ocean.

1) Model corrections for wet and dry troposphere,
2) The DTU MSS as it has no voids in the Arctic Ocean.

Parameter	Instr. Operation Mode	Description
1Hz/20Hz Surface Height	PLRM/SAR	Distance of the satellite from the reference surface, so: (corrected) Height = Altitude – Range - Corrections Where Corrections = altimeter ionospheric correction + model dry tropospheric correction + model wet tropospheric correction+ sea state bias correction + solid earth tide height + geocentric ocean tide height solution1 (GOT solution) + geocentric pole tide height + combined corrections from MOG2D model The sea surface height anomaly (SSHA) is defined here as the altitude minus the corrected range minus the Mean Sea Surface (MSS) and minus known geophysical effects. For the Polar Ocean, the DTU10MSS should be preferred as it has no voids. Instrumental corrections will be included
1Hz/20Hz Significant Wave Height	PLRM/SAR	It is the average wave height, trough to crest, of the one-third largest waves in a particular geographic location. In conventional altimetry, it is computed from the slope of the return radar pulse (the gradient of the leading edge of the radar echo, known as the leading-edge slope), after reflection on the surface.
1Hz/20Hz Backscatter coefficient	PLRM/SAR	The backscatter coefficient, sigma0, is computed from the power of the altimeter's return pulse. AGC corrections included
1Hz/20Hz Wind speed	PLRM/SAR	Wind speed is calculated from the mathematical relationship with the backscatter coefficient and the significant wave height.
1Hz/20Hz Mispointing	PLRM	Square of the off-nadir angle is derived from the waveform (deviation of boresight from nadir). Variations of this parameter can reveal actual platform mispointing, if any, but can also reveal waveform contamination by rain or by sea-ice.

Table 5: Retrieved parameters description for polar ocean

3.1.3.2 *The PO-3-OCE data description*

The Polar Ocean present a potential problem for empirical correction of long wavelength against the Jason-2 as this satellite maximum latitude is 66 and hence outside the Polar Ocean. However we suggest that global or semi-global Cryosat-2 arcs are adjusted to Jason-2 to perform the long wavelength adjustment.

Parameter	Instr. Operation Mode	Description
Sea Level Anomaly	PLRM/SAR	Sea Level anomaly edited, filtered and sub-sampled at 5 Hz. An empirical adjustment on Jason-2 is applied to correct Cryosat-2 from long wavelength errors.

Table 6: Level-3 Geophysical parameters description for polar ocean

3.2 Land prototype data sets

3.2.1 River and Lake Products

3.2.1.1 *RL_2_LAN*

The Level-2 SIRAL CryoSat-2 prototype data sets for rivers and lakes contain 20 Hz water levels, a land-water mask value, an along-track mean river/lake levels and all required geophysical corrections.

The 20 Hz water levels are estimated using an algorithm that includes initial- and post-processing procedures. In the initial processing the surface heights related to up to 10 peaks in the waveform are estimated by an empirical 80 % threshold retracker. Additionally each waveform is retracked using an 80% Primary Peak Threshold (PPT) retracker.

In the post-processing a land-water mask is applied to locate inland water. An along-track mean water level is estimated for water bodies that contain 5 or more measurements. For each water body the mean water level is compared to the individual heights (up to 10) from each waveform. For a given waveform the (individual peak) height that is closest to the mean water level is returned as the 20Hz water level. When the mask indicates land and when a water body contains less than 5 measurements, then the water level/surface height based on the PPT retracker is returned.

Below is a description of the 20 Hz water levels.

Parameter	Instr. Operation Mode	Description
20Hz Water levels/surface heights	SAR	Distance of the satellite from the reference surface, so: (corrected) Height = Altitude – Range - Corrections Where Corrections = altimeter ionospheric correction + model dry tropospheric correction + modelled wet tropospheric correction + solid earth tide height + ocean loading tide + geocentric pole tide height. Instrumental corrections are included
20 Hz Mask value	SAR	Value that indicates the underlying surface type; water =1, land=0
Mean water level	SAR	Robust estimate of the along-track mean water level. This value is only returned if a water body contains 5 or more measurements otherwise the value 99999 is returned

Table 7: Retrieved parameters description for river and lake

3.2.1.2 *RL_3_LAN*

The Level-3 SIRAL CryoSat-2 prototype data sets for rivers and lakes contain two products; a filtered subset of the Level-2 product RL_2_LAN and time series at virtual stations.

The RL_3_LAN data product contains river and lake levels for the prototype data sets. These have been edited, hence outliers have been removed. This product contains read-to-use data to study global/continental scale water balances and dynamics.

Virtual station time series for rivers and lakes: A subset of RL_2_LAN but now arranged as time series for individual targets. An important issue here is to continue existing ERS-2 and Envisat time series as much as possible.

Parameter	Instr. Operation Mode	Description
Filtered 20Hz Water levels	SAR	A subset of data product RL_2_LAN. Water levels have been filtered out by applying land-water mask. An automatic outlier detection routine has been applied to the data.
Time series	SAR	Ready to use time series at virtual stations for the demo data sets.

Table 8: Level-3 Geophysical parameters description for river and lake

3.2.2 Snow Water Equivalent Products

3.2.2.1 *SW_2_LAN geophysical product description*

Conventionally, snow depth is measured at single points on the surface using snow rulers or ultrasonic ranging sensors with a centimeter accuracy. These measurements are extrapolated temporally and spatially in order to cover wider areas. Space-borne sensors, which can cover a wide swath and can provide rapid repeat global coverage, are ideally suited to augment the snow information on a regional and global scale. Snow depth estimation by means of altimeter measurements is based on the analysis of backscattering changes during a snow season.

For Sentinel-3 derived Snow Depth estimations two products are planned: a level 3 product, which contains the along-track filtered snow depth; a level 4 product which contains time series of snow depth evolution. The Level 2 product, i.e. the 20 Hz Backscatter coefficient is not delivered due to the high noise in the observable.

Parameter	Instr. Operation Mode	Description
20Hz Backscatter coefficient	SAR/LRM	Radar backscattering coefficient estimated by retracking the SAR or LRM waveform and applying required corrections

Table 9: Level-2 Geophysical parameters description for Snow Depth

3.2.2.2 *SW_3_LAN geophysical product description*

Parameter	Instr. Operation Mode	Description
Filtered 20Hz Snow depth	SAR/LRM	Snow depth estimates filtered to remove outliers.

Table 10: Level-3 Geophysical parameters description for Snow Depth

3.2.2.3 *SW_4_LAN geophysical product description*

Parameter	Instr. Operation Mode	Description
Time series	SAR/LRM	Snow Depth Time Series

Table 11: Level-4 Geophysical parameters description for Snow Depth

3.2.3 Soil Moisture Products

3.2.3.1 *SM_2_LAN*

Surface soil moisture estimates are derived over desert and semi-arid terrain by analysing each 20Hz waveform and computing the altimeter backscatter, applying all required corrections and scaling factors. These values are then compared with a DRy EArth Model (DREAM) which encodes the detailed variation in this parameter expected over the surface in dry earth conditions. The requirement for DREAM creation presently constrains this application to deserts and semi-arid terrain.

From a comparison of the measurement with the model it is then possible to calculate the surface soil moisture. Because the highest spatial frequency variations in this parameter (resulting from changes in small-scale roughness and surface composition) are not captured in the DREAMS, some filtering and averaging of the values is essential. Accordingly the SM_2_LAN product is not envisaged to be released. There are thus only two products envisaged for this parameter, at levels 3 and 4. The level 3 product contains along-track filtered and averaged mean soil moisture estimates (SMMEs) for each pass; the level 4 product contains time series for each SSME.

It is noted that Cryosat2 currently overflies all DREAM regions in LRM mode. However, this technique is applicable to both SAR and LRM mode data.

Parameter	Instr. Operation Mode	Description
20Hz Backscatter coefficient	PLRM/SAR	The backscatter coefficient is computed by retracking each waveform to obtain corrected peak power and then calculating the backscatter, applying required corrections.

Table 12: Retrieved parameters description for soil moisture

3.2.3.2 *SM_3_LAN*

For SM-3-LAN a variable along-track averaging is applied to create Soil Moisture Mean Estimates (SMMEs) along the satellite track. The extent of this averaging may be different for each desert, but is fixed for all data derived using a single DREAM.

Parameter	Instr. Operation Mode	Description
Filtered and averaged along-track surface soil moisture estimates	PLRM/SAR	A series of along-track averaged surface soil moisture values (as % soil moisture) for each pass over each DREAM.

Table 13: SM_3_LAN Soil Moisture geophysical parameters description

3.2.3.3 *SM_3_LAN*

Because the soil moisture user community works with time series data at specific locations, the SM_4_LAN product contains time series of each Soil Moisture Mean Estimate (SMME) produced in SM_3_LAN. This product can be generated for Cryosat2 data, but the long repeat period means that this product is of benefit primarily for Sentinel3.

Parameter	Instr. Operation Mode	Description
Time series	PLRM/SAR	The soil moisture community requires time series at spatially collocated locations, thus a time series for each along-track-averaged SSME is foreseen, derived from the repeat passes. The long repeat cycle of Cryosat2 severely constrains this dataset.

Table 14: SM_4_LAN Time series for Soil Moisture

APPENDIX A

Table 0.1: Products corrections and models overview

Parameter	Description
Dry troposphere	Model dry tropospheric correction is computed at the altimeter time-tag from the interpolation of 2 meteorological fields that surround the altimeter time-tag. A dry tropospheric correction must be added (negative value) to the instrument range to correct this range measurement for dry tropospheric range delays of the radar pulse. From European Center for Medium Range Weather Forecasting
Wet troposphere	Model wet tropospheric correction is computed at the altimeter time-tag from the interpolation of 2 meteorological fields that surround the altimeter time-tag. A wet tropospheric correction must be added (negative value) to the instrument range to correct this range measurement for wet tropospheric range delays of the radar pulse. From European Center for Medium Range Weather Forecasting
Ionosphere	GIM ionospheric correction from NASA/JPL must be added (negative value) to the instrument range to correct this range measurement for ionospheric range delays of the radar pulse.
Ocean tide and loading tide	Geocentric ocean tide height (solution 1): GOT4.8 from GSFC Includes the loading tide and equilibrium long-period ocean tide height. The permanent tide (zero frequency) is not included in this parameter because it is included in the geoid and mean sea surface.
Solid Earth tide	Solid earth tide height is calculated using Cartwright and Taylor tables and consisting of the second and third degree constituents. The permanent tide (zero frequency) is not included. From Cartwright and Edden [1973] Corrected tables of tidal harmonics - J. Geophys. J. R. Astr. Soc., 33, 253-264.
Pole tide	Computed from Wahr [1985] Deformation of the Earth induced by polar motion - J. Geophys. Res. (Solid Earth), 90, 9363-9368.
Combined atmospheric correction	Also known as high frequency fluctuations of the sea surface topography which contains the combined atmospheric corrections (from MOG2D model + inverse barometer)
Sea State Bias	A sea state bias correction must be added (negative value) to the instrument range to correct this range measurement for sea state

Parameter	Description
	delays of the radar pulse. The SAR CryoSat-2 sea state bias cannot be directly calculated within restricted areas. The LRM sea state bias produced from a non-parametric method applied at crossovers is used to derive the sea state bias in SAR mode.
Mean Sea Surface CLS	MSS_CNES_CLS-2011: mean sea surface height above T/P reference ellipsoid from CLS/CNES 2011
Mean Sea Surface DTU	MSS_DTU10: mean sea surface height above T/P reference ellipsoid from DTU 2010
Mean Dynamic Topography	MDT_CNES-CLS09_v1.1: mean dynamic Topography above the geoid from CLS/CNES
Geoid	Height above the T/P reference ellipsoid based on the 1996 earth gravity model from NASA/GSFC
Bathymetry	Ocean depth or land elevation based on the digital topographic model 2000 from NASA/GSFC

References

[LOTUS D1.3 report, 2014]: LOTUS report, "*Test Site Areas Selection*", D1.3, 17th Jan. 2014.

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