S3ETRAC

PREPROCESSING AND EXTRACTION SPECIFICATION OF THE SENTINEL-3 EXTRACTION TOOL FOR RADIOMETRIC ANALYSIS AND CALIBRATION (ATBD)

	Nom et Sigle	Date et Visa
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For application		

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INFORMATIONS

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HISTORIC

Version	Date	Objet
1.0	15/05/13	First version
2.0	08/08/14	The following aspects were clarified : - Section 4.4 : the use of additional calibration sites - Section 6.6, section 7.6, section 9.6 : addition of brightness temperature as an output for SLSTR thermal spectral bands - Section 10 : inputs are fixed . Use of Reduced resolution. Level-1C and Full resolution will not be considered - Section 11 : outputs are clarified - All sections : introduction of stripes for SWIR bands

SUMMARY

1. INTRODUCTION

This document describes the pre-processing specification of the tool which will be implemented for data extraction for calibration purposes. This tool, strongly inspired by the historical METRIC tool developed or MERIS (DR12), will process extraction for both Sentinel-3 sensors : OLCI and SLSTR. The measurements will be collected over desert sites, oceanic sites, and snowy sites. These calibration methods are only valid for reflective spectral bands.
These pre-processing specifications will be part of a higher-level SoW (DR11), where further requirements on format, interfaces, testing and validation are described.

2. REFERENCE DOCUMENTS

2.1. APPLICABLE DOCUMENT

AD1		

2.2. REFERENCE DOCUMENT

DR1	MMCAL-RAL-TN-001, Issue: 1.3, 14-Jun-2013	Extraction of AATSR and SLSTR Radiometric Data over Vicarious Calibration Sites, Cox&Smith
DR2	*IEEE Trans. Geosci. and Remote Sensing*, vol. 51, pp. 1098-1113, 2013	Lachérade, Fougnie, Henry, and Gamet, “Cross-calibration Over Desert Sites : Description, Methodology, and Operational Implementation”
DR3	*Earth Observing Systems XV*, SPIE Optics & Photonics, San Diego, California, 1-5 August, 2010.	Fougnie, Llido, Gross-Colzy, Henry, and Blumstein, “Climatology of Oceanic Zones Suitable for In-flight Calibration of Space Sensors”
DR4	*IEEE Trans. Geosci. and Remote Sensing*, vol. 42, No.7, pp. 1472-1481, 2004.	Hagolle, O., J.M. Nicolas, B. Fougnie, F. Cabot, and P. Henry, Absolute Calibration of VEGETATION derived from an interband method based on the Sun Glint over Ocean
DR6	S3-TN-RAL-SL-032	SLSTR ATBD – Document for Level1 Observables
DR7	S3-RS-ACR-SY-0004 (7.0)	Sentinel-3 Level 0, Level 1a/b/c Products Definition – OLCI L0,L1b products
DR8	S3-RS-RAL-SY-003 (6.1)	Sentinel-3 Level 0, Level 1a/b/c Products Definition - SLSTR products
DR9	S3-RS-ACR-SY-0001 (6.1)	Sentinel-3 Level 0, Level 1a/b/c Products Definition – Vol 1 : Introduction, Conventions and Common Structures
DR10	S3-RS-ACR-SY-0002 (7.0)	Sentinel-3 Level 0, Level 1a/b/c Products Definition – Vol 5 : Common Auxiliary Data Files
DR11	S3-SW-ESA-SY-396 version 1	SoW Sentinel-3 Data Extraction Tool for Radiometric Analysis and Calibration (S3ETRAC)
DR12	OLIVIER HAGOLLE, CNES, 2000	Spécification Technique des Besoins Sélection des points d’étalonnage MERIS

3. SENTINEL-3 SENSORS – OLCI&SLSTR

3.1. OLCI

The OLCI instrument is a follow-up of MERIS onboard ENVISAT. Main differences are additional spectral bands, different camera arrangements, and a simplified onboard processing.

OLCI is a pushbroom instrument composed by 5 camera modules sharing the field of view:

- The five cameras are arranged in a fan-shaped configuration in the vertical plan perpendicular to the platform velocity (across-track).
- The field of view of each camera is 14.2 degrees and a 0.6 degree overlap exists with its neighbours cameras. The total field of view of the instrument is 68.5 degrees.
- The whole instrumental field of view (so the 5 cameras) is tilted across-track by 12.58 degrees away from the Sun in order to minimize sunglint impact

OLCI will provide measurements of the top of atmosphere radiances for 21 wavelengths in the reflective part of the spectrum : 400nm, 412.5nm, 442.5nm, 490nm, 510nm, 560nm, 620nm, 665nm, 673.75nm, 681.25nm, 708.75nm, 753.75nm, 761.25nm, 764.375nm, 767.5nm, 778.75nm, 865nm, 885nm, 900nm, 940nm, and 1020nm.

Spectral bands are programmable because the instrumental concept is an imaging spectrometer which allows redefinition of bands in both location and width.

OLCI will perform acquisitions for solar zenith angles lower than 80 degrees. Acquisition step is 44ms, and the pixel size is 290m along-track (mean), and 270m across-track (min). Nevertheless, the native acquisition resolution is the one used to compute the product grid of full resolution products (FR), or reduced resolution products (RR).

OLCI is equipped with an onboard calibration device. It is based on 3 Sun diffusers : two of them are "white" diffusers dedicated for radiometric calibration, while the third one includes spectral reflectance features dedicated to spectral characterization.

3.2. SLSTR

The Sea and Land Surface Temperature Radiometer (SLSTR) is designed to maintain continuity with (A)ATSR series of instruments. The instrument design supports this by incorporating the basic functionality of AATSR, with the addition of some new, more advanced, features. These include a wider swath, new channels, and higher spatial resolution in some channels.

The proposed instrument will include the set of channels used by AATSR, thus ensuring continuity, together with two new channels in the short wave infrared domain, at wavelengths 2.25 and 1.375 microns in support of cloud clearing for SST retrieval. The instrument will provide eleven channels as follows :

- Reflective VIS-SWIR bands : 555nm (S1), 660nm (S2), 870nm (S3), 1375nm (S4), 1600nm (S5), and 2225nm (S6)
- Thermal IR and Fire bands : 3700nm (S7), 3700nm (S7F), 10800nm (S8), 10800nm (S8F), and 12000nm (S9)

Like AATSR, the SLSTR instrument will measure a nadir and oblique view scan, each of which will also intersect the calibration black bodies and the visible calibration unit. To achieve the increased swath width of 1400km in the nadir view , the SLSTR instrument will use two independent scan mirrors each scanning at 200 scans per minute, but each scan will measure 2 along-track pixels of 1km at nadir (and 8 pixels at 500m resolution for reflective channels) simultaneously. This configuration increases the swath width in the both views as well as providing 500m resolution in the reflective channels.

Each scan mirror is mounted at an oblique angle to its axis of rotation, and directs radiation into a telescope assembly the optical axis of which is aligned parallel to the rotation axis. As the scan mirror rotates, the line of sight traces out a cone whose intersection with the Earth traces out the measurement swath of the instrument. The scan cone will intersect the Earth view, the two calibration black bodies, and the VISible CALibration (VISCAL) Unit, so that the line of sight will encounter each of these once during a complete rotation.

Radiation incident along the line of sight enters the focal plane assembly, where it is split into frequency bands corresponding to different channels. Radiation in each channel is focused onto a small array of detector elements which correspond to pixels.

Note regarding SWIR bands : SLSTR level-1 provides two different SWIR information, one for each stripe A and B (+ a third information called TDI which is a straight addition of stripes A and B). All thresholds based on radiometric criteria for SWIR bands will be based on A-stripe. On the other hand, both stripes have to be generated independently when computing statistics. These stripes could be considered as duplication of SWIR bands (i.e. S4-A, S4-B, S5-A, S5-B, S6-A, S6-B) .

4. DEFINITION OF CALIBRATION SITES

4.1. DESERT SITES

Twenty pseudo invariant African and Arabian desert sites are considered according their definitions in Lachérade et al., 2013 (DR4). They are defined by a +/-0.45° square in latitude/longitude around their geographic center. Geographical coordinates are reported in Appendix I, part 1.
Sites are also characterized in term of brightness (bright or moderate) and spatial homogeneity (homogeneous or heterogeneous) in order to activate or not some specific cloud filtering.

4.2. OCEANIC SITES

Oceanic sites are considered according their definitions in Fougnie et al., 2010 (DR5).
They are defines as rectangular large areas in latitude/longitude and their geographical coordinates are reported in Appendix I, part 2.

4.3. SNOW SITES

Snow sites are located in Antarctica. These Domes are defined as square areas, but due to the polar projection, they don't correspond to square in latitude/longitude.
For this reason, coordinates of the four corners, in addition to the center, are provided in Appendix I, part 3.

4.4. OTHER SITES

Calibration sites (PICS or oceanic) are standard for the use in the CNES SADE/MUSCLE operational calibration tools. Other calibration sites ~~may~~ will be added to the list and processed as desert sites, oceanic sites for Rayleigh, oceanic sites for sunglint, and snowy sites. These additional sites will be defined by ESA and RAL in order to facilitate the continuity of historical calibration (mainly from Envisat).

5. CALIBRATION APPROACHES

The data extraction described in this specification will be used through four different calibration approaches.

- The cross-calibration and trending over desert sites – These sites were defined as stable (pseudo-invariant sites) and can be used to 1/ to follow the radiometric trending of the instrument and 2/ to cross-calibrate the instrument with another sensor used as reference
- The absolute calibration over Rayleigh scattering – This approach select very clear oceanic and atmosphere condition for which, the observed signal will be composed by 90% of Rayleigh scattering, a quantity that is easily predictable. This calibration is applicable for visible bands.
- The interband calibration over sunglint – The reflection of the sun over the ocean is nearly white and can be used to intercalibrate, after correction, all the spectral bands, except for bands with strong gaseous absorption.
- The cross-calibration over snowy sites – This approach is nearly the same than for desert sites.

The following tables provide a summary of the expected calibration approaches for all the OLCI and SLSTR reflective spectral bands. This list is only indicative and could be reviewed.

SLSTR Band	Desert	Rayleigh	Sunglint	Snow
555	yes	yes	yes	yes
~~660~~659	yes	yes	yes	yes
~~870~~865	yes	-	yes	yes
1 375	-	-	-	-
~~1 600~~1 610	yes	-	yes	-
2 225	yes	-	yes	-

SLSTR reflective spectral bands and calibration approaches that are expected to be efficient.

OLCI Band	Desert	Rayleigh	Sunglint	Snow
400	yes	yes	yes	yes
412.5	yes	yes	yes	yes
442.5	yes	yes	yes	yes
490	yes	yes	yes	yes
510	yes	yes	yes	yes
560	yes	yes	yes	yes
620	yes	yes	yes	yes
665	yes	yes	yes	yes
681.25	yes	-	yes	yes
708.75	yes	-	yes	yes
753.75	yes	-	yes	yes
761.25	-	-	-	-
764.375		-		
773.75	yes	-	yes	yes
781.25	yes	-	yes	yes
862.5	yes	-	yes	yes
872.5	yes	-	yes	yes
885	yes	-	yes	yes
900	-	-	-	-
940	-	-	-	-
1020	yes	-	yes	yes

OLCI reflective spectral bands and calibration approaches that are expected to be efficient. To be updated after the final OLCI band definition.

Definition : .some parameters used on the following calibration methods are redefined here in order to avoir confusion :

- L is the Radiance
- I is the Normalized radiance : I = pi*L/Eo
- R is the Reflectance : R = pi*L/Eomus or R = I / mus

where Eo is the extraterrestrial solar irradiance for the considered band and mus is the cosine of solar zenith angle.

6. DATA SELECTION OVER DESERT SITES

6.1. INTRODUCTION

The basic approach is to compute the mean radiometry over each of the desert sites after a cloud filtering defined as precise as possible.
Note that OLCI and SLSTR will be considered as two independent sensors. No cross-selection will be operated in this implementation. That could be the case for example to be able to enlarge the spectral coverage and directional ability in order to improve the cloud detection efficiency.

6.2. PRODUCT SELECTION

The 20 desert sites are defined by their 4 corners. The site is not necessarily a rectangular shape in latitude and longitude. Their size is approximately 90x90km². All the OLCI and SLSTR products that view one site will be processed. Most of the time, one single product will view several desert sites.

General parameters for desert :

- Latitude and longitude of the 4 corners of the site
- Characteristic of the site : bright/moderate, homogeneous/heterogeneous (in the sense non-homogeneous).

6.3. GENERIC PREPROCESSING

Extraction of geometrical/geographical information – It is first necessary to extract from all the tie-points of the image (see DR 7-10), the latitude, longitude, viewing and solar angles. These geometrical/geographical information are bi-linearly interpolated for each pixel of the image.

Scaling factors – Data are extracted from corresponding MDS fields of level-1 products (see applicable documentation). Digits are converted into radiances (for OLCI and SLSTR reflective bands) and brightness temperatures (for SLSTR thermal bands) using scale_factor and add_offset taken from corresponding Main Data Set (MDS, see DR7-10).

Normalization to reflectance – For all reflective OLCI&SLSTR bands, radiances are normalized to the solar irradiance corresponding to each pixel/band in order to compute reflectance. In-band solar irradiances (or solar flux) are provided into the General Information Data File (see DR7)

6.4. SELECTION FOR OLCI

The pixel selection for OLCI relies on the use of threshold on radiometry for reflective bands.

6.4.1. SPECIFIC PREPROCESSING

Geographical selection – A first step is to identify for each pixel of a given image, the corresponding desert site. All the pixels located inside a site have to be selected.

Quality index – A quality mask has to be initialized to the zero value for each pixel. Pixel corresponding to degraded level-1 quality must be identified. This test is based on the comparison of the quality index from level-1 (MDSR(16) equivalent index) with an quality index mask (set as parameter). When a pixel is considered as doubtful or saturated, the quality mask is assigned to the 1 value.

Cloud mask initialization – A cloud mask has to be initialized to the zero value for each pixel.
It is not managed for each pixel which one of the test will pass or not. The cloud mask value will be assigned to 1 if at least one of the test is not satisfied.
Nevertheless, a cloudy pixel counter has to be generated for each test and incremented each time a pixel is identified as cloudy.

6.4.2. CLOUD DETECTION

Parameters :
- r443max – Maximum threshold reflectance at 443nm
- Smin – Minimum threshold on spectral index
- Svar – Maximum threshold on local variance at 490nm
- N_var – Size of the spatial window for the local variance computation

Selection :

Step 1 - Threshold on the 443 TOA reflectance. A pixel corresponding to reflectance brighter than r443max in the blue is considered as cloudy. In this case, the cloud mask for this pixel is assigned to 1, and the test counter is incremented.

Step 2 - Threshold on the normalized spectral index (R865-R443)/(R865+R443). Pixels corresponding to index under Smin are considered as cloudy. In this case, the cloud mask for this pixel is assigned to 1, and the test counter is incremented.

Step 3 – The OLCI level-1 provides an index identifying bright pixels. This index is based on a threshold which considers the geometry of the scene. This index is only considered if the site is not identified as a "BRIGHT" site (general parameter of the desert site). A pixel corresponding to a "bright" pixel is considered as cloudy. In this case, the cloud mask for this pixel is assigned to 1, and the test counter is incremented.

Step 4 – For desert sites which were identified as "HOMOGENEOUS", an additional selection based on the spatial variance at 490nm is used. The variance is computed for band 490nm on a spatial window of N_var by N_var size. For these sites, a pixel corresponding to variance larger than Svar is considered as cloudy. In this case, the cloud mask for this pixel is assigned to 1, and the test counter is incremented.

Step 5 – combination of all cloudy pixel detections to derive the total cloud mask. A pixel is definitively clear if he passed successfully all the previous steps.

6.5. SELECTION FOR SLSTR

The pixel selection for SLSTR uses not only the radiometry for reflective bands, but information from thermal bands is precious to improve the selection.

6.5.1. SPECIFIC PREPROCESSING

Parameters :
- Width_HSI, Height_HSI – Width and height of the histogram sub-image in km

- R16_max – maximum reflectance for 1.6 microns channel
- BT11_min, BT12_min – minimum value for BT11 and BT12 channels
- Val_neg_DES – value replacing negative radiometry for VIS/SWIR bands

Identification of the desert site – For each of the considered desert sites, the first step is to identify if some pixels are located inside the site.

Histogram sub-image – A sub-image has to be defined in order to later compute a histogram for cloud masking. This area is larger than the desert site, roughly 320x512km² compared to 90x90km². This sub-image is centered with the same geographical center than the considered site. The size of the sub-image is Width_HSI and Height_HSI km². The desert site will be the smallest possible size for this sub-image.

Geographical selection – A mask is created activated for all pixels of the sub-image which are located inside the desert site.

Cloud mask initialization – A cloud mask (byte array) has to be initialized to the zero value for each pixel of the histogram sub-image.
Depending on each test that will be performed in the following lines, this cloud mask will be assigned for each pixel to a specific value. The associated possible values are reported in Annex.
A different cloud mask is created for each of the two instrument views.

Data validity check – This preprocessing step controls the validity of data regarding 3 aspects :

- All negative values for VIS/SWIR channels are set to the Val_neg_DES value (zero).

- Invalidity of data for the 1.6 microns channel : if the reflectance in this channel is greater than 100% (to be fixed using ~~as~~the ~~a~~ parameter R16_max), the pixel must be considered as invalid.
  In this case, +1 must be added to the the cloud mask value.

- Saturation of values for channel BT_11 and BT_12 ; if values are less than 150K (to be fixed ~~as a~~using parameters BT11_min and BT12_min), the pixel must be considered as saturated.
  In this case, the pixel value has to be replaced by the maximum value of BT_11, respectively BT_12, over the considered desert site. The cloud mask value is not modified.

6.5.2. CLOUD DETECTION

Parameters :
- BT11var_max – Maximum relative variation of brightness temperature in TIR channel at 11 microns (initial 0.01)
- BT12var_max – Maximum relative variation of brightness temperature in TIR channel at 12 microns (initial 0.01)
- V16var_max – Maximum relative variation of reflectance in SWIR channel at 1,6 microns (initial 0.1)
- V22var_max – Maximum relative variation of reflectance in SWIR channel at 2,2 microns (initial 0.1)
- R16_min – Minimum reflectance in SWIR channel at 1.6 microns (initial 10%)
- Dual_view – Optional activation of the dual_view cloud mask (initial 0)
- Histo_Bin_size – Size of the bin to consider for the histogram construction (initial 0.5°K)

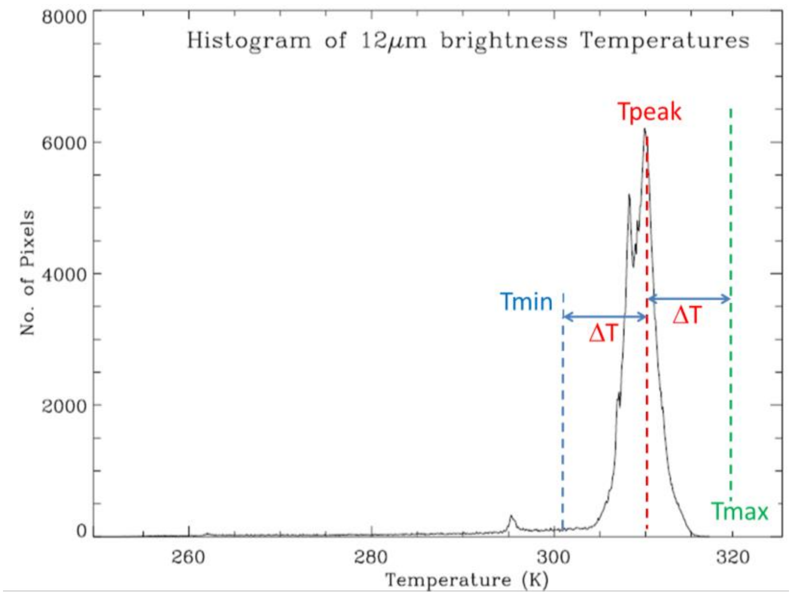
- Cirrus_L1 – activate the consideration of level-1 cirrus cloud mask

Selection :

Step 1 – Threshold on reflectance for 1,6 microns.
Pixels of the histogram sub-image corresponding to reflectance smaller than R16_min are considered as wet surfaces, so conditions that are inappropriate for calibration.
In this case, +1 must be added to the cloud mask value.

Step 2 – Computation of the spatial variability –
The spatial variability is defined by difference (maximum - minimum) over all 4x4km² bins inside the histogram sub-image. This variability is computed for reflectance at 1,6 microns and brightness temperatures at 11 and 12 microns.

Step 3 – Threshold on the relative variability
The relative variability is defined as the ratio of the variability computed on step 2 to the corresponding value of the pixel (i.e. reflectance for 1.6 micron and brightness temperatures for BT11 and BT12).
If the relative variability for BT_11 is greater than BT11var_max, then the pixels is considered as cloudy. In this case, +2 must be added to the cloud mask value.
If the relative variability for BT_12 is greater than BT12var_max, then the pixels is considered as cloudy. In this case, +4 must be added to the cloud mask value.
If the relative variability for V16 is greater than V16var_max, or V22 is greater than V22var_max then the pixels is considered as cloudy. In this case, +8 must be added to the cloud mask value.
This test is made for all the pixels of the histogram sub-image.



Example of histogram elaborated on a 320x512km² sub-image.

Step 4 – Brightness temperature histogram
This test is made considering all pixels of the sub-image histogram that passed successfully the previous selections, so pixels for which the cloud mask value is still the zero value.
First, a histogram is constructed over the histogram constructed over the sub-image for brightness temperature BT_12. The bin size is Histo_Bin_size (0.5°K), minimum value is 250°K, and maximum value is 325°K (all defined as parameters). An example is provided in the upper figure.

Find the maximum temperature Tmax in the sub-image.
Find the peak temperature Tpeak corresponding to the temperature with the maximum occurrence.
Compute the minimum temperature Tmin defined as 2xTpeak-Tmax
For all pixels of the considered desert site inside the sub-image, all brightness temperature BT_12 lower than Tmin are considered as clouds.
In this case, +16 must be added to the cloud mask value of this pixel.

Step 5 – Cirrus band from L1
If Cirrus_L1 is activated, the cirrus cloud mask which uses band 1.37microns is extracted from the level-1 cloud mask (1.375 micron threshold test on L1b). If a cirrus (or cloud) is detected from this mask, the pixel is considered as cloudy.

Step ~~5~~ 6 – Cloud mask reduction
The cloud mask elaborated for the sub-image is reduced to the desert site.

Step ~~6~~ 7 –Optional Dual view
This step is activated if the corresponding switch Dual_view is set to 1 (in a nominal case, Dual_view will be set to 0).
In this case, every ground pixel observed by both nadir and forward views will be considered as clear only if no cloud has been detected for the 2 different views. In this condition, both views will be selected as non-cloudy.
For pixel not observed by both views, this test will not be considered.

6.6. STATISTICS COMPUTATION

Parameters :
- Pmin - Minimum percentage of available (non-cloudy and valid) pixels (initial 90%)

For OLCI and SLSTR, the mean radiometry will be computed only if the percentage of non-cloudy pixels is greater or equal to Pmin (roughly 90%). The percentage is computed using the total cloud mask as well as validity mask.
Of course, in this case the mean value must be computed considering only valid and non-cloudy pixels of the considered site. The percentage of non-cloudy/invalid pixels will be reported.

~~For each spectral band~~The following mean radiometry will be provided~~,~~ :
- the mean reflectance (i.e. normalized radiance / cos(SZA)) for OLCI and SLSTR reflective bands~~,~~
- the mean brightness temperature for SLSTR thermal bands

These mean values are associated with their respective standard-deviation, minimum and maximum values computed over the site

The following information will be added :
- Geographical coordinate of the measurement (so the desert site)
- Coordinate, line/column, inside the product
- Viewing angles : VZA, VAA
- Solar angles : SZA, SAA
-

For OLCI, the coordinate of the detector inside the instrument (i.e. detector number and camera number) will be saved on a comment field. The exact coordinate is not required, but a value sufficiently representative to allow further analysis with viewing angle.

For SLSTR, both detectors of SWIR bands (A-stripe and B-stripe) will be considered separately as two different bands. Temperatures of the focal plane and optics will be saved on a comment field. In addition, one statistics is computed for each of the 2 viewing angles. The identifier of the corresponding viewing angle (nadir or oblique) will be kept on a comment field for easy identification.

6.7. ANCILLARY DATA

For each desert sites and date, ancillary data have to be added.

The source of data is ECMWF operational forecasts or analysis fields that can be extracted from the Meteorological Parameters Auxiliary Dataset part of level-1 products (see DR7-10).

Ozone (TCO3), total column water vapor (TCWV) and surface pressure (SP) are the fields of interest. If this is not the case (i.e. mean sea level pressure), the pressure has to be converted into a surface pressure at the altitude of the desert site.

Regarding the accuracy of these ancillary data, it is not required to compute the mean value over all each site. A simple tri-linear interpolation with latitude, longitude, then time, will be performed if necessary to derive the content corresponding to the center of the desert site and the exact time.

7. DATA SELECTION OVER OCEANIC SITES - RAYLEIGH

7.1. INTRODUCTION

In this section, the main activity will be to select measurements, pixel by pixel, regarding their geographical and geophysical conditions. The processing will be made at a full spatial resolution, but nevertheless, a last step of under-sampling will be performed in order to limit the amount of data.

7.2. PRODUCT SELECTION

Six main oceanic sites are considered as operational sites. They are defined as rectangular areas in latitude/longitude and their 4 corners are provided in Appendix.

Because their size are large and in order to limit the volume of product to be processed, it will be necessary to define a selection area, smaller than the oceanic site. A product will be selected for processing only if an intersection of a minimum of Nmin_selarea_ray pixels is found with the selection area. This strategy will discard product associated with a very limited region of interest, and so only select product with a significant useful area.

Selection area corresponding to each oceanic site will be defined in configuration files.

<u>General parameters for Rayleigh :</u>

- Latitude and longitude of the 4 corners of the site
- Associated latitude and longitude of selection area for Rayleigh
- Nmin_selarea_ray – Minimum number of pixel inside the area

7.3. GENERIC PREPROCESSING

This section includes the 2 first steps described in section 6.3 :

- extraction of geometrical/geographical information
- scaling factors

The following additional steps are necessary :

<u>Conversion to Normalized Radiance</u> – For all reflective OLCI&SLSTR bands, radiances are normalized by the solar irradiance corresponding to each pixel/band in order to derive normalized radiances. In-band solar irradiances (or solar flux) are provided into the General Information Data File (see DR7)

<u>Geographical selection</u> – The first step is to identify for each pixel of a given image, previously selected regarding section 7.2, the corresponding oceanic site. All the pixels located inside a site have to be selected.

<u>Meteorological information</u> – The surface wind speed will be used for selection and has to be extracted from level-1. This parameter is found on the wind field in the Meteorological Auxiliary Dataset.

7.4. SELECTION FOR OLCI

The pixel selection for OLCI relies on the use of various thresholds on geometry and radiometry for reflective bands. In general, OLCI RR products will be processed.

7.4.1. SPECIFIC PREPROCESSING

Parameters :

- Mask_MDSR_O – mask to be applied to the quality index MDSR for OLCI

Quality index – A quality mask has to be initialized to the zero value for each pixel. Pixel corresponding to degraded level-1 quality must be identified. This test is based on the comparison of the quality index from level-1 (MDS exception flag_masks equivalent to the MDS(16) for MERIS - TBC) with the quality index mask Mask_MDSR_O for OLCI. When a pixel is considered as doubtful or saturated, the quality mask is assigned to the 1 value.

Unselect mask initialization – An unselect mask has to be initialized to the zero value for each pixel. It is not managed for each pixel which one of the test will pass or not. The selection mask value will be assigned to 1 if at least one of the test is not satisfied. Nevertheless, a selection pixel counter has to be generated for each test and incremented each time a pixel is identified as unselected.

7.4.2. CLOUD AND LAND DETECTION

Parameters :

- Ncoast – Minimum distance from the coast
- Ncloud – Minimum distance from a cloud
- Mask_cld_ray_O – mask to consider for the ASD cloud mask for OLCI

Selection :

Step 1 – Threshold on distance from a coast. For each pixel, the land/sea mask provided by the flag_masks on the confidence field of the Global flags ADS (TBC) is analyzed for every pixel inside a (2Ncoast+1)x(2Ncoast+1) square around the pixel. If one of the pixels inside the square is identified as land, the central pixel of the square has to be rejected. In this case, the unselect mask is assigned to 1 and the test counter is incremented.

Step 2 – Threshold on distance from a cloud. For each pixel, the cloud mask provided by the flag_mask on the cloud field of the Global flags ADS is analyzed for every pixel inside a (2Ncloud+1)x(2Ncloud+1) square around the pixel. This mask is compared to the parameter Mask_cld_ray_O in order to identify clouds. If one of the pixels inside the square is identified as cloud, the central pixel of the square has to be rejected. In this case, the unselect mask is assigned to 1 and the test counter is incremented.

7.4.3. DETECTION OF TURBID SITUATIONS

The goal is to discard situations for which it is identified an atmospheric turbidity, and inappropriate surface conditions regarding whitecaps (foam).

Parameters :

- SWS_max – Maximum threshold on the surface wind speed
- Tau_aero_max – Maximum threshold on the aerosol optical thickness in the NIR_band

- NIR_band – spectral band to consider for the aerosol optical thickness
- aNIR, bNIR – parameters for the molecular phase function
- tau_NIR – molecular optical thickness for the NIR_band
- Pa_NIR(SCA) – Phase function for the NIR_band as a function of the scattering angle

Selection :

Step 1 – Threshold on the surface wind speed. A pixel corresponding to a surface wind speed larger than SWS_max is considered as potentially perturbed by whitecaps. In this case, the unselect mask for this pixel is assigned to 1, and the test counter is incremented.

Step 2 – Computation of the aerosol optical thickness. This evaluation is made considering the NIR_band and assuming a single scattering approach. This approximation is sufficient for this selection step (of course not for calibration).

The scattering angle, SCA, is computed using viewing and solar zenith angles, and relative azimuth angle.

The approximated molecular normalized radiance is computed using tau_NIR, aNIR, b_NIR and the single scattering approximation.

$$CI\_NIR = tau\_NIR * (aNIR + bNIR.\cos^2(SCA)) / 4 \cos(VZA)$$

The typical aerosol optical thickness is evaluated using the measured normalized radiance in the NIR_band, MI_NIR, by

$$Taot\_NIR = (MI\_NIR – CI\_NIR) \times 4. \times \cos(VZA) / Pa\_NIR(SCA)$$

A pixel corresponding to typical aerosol optical thickness Taot_NIR greater than the threshold Tau_aero_max is considered as turbid. In this case, the unselect mask for this pixel is assigned to 1, and the test counter is incremented.

Note : this classification as “turbid pixel” is general and may include aerosol event, undetected or sub-pixel clouds, oceanic turbidity or blooms, unpredicted surface foam…

7.4.4. GEOMETRICAL SELECTION

In order to discard measurements that may be perturbed by sunglint, a geometrical selection based on the wave angle is made.

Parameters :

- wa_0_ray – minimum wave angle

Selection :

Step 1 – Computation of the wave angle (see also DR4).

The half-angle i between the specular direction and the current viewing direction is defined by

$$i = 0.5 \arccos[\cos(SZA)\cos(VZA) + \sin(SZA)\sin(VZA)\cos(SAA-VZA)]$$

The wave angle is defined by

$$wa = \arccos[(\cos(SZA) + \cos(VZA)) / (2\cos(i))]$$

Step 2 – Threshold on the wave angle. A pixel corresponding to a wave angle less than wa_0_ray is considered as potentially perturbed by sunglint. In this case, the unselect mask is assigned to 1, and the test counter is incremented.

Note : a flag_mask from ADS could have been used, but the previously described formulation is proposed in order to keep the same generic approach than the one historically applied for various sensors. In addition, this is a step that will also be used for sunglint selection (see section 8).

7.5. SELECTION FOR SLSTR

The pixel selection for SLSTR relies on the use of various thresholds on geometry and radiometry for reflective bands.

7.5.1. SPECIFIC PREPROCESSING

Parameters :

- Mask_MDSR_S – mask to be applied to the quality index MDSR for SLSTR
- Val_neg_RAY - value replacing negative radiometry for VIS/SWIR bands

Quality index – A quality mask has to be initialized to the zero value for each pixel. Pixel corresponding to degraded level-1 quality must be identified. This test is based on the comparison of the quality index from level-1 (MDS exception flag_masks - TBC) with the quality index mask Mask_MDSR_S for SLSTR. When a pixel is considered as doubtful or saturated, the quality mask is assigned to the 1 value.

Unselect mask initialization – An unselect mask has to be initialized to the zero value for each pixel. It is not managed for each pixel which one of the test will pass or not. The selection mask value will be assigned to 1 if at least one of the test is not satisfied. Nevertheless, a selection pixel counter has to be generated for each test and incremented each time a pixel is identified as unselected.

Data validity check – This preprocessing step controls the validity of data regarding :

- All negative values for VIS/SWIR channels are set to Val_neg_RAY value (zero)

7.5.2. CLOUD AND LAND DETECTION

Parameters :

- Ncoast – Minimum distance from the coast
- Ncloud – Minimum distance from a cloud
- Mask_cld_ray_S – mask to consider for the ASD cloud mask for SLSTR

Selection :

Step 1 – Threshold on distance from a coast. For each pixel, the land/sea mask provided by the flag_masks on the confidence field of the Global flags ADS (TBC) is analyzed for every pixel inside a (2Ncoast+1)x(2Ncoast+1) square around the pixel. If one of the pixels inside the square is identified as land, the central pixel of the square has to be rejected. In this case, the unselect mask is assigned to 1 and the test counter is incremented.

Step 2 – Threshold on distance from a cloud. For each pixel, the cloud mask provided by the flag_mask on the cloud field of the Global flags ADS is analyzed for every pixel inside a (2Ncloud+1)x(2Ncloud+1) square around the pixel. This mask is compared to the parameter Mask_cld_ray_S in order to identify clouds (mainly based on TIR band tests). If one of the pixels inside the square is identified as cloud, the central pixel of the square has to be rejected. In this case, the unselect mask is assigned to 1 and the test counter is incremented.

7.5.3. PIXEL SELECTION

The two following steps defined for OLCI have to be implemented for SLSTR independently for both viewing directions:

- Detection of turbid situations (see section 7.4.3)
- Geometrical selection (see section 7.4.4)

Note that there is no use of thermal bands.

7.6. STATISTICS COMPUTATION

Parameter :

- Npix_O, Npix_S : Number of pixels for the sub-sampling for OLCI & SLSTR resp.

This statistic computation is made for all pixels every Npix pixels included in the geographical area. For all these pixels, the vicinity is defined by a Npix x Npix area around the pixel.

The pixel is discarded if one of the pixel inside the Npix x Npix box has its unselect mask value equal to 1. If selected, the mean normalized radiance and its standard deviation are computed inside the Npix x Npix box.

For each spectral band, the mean normalized radiance (for reflective bands) or mean brightness temperature (for TIR bands), as well as the associated standard-deviation over the Npix x Npix box, are saved.

The following information will be added :

- Geographical coordinate of the measurement (so the desert site)
- Coordinate, line/column, inside the product
- Viewing angles : VZA, VAA
- Solar angles : SZA, SAA
- Coordinate of the detector inside the instrument (detector number, camera)

For SLSTR, one statistics is computed for each of the 2 viewing angles.

7.7. ANCILLARY DATA

For each selected measurements, ancillary data will be added.
The source of data is the same as section 6.7.
In addition to ozone, total column water and surface pressure, the surface wind speed is required.
Ancillary data will be provided for every selected sub-sampled pixel.

8. DATA SELECTION OVER OCEANIC SITES – SUNGLINT

8.1. INTRODUCTION

In this section, the main activity will be to select measurements, pixel by pixel, regarding their geographical, geometrical, and geophysical conditions. The processing will be made at a full spatial resolution, but nevertheless, a last step of under-sampling will be performed in order to limit the amount of data.

8.2. PRODUCT SELECTION

The product selection will be made in exactly the same way as for Rayleigh selection described in section 7.2. Nevertheless, it is required to define the selection area with specific parameters because sunglint is distributed in a specific geometry (specular direction) and is more limited in term of coverage.

As for section 7.2, a product will be selected for sunglint processing only if an intersection of a minimum of Nmin_selarea_sun pixels is found with the selection area.

General parameters for Sunglint :

- Latitude and longitude of the 4 corners of the site
- Associated latitude and longitude of selection area for Sunglint
- Nmin_selarea_gli – Minimum number of pixel inside the area

8.3. GENERIC PREPROCESSING

This section is similar to section 7.3 and includes 5 steps :

- extraction of geometrical/geographical information
- scaling factors
- conversion to normalized radiance
- geographical selection
- meteorological information

8.4. SELECTION FOR OLCI

The pixel selection for OLCI relies on the use of various thresholds on geometry and radiometry for reflective bands. In general, OLCI RR products will be processed.

8.4.1. SPECIFIC PREPROCESSING

This data preprocessing is identical to section 7.4.1 (Rayleigh) and includes :

- Quality index
- Unselected mask initialization

8.4.2. CLOUD AND LAND DETECTION

Parameters :

- Ncoast – Minimum distance from the coast
- Ncloud – Minimum distance from a cloud
- Mask_cld_gli_O – mask to consider for the ASD cloud mask for OLCI

The detection of land and clouds is made similarly to section 7.4.2 (for Rayleigh).
It is probable that the OLCI cloud mask will be inaccurate over bright sunglint. In this case, the Mask_cld_gli_O will be adapted (relaxed) in order to inhibit this selection.

8.4.3. GEOMETRICAL SELECTION

Parameters :

- wa_0_sun – maximum wave angle

In order to select measurements that are geometrically in the sunglint direction, a geometrical selection based on the wave angle is made.
The wave angle is defined similarly to section 7.4.4.
A pixel corresponding to a wave angle greater than wa_0_sun is considered as out of the sunglint. In this case, the unselect mask is assigned to 1, and the test counter is incremented.

8.4.4. DETECTION OF TURBID SITUATIONS

No detection of turbid situation can be done in this case.
A further development could be to use the dual view from SLSTR to identify turbid situation using the out-of-glint view.

8.4.5. ADDITIONAL CLOUD DETECTION

Parameters :

- SB_spauni – Spectral band to consider for the spatial uniformity test
- Nloc – Number of pixel defined the half-size of the window
- Loc_Rstdev_max – Maximum threshold of the relative spatial homogeneity
- Papp_min – Minimum threshold on the apparent pressure

Selection :

Step 1 – Threshold on the spatial homogeneity.

For the spectral band SB_spauni (band 865 or equivalent), the relative spatial homogeneity is computed. For that, the mean value of the normalized radiance and its standard deviation is computed over a (2Nloc+1)x(2Nlox+1) box around the considered pixel. The relative spatial homogeneity is defined by the ratio standard deviation by mean value.
A pixel corresponding to a relative spatial homogeneity greater than Loc_Rstdev_max is considered as probably clouds. In this case, the unselect mask is assigned to 1 and the test counter is incremented.

Step 2 – Threshold on the apparent pressure.

First, the apparent pressure is computed according the MERIS level-2 algorithm (ODESA/MEGS) or the corresponding algorithm for OLCI (TBD).
A pixel corresponding to an apparent pressure smaller than Papp_min is considered as probably cloudy. In this case, the unselect mask is assigned to 1 and the test counter is

incremented.

8.4.6. RADIANCE LEVEL

Parameters :
- SB_normrad – Spectral band to consider for the normalized radiance tests
- S_NR_min – Minimum threshold on the normalized radiance
- S_R_max – Maximum threshold on the reflectance

Selection :

Step 1 – Threshold on the normalized radiance. A pixel corresponding to a normalized radiance in the SN_normrad spectral band (NIR band) smaller than S_NR_min is considered as not appropriate for calibration regarding the sensitivity to noise. In this case, the unselect mask is assigned to 1 and the test counter is incremented.

Step 2 – Threshold on the reflectance. A pixel corresponding to a reflectance in the SN_normrad spectral band (NIR band) greater than S_R_max is considered as probably cloudy. In this case, the unselect mask is assigned to 1 and the test counter is incremented.

8.5. SELECTION FOR SLSTR

8.5.1. SPECIFIC PREPROCESSING

This data preprocessing is identical to section 7.5.1 (Rayleigh) and includes :
- Quality index
- Unselected mask initialization
- Data validity check (with parameter Val_neg_GLI)

8.5.2. CLOUD AND LAND DETECTION

Parameters :
- Ncoast – Minimum distance from the coast
- Ncloud – Minimum distance from a cloud
- Mask_cld_gli_S – mask to consider for the ASD cloud mask for SLSTR

The detection of land and clouds is made similarly to section 7.5.2 (for Rayleigh). Especially, the 1.375 micron threshold test of level-1b will be considered.

8.5.3. GEOMETRICAL SELECTION

The selection based on wave angle is similar the one defined for OLCI in section 8.4.3.

8.5.4. DETECTION OF TURBID SITUATIONS

Parameters :
- Activate_dual_gli – activate the dual view option for detection of turbid situations
- Tau_aero_max – Maximum threshold on the aerosol optical thickness in the NIR_band

Depending on the Activate_dual_gli flag, this optional step is activated.
The idea is that, when one viewing direction (nadir or forward) observed the sunglint, the other one doesn't. Consequently, this second viewing direction, called out-of-glint direction, can be used in order to identify turbid situation as it was described in section 6.4.3 (step2).
The detection described in section 6.4.3-step2 is applied to every pixel in the sunglint and if the corresponding out-of-glint direction is available.

8.5.5. SPATIAL HOMOGENEITY

Parameters :

- SB_spauni – Spectral band to consider for the spatial uniformity test
- Nloc – Number of pixel defined the half-size of the window
- Loc_Rstdev_max – Maximum threshold of the relative spatial homogeneity

For the spectral band SB_spauni (band 865 or equivalent), the relative spatial homogeneity is computed. For that, the mean value of the normalized radiance and its standard deviation is computed over a (2Nloc+1)x(2Nlox+1) box around the considered pixel. The relative spatial homogeneity is defined by the ratio standard deviation by mean value.
A pixel corresponding to a relative spatial homogeneity greater than Loc_Rstdev_max is considered as probably clouds. In this case, the unselect mask is assigned to 1 and the test counter is incremented.

8.5.6. RADIANCE LEVEL

The selection based on a maximum on the reflectance and a minimum on the normalized radiance is similar the one defined for OLCI in section 8.4.6.

8.6. STATISTICS COMPUTATION

The statistics computation is exactly the same than for Rayleigh scattering method in section 7.6.
For SLSTR, only one viewing angle will be available.

8.7. ANCILLARY DATA

Same section than for Rayleigh scattering method in section 7.7.

9. DATA SELECTION OVER SNOWY SITES

9.1. INTRODUCTION

The basic approach is to compute the mean radiometry over each of the snowy sites after a cloud filtering defined as precise as possible.

9.2. PRODUCT SELECTION

The snowy sites are defined by their 4 corners. The site is not necessarily a rectangular shape in latitude and longitude. Their size is approximately 90x90km². All the OLCI and SLSTR products that view one site will be processed. Most of the time, one single product will view several snowy sites (for Antarctica).

General parameters for snowy sites :

- Latitude and longitude of the 4 corners of the site

9.3. GENERIC PREPROCESSING

This section is identical to the generic preprocessing for desert sites described in section 6.3. This preprocessing includes 3 steps :

- Extraction of geometrical/geographical information
- Scaling factors
- Normalization to reflectance

9.4. SELECTION FOR OLCI

The pixel selection for OLCI relies on the use of threshold on radiometry for reflective bands.

9.4.1. SPECIFIC PREPROCESSING

This section is identical to the specific preprocessing for desert sites described in section 6.4.1. This preprocessing includes 3 steps :

- Geographical selection
- Quality index
- Cloud mask initialization

9.4.2. CLOUD DETECTION

Parameters :

- Blue_SpecBd – Blue spectral band to be used for thresholds (initial 443nm)
- rBluemax – Maximum threshold reflectance for Blue_SpecBd
- SvarB – Maximum threshold on local variability at Blue_SpecBd
- N_varB – Size of the spatial window for the Blue_SpecBd
- NIR_SpecBd – NIR spectral band to be used for thresholds (initial 865nm)
- SvarNIR – Maximum threshold on local variability at NIR_SpecBd
- N_varNIR – Size of the spatial window for the NIR_SpecBd

Selection :

Step 1 - Threshold on the Blue TOA reflectance. A pixel corresponding to reflectance for the Blue_SpecBd band brighter than rBluemax is considered as cloudy. In this case, the cloud mask for this pixel is assigned to 1, and the test counter is incremented.

Step 2 – Threshold on relative spatial variability in the blue –The spatial relative variability is computed for band Blue_SpecBd on a spatial window of N_varB by N_varB size. For the window, the relative variability is defined as the ratio standard deviation to mean values. A pixel corresponding to relative variation larger than SvarB is considered as cloudy. This criterion is efficient for the detection of large cloud structures. In this case, the cloud mask for this pixel is assigned to 1, and the test counter is incremented.

Step 3 – Threshold on relative spatial variability in the near infrared –The spatial relative variability is computed for band NIR_SpecBd on a spatial window of N_varNIR by N_varNIR size. For the window, the relative variability is defined as the ratio standard deviation to mean values. A pixel corresponding to relative variation larger than SvarNIR is considered as cloudy. This criterion is efficient for the detection of small clouds and cloud edges. In this case, the cloud mask for this pixel is assigned to 1, and the test counter is incremented.

9.5. SELECTION FOR SLSTR

The pixel selection for SLSTR uses not only the radiometry for reflective bands, but information from thermal bands is precious to improve the selection.

9.5.1. Specific preprocessing

This data preprocessing is identical to section 6.5.1 (Desert as if parameters are in general not identical) and includes :

- Identification of snowy sites
- Histogram sub-image
- Geographical selection
- Cloud mask initialization
- Data validity check

9.5.2. Data validity checkCloud and Land detection

Parameters :

- BT12var_max – Maximum relative variation of brightness temperature in TIR channel at 12 microns (initial 0.5)
- V87var_max – Maximum relative variation of reflectance in SWIR channel at 0,87 microns (initial 1.0)
- R16_min – Minimum reflectance in SWIR channel at 1.6 microns (initial 20%)
- R22_min – Minimum reflectance in SWIR channel at 2.2 microns (initial 20%)
- Dual_view – Optional activation of the dual_view cloud mask (initial 0)
- Histo_Bin_size – Size of the bin to consider for the histogram construction (initial 0.5°K)
- Cirrus_L1 – activate the consideration of level-1 cirrus cloud mask

Selection :

Step 1 – Threshold on reflectance for ~~1,6 microns~~SWIR bands.
Pixels of the histogram sub-image corresponding to reflectance at 1.6microns smaller than

R16_min or reflectance at 2.2 microns smaller than R22_min are considered as ~~wet surf~~not snowy surfaces, so conditions that are inappropriate for calibration.
In this case, +8 must be added to the cloud mask value.

Step 2 – Computation of the spatial variability –
The spatial variability is defined by difference (maximum - minimum) over all 4x4km² bins inside the histogram sub-image. This variability is computed for reflectance at 0,87 microns and brightness temperatures at 12 microns.

Step 3 – Threshold on the spatial variability.
Note : contrarily to selection over desert sites, this threshold is made on the spatial variability and not the relative spatial variability.
If the relative variability for BT_12 is greater than BT12var_max, then the pixels is considered as cloudy. In this case, +2 must be added to the cloud mask value.
If the relative variability for V87 is greater than V87var_max, then the pixels is considered as cloudy. In this case, +4 must be added to the cloud mask value.
This test is made for all the pixels of the histogram sub-image.

Step 4 – Brightness temperature histogram
This test is made considering all pixels of the sub-image histogram that passed successfully the previous selections, so pixels for which the cloud mask value is still the zero value.
First, a histogram is constructed over the histogram constructed over the sub-image for brightness temperature BT_12. The bin size is Histo_Bin_size (0.5°K), minimum value is 250°K, and maximum value is 325°K (all defined as parameters). An example is provided in the upper figure.
Find the peak temperature Tpeak corresponding to the temperature with the maximum occurrence.
For all pixels of the considered snowy site inside the sub-image, all brightness temperature BT_12 lower than Tpeak are considered as clouds.
In this case, +16 must be added to the cloud mask value of this pixel.

Step 5 – Cirrus band from L1
If Cirrus_L1 is activated, the cirrus cloud mask which uses band 1.37microns is extracted from the level-1 cloud mask (1.375 micron threshold test on L1b). If a cirrus (or cloud) is detected from this mask, the pixel is considered as cloudy

9.6. STATISTICS COMPUTATION

This section is identical to the statistics computation for desert sites described in section 6.6. It includes :

- The rejection of the site if less than Pmin % of pixels are cloudy or invalid
- For OLCI and SLSTR reflective bands : computation of the mean reflectance, standard deviation, min and max values over the remaining pixels
- For SLSTR thermal bands : computation of the mean brightness temperature, standard deviation, min and max values over the remaining pixels
- Addition of ancillary information : viewing/solar geometries, geographic coordinates, position inside the instrument

9.7. ANCILLARY DATA

For each snow sites and date, ancillary data have to be added.
This section is similar to section 6.7 for desert sites.

10. INPUT DATA

Inputs data are SLSTR and OLCI level-1B input data. Reduced Resolution (RR) ~~data is~~products are the standard inputs.

Full-Resolution (FR) data ~~can~~ could be an alternative input but will not be considered in this version of S3ETRAC.

OLCI level-1B input data..
OLCI&SLSTR Level-1C input data ~~can~~ could also be an option by taking advantage of the synergy between instrument (higher spatial resolution for MERIS and TIR bands + directionality for SLSTR) in order to improve the cloud masking. The use of Level-1C product is not considered in this version of S3ETRAC.

11. OUTPUT DATA

Trace files, including the number of rejected pixels for each threshold, have to be generated.

The output of the software will be a single netCDF file per site and per overpass. The NetCDF4 format is proposed as a baseline and has to be fully backwards compatible with the older Version 3 format.
A typical file structure is proposed in Appendix-II as a template and could be adapted as needed.

The proposed naming convention of netCDF files is as follows :
<type>_XXXZZ_S3ETRAC_<site>_YYYYMMDD_HHMMSS_VV.nc

where
<type> : 3 characters method type [DES, DOM, RAY, GLI]
XXX : 4 or 5 characters instrument code [SLSTR, OLCI]
ZZ : 3 characters satellite code [S3A, S3B]
<site> : name of the geographical site
YYYYMMDD : year, month and day of the acquisition
HHMMSS : hour, minute and second of the acquisition
VV : version of the processing (L1B or S3ETRAC)

12. APPENDIX I – GEOGRAPHICAL DEFINITION OF CALIBRATION SITES

12.1. DESERT SITES – AFRICA AND ARABIA

Regions are defined as +/-0.45° square around their geographic center.

Standard Sites	*Lat centre*	*Lon centre*	*Lat min*	*Lat max*	*Lon min*	*Lon max*	*Radiometric homogeneity*	*Brightness*
Algeria 1	23,80	-00,40	23,35	24,25	-0,85	0,05	Homogeneous	Moderate
Algeria 2	26,09	-01,38	25,64	26,54	-1,83	-0,93	Heterogeneous	Moderate
Algeria 3	30,32	07,66	29,87	30,77	7,21	8,11	Homogeneous	Moderate
Algeria 4	30,04	05,59	29,59	30,49	5,14	6,04	Heterogeneous	Moderate
Algeria 5	31,02	02,23	30,57	31,47	1,78	2,68	Homogeneous	Moderate
Arabia 1	18,88	46,76	18,43	19,33	46,31	47,21	Homogeneous	Moderate
Arabia 2	20,13	50,96	19,68	20,58	50,51	51,41	Homogeneous	Bright
Arabia 3	28,92	43,73	28,47	29,37	43,28	44,18	Heterogeneous	Bright
Egypt 1	27,12	26,10	26,67	27,57	25,65	26,55	Homogeneous	Bright
Libya 1	24,42	13,35	23,97	24,87	12,90	13,80	Homogeneous	Moderate
Libya 2	25,05	20,48	24,60	25,50	20,03	20,93	Heterogeneous	Bright
Libya 3	23,15	23,10	22,70	23,60	22,65	23,55	Heterogeneous	Moderate
Libya 4	28,55	23,39	28,10	29,00	22,94	23,84	Homogeneous	Bright
Mali 1	19,12	-04,85	18,67	19,57	-5,30	-4,40	Homogeneous	Bright
Mauritania 1	19,40	-09,30	18,95	19,85	-9,75	-8,85	Homogeneous	Moderate
Mauritania 2	20,85	-08,78	20,40	21,30	-9,23	-8,33	Homogeneous	Moderate
Niger 1	19,67	09,81	19,22	20,12	9,36	10,26	Heterogeneous	Bright
Niger 2	21,37	10,59	20,92	21,82	10,14	11,04	Homogeneous	Moderate
Niger 3	21,57	07,96	21,12	22,02	7,51	8,41	Heterogeneous	Moderate
Sudan 1	21,74	28,22	21,29	22,19	27,77	28,67	Homogeneous	Bright

12.2. OCEANIC SITES

Regions are defined by rectangular areas in latitude/longitude. These sites are applicable for absolute over Rayleigh scattering and interband calibration over sunglint.

n°	Name	Location	Sub-areas	Latitude min	Latitude max	Longitude min	Longitude max
0	PacSE	South-East of Pacific	8	-44.9	-20.7	-130.2	-89.0
1	PacNW	North-West of Pacific	4	10.0	22.7	139.5	165.6
2	PacN	North of Pacific	3	15.0	23.5	179.4	200.6
3	AtlN	North of Atlantic	3	17.0	27.0	-62.5	-44.2
4	AtlS	South of Atlantic	5	-19.9	-9.9	-32.3	-11.0
5	IndS	South of Indian	1	-29.9	-21.2	89.5	100.1

12.3. SNOW SITES – DOMES IN ANTARCTICA

Regions are defined in latitude/longitude by their four corners.

Antarctica	Dome 1		Dome 2		Dome C		Dome 3	
	Lat	***Lon***	***Lat***	***Lon***	***Lat***	***Lon***	***Lat***	***Lon***
Centre	-78,5933	120,2648	-75,7431	113,7356	-75,1017	123,3950	-77,3825	128,715
TL corner	-79,3323	119,1764	-76,4406	112,512	-75,8412	122,7243	-78,1391	128,3009
TR corner	-78,3933	116,6047	-76,0015	116,5486	-74,9425	120,5312	-77,2901	125,3167
BR corner	-77,8808	121,1238	-75,0498	114,7224	-74,3807	123,8996	-76,6499	129,0565
BL corner	-78,7758	123,9443	-75,459	110,9032	-75,2435	126,209	-77,4542	132,1304

13. APPENDIX II – PROPOSED STRUCTURE FOR OUTPUT NETCDF FILES

The following structure is proposed for netDCF Output files.

Element name	Description	Unit	Type	Dimens
dataset	Open container			
dimensions	Open container			
n_chan	Number of instrument channels	-		11
n_view	Number of views (Nadir or forward)	-		2
dimensions	Close container			
attributes (global)	Open container			
Title	Title of extraction			
Filename	Name of Netcdf file	dl	st	1
Tool	Name of Cal-Val Tool	dl	st	1
Supplier	Name of supplier	dl	St	1
Version	Version number of tool	dl	st	1
Proc_Time	Time this file was generated	dl	st	1
Reference_Doc	Reference to data extraction procedure	dl	st	1
Sensor	Name of Sensor	dl	St	1
Platform	Platform on which sensor is mounted	dl	st	1
L1b_product	Filename of L1b product used	-	st	1
Software_version	L1b processing version from MPH	-	st	1
Time	Time at test site	-	st	1
Sensing_start_time	Sensing start time from MPH	-	st	1
Sensing_stop_time	Sensing stop time from MPH	-	st	1
L1B_Proc_time	Processing time from MPH		st	
Viscal ADS	Reference to calibration file used		st	1
Vicarious calibration ADS	Reference to calibration file containing drift corrections used		st	1
Site_name	Name of test site	-	st	1
Site_Description	Short description of test site			
Site_type	Desert, snow etc	-	St	1
Site__NE_Lat	Lat coordinate of NE corner of site	Degrees north	St	1
Site__NW_Lat	Lat coordinate of NW corner of site	Degrees north	St	1
Site__SE_Lat	Lat coordinate of SE corner of site	Degrees north	St	1
Site__SW_Lat	Lat coordinate of SW corner of site	Degrees north	St	1
Site__NE_Lon	Lon coordinate of NE corner of site	Degrees east	St	1
Site__NW_Lon	Lon coordinate of NW corner of site	Degrees east	St	1
Site__SE_Lon	Lon coordinate of SE corner of site	Degrees east	St	1
Site__SW_Lon	Lon coordinate of SW corner of site	Degrees east	St	1
attributes (global)	Close container			

variable	Open container			
Wavelength	Channel wavelength	nm	fl	n_chan*n_view
attributes	Open container			
units	Variable – “nm”		st	
Variable	Units– “Nominal channel wavelength”		st	
attributes	Close container			
variable	Close container			

variable	Open container			
Band Name	Band ID number/name for channel		ch	n_chan*n_view
variable	Close container			

variable	Open container			
Radiometric Units	Radiometric Units for given channel – eg.	Dl	ch	n_chan*n_

	“%”, “K” or “$Wm^{-2}sr^{-1}nm^{-1}$”			view
variable	Close container			

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variable	Open container			
N_pixels	Number of cloud-free pixels over site	dl	ul	n_chan*n_ view
Attributes	Open container			
Variable	Variable – “Number of cloud-free pixels over site”			
attributes	Close container			
variable	Close container			

variable	Open container			
N_site	Total number of pixels over site	dl	ul	n_chan*n_ view
Attributes	Open container			
Variable	Variable	Total number of pixels over site		
attributes	Close container			
variable	Close container			

variable	Open container			
N_valid	Number of valid pixels in site for channel – dependent on range in	dl	ul	n_chan*n_ view
Attributes	Open container			
Variable	Variable – “Number of valid pixels”			
attributes	Close container			
variable	Close container			

variable	Open container			
Cloud_fraction	Cloud fraction over site	“%”	db	n_view
Attributes	Open container			
Variable	Variable – “Cloud fraction”		st	1
attributes	Close container			
variable	Close container			

variable	Open container			
Site_Average	Average radiance/reflectance/BT value in region	“%”, “K” or “$Wm^{-2}sr^{-1}nm^{-1}$	db	n_chan*n_ view
Attributes	Open container			
Variable	Variable – “Site Average value”		st	1
attributes	Close container			
variable	Close container			

variable	Open container			
Site_stddev	Standard deviation of measurement	“%”, “K” or “$Wm^{-2}sr^{-1}nm^{-1}$	db	n_chan*n_ view
Attributes	Open container			
Variable	Variable – “Site Standard Deviation”			
attributes	Close container			
variable	Close container			

variable	Open container			
Site_Minimum	Minimum value of measurement	“%”, “K” or “$Wm^{-2}sr^{-1}nm^{-1}$	db	n_chan*n_ view
Attributes	Open container			
Variable	Variable – “Site Minimum”			
attributes	Close container			
variable	Close container			

variable	Open container			
Site_Maximum	Maximum value of measurement	“%”, “K” or “$Wm^{-2}sr^{-1}nm^{-1}$	db	n_chan*n_ view
Attributes	Open container			
Variable	Variable – “Site Maximum”			
attributes	Close container			
variable	Close container			

variable	Open container			
Mean_view_Zenith	Mean View zenith angle over site	degrees	db	n_view
Attributes	Open container			
Variable	Variable – "Mean View zenith angle over site"			
units	Units– "degrees"			
attributes	Close container			
variable	Close container			

variable	Open container			
Mean_Solar_Zenith	Mean Solar zenith angle over site	degrees	db	n_view
Attributes	Open container			
Variable	Variable – "Mean View zenith angle over site"			
units	Units– "degrees"			
attributes	Close container			
variable	Close container			

variable	Open container			
mean_view_azimuth	Mean view azimuth angle over site	degrees	db	n_view
Attributes	Open container			
Variable	Variable – ""Mean view azimuth angle over site"			
units	Units– "degrees"			
attributes	Close container			
variable	Close container			

variable	Open container			
mean_solar_azimuth	Mean Solar azimuth angle over site	degrees	db	n_view
Attributes	Open container			
Variable	Variable – "Mean Solar azimuth angle over site"			
units	Units– "degrees"			
attributes	Close container			
variable	Close container			

variable	Open container			
Ozone	ECMWF Ozone concentration	DU	db	n_view
Attributes	Open container			
Variable	Variable – "ECMWF Ozone Concentration"			
units	Units– "DU"			
attributes	Close container			
variable	Close container			

variable	Open container			
TCWV	Total Column Water Vapour	kg.m-2	db	n_view
Attributes	Open container			
Variable	Variable – "Total Column Water Vapour"			
units	Units– "kg.m-2"			
attributes	Close container			
variable	Close container			

DIFFUSION

NOM	SIGLE/SOCIETE	NB	NOM	SIGLE/SOCIETE	NB
E. Boussarie	DCT/SI		Philippe Goryl	ESA/ESRIN	
JM Laherrere	DCT/SI		Jens Nieke	ESA/ESTEC	
A. Meygret	DCT/SI/MO		Marc Bouvet	ESA/ESTEC	
B. Fougnie	DCT/SI/MO				
P. Henry	DCT/ME/OT				
F. Meunier	DCT/ME/EI				
JL Raynaud	DCT/ME/EI				
N. Picot	DCT/PO/AL				