La Agencia Espacial Argentina

SAOCOM MISSION PRODUCTS DEFINITION

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OBJECTIVE

The objective of this document is to determine de product definition for the SAOCOM mission. The document explains the instrument sensor characteristics, different levels of processing and modes of operation.

1 SCOPE

This Document contains the description of all SAOCOM Mission operative Products, including interferometric products, Soil Moisture and Strategic Applications products.

2 APPLICABLE AND REFERENCE DOCUMENTS

2.1 APLICABLE DOCUMENTS

ID	Document Code	Document Title
AD-1	SAO-MIS-RS-00002-A	L2A

2.2 REFERENCE DOCUMENTS

ID	Document Code	Document Title
RD-1	SAR-SAOD-DES-06159	Complete swath-design and performance with SIASGE compatibility analysis
RD-2	SAO-TN-ARE-PL-0003	Overall SAR performances

3 DEFINITIONS AND ABREVIATIONS

3.1 DEFINITIONS

The following definitions shall be considered for the present document:

Internal calibration: The process of characterizing the system using onboard calibration loops and satellite telemetry data.
External calibration: The process of calibrating SAR data using only image parameters.
Beam: A radiation pattern defined by the configuration in phase and attenuation of the 140 MTR.
Mode: An operational configuration defined by beams selection, polarization.
Quad-pol: Operational configuration where the sensor transmits in the two polarizations sequentially and receives in both simultaneously resulting in HH, HV, VH, and VV images.
Dual-pol: Operational configuration where the sensor transmits in the one polarization and receives in both simultaneously resulting in HH and HV or VH, and VV images.
Single-pol: Operational configuration where the sensor transmits in the one polarization and receives in only one polarization resulting in HH or VV images.
Stripmap: A set of operational modes where the sensor transmits and receives in one single beam through a whole acquisition.
TOPSAR: A set of operational modes where the sensor transmits and receives in different azimuth and elevation pointings in order to achieve bigger swaths sacrificing spatial resolution.
Surface Soil Moisture Product; the image of estimated soil moisture integrated at 5 cm, using soil moisture models and the SAR image.

3.2 ABBREVIATIONS AND ACRONYMS

Acronyms & Abb.	Description
DP	Dual Polarization
GCP	Ground Control Point
GK	Gauss-Kruger
IRF	Impulse Response Function
POSGAR	Posiciones Geodésicas Argentinas
PRF	Pulse Repetition Frequency
QP	Quadruple Polarization
SAR	Synthetic Aperture Radar
SP	Single Polarization
SSM	Surface Soil Moisture Product
SWST	Sampling Window Start Time
TBC	To Be Confirmed

TRM	Transmission Reception Module
UTM/UPS	Universal Transversal Mercator / Universal Polar Stereographic
XML	eXtensible Markup Language

4 SAOCOM MISSION SUMMARY

SAOCOM project is an Earth observation system, developed for the better use of remote sensing data in the optimization of socio-economical activities and scientific studies. The project includes placing into orbit two satellite constellations: SAOCOM 1 and SAOCOM 2, each constellation composed by two satellites: SAOCOM-1A and SAOCOM-1B; followed by SAOCOM-2A and SAOCOM-2B, respectively.

Each satellite provides service for a minimum of 5 years. Regarding the orbit, in both cases it is expected to obtain global coverage and a 16-days revisit for each satellite, resulting in a 8-days revisit for the constellation.

SAOCOM-1A and SAOCOM-1B share the same technical design requirements, functionality and operating capacity, so their development is been carried out simultaneously resulting in two identical satellites.

4.1 Sensor

The main instrument is an active sensor consisting in a polarimetric Synthetic Aperture Radar (SAR) operating in the L band.

The main characteristics are reported in Table 1.

Parameter	Value
Central frequency	L Band (1,275 GHz)
Observation orientation	Right looking (nominal) and left looking(for short periods)
Orbit type	Frozen orbit Quasi circular Sun-synchronous Height: ~620 km Ascending node: local time 05:57:45 am Orbit Repetition Period: 16 days for one satellite and 8 days for two satellites.
Spatial resolution	10 to 100 m
Coverage	20 to 350 km
Angle of incidence	20 to 50 degrees
Absolute radiometric accuracy	0.5 dB
Relative radiometric accuracy	0.2 dB
Polarimetric accuracy (HH to VV)	0.3 dB
Geometric accuracy	25m radial (offline delivery mode)
Polarizations	SP, DP and QP (CP technological)

Table 1: SAOCOM general characteristics

4.2 Processing products

For each one of satellite acquisition modes the foreseen processing products are reported in Table 2.

Product Name	Level	Description
Annotated Raw Data(AR)	Level-0	Formatted synchronized data obtained from binary data stream.
Single look Complex(SLC)	Level-1A	Complex data in slant range, radiometrically calibrated with no geometric corrections.
Detected Image(DI)	Level-1B	Data projected to ground range, radiometrically calibrated and georeferenced.
Ground Ellipsoid Corrected(GEC)	Level-1C	Radiometrically calibrated, geocoded and georeferenced exploiting ellipsoid.
Ground Terrain Corrected(GTC)	Level-1D	Radiometrically calibrated, geocoded and georeferenced exploiting topography.

Table 2: SAOCOM processing products

4.3 Acquisition modes

The operative working modes include STRIPMAP, TOPSAR Narrow and TOPSAR Wide modes with Single, Dual or Quad Polarization.

A graphical representation of the different modes is reported in Figure 1.

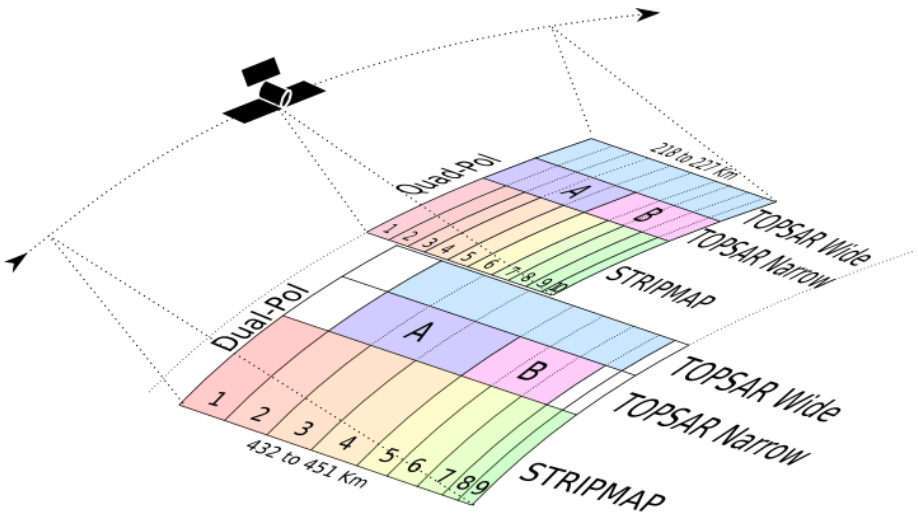

Figure 1: Acquisition modes of the SAOCOM SAR antenna.

4.3.1 Imaging mode

Imaging modes are operation configurations of the central electronics and active antenna that define the acquisition swath. This includes burst sequence, sampling window start time, TRM phase and attenuation, etc. In this document, the imaging modes described are Stripmap, TOPSAR Narrow or TOPSAR Wide.

4.3.2 Polarization mode

Polarization mode refers to the combination of polarizations present on a given product. For SAOCOM, this can either be single-pol (HH or VV), dual-pol (HH-HV or VH-VV), or quad-pol (HH-HV-VH-VV). There is also a technological mode, named

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compact-pol, consisting in transmitting in circular polarization (Right or Left) and receiving in both linear polarizations (H and V). The compact-pol shares the same specifications as single-pol and dual-pol corresponding modes.

5 SAOCOM WORLD REFERENCE SYSTEM DEFINITION

5.1 Frames

The SAOCOM products will be distributed in standard sized frames. This approach is motivated in order to minimize the planning effort and standardize the cataloging.

The resultant frames will comply with the following:

- Any product at any part of the orbit or any time will have nominally fix azimuth and range sizes (in ground distance). This may slightly be altered due to orbit speed/altitude or attitude variations as the acquisition is defined in reference to the orbit time (not ground distance). Other factors that may alter the product length are different incidence angles, earth non sphericity, etc.
- All products within the same imaging mode (Stripmap, TOPSAR narrow or TOPSAR wide) regardless of the polarization mode (single, dual, compact or quad-pol) will have the same azimuth length. This way, the aspect ratio is not maintained among different modes and swath positions.
- The relation of the azimuth lengths between the different imaging modes (Stripmap, TOPSAR narrow or TOPSAR wide) will be an integer number. TOPSAR wide will be 2 times longer than TOPSAR narrow and TOPSAR narrow will be 3 times longer than Stripmap.

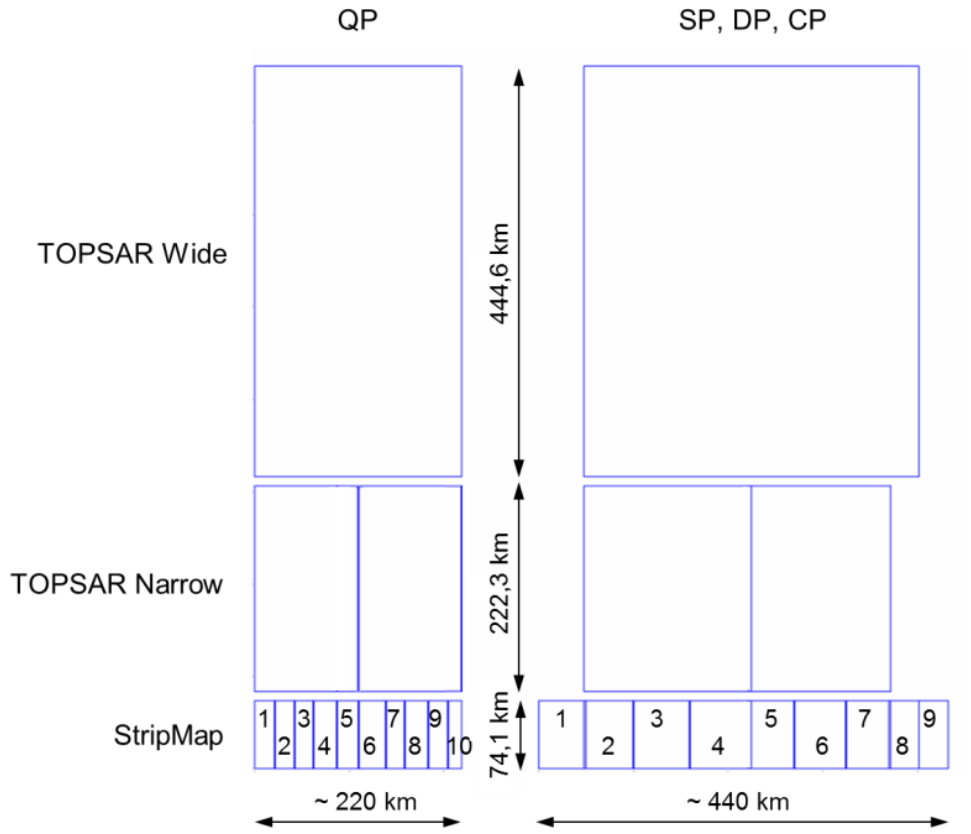


Figure 2: Frames approximated dimensions for certain conditions of orbits. On the left: quad-pol modes. On the right: Single, dual and compact modes. From top to bottom: TOPSAR wide (the two upper big frames), TOPSAR narrow (the two medium frames) and Stripmap (the nineteen small frames).

5.2 Global frame distribution grid

In order to facilitate the cataloging and product ordering the different frames will be geographically distributed using a common fixed grid. This grid will prevail during the whole mission and all standard products will referred to it. The grid will comply with the following.

- All standard products, regardless the imaging mode, will be placed on a commonly defined grid.
- The grid will be defined by a path number, constant within an orbit, and a row number that varies with latitude.
- The path number will start with 1 on the Pacific Ocean and sequentially increase towards the west reaching the maximum value 237. Any product acquired on a given orbit, regardless its mode or position, will share the same path number.

  Note: the path number is not the orbit number on a 16 days cycle; it is designed to be geographically consecutive for cataloging and ordering convenience.

- The row number will start with 1 on the North Pole (at its maximum latitude) and will reach 600 when the satellite reaches back the North Pole. This way for descending passes the row number will increase from 1 in the North Pole to 300 in the South Pole while for ascending passes the numeration will continue increasing from south to North reaching 600.
- Row numbers will only be consecutive for Stripmap frames while TOPSAR wide and narrow will have a step of 6 and 3 respectively due to the scale factor between imaging modes.
- The row number is referred to the first received echo. In this way, two images that share in the grid the same initial line, will have the same row number, disregarding their azimuth size.

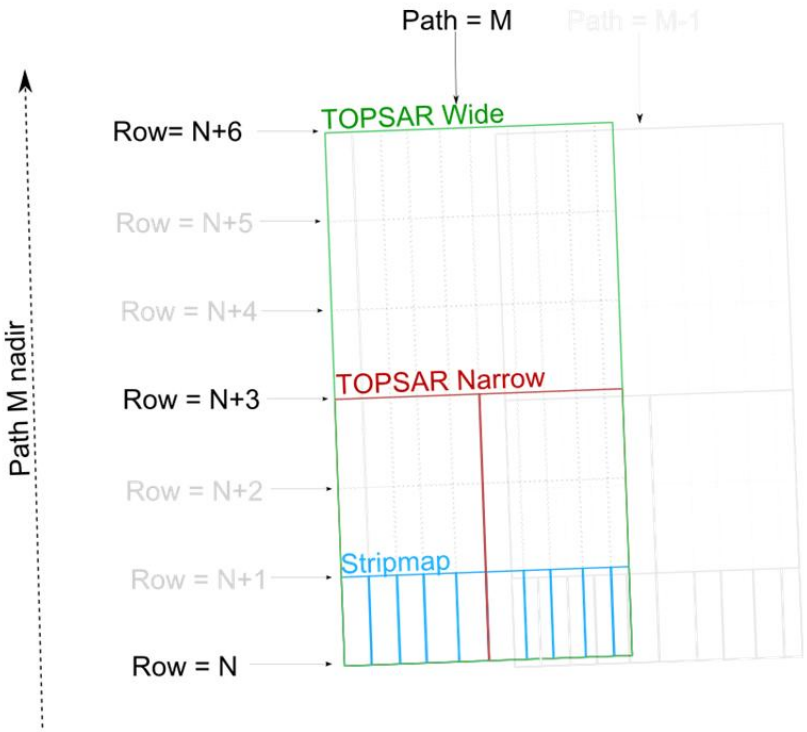


Figure 3: Different products from different modes placed in the common grid. Stripmap products in blue, TOPSAR Narrow in red and TOPSAR Wide in green. All the 12 scenes have the same frame and path number (Path=M, Frame=N) as they all share the same initial line

- Frames are defined over the path in order to have the same numbering as rows and being slightly longer to include azimuth overlaps with both adjacent frames.
- Two consecutive frames of the same imaging mode will have an azimuth spatial overlap of 5% with each predecessor and successor corresponding rows. This gives an effective 10% of common area between consecutive images. The next figure shows the overlap.
- Due to system constrains (ie: mode switching between frames, acquisition request conflict, etc) some may be incomplete. In this case the frame will be delivered as a standard frame with a zero value patch in the missing lines.

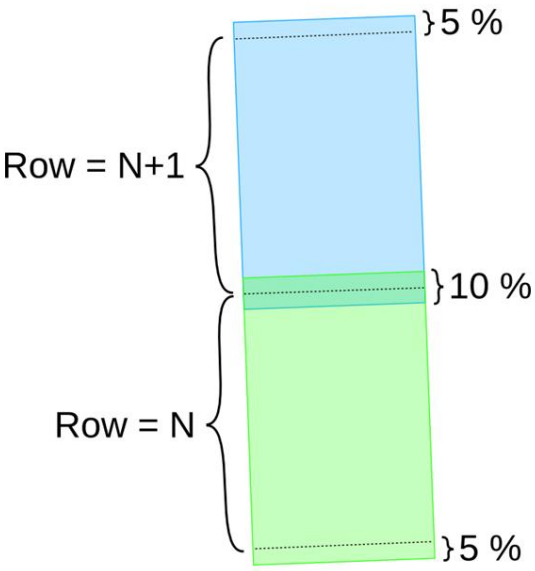


Figure 4: Azimuth spacial overlap

6 SAOCOM products definition

The following figure shows the family tree for the SAOCOM Level 0 products.

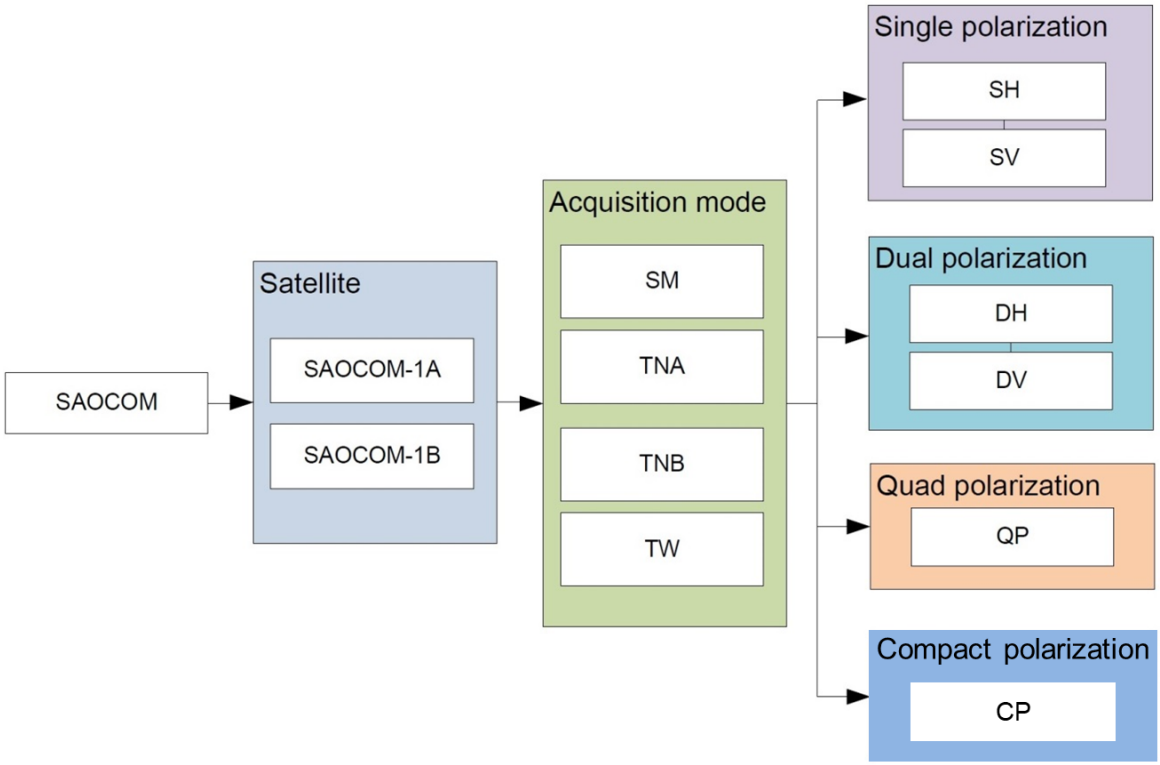


Figure 5: Family tree for the SAOCOM Level 0 products

The diagram represents the products tree for the SAOCOM data. Data can be classified according to:

- The first distinction is based on the satellite. Data can belong to SAOCOM-1A or 1B.
- Data can be separated according to acquisition mode.
- Data can be distinguished by polarization: we can separate in single polarization product, dual polarization product, quad polarization product and compact polarization product.
- Finally, all the products be generated containing both data and metadata with data in baseband and written as floating point data.

The SAOCOM Level 1 products family tree is depicted in the next figure.

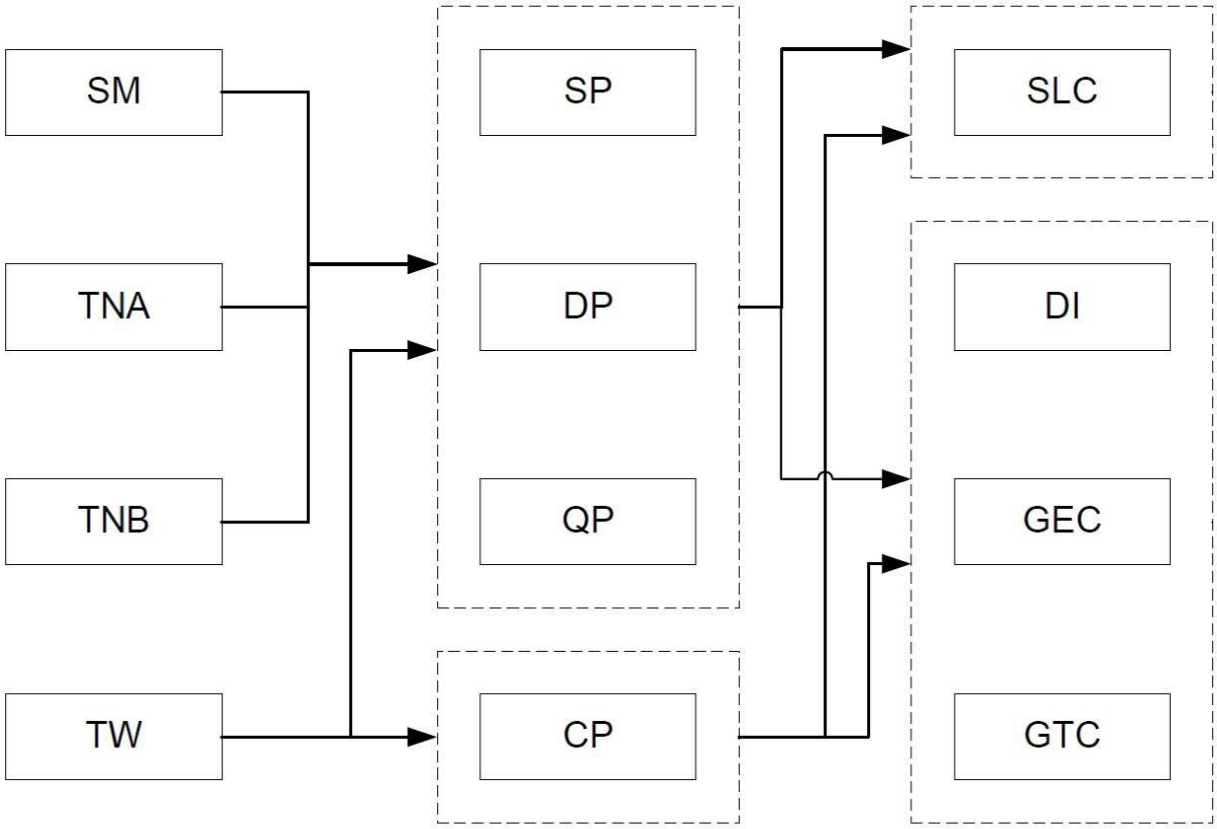


Figure 6: Product family tree Level 1

6.1 Level 0 product definition

In this section the product introduced in Sec. 6 will be described in details, in particular with reference to the following aspects:

- Main product Characteristics;
- Approximate Data Size & Volume.

The values are taken from the mode design activity. In order to take into account the possible processing inaccuracies, some margins on these values shall be considered. The following tables summarize the most important points.

6.1.1 Stripmap

6.1.1.1 Single and dual polarization

Product ID	**SM_DP_Raw**								
Product Type	Stripmap, Slant-Range, Complex								
Main product Characteristics									
Pixel Value	Complex								
Coordinate System	Slant Range								
Bits Per Pixel	32 I and 32 Q								
Polarization Options	Single (HH or VV) or Dual (HH+HV or VV+VH)								
Beam ID	**S1-DP**	**S2-DP**	**S3-DP**	**S4-DP**	**S5-DP**	**S6-DP**	**S7-DP**	**S8-DP**	**S9-DP**
Ground Range Coverage [km]	49.7	52.3	61.4	65.7	49.1	55.6	48	31.9	31.1
Incidence Angle Near [deg]	20.7	24.9	29.1	33.7	38.1	41.2	44.5	47	48.7

Table 3: Stripmap SP/DP Level-0 product specification

6.1.1.2 Quadruple polarization

Product ID	**SM_QP_RAW**
Product Type	Stripmap, Slant-Range
Main product Characteristics	
Pixel Value	Complex
Coordinate System	Slant Range
Bits Per Pixel	32 I and 32 Q

Polarization Options	QuadPol (HH VV HV VH)									
Beam ID	**S1-QP**	**S2-QP**	**S3-QP**	**S4-QP**	**S5-QP**	**S6-QP**	**S7-QP**	**S8-QP**	**S9-QP**	**S10-QP**
Ground Range Coverage [km]	21.9	22.0	21.0	25.4	23.4	29.4	20.9	25.1	22.1	14.2
Incidence Angle Near [deg]	17.6	19.5	21.4	23.2	25.3	27.2	29.5	31.1	33.0	34.5

Table 4: Stripmap QP Level-0 product specification

6.1.2 TOPSAR Narrow-A

6.1.2.1 Single and dual polarization

Product ID	**TNA_DP_Raw**		
Product Type	TOPSAR Narrow-A, Slant-Range, Complex		
Main product Characteristics			
Pixel Value	Complex		
Coordinate System	Slant Range		
Bits Per Pixel	32 I and 32 Q		
Polarization Options	Single (HH or VV) or Dual (HH+HV or (VV+VH)		
Beam ID	**S2-DP**	**S3-DP**	**S4-DP**
Ground Range Coverage [km]	52.3	61.4	65.7
Incidence Angle Near [deg]	24.9	29.1	33.7

Table 5: TOPSAR Narrow A DP Level-0 product specification

6.1.2.2 Quadruple polarization

Product ID	**TNA_QP_Raw**				
Product Type	TOPSAR Narrow-A, Slant-Range				
Main product Characteristics					
Pixel Value	Complex				
Coordinate System	Slant Range				
Bits Per Pixel	32 I and 32 Q				
Polarization Options	QuadPol (HH VV HV VH)				
Beam ID	**S1-QP**	**S2-QP**	**S3-QP**	**S4-QP**	**S5-QP**
Ground Range Coverage [km]	21.9	22.0	21.0	25.4	23.4
Incidence Angle Near [deg]	17.6	19.5	21.4	23.2	25.3

Table 6: TOPSAR Narrow A QP Level-0 product specification

6.1.3 TOPSAR Narrow-B

6.1.3.1 Single and dual polarization

Product ID	**TNB_DP_Raw**		
Product type	TOPSAR Narrow-B, Slant-Range, Complex		
Main product Characteristics			
Pixel Value	complex		
Coordinate System	Slant Range		
Bits Per pixel	32 I and 32 Q		
Polarization Options	Single (HH or VV) or Dual (HH+HV or VV+VH)		
Beam ID	**S5-DP**	**S6-DP**	**S7-DP**
Ground Range Coverage [km]	49.1	55.6	48.0
Incidence Angle Near [deg]	38.1	41.2	44.5

Table 7: TOPSAR Narrow B DP Level-0 product specification

6.1.3.2 Quadruple polarization

Product ID	**TNB_QP_Raw**				
Product Type	TOPSAR Narrow-B, Slant-Range, Complex				
Main product Characteristics					
Pixel Value	Complex				
Coordinate System	Slant Range				
Bits Per Pixel	32 I and 32 Q				
Polarization Options	QuadPol (HH VV HV VH)				
Beam ID	**S6-QP**	**S7-QP**	**S8-QP**	**S9-QP**	**S10-QP**
Ground Range Coverage [km]	29.4	20.9	25.1	22.1	14.2
Incidence Angle Near [deg]	27.2	29.5	31.1	33.0	34.5

Table 8: TOPSAR Narrow B QP Level-0 product specification

6.1.4 TOPSAR wide

6.1.4.1 Single and dual polarization

Product ID	**TW_DP_Raw**						
Product type	TOPSAR Wide, Slant-Range, Complex						
Main product Characteristics							
Pixel Value	Complex						
Coordinate System	Slant Range						
Bits Per pixel	32 I and 32 Q						
Polarization Options	Single (HH or VV) or Dual (HH+HV or VV+VH)						
Beam ID	**S2-DP**	**S3-DP**	**S4-DP**	**S5-DP**	**S6-DP**	**S7-DP**	**S8-DP**
Ground Range Coverage [km]	52.3	61.4	65.7	49.1	55.6	48.0	31.9
Incidence Angle Near [deg]	24.9	29.1	33.7	38.1	41.2	44.5	47.0

Table 9: TOPSAR Wide DP Level-0 product specification

6.1.4.2 Quadruple polarization

Product ID	**TW_QP_Raw**									
Product Type	TOPSAR Wide, Slant-Range, Single Look, Complex									
Main product Characteristics										
Pixel Value	Complex									
Coordinate System	Slant Range									
Bits Per Pixel	32 I and 32 Q									
Polarization Options	QuadPol (HH VV HV VH)									
Beam ID	**S1-QP**	**S2-QP**	**S3-QP**	**S4-QP**	**S5-QP**	**S6-QP**	**S7-QP**	**S8-QP**	**S9-QP**	**S10-QP**
Ground Range Coverage [km]	21.9	22.0	21.0	25.4	23.4	29.4	20.9	25.1	22.1	14.2
Incidence Angle Near [deg]	17.6	19.5	21.4	23.2	25.3	27.2	29.5	31.1	33.0	34.5

Table 10: TOPSAR Wide QP Level-0 product specification

6.2 Level 1 product definition

In this section the product will be described in details, in particular with reference to the following aspects:

- Main product Characteristics;
- Product Performance Parameters;
- SAR Processing Parameters;
- Approximate Data Size & Volume.

In order to take into account the possible processing inaccuracies, some margins on these values shall be considered. The following table summarizes the most important points.

Parameter	Margin
Spatial Resolution	10%
Peak Side Lobe Ratio	1 dB
Integrated Side Lobe Ratio	1 dB
Point Target Ambiguity Ratio	1 dB
Distributed Target Ambiguity Ratio	1 dB
Noise Equivalent Sigma0	1 dB
ENL	-10%
Coverage (swath width)	-2%

Table 11: Processing margins on products definition.

The SLC acronym is used to indicate images that are in slant-range and azimuth coordinates plane, not multi-looked and represented by complex values. For STRIPMAP data this product is sampled at the natural pixel spacing. For TOPSAR case the azimuth sampling is kept fixed for all the sub-swaths through a proper re-sampling performed at focusing time. Moreover, each sub-swath is stored in a separate image, juxtaposing all the independently processed bursts. For TOPSAR case there is a mosaicked version (complex) of SLC called SLC merged; the subswaths

are debursted and merged. The DI (or GRD) acronym is used to indicate images that are in ground-range and azimuth coordinates plane, multi-looked and represented by detected values. For the TOPSAR case all the bursts and sub- swaths are merged together to have a single image, as in the STRIPMAP case.

The GEC and GTC acronyms are used to indicate images that are in a cartographic projection coordinates plane, multi-looked and represented by detected values. The main difference with respect to the GRD data consists in the image geocoding and then in its projection (from SAR to a map projection coordinates). In order to perform this step, for GEC the Ellipsoid model is exploited, while for GTC a Digital Elevation Model is needed.

6.2.1 Stripmap

6.2.1.1 Single and dual polarization

6.2.1.1.1 SLC

Product ID	**SM_DP_SLC**								
Product Type	Stripmap, Slant-Range, Single Look, Complex								
Main product Characteristics									
Pixel Value	Complex								
Coordinate System	Slant Range								
Bits Per Pixel	32 I and 32 Q								
Polarization Options	Single (HH or VV) or Dual (HH+HV or VV+VH)								
Beam ID	**S1-DP**	**S2-DP**	**S3-DP**	**S4-DP**	**S5-DP**	**S6-DP**	**S7-DP**	**S8-DP**	**S9-DP**
Ground Range Coverage [km]	49.7	52.3	61.4	65.7	49.1	55.6	48.0	31.9	31.1
Slant Range Resolution [m]	3.5	4.2	4.9	5.6	6.2	6.6	7.0	7.3	7.5
Azimuth Resolution [m]	5	5	5	5	5	5	5	5	5
Slant Range Pixel Spacing [m]	2.5								
Azimuth Pixel Spacing [m]	3.8	3.9	3.3	3.8	3.3	3.7	3.3	3.6	3.7
Incidence Angle Near [deg]	20.7	24.9	29.1	33.7	38.1	41.2	44.5	47.0	48.7
Equivalent Number of Looks (ENL)	1								
SAR Processing Parameters									
Number of Looks (Range x Azimuth)	1 x 1								
Look Overlap (Range x Azimuth)	N/A								

Table 12: Stripmap SP/DP SLC product specification

6.2.1.1.2 DI

Product ID	**SM_DP_DI**
Product Type	Stripmap, Ground-Range, Multi-Look, Detected
Main product Characteristics	

Pixel Value	Magnitude								
Coordinate System	Ground Range								
Bits Per Pixel	32								
Polarization Options	Single (HH or VV) or Dual (HH+HV or VV+VH)								
Beam ID	S1-DP	S2-DP	S3-DP	S4-DP	S5-DP	S6-DP	S7-DP	S8-DP	S9-DP
Ground Range Coverage [km]	49.7	52.3	61.4	65.7	49.1	55.6	48.0	31.9	31.1
Ground Range Resolution [m]	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Azimuth Resolution [m]	12.5	12.5	12.4	12.5	12.4	12.5	12.4	12.5	12.5
Ground Range Pixel Spacing [m]	5.2								
Azimuth Pixel Spacing [m]	9								
Incidence Angle Near [deg]	20.7	24.9	29.1	33.7	38.1	41.2	44.5	47.0	48.7
Equivalent Number of Looks (ENL)	3.125								
SAR Processing Parameters									
Number of Looks (Range x Azimuth)	1.25 x 2.5								
Look Overlap (Range x Azimuth)	0.75 x 0.5								

Table 13: Stripmap SP/DP DI product specification

6.2.1.1.3 GEC and GTC

Product ID	SM_DP_GEC, SM_DP_GTC								
Product Type	Stripmap, Geocoded, Ellipsoid/Terrain Corrected, Detected								
Main product Characteristics									
Pixel Value	Magnitude								
Coordinate System	UTM								
Bits Per Pixel	32								
Polarization Options	Single (HH or VV) or Dual (HH+HV or VV+VH)								
Beam ID	S1-DP	S2-DP	S3-DP	S4-DP	S5-DP	S6-DP	S7-DP	S8-DP	S9-DP
Ground Range Coverage [km]	49.7	52.3	61.4	65.7	49.1	55.6	48.0	31.9	31.1
Lines and Columns Pixel Spacing [m]	9								
Incidence Angle Near [deg]	20.7	24.9	29.1	33.7	38.1	41.2	44.5	47	48.7

Table 14: Stripmap SP/DP GEC/GTC product specification

NOTE: the other values for GEC and GTC products are not reported while identical to those of DI products. Moreover the dimensions don't take into account the tilting due to the geocoding operation, while depending on the orbit direction.

6.2.1.2 Quadruple polarization

6.2.1.2.1 SLC

Product ID	SM_QP_SLC									
Product Type	Stripmap, Slant-Range, Single Look, Complex									
Main product Characteristics										
Pixel Value	Complex									
Coordinate System	Slant Range									
Bits Per Pixel	32 I and 32 Q									
Polarization Options	QuadPol (HH VV HV VH)									
Beam ID	S1-QP	S2-QP	S3-QP	S4-QP	S5-QP	S6-QP	S7-QP	S8-QP	S9-QP	S10-QP
Ground Range Coverage [km]	21.9	22.0	21.0	25.4	23.4	29.4	20.9	25.1	22.1	14.2
Slant Range Resolution [m]	3	3.3	3.7	3.9	4.3	4.6	4.9	5.2	5.4	5.7
Azimuth Resolution [m]	6	6	6	6	6	6	6	6	6	6
Slant Range Pixel Spacing [m]	2.5	2.5	2.5	2.5	3.7	3.7	3.7	3.7	5	5
Azimuth Pixel Spacing [m]	4.1	4.1	3.3	3.7	3.7	4.1	3.5	3.9	4	4.1
Incidence Angle Near [deg]	17.6	19.5	21.4	23.2	25.3	27.2	29.5	31.1	33.0	34.5
Equivalent Number of Looks (ENL)	1									
SAR Processing Parameters										
Number of Looks (Range x Azimuth)	1 x 1									
Look Overlap (Range x Azimuth)	N/A									

Table 15: Stripmap QP SLC product specification

6.2.1.2.2 DI

Product ID	SM_QP_DI									
Product Type	Stripmap, Ground-Range, Multi-Look, Detected									
Main product Characteristics										
Pixel Value	Magnitude									
Coordinate System	Ground Range									
Bits Per Pixel	32									
Polarization Options	QuadPol (HH VV HV VH)									
Beam ID	S1-QP	S2-QP	S3-QP	S4-QP	S5-QP	S6-QP	S7-QP	S8-QP	S9-QP	S10-QP
Ground Range Coverage [km]	21.9	22.0	21.0	25.4	23.4	29.4	20.9	25.1	22.1	14.2
Ground Range Resolution [m]	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Azimuth Resolution [m]	12.2	12.2	12.4	12.5	12.4	12.4	12.4	12.3	12.3	12.3
Ground Range Pixel Spacing [m]	7.2									
Azimuth Pixel Spacing [m]	7.8									
Incidence Angle Near [deg]	17.6	19.5	21.4	23.2	25.3	27.2	29.5	31.1	33.0	34.5
Equivalent Number of Looks (ENL)	2.5625									
SAR Processing Parameters										
Number of Looks (Range x Azimuth)	1.25 x 2.05									
Look Overlap (Range x Azimuth)	0.75 x 0.95									

Table 16: Stripmap QP DI product specification

6.2.1.2.3 GEC and GTC

Product ID	SM_QP_GEC, SM_QP_GTC									
Product Type	Stripmap, Geocoded, Ellipsoid/Terrain Corrected, Detected									
Main product Characteristics										
Pixel Value	Magnitude									
Coordinate System	UTM/UPS									
Bits Per Pixel	32									
Polarization Options	QuadPol (HH VV HV VH)									
Beam ID	S1-QP	S2-QP	S3-QP	S4-QP	S5-QP	S6-QP	S7-QP	S8-QP	S9-QP	S10-QP
Ground Range Coverage [km]	21.9	22.0	21.0	25.4	23.4	29.4	20.9	25.1	22.1	14.2
Lines and Columns Pixel Spacing [m]	7.9									
Incidence Angle Near [deg]	17.6	19.5	21.4	23.2	25.3	27.2	29.5	31.1	33.0	34.5

Table 17: Stripmap QP GEC/GTC product specification

NOTE: the other values for GEC and GTC products are not reported while identical to those of DI products. Moreover the dimensions don't take into account the tilting due to the geocoding operation, while depending on the orbit direction.

6.2.2 TOPSAR Narrow-A

6.2.2.1 Single and dual polarization

6.2.2.1.1 SLC

TOPSAR SLC images can be delivered both as a single image per polarization where all the subswaths are merged together or by separated files per subswaths.

Product ID	**TNA_DP_SLC_Merged**		
Product Type	TOPSAR Narrow-A, Slant-Range, Single Look, Complex		
Main product Characteristics			
Pixel Value	Complex		
Coordinate System	Slant Range		
Bits Per Pixel	32 I and 32 Q		
Polarization Options	Single (HH or VV) or Dual (HH+HV or VV+VH)		
Beam ID	**S2-DP + S3-DP +S4-DP**		
Ground Range Coverage [km]	176.3		
Slant Range Resolution [m]	4.2	4.9	5.6
Azimuth Resolution [m]	30.1		
Slant Range Pixel Spacing [m]	2.5		
Azimuth Pixel Spacing [m]	20		
Incidence Angle Near [deg]	24.9		
Equivalent Number of Looks (ENL)	1		
SAR Processing Parameters			
Number of Looks (Range x Azimuth)	1 x 1		
Look Overlap (Range x Azimuth)	N/A		

Table 18: TOPSAR Narrow A SP/DP SLC merged product specification

Product ID	**TNA_DP_SLC**		
Product Type	TOPSAR Narrow-A, Slant-Range, Single Look, Complex		
Main product Characteristics			
Pixel Value	Complex		
Coordinate System	Slant Range		
Bits Per Pixel	32 I and 32 Q		
Polarization Options	Single (HH or VV) or Dual (HH+HV or VV+VH)		
Beam ID	**S2-DP**	**S3-DP**	**S4-DP**
Ground Range Coverage [km]	52.3	61.4	65.7
Slant Range Resolution [m]	4.2	4.9	5.6
Azimuth Resolution [m]	30.1	30.1	30.1
Slant Range Pixel Spacing [m]	2.5		
Azimuth Pixel Spacing [m]	20		
Incidence Angle Near [deg]	24.9	29.1	33.7

Equivalent Number of Looks (ENL)	1
SAR Processing Parameters	
Number of Looks (Range x Azimuth)	1 x 1
Look Overlap (Range x Azimuth)	N/A

Table 19: TOPSAR Narrow A SP/DP SLC product specification

Please notice that data are acquired at burst so there is an overlap between them. To compute the azimuth covertures is necessary to consider the overlap between the burst and consider the different starting time of each swath. The total image is then composed by a scaled image with empty space at each margin.

6.2.2.1.2 DI

Product ID	**TNA_DP_DI**		
Product Type	TOPSAR narrow-A, Ground-Range, Multi-Look, Detected		
Main product Characteristics			
Pixel Value	Magnitude		
Coordinate System	Ground Range		
Bits Per Pixel	32		
Polarization Options	Single (HH or VV) or Dual (HH+HV or VV+VH)		
Beam ID	**S2-DP**	**S3-DP**	**S4-DP**
Ground Range Coverage [km]	52.3	61.4	65.7
Ground Range Resolution [m]	30	30	30
Azimuth Resolution [m]	30.1	30.1	30.1
Ground Range Pixel Spacing [m]	23		
Azimuth Pixel Spacing [m]	20		
Incidence Angle Near [deg]	24.9	29.1	33.7
Equivalent Number of Looks (ENL)	3		
SAR Processing Parameters			
Number of Looks (Range x Azimuth)	3 x 1		
Look Overlap (Range x Azimuth)	0 x 0		

Table 20: TOPSAR Narrow A SP/DP DI product specification

6.2.2.1.3 GEC and GTC

Product ID	**TNA_DP_GEC, TNA_DP_GTC**		
Product Type	TOPSAR Narrow-A, Geocoded, Ellipsoid/Terrain Corrected, Detected		
Main product Characteristics			
Pixel Value	Magnitude		
Coordinate System	UTM/UPS		
Bits Per Pixel	32		
Polarization Options	Single (HH or VV) or Dual (HH+HV or VV+VH)		
Beam ID	**S2-DP**	**S3-DP**	**S4-DP**
Ground Range Coverage [km]	52.3	61.4	65.7
Lines and Columns Pixel Spacing [m]	23		
Incidence Angle Near [deg]	24.9	29.1	33.7

Table 21: TOPSAR Narrow A SP/DP GEC/GTC product specification

NOTE: the other values for GEC and GTC products are not reported while identical to those of DI products. Moreover the dimensions don't take into account the tilting due to the geocoding operation, while depending on the orbit direction.

6.2.2.2 Quadruple polarization

6.2.2.2.1 SLC

TOPSAR SLC images can be delivered both as a single image per polarization where all the subswaths are merged together or by separated files per subswaths.

Product ID	**TNA_QP_SLC_Merged**				
Product Type	TOPSAR Narrow-A, Slant-Range, Single Look, Complex				
Main product Characteristics					
Pixel Value	Complex				
Coordinate System	Slant Range				
Bits Per Pixel	32 I and 32 Q				
Polarization Options	Single (HH or VV) or Dual (HH+HV or VV+VH)				
Beam ID	**S1-QP +S2-QP + S3-QP +S4-QP+S5-QP**				
Ground Range Coverage [km]	109.9				
Slant Range Resolution [m]	3	3.3	3.7	3.9	4.3
Azimuth Resolution [m]	49.9				
Slant Range Pixel Spacing [m]	2.5				
Azimuth Pixel Spacing [m]	34.2				
Incidence Angle Near [deg]	17.6				
Equivalent Number of Looks (ENL)	1				
SAR Processing Parameters					
Number of Looks (Range x Azimuth)	1 x 1				
Look Overlap (Range x Azimuth)	N/A				

Table 22: TOPSAR Narrow A QP SLC merged product specification

Product ID	**TNA_QP_SLC**				
Product Type	TOPSAR Narrow-A, Slant-Range, Single Look, Complex				
Main product Characteristics					
Pixel Value	Complex				
Coordinate System	Slant Range				
Bits Per Pixel	32 I and 32 Q				
Polarization Options	QuadPol (HH VV HV VH)				
Beam ID	**S1-QP**	**S2-QP**	**S3-QP**	**S4-QP**	**S5-QP**
Ground Range Coverage [km]	21.9	22.0	21.0	25.4	23.4
Slant Range Resolution [m]	3	3.3	3.7	3.9	4.3
Azimuth Resolution [m]	50	50	50	49.9	50
Slant Range Pixel Spacing [m]	2.5	2.5	2.5	2.5	3.7
Azimuth Pixel Spacing [m]	34.2				
Incidence Angle Near [deg]	17.6	19.5	21.4	23.2	25.3
Equivalent Number of Looks (ENL)	1				
SAR Processing Parameters					
Number of Looks (Range x Azimuth)	1 x 1				
Look Overlap (Range x Azimuth)	N/A				

Table 23: TOPSAR Narrow A QP SLC product specification

6.2.2.2.2 DI

Product ID	TNA_QP_DI				
Product Type	TOPSAR Narrow-A, Ground-Range, Multi-Look, Detected				
Main product Characteristics					
Pixel Value	Magnitude				
Coordinate System	Ground Range				
Bits Per Pixel	32				
Polarization Options	QuadPol (HH VV HV VH)				
Beam ID	S1-QP	S2-QP	S3-QP	S4-QP	S5-QP
Ground Range Coverage [km]	21.9	22.0	21.0	25.4	23.4
Ground Range Resolution [m]	50	54.6	53.9	54.3	50
Azimuth Resolution [m]	50	50	50	49.9	50
Ground Range Pixel Spacing [m]	35.8				
Azimuth Pixel Spacing [m]	34.2				
Incidence Angle Near [deg]	17.6	19.5	21.4	23.2	25.3
Equivalent Number of Looks (ENL)	5				
SAR Processing Parameters					
Number of Looks (Range x Azimuth)	5 x 1				
Look Overlap (Range x Azimuth)	0 x 0				

Table 24: TOPSAR Narrow A QP DI product specification

6.2.2.2.3 GEC and GTC

Product ID	TNA_QP_GEC, TNA_QP_GTC				
Product Type	TOPSAR Narrow-A, Geocoded, Ellipsoid/Terrain Corrected, Detected				
Main product Characteristics					
Pixel Value	Magnitude				
Coordinate System	UTM/UPS				
Bits Per Pixel	32				
Polarization Options	QuadPol (HH VV HV VH)				
Beam ID	S1-QP	S2-QP	S3-QP	S4-QP	S5-QP
Ground Range Coverage [km]	21.9	22.0	21.0	25.4	23.4
Lines and columns Pixel Spacing [m]	35.8				
Incidence Angle Near [deg]	17.6	19.5	21.4	23.2	25.3

Table 25: TOPSAR Narrow A QP GEC/GTC product specification

NOTE: the other values for GEC and GTC products are not reported while identical to

those of DI products. Moreover the dimensions don’t take into account the tilting due to the geocoding operation, while depending on the orbit direction.

6.2.3 TOPSAR Narrow-B

6.2.3.1 Single and dual polarization

6.2.3.1.1 SLC

TOPSAR SLC images can be delivered both as a single image per polarization where all the subswaths are merged together or by separated files per subswaths.

Product ID	**TNB_DP_SLC_Merged**		
Product Type	TOPSAR Narrow-A, Slant-Range, Single Look, Complex		
Main product Characteristics			
Pixel Value	Complex		
Coordinate System	Slant Range		
Bits Per Pixel	32 I and 32 Q		
Polarization Options	Single (HH or VV) or Dual (HH+HV or VV+VH)		
Beam ID	**S5-DP + S6-DP +S7-DP**		
Ground Range Coverage [km]	150.2		
Slant Range Resolution [m]	6.2	6.6	7
Azimuth Resolution [m]	29.9		
Slant Range Pixel Spacing [m]	2.5		
Azimuth Pixel Spacing [m]	24.6		
Incidence Angle Near [deg]	38.1		
Equivalent Number of Looks (ENL)	1		
SAR Processing Parameters			
Number of Looks (Range x Azimuth)	1 x 1		
Look Overlap (Range x Azimuth)	N/A		

Table 26: TOPSAR Narrow B SP/DP SLC merged product specification

Product ID	**TNB_DP_SLC**		
Product type	TOPSAR Narrow-B, Slant-Range, Single Look, Complex		
Main product Characteristics			
Pixel Value	Complex		
Coordinate System	Slant Range		
Bits Per pixel	32 I and 32 Q		
Polarization Options	Single (HH or VV) or Dual (HH+HV or VV+VH)		
Beam ID	**S5-DP**	**S6-DP**	**S7-DP**
Ground Range Coverage [km]	49.1	55.6	48.0
Slant Range Resolution [m]	6.2	6.6	7
Azimuth Resolution [m]	29.9		
Slant Range Pixel Spacing [m]	2.5		

Azimuth Pixel Spacing [m]	24.6		
Incidence Angle Near [deg]	38.1	41.2	44.5
Equivalent Number of Looks (ENL)	1		
SAR Processing Parameters			
Number of Looks (Range x Azimuth)	1 x 1		
Look Overlap (Range x Azimuth)	N/A		

Table 27: TOPSAR Narrow B SP/DP SLC product specification

6.2.3.1.2 DI

Product ID	TNB_DP_DI		
Product Type	TOPSAR Narrow-B, Ground-Range, Multi-Look, Detected		
Main product Characteristics			
Pixel Value	Magnitude		
Coordinate System	Ground Range		
Bits Per Pixel	16		
Polarization Options	Single (HH or VV) or Dual (HH+HV or VV+VH)		
Beam ID	S5-DP	S6-DP	S7-DP
Ground Range Coverage [km]	49.1	55.6	48
Ground Range Resolution [m]	30.1	29.9	30.1
Azimuth Resolution [m]	29.9	29.8	30
Ground Range Pixel Spacing [m]	22.7		
Azimuth Pixel Spacing [m]	24.6		
Incidence Angle Near [deg]	38.1	41.2	44.5
Equivalent Number of Looks (ENL)	3		
SAR Processing Parameters			
Number of Looks (Range x Azimuth)	3 x 1		
Look Overlap (Range x Azimuth)	0 x 0		

Table 28: TOPSAR Narrow B SP/DP DI product specification

6.2.3.1.3 GEC and GTC

Product ID	TNB_DP_GEC, TNB_DP_GTC		
Product Type	TOPSAR Narrow-B, Geocoded, Ellipsoid/Terrain Corrected, Detected		
Main product Characteristics			
Pixel Value	Magnitude		
Coordinate System	UTM/UPS		
Bits Per Pixel	16		
Polarization Options	Single (HH or VV) or Dual (HH+HV or VV+VH)		
Beam ID	S5-DP	S6-DP	S7-DP
Ground Range Coverage [km]	49.1	55.6	48
Lines and Columns Pixel Spacing [m]	24.6		
Incidence Angle Near [deg]	38.1	41.2	44.5

Table 29: TOPSAR Narrow B SP/DP GEC/GTC product specification

NOTE: the other values for GEC and GTC products are not reported while identical to those of DI products. Moreover the dimensions don't take into account the tilting due to the geocoding operation, while depending on the orbit direction.

6.2.3.2 Quadruple polarization

6.2.3.2.1 SLC

TOPSAR SLC images can be delivered both as a single image per polarization where all the subswaths are merged together or by separated files per subswaths.

Product ID	**TNB_QP_SLC_Merged**				
Product Type	TOPSAR Narrow-B, Slant-Range, Single Look, Complex				
Main product Characteristics					
Pixel Value	Complex				
Coordinate System	Slant Range				
Bits Per Pixel	32 I and 32 Q				
Polarization Options	QuadPol (HH VV HV VH)				
Beam ID	**S6-QP + S7-QP + S8-QP + S9-QP + S10-QP**				
Ground Range Coverage [km]	108.8				
Slant Range Resolution [m]	4.6	4.9	5.2	5.4	5.7
Azimuth Resolution [m]	50				
Slant Range Pixel Spacing [m]	3.7				
Azimuth Pixel Spacing [m]	41.6				
Incidence Angle Near [deg]	27.2	29.5	31.1	33.0	34.5
Equivalent Number of Looks (ENL)	1				
SAR Processing Parameters					
Number of Looks (Range x Azimuth)	1 x 1				
Look Overlap (Range x Azimuth)	N/A				

Table 30: TOPSAR Narrow B QP SLC merged product specification

Product ID	**TNB_QP_SLC**				
Product Type	TOPSAR Narrow-B, Slant-Range, Single Look, Complex				
Main product Characteristics					
Pixel Value	Complex				
Coordinate System	Slant Range				
Bits Per Pixel	32 I and 32 Q				
Polarization Options	QuadPol (HH VV HV VH)				
Beam ID	**S6-QP**	**S7-QP**	**S8-QP**	**S9-QP**	**S10-QP**
Ground Range Coverage [km]	29.4	20.9	25.1	22.1	14.2
Slant Range Resolution [m]	4.6	4.9	5.2	5.4	5.7
Azimuth Resolution [m]	50	50	50.4	50	50.2
Slant Range Pixel Spacing [m]	3.7	3.7	3.7	5	5
Azimuth Pixel Spacing [m]	41.6				
Incidence Angle Near [deg]	27.2	29.5	31.1	33.0	34.5
Equivalent Number of Looks (ENL)	1				
SAR Processing Parameters					
Number of Looks (Range x Azimuth)	1 x 1				
Look Overlap (Range x Azimuth)	N/A				

Table 31: TOPSAR Narrow B QP SLC product specification

6.2.3.2.2 DI

Product ID	TNB_QP_DI				
Product Type	TOPSAR Narrow-B, Ground-Range, Multi-Look, Detected				
Main product Characteristics					
Pixel Value	Magnitude				
Coordinate System	Ground Range				
Bits Per Pixel	16				
Polarization Options	QuadPol (HH VV HV VH)				
Beam ID	S6-QP	S7-QP	S8-QP	S9-QP	S10-QP
Ground Range Coverage [km]	29.4	20.9	25.1	22.1	14.2
Ground Range Resolution [m]	50.1	50	50	50	50
Azimuth Resolution [m]	50	50	50.4	50	50.2
Ground Range Pixel Spacing [m]	36.3				
Azimuth Pixel Spacing [m]	41.6				
Incidence Angle Near [deg]	27.2	29.5	31.1	33.0	34.5
Equivalent Number of Looks (ENL)	5				
SAR Processing Parameters					
Number of Looks (Range x Azimuth)	5 x 1				
Look Overlap (Range x Azimuth)	0 x 0				

Table 32: TOPSAR Narrow B QP DI product specification

6.2.3.2.3 GEC and GTC

Product ID	TNB_QP_GEC, TNB_QP_GTC				
Product Type	TOPSAR Narrow-B, Geocoded, Ellipsoid/Terrain Corrected, Detected				
Main product Characteristics					
Pixel Value	Magnitude				
Coordinate System	UTM/UPS				
Bits Per Pixel	16				
Polarization Options	QuadPol (HH VV HV VH)				
Beam ID	S6-QP	S7-QP	S8-QP	S9-QP	S10-QP
Ground Range Coverage [km]	29.4	20.9	25.1	22.1	14.2
Lines and Columns Pixel Spacing [m]	41.6				
Incidence Angle Near [deg]	27.2	29.5	31.1	33.0	34.5

Table 33: TOPSAR Narrow B QP GEC/GTC product specification

NOTE: the other values for GEC and GTC products are not reported while identical to those of DI products. Moreover the dimensions don't take into account the tilting due to the geocoding operation, while depending on the orbit direction.

6.2.4 TOPSAR Wide

6.2.4.1 Single and dual polarization

6.2.4.1.1 SLC

TOPSAR SLC images can be delivered both as a single image per polarization where all the subswaths are merged together or by separated files per subswaths.

Product ID	TW_DP_SLC_merged						
Product type	TOPSAR Wide, Slant-Range, Single Look, Complex						
Main product Characteristics							
Pixel Value	Complex						
Coordinate System	Slant Range						
Bits Per pixel	32 I and 32 Q						
Polarization Options	Single (HH or VV) or Dual (HH+HV or VV+VH)						
Beam ID	S2-DP	S3-DP	S4-DP	S5-DP	S6-DP	S7-DP	S8-DP
Ground Range Coverage [km]	353.7						
Slant Range Resolution [m]	4.2	4.9	5.6	6.2	6.6	7	7.3
Azimuth Resolution [m]	50.1						
Slant Range Pixel Spacing [m]	3.7						
Azimuth Pixel Spacing [m]	44.9						
Incidence Angle Near [deg]	24.9	29.1	33.7	38.1	41.2	44.5	47.0
Equivalent Number of Looks (ENL)	1						
SAR Processing Parameters							
Number of Looks (Range x Azimuth)	1 x 1						
Look Overlap (Range x Azimuth)	N/A						

Table 34: TOPSAR Wide SP/DP SLC merged product specification

Product ID	TW_DP_SLC						
Product type	TOPSAR Wide, Slant-Range, Single Look, Complex						
Main product Characteristics							
Pixel Value	Complex						
Coordinate System	Slant Range						
Bits Per pixel	32 I and 32 Q						
Polarization Options	Single (HH or VV) or Dual (HH+HV or VV+VH)						
Beam ID	S2-DP	S3-DP	S4-DP	S5-DP	S6-DP	S7-DP	S8-DP
Ground Range Coverage [km]	52.3	61.4	65.7	49.1	55.6	48.0	31.9
Slant Range Resolution [m]	4.2	4.9	5.6	6.2	6.6	7	7.3
Azimuth Resolution [m]	50.1						
Slant Range Pixel Spacing [m]	3.7	3.7	5	5	5	5	5
Azimuth Pixel Spacing [m]	44.9						
Incidence Angle Near [deg]	24.9	29.1	33.7	38.1	41.2	44.5	47.0
Equivalent Number of Looks (ENL)	1						
SAR Processing Parameters							
Number of Looks (Range x Azimuth)	1 x 1						
Look Overlap (Range x Azimuth)	N/A						

Table 35: TOPSAR Wide SP/DP SLC product specification

6.2.4.1.2 DI

Product ID	TW_DP_DI						
Product Type	TOPSAR Wide, Ground-Range, Multi-Look, Detected						
Main product Characteristics							
Pixel Value	Magnitude						
Coordinate System	Ground Range						
Bits Per Pixel	16						
Polarization Options	Single (HH or VV) or Dual (HH+HV or VV+VH)						
Beam ID	S2-DP	S3-DP	S4-DP	S5-DP	S6-DP	S7-DP	S8-DP
Ground Range Coverage [km]	52.3	61.4	65.7	49.1	55.6	48.0	31.9
Ground Range Resolution [m]	50	49.9	50.1	50.1	49.9	50.1	50
Azimuth Resolution [m]	50.1	50.1	50.1	50.2	49.9	50	49.9
Ground Range Pixel Spacing [m]	31.2						
Azimuth Pixel Spacing [m]	44.9						
Incidence Angle Near [deg]	24.9	29.1	33.7	38.1	41.2	44.5	47.0
Equivalent Number of Looks (ENL)	5						
SAR Processing Parameters							
Number of Looks (Range x Azimuth)	5 x 1						
Look Overlap (Range x Azimuth)	0 x 0						

Table 36: TOPSAR Wide SP/DP DI product specification

6.2.4.1.3 GEC and GTC

Product ID	TW_DP_GEC, TW_DP_GTC						
Product Type	TOPSAR Wide, Geocoded, Ellipsoid/Terrain Corrected, Detected						
Main product Characteristics							
Pixel Value	Magnitude						
Coordinate System	UTM/UPS						
Bits Per Pixel	16						
Polarization Options	Single (HH or VV) or Dual (HH+HV or VV+VH)						
Beam ID	S2-DP	S3-DP	S4-DP	S5-DP	S6-DP	S7-DP	S8-DP
Ground Range Coverage [km]	52.3	61.4	65.7	49.1	55.6	48.0	31.9
Lines and Columns Pixel Spacing [m]	44.9						
Incidence Angle Near [deg]	24.9	29.1	33.7	38.1	41.2	44.5	47.0

Table 37: TOPSAR Wide SP/DP GEC/GTC product specification

NOTE: the other values for GEC and GTC products are not reported while identical to those of DI products. Moreover the dimensions don't take into account the tilting due to the geocoding operation, while depending on the orbit direction.

6.2.4.2 Quadruple polarization

6.2.4.2.1 SLC

TOPSAR SLC images can be delivered both as a single image per polarization where all the subswaths are merged together or by separated files per subswaths.

Product ID	TW_QP_SLC_merged									
Product Type	TOPSAR Wide, Slant-Range, Single Look, Complex									
Main product Characteristics										
Pixel Value	Complex									
Coordinate System	Slant Range									
Bits Per Pixel	32 I and 32 Q									
Polarization Options	QuadPol (HH VV HV VH)									
Beam ID	S1-QP	S2-QP	S3-QP	S4-QP	S5-QP	S6-QP	S7-QP	S8-QP	S9-QP	S10-QP
Ground Range Coverage [km]	218.1									
Slant Range Resolution [m]	3	3.3	3.7	3.9	4.3	4.6	4.9	5.2	5.4	5.7
Azimuth Resolution [m]	100.7									
Slant Range Pixel Spacing [m]	2.5									
Azimuth Pixel Spacing [m]	68.6									
Incidence Angle Near [deg]	17.6	19.5	21.4	23.2	25.3	27.2	29.5	31.1	33.0	34.5
Equivalent Number of Looks (ENL)	1									
SAR Processing Parameters										
Number of Looks (Range x Azimuth)	1 x 1									
Look Overlap (Range x Azimuth)	N/A									

Table 38: TOPSAR Wide QP SLC product specification

Product ID	TW_QP_SLC									
Product Type	TOPSAR Wide, Slant-Range, Single Look, Complex									
Main product Characteristics										
Pixel Value	Complex									
Coordinate System	Slant Range									
Bits Per Pixel	32 I and 32 Q									
Polarization Options	QuadPol (HH VV HV VH)									
Beam ID	S1-QP	S2-QP	S3-QP	S4-QP	S5-QP	S6-QP	S7-QP	S8-QP	S9-QP	S10-QP
Ground Range Coverage [km]	21.9	22.0	21.0	25.4	23.4	29.4	20.9	25.1	22.1	14.2
Slant Range Resolution [m]	3	3.3	3.7	3.9	4.3	4.6	4.9	5.2	5.4	5.7
Azimuth Resolution [m]	99.5	99.5	99.9	99.6	100.3	100.7	100	99.5	100.2	99.6
Slant Range Pixel Spacing [m]	2.5	2.5	2.5	2.5	3.75	3.75	3.75	3.75	5	5
Azimuth Pixel Spacing [m]	67.1									
Incidence Angle Near [deg]	17.6	19.5	21.4	23.2	25.3	27.2	29.5	31.1	33.0	34.5
Equivalent Number of Looks (ENL)	1									
SAR Processing Parameters										
Number of Looks (Range x Azimuth)	1 x 1									
Look Overlap (Range x Azimuth)	N/A									

Table 39: TOPSAR Wide QP SLC product specification

6.2.4.2.2 DI

Product ID	TW_QP_DI									
Product Type	TOPSAR Wide, Ground-Range, Multi-Look, Detected									
Main product Characteristics										
Pixel Value	Magnitude									
Coordinate System	Ground Range									
Bits Per Pixel	16									
Polarization Options	QuadPol (HH VV HV VH)									
Beam ID	S1-QP	S2-QP	S3-QP	S4-QP	S5-QP	S6-QP	S7-QP	S8-QP	S9-QP	S10-QP
Ground Range Coverage [km]	21.9	22.0	21.0	25.4	23.4	29.4	20.9	25.1	22.1	14.2
Ground Range Resolution [m]	100.1	100.1	100	100	100	100.1	100	100.1	100	100
Azimuth Resolution [m]	99.5	99.5	99.9	99.6	100.3	100.7	100	99.5	100.2	99.6
Ground Range Pixel Spacing [m]	58.4									
Azimuth Pixel Spacing [m]	67.1									
Incidence Angle Near [deg]	17.6	19.5	21.4	23.2	25.3	27.2	29.5	31.1	33.0	34.5
Equivalent Number of Looks (ENL)	10									
SAR Processing Parameters										
Number of Looks (Range x	10 x 1									
Look Overlap (Range x Azimuth)	0 x 0									

Table 40: TOPSAR Wide QP DI product specification

6.2.4.2.3 GEC and GTC

Product ID	TW_QP_GEC, TW_QP_GTC									
Product Type	TOPSAR Wide, Geocoded, Ellipsoid/Terrain Corrected, Detected									
Main product Characteristics										
Pixel Value	Magnitude									
Coordinate System	UTM/UPS									
Bits Per Pixel	16									
Polarization Options	QuadPol (HH VV HV VH)									
Beam ID	S1-QP	S2-QP	S3-QP	S4-QP	S5-QP	S6-QP	S7-QP	S8-QP	S9-QP	S10-QP
Ground Range Coverage [km]	21.9	22.0	21	25.4	23.4	29.4	20.9	25.1	22.1	14.2
Lines and Columns Pixel Spacing [m]	67.1									
Incidence Angle Near [deg]	17.6	19.5	21.4	23.2	25.3	27.2	29.5	31.1	33.0	34.5

Table 41:TOPSAR Wide QP GEC/GTC product specification

7 XML product

7.1 Level 0

The XML file contains all the metadata associated to the SAR image. It is generated univocally from an XML Schema Definition (XSD) and it's organized in a set of complex types, as reported in the following diagram:

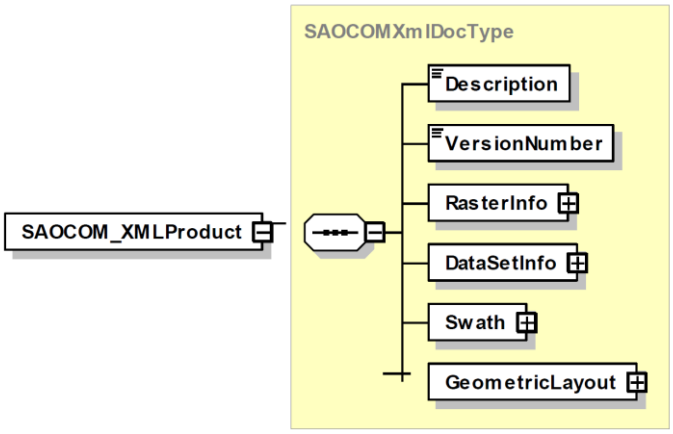


Table 42: Level-0 root element

7.1.1 RasterInfo type

This complex type contains information regarding binary file format and time coordinates of the image. The description of its elements is reported in the following table:

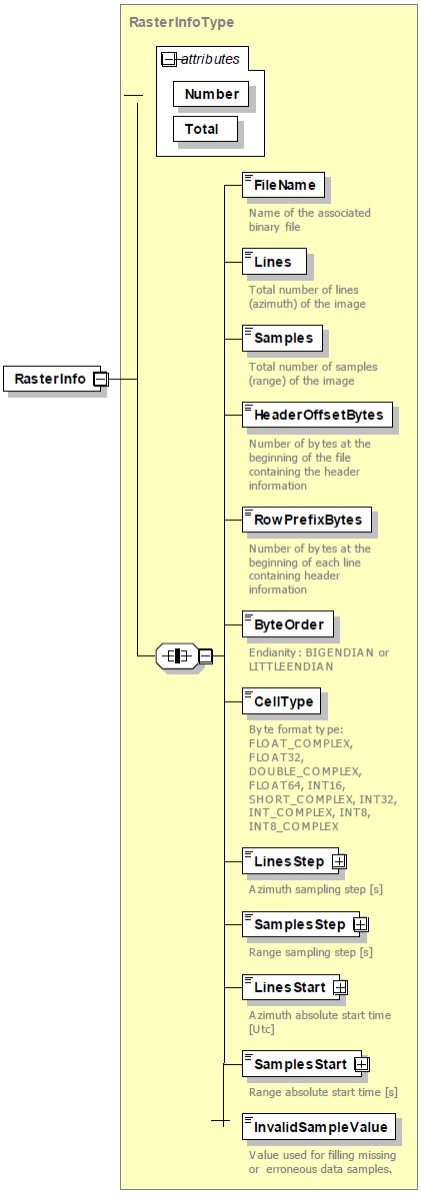


Table 43: XML Schema Definition: RasterInfo complex type.

7.1.2 DataSetInfo type

This complex type contains information regarding the dataset.

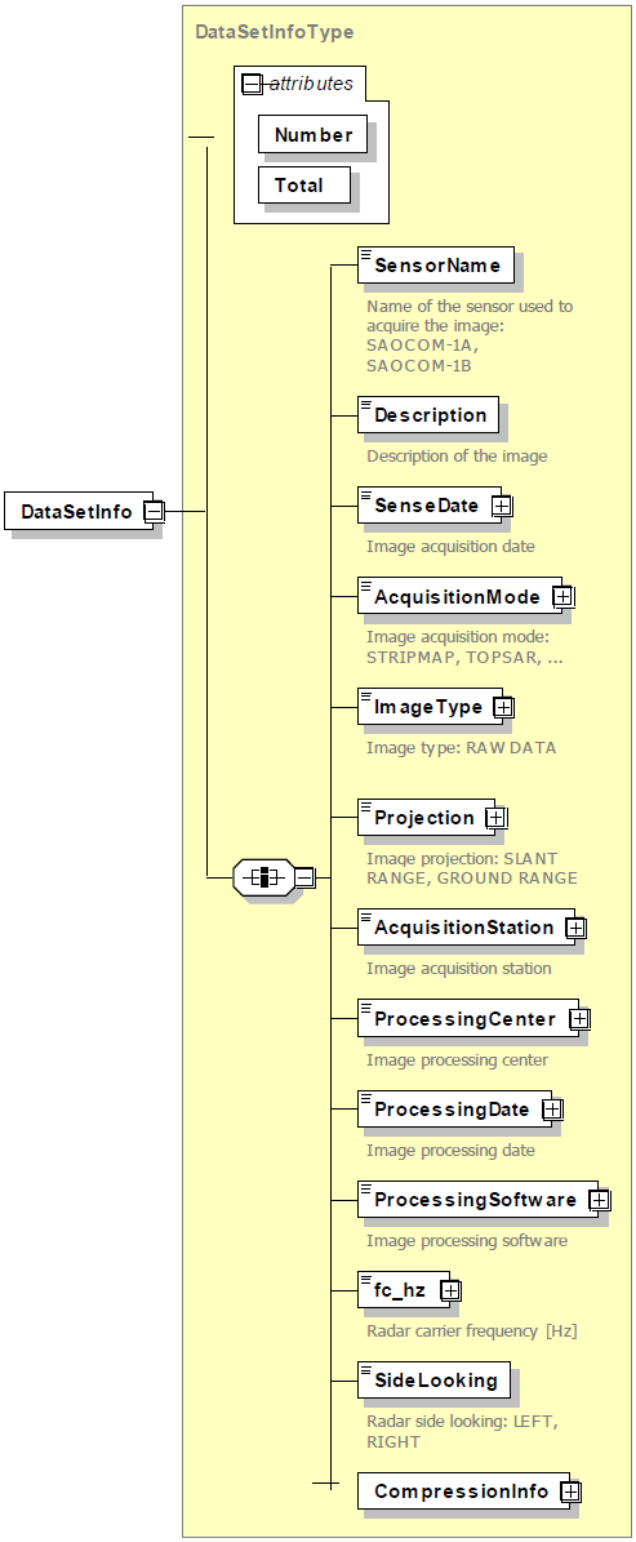

DataSetInfoType
attributes
Number
Total
DataSetInfo
SensorName
Name of the sensor used to acquire the image: SAOCOM-1A, SAOCOM-1B
Description
Description of the image
SenseDate
Image acquisition date
AcquisitionMode
Image acquisition mode: STRIPMAP, TOPSAR, ...
ImageType
Image type: RAW DATA
Projection
Image projection: SLANT RANGE, GROUND RANGE
AcquisitionStation
Image acquisition station
ProcessingCenter
Image processing center
ProcessingDate
Image processing date
ProcessingSoftware
Image processing software
fc_hz
Radar carrier frequency [Hz]
SideLooking
Radar side looking: LEFT, RIGHT
CompressionInfo

Table 44: DataSetInfo complex type.

The element CompressionInfo contains information about the compression schema adopted for the data.

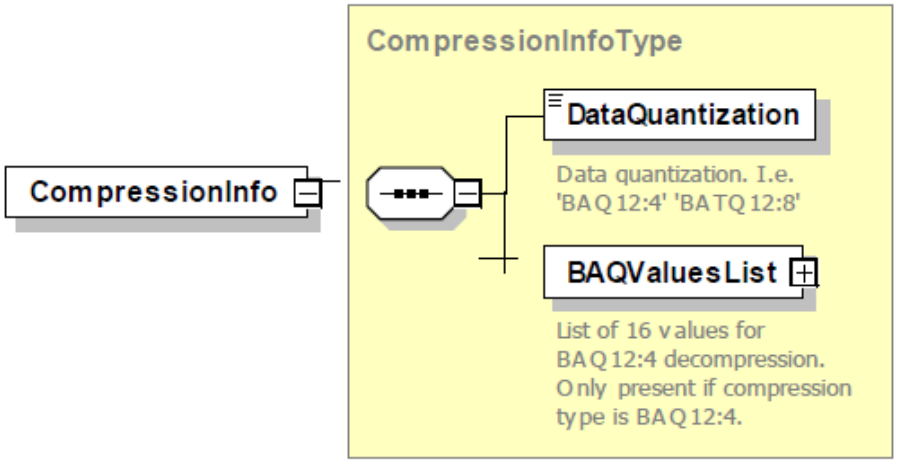


Table 45: CompressionInfo complex type for Level-0.

7.1.3 Swath type

This complex type contains information about the Swath timeline, acquisition parameters, pulse parameters and timing of each burst composing the swath.

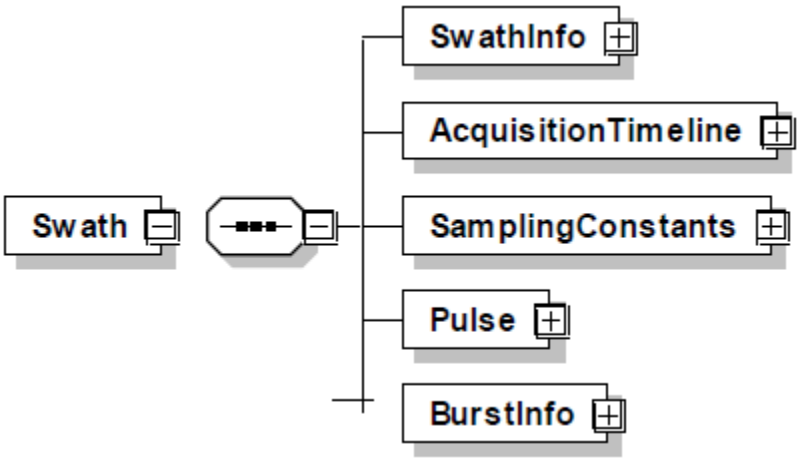
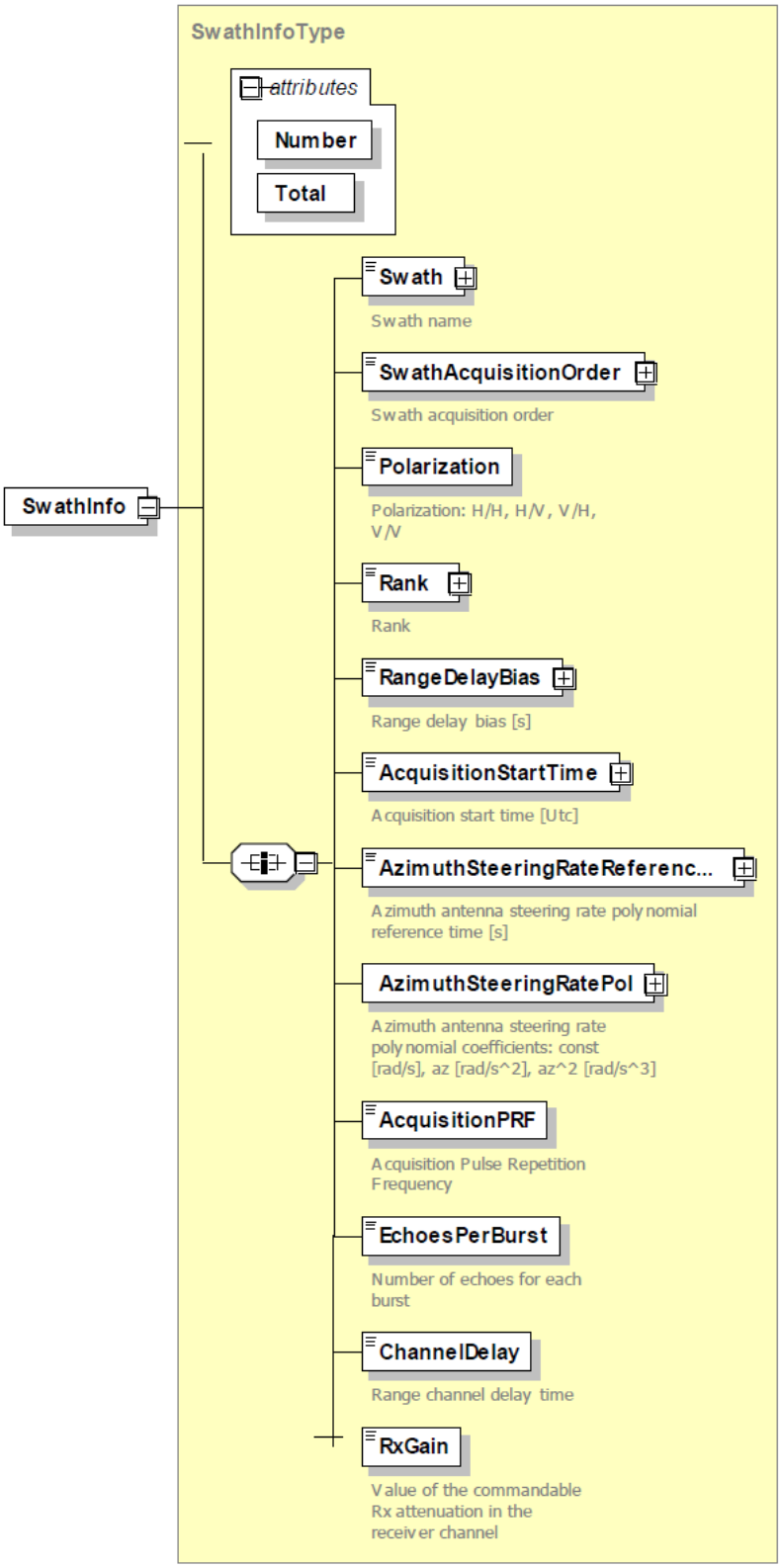


Table 46: Swath complex type for Level-0.

The *Swath* complex type is divided into five complex types, as visible from previous figure.

- SwathInfo, described in table Tab.47, contains information about the swath (name, acquisition order, Rank, PRF, etc.)
- AcquisitonTimeline, described in table Tab.48, containing information about the timing of the data and the presence of SWST, SWL, and PRF changes.
- Samplingconstant, described in table 49, contains a collection of constant used in the swaths.
- Pulse, described in table Tab.50, contains information about the length, the bandwidth and the energy of the pulse relative to the swaths.
- BurstInfo, described in table Tab.51, contains information about the timing of each burst of the acquisition relative to the considered swath.

Their description is reported in the following table and subsequent.


SwathInfoType
attributes
Number
Total
SwathInfo
Swath
Swath name
SwathAcquisitionOrder
Swath acquisition order
Polarization
Polarization: H/H, H/V, V/H, V/V
Rank
Rank
RangeDelayBias
Range delay bias [s]
AcquisitionStartTime
Acquisition start time [Utc]
AzimuthSteeringRateReferenc...
Azimuth antenna steering rate polynomial reference time [s]
AzimuthSteeringRatePol
Azimuth antenna steering rate polynomial coefficients: const [rad/s], az [rad/s^2], az^2 [rad/s^3]
AcquisitionPRF
Acquisition Pulse Repetition Frequency
EchoesPerBurst
Number of echoes for each burst
ChannelDelay
Range channel delay time
RxGain
Value of the commandable Rx attenuation in the receiver channel

---

Table 47: SwathInfo complex type for Level-0.

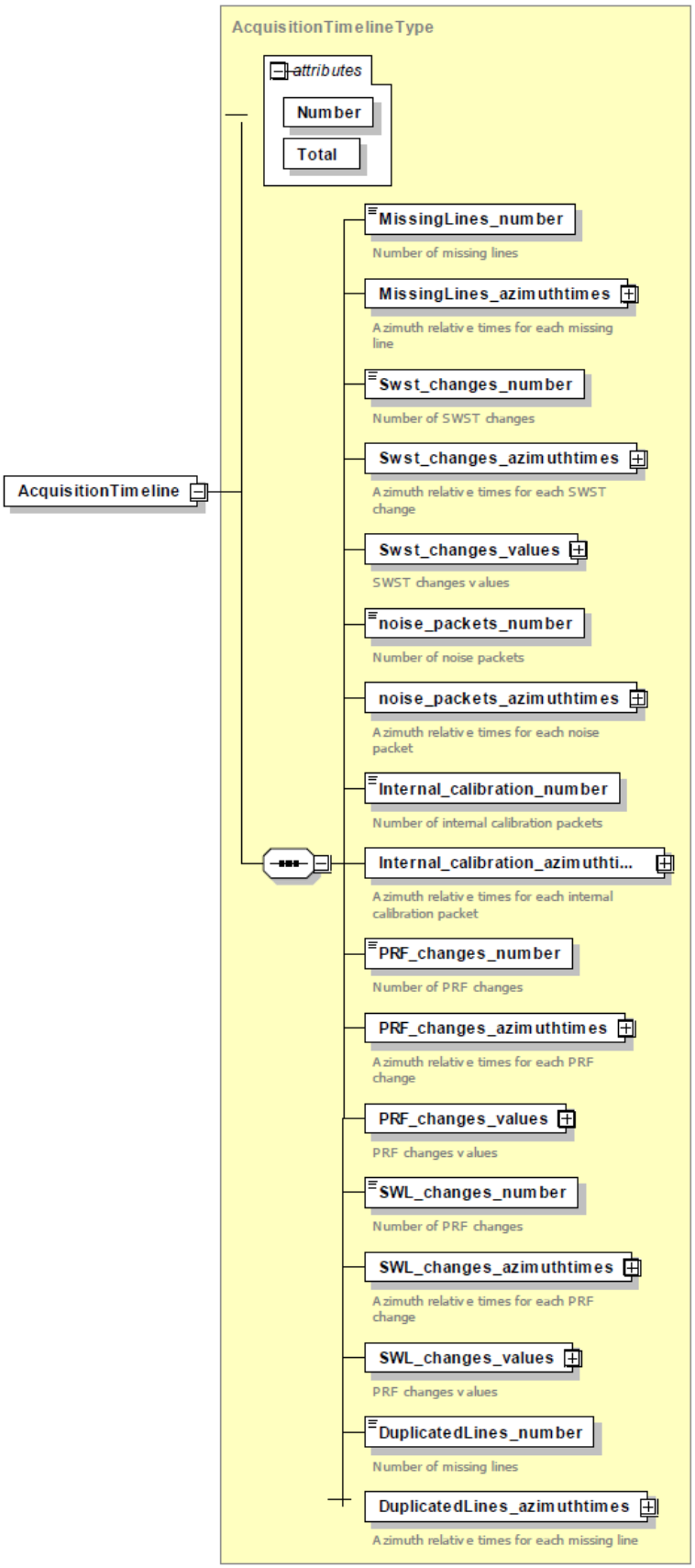

AcquisitionTimelineType
attributes
Number
Total
AcquisitionTimeline
MissingLines_number
Number of missing lines
MissingLines_azimuthtimes
Azimuth relative times for each missing line
Swst_changes_number
Number of SWST changes
Swst_changes_azimuthtimes
Azimuth relative times for each SWST change
Swst_changes_values
SWST changes values
noise_packets_number
Number of noise packets
noise_packets_azimuthtimes
Azimuth relative times for each noise packet
Internal_calibration_number
Number of internal calibration packets
Internal_calibration_azimuthti...
Azimuth relative times for each internal calibration packet
PRF_changes_number
Number of PRF changes
PRF_changes_azimuthtimes
Azimuth relative times for each PRF change
PRF_changes_values
PRF changes values
SWL_changes_number
Number of PRF changes
SWL_changes_azimuthtimes
Azimuth relative times for each PRF change
SWL_changes_values
PRF changes values
DuplicatedLines_number
Number of missing lines
DuplicatedLines_azimuthtimes
Azimuth relative times for each missing line

Table 48: AcquisitionTimeline complex type for Level-0.

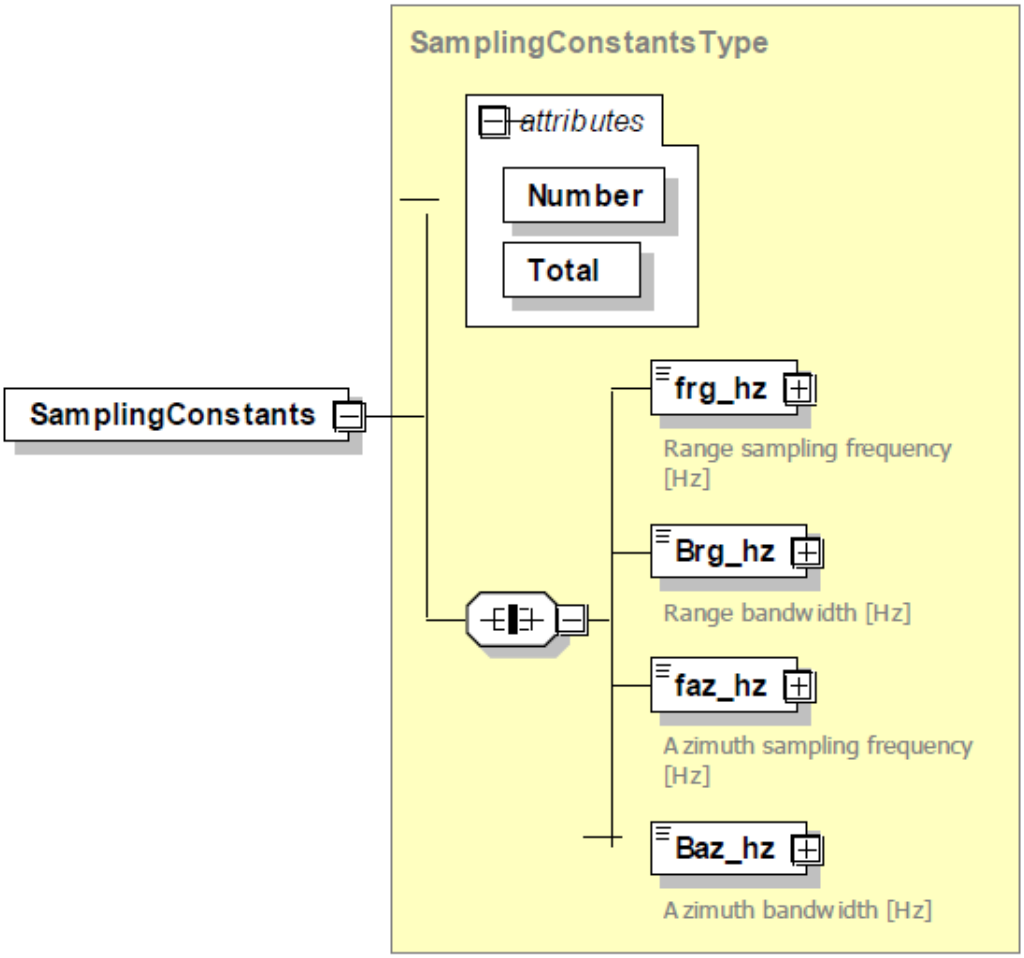


Table 49: SamplingConstants complex type for Level-0.

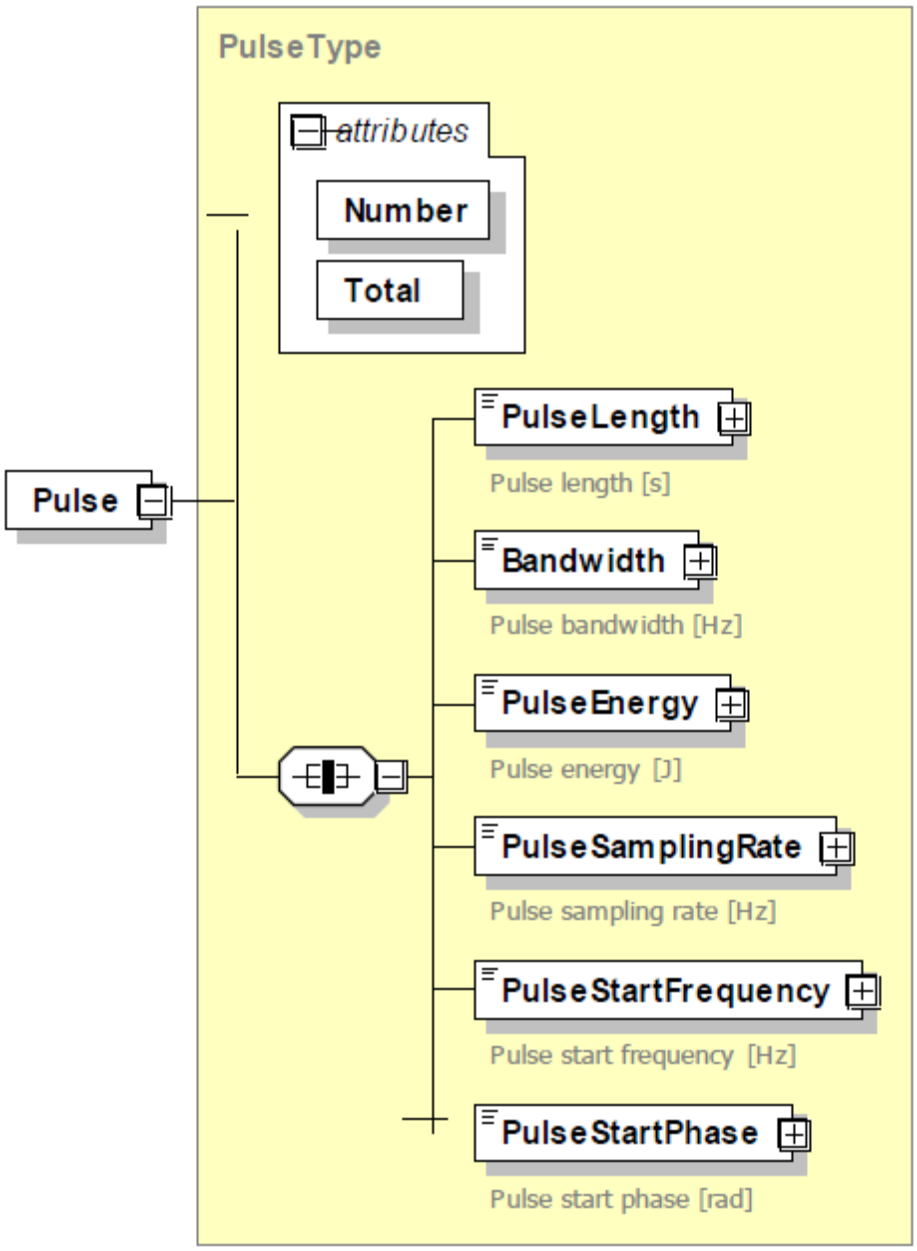


Table 50: Pulse complex type for Level-0.

To describe the burst in case of bursted acquisition an additional complex type, named BurstInfo, is present in Swath. Its description is reported in the following table.

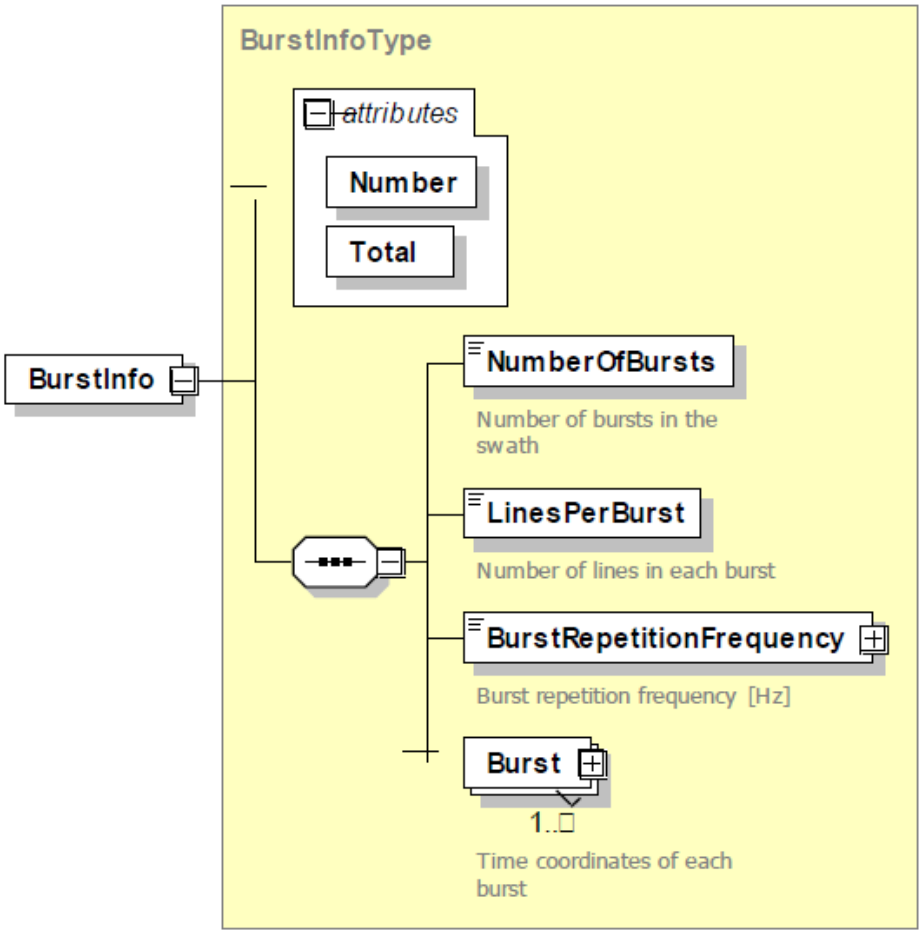


Table 51: BurstInfo complex type for Level-0.

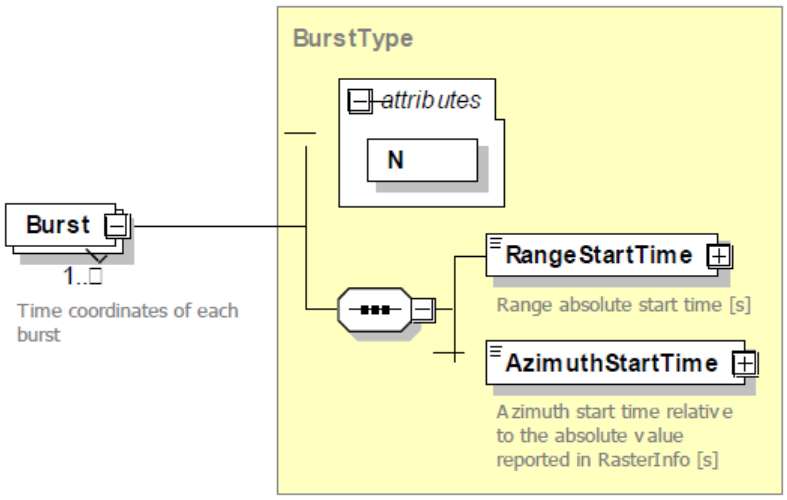


Table 52: BurstInfo/Burst complex type for Level-0.

7.1.4 GeometricLayout type

This complex type contains information regarding the sensor nominal attitude.

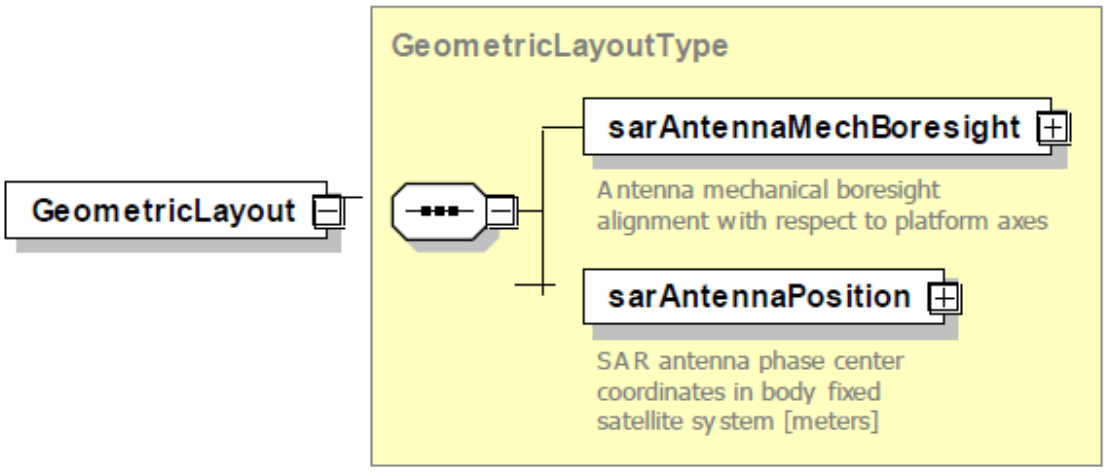


Table 53: GeometricLayout element complex type for Level-0.

The sub-elements are described in the following tables:

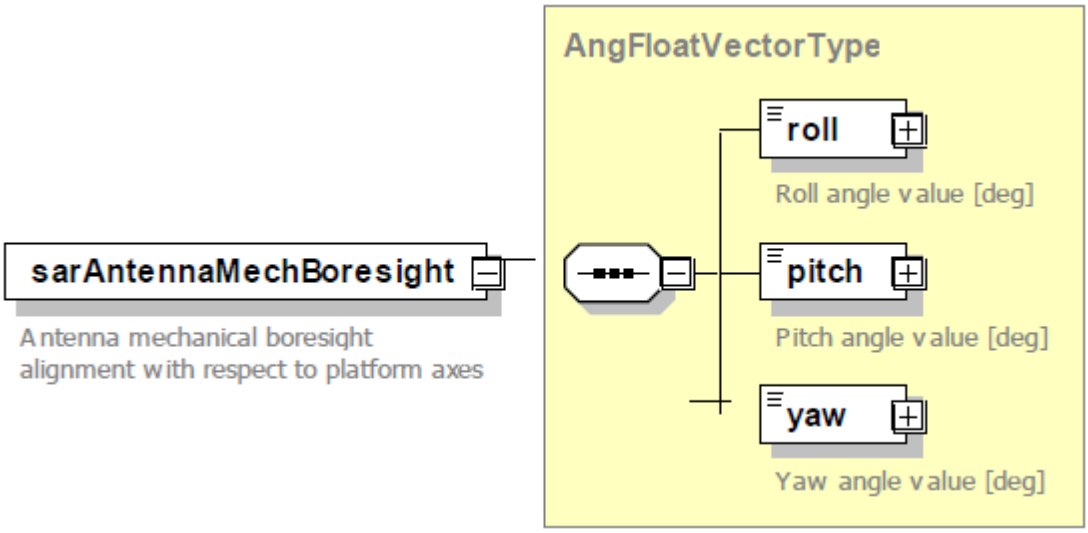


Table 54: GeometricLayout/sarAntennaMechBoresight element complex type for Level-0.

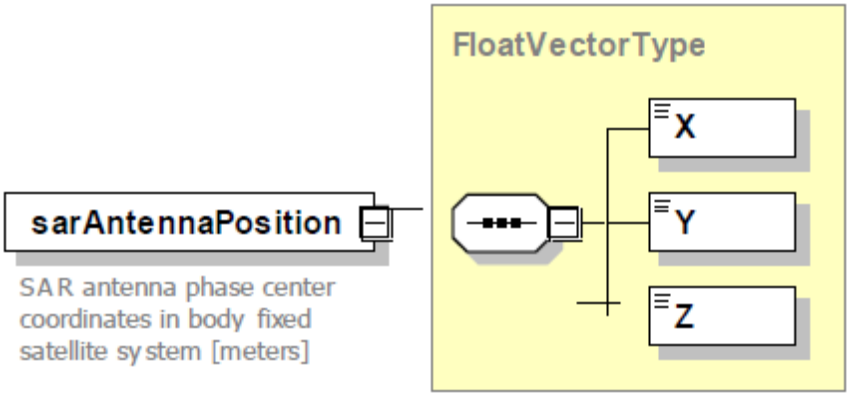


Table 55: GeometricLayout/sarAntennaPosition element complex type for Level-0.

7.2 Level 1

Measurement Data Level-1 file given in output are encoded as a binary big geoTIFF + annotation file in xml format, i.e.:

- The binary geoTIFF file contains the SAR image written column-wise in single precision floating point (8 bytes for each sample of SLC products, being 4 for the real part and 4 for the imaginary part, and 4 bytes for each sample of DI, GEC and GTC products).
- The XML file contains all the metadata associated to the SAR image. It is generated univocally from an XML Schema Definition (XSD) and it's organized in a set of complex types, as reported in the following diagram.

The root element of the product is reported hereafter.

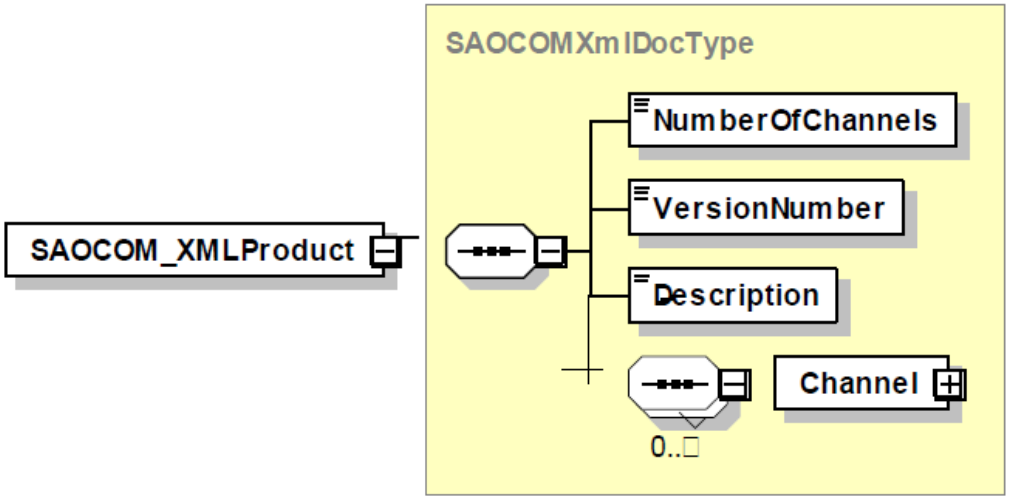


Table 56: Root element of Level-1 data.

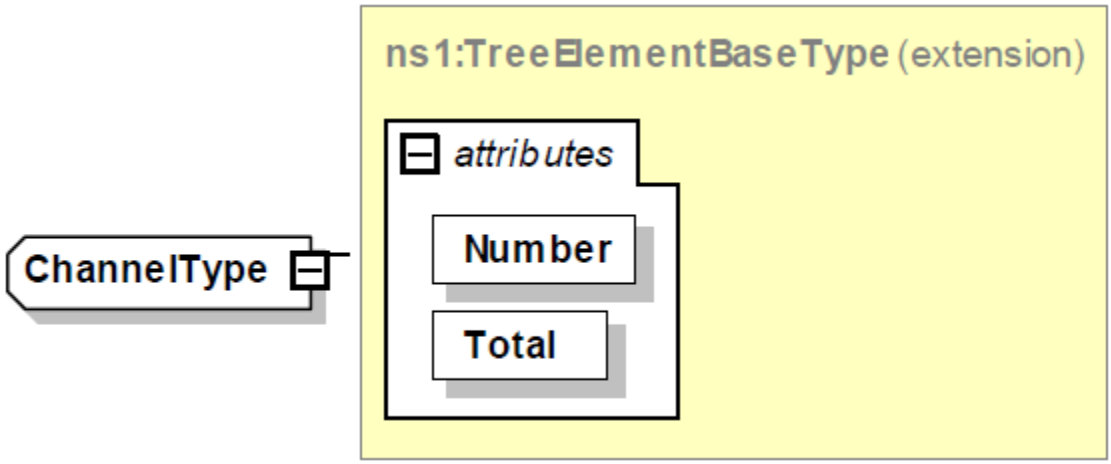


Table 57: Attribute of element Channel

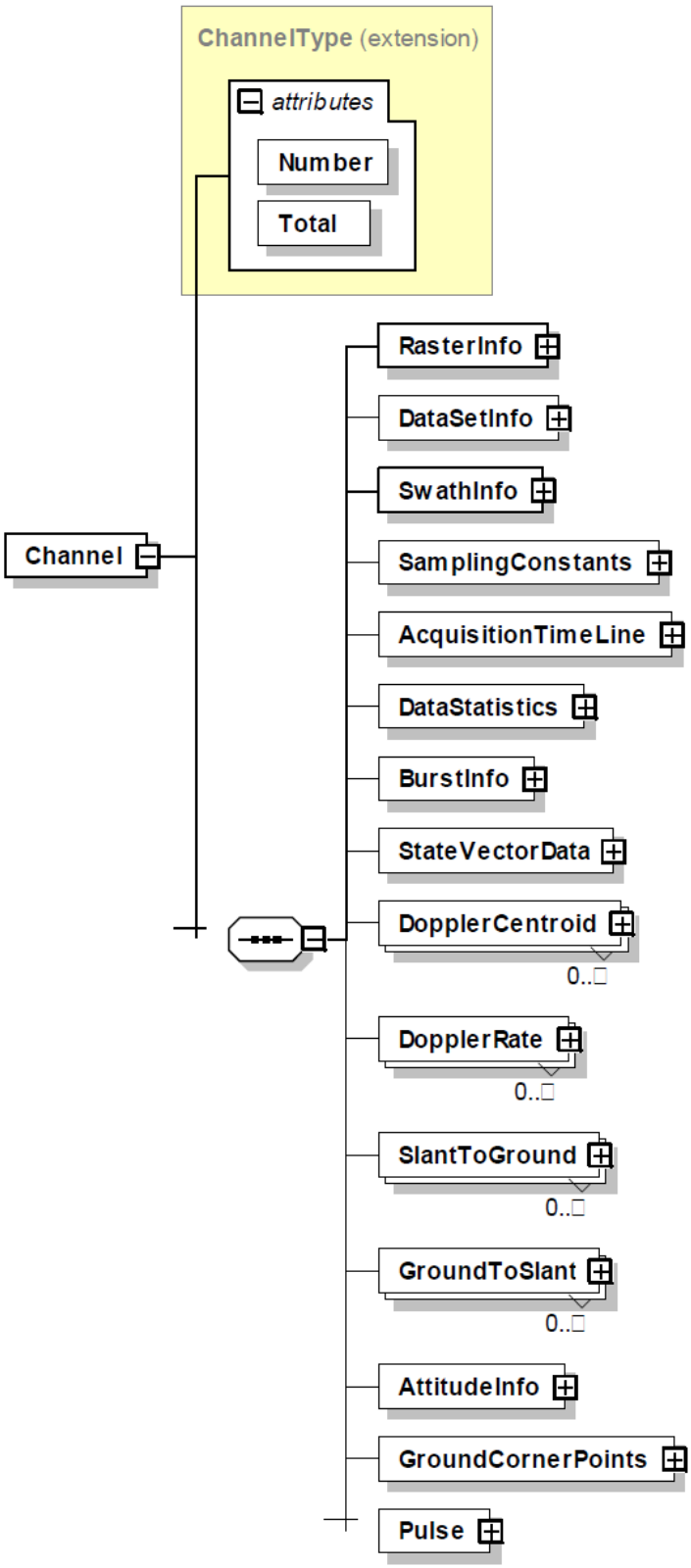

ChannelType (extension)
attributes
Number
Total
Channel
RasterInfo
DataSetInfo
SwathInfo
SamplingConstants
AcquisitionTimeLine
DataStatistics
BurstInfo
StateVectorData
DopplerCentroid
0..□
DopplerRate
0..□
SlantToGround
0..□
GroundToSlant
0..□
AttitudeInfo
GroundCornerPoints
Pulse

Table 58: SAOCOM_XMLProduct/Channel element description.

The channel element contains as sub tags all the information related to one acquisition. It contains mandatorily the RasterInfo section with information about the geoTIFF data (number of samples, number of lines, header offset size) and SwathInfo, useful to identify univocally the data.

The other sections are optional. The Level 1 data foreseen the presence of the following sections:

- DatasetInfo;
- SamplingConstants;
- AcquisitionTimeline;
- DataStatistics;
- BurstInfo;
- StateVectorData;
- DopplerCentroid;
- DopplerRate;
- SlantToGround;
- GroundToSlant;
- AttitudeInfo;
- GroundCornerPoints
- Pulse

7.2.1 RasterInfo

The RasterInfo information block contains the main properties and parameters of the raster binary data.

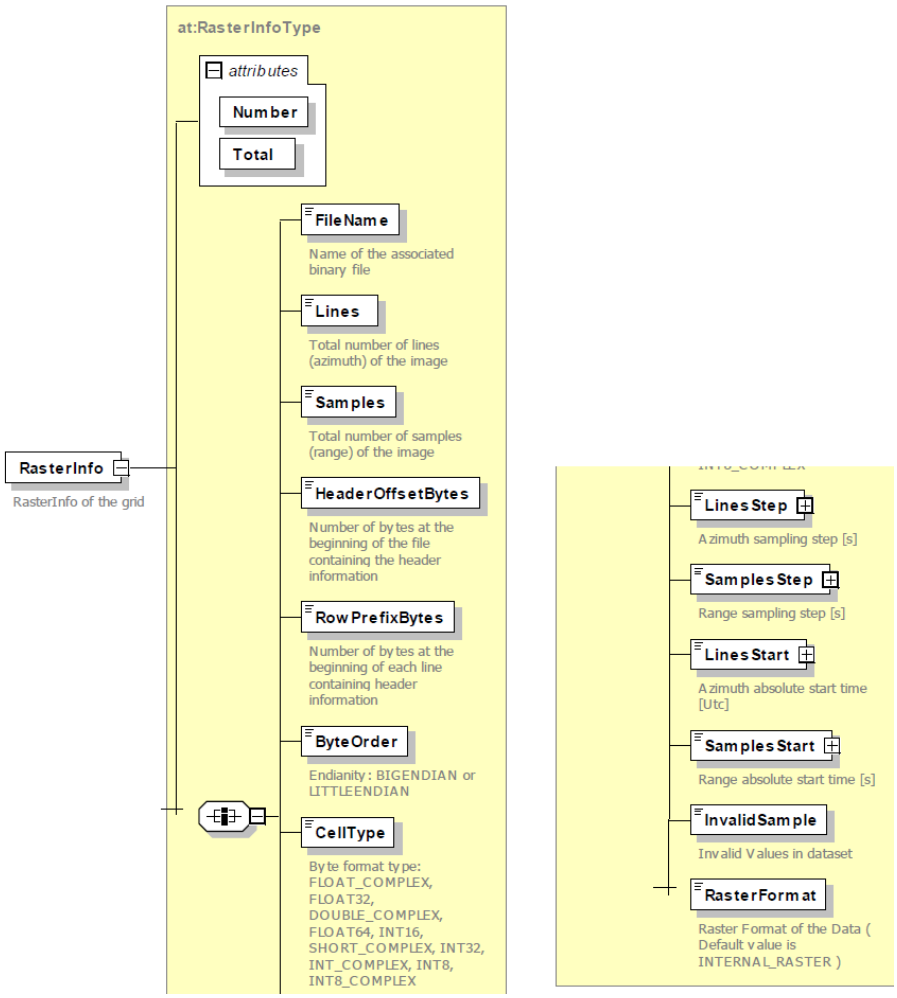


Table 59: RasterInfo element description.

7.2.2 DataSetInfo

The DataSetInfo information block contains high-level information regarding the data set (acquisition mode, sensor, etc.).

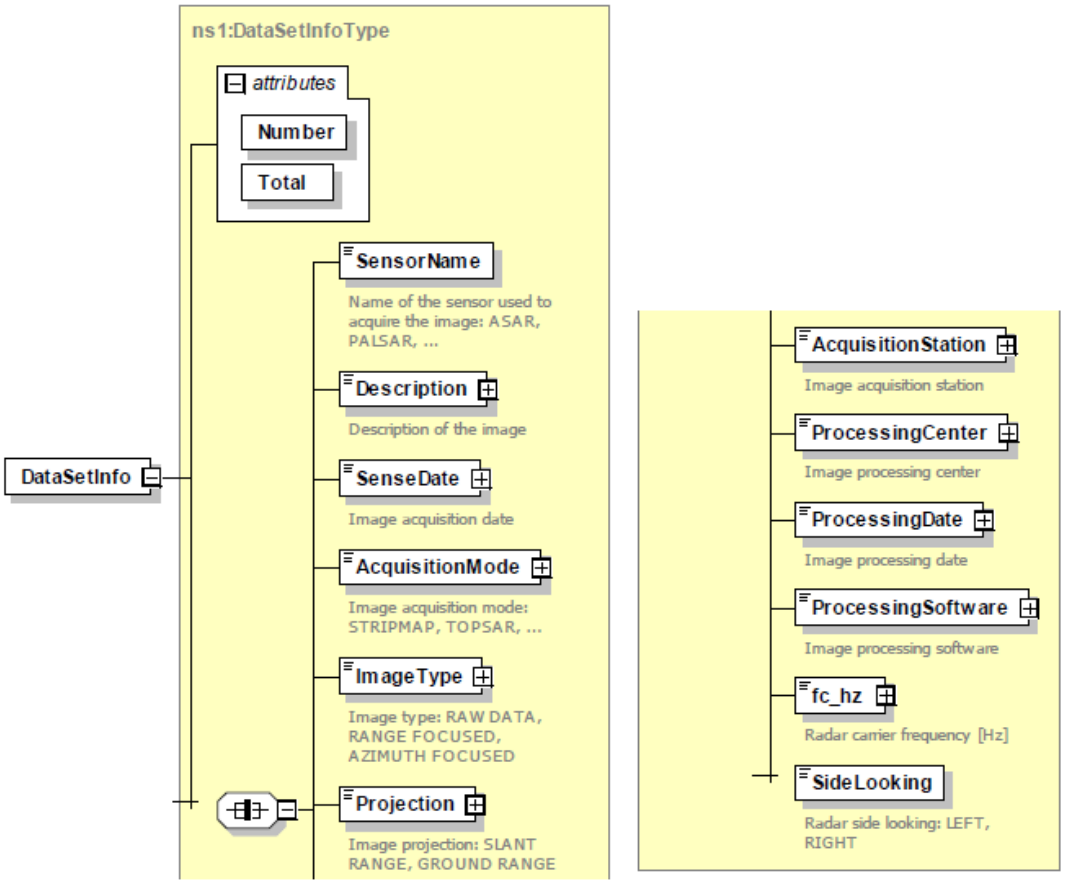
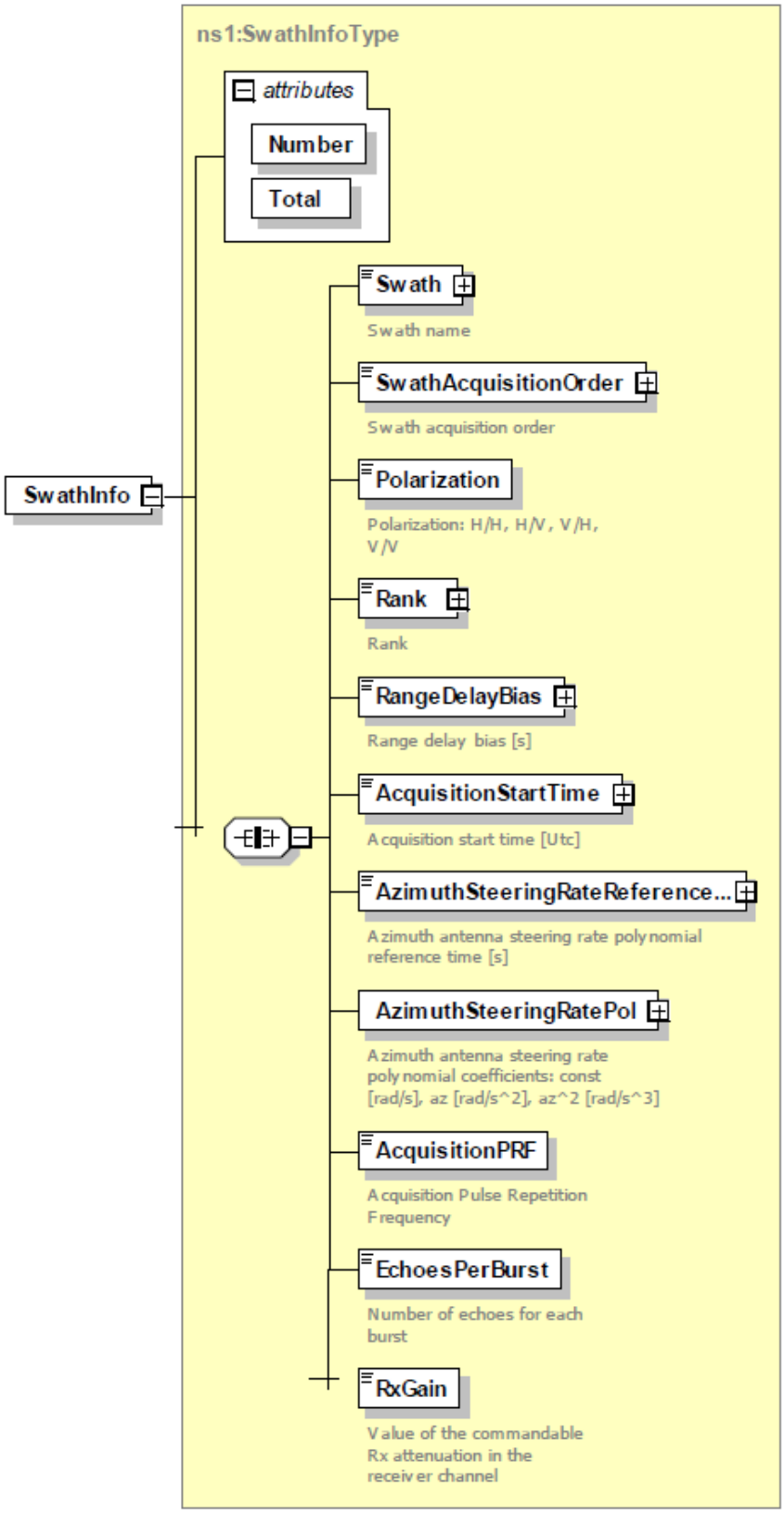


Table 60: DataSetInfo element description.

7.2.3 SwathInfo

The SwathInfo information block contains information about the specific swath.


ns1:SwathInfoType
attributes
Number
Total
SwathInfo
Swath
Swath name
SwathAcquisitionOrder
Swath acquisition order
Polarization
Polarization: H/H, H/V, V/H, V/V
Rank
Rank
RangeDelayBias
Range delay bias [s]
AcquisitionStartTime
Acquisition start time [Utc]
AzimuthSteeringRateReference...
Azimuth antenna steering rate polynomial reference time [s]
AzimuthSteeringRatePol
Azimuth antenna steering rate polynomial coefficients: const [rad/s], az [rad/s^2], az^2 [rad/s^3]
AcquisitionPRF
Acquisition Pulse Repetition Frequency
EchoesPerBurst
Number of echoes for each burst
RxGain
Value of the commandable Rx attenuation in the receiver channel

---

Table 61: SwathInfo element description.

7.2.4 SamplingConstants

The SamplingConstants information block contains information about the sampling frequencies and bandwidths related to the data acquisition.

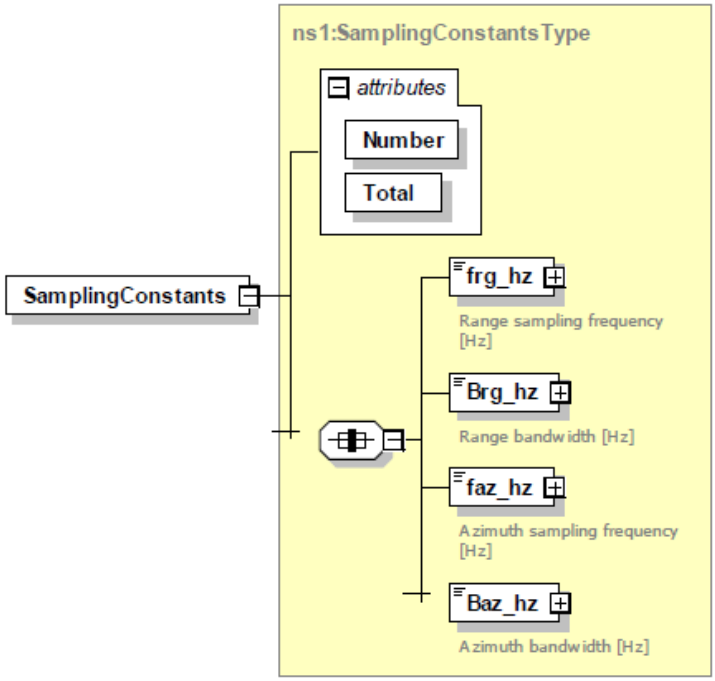


Table 62: SamplingConstants element description.

7.2.5 AcquisitionTime Line

The AcquisitionTimeLine information block contains information about the echoes acquisition time line.

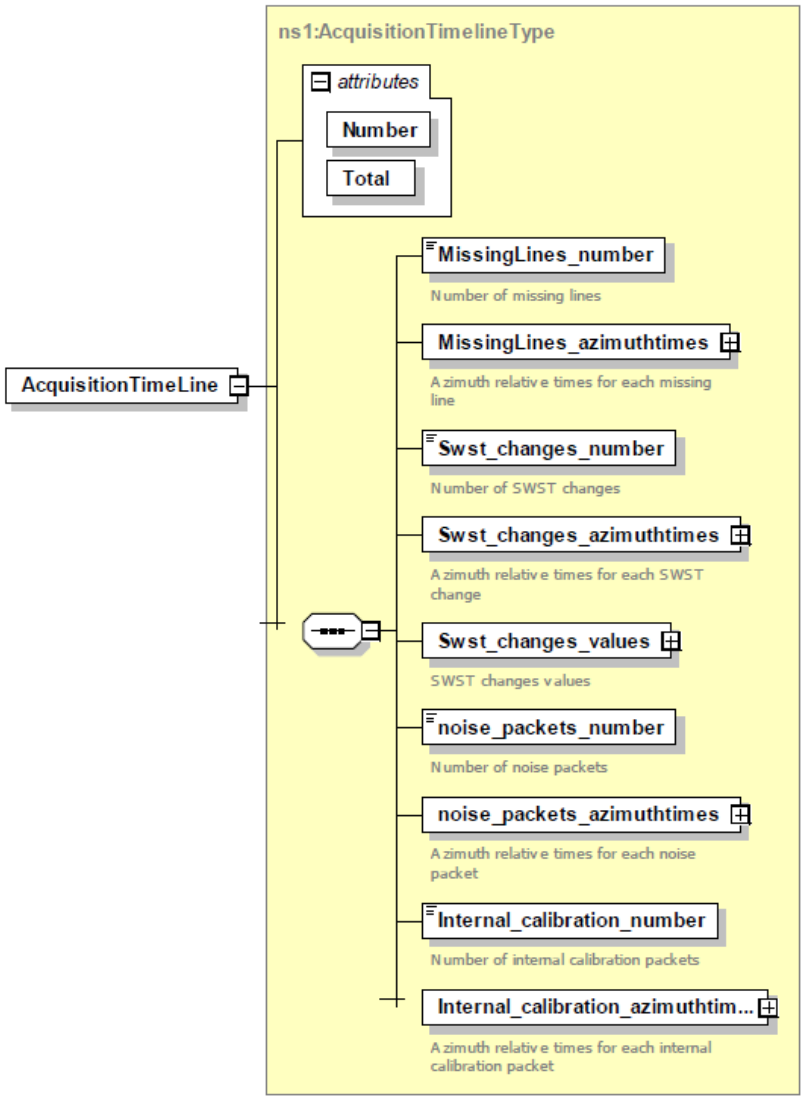


Table 63: AcquisitionTimeLine element description.

7.2.6 DataStatistics

The DataStatistics information block contains information about some important statistics computed from image data.

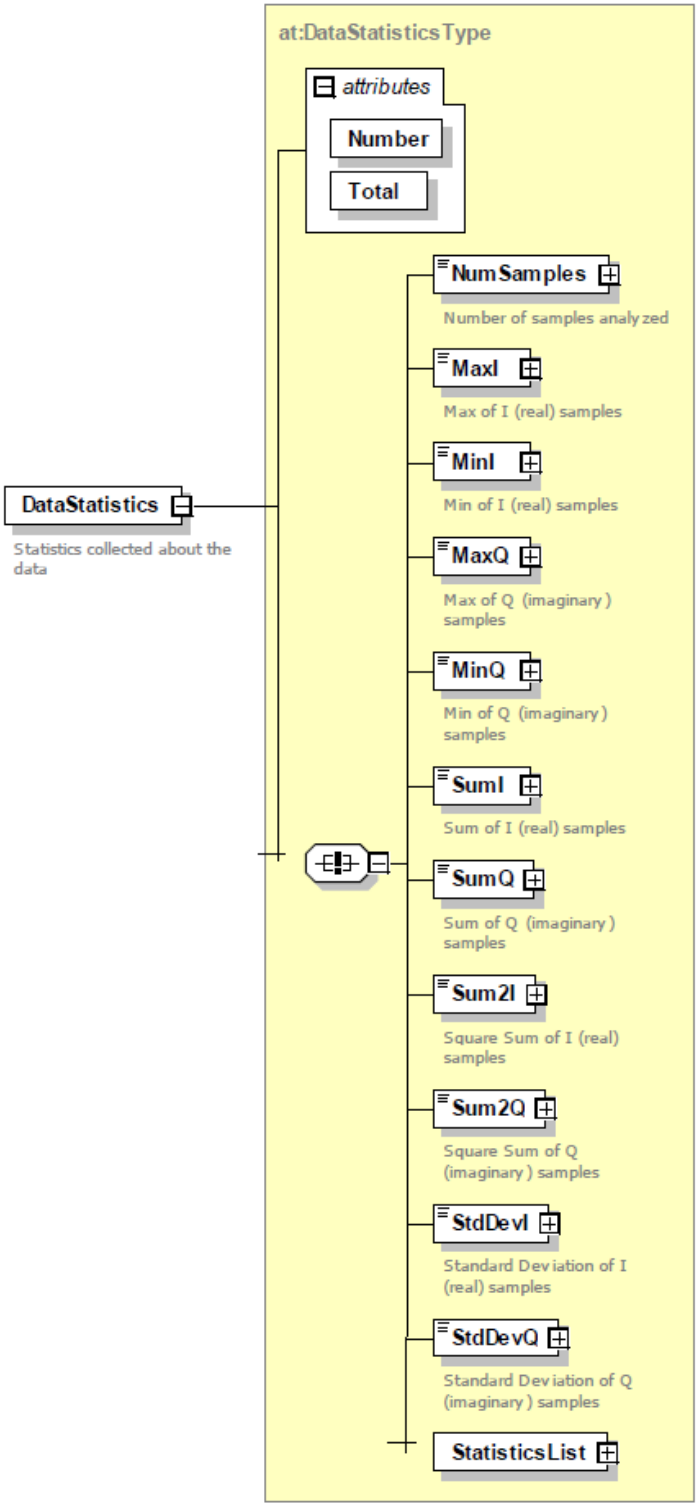


Table 64: DataStatistics element description.

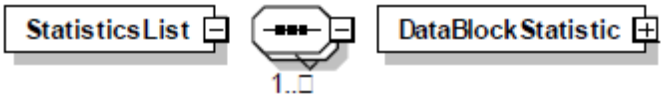


Table 65: DataStatisticsType/StatisticsList.

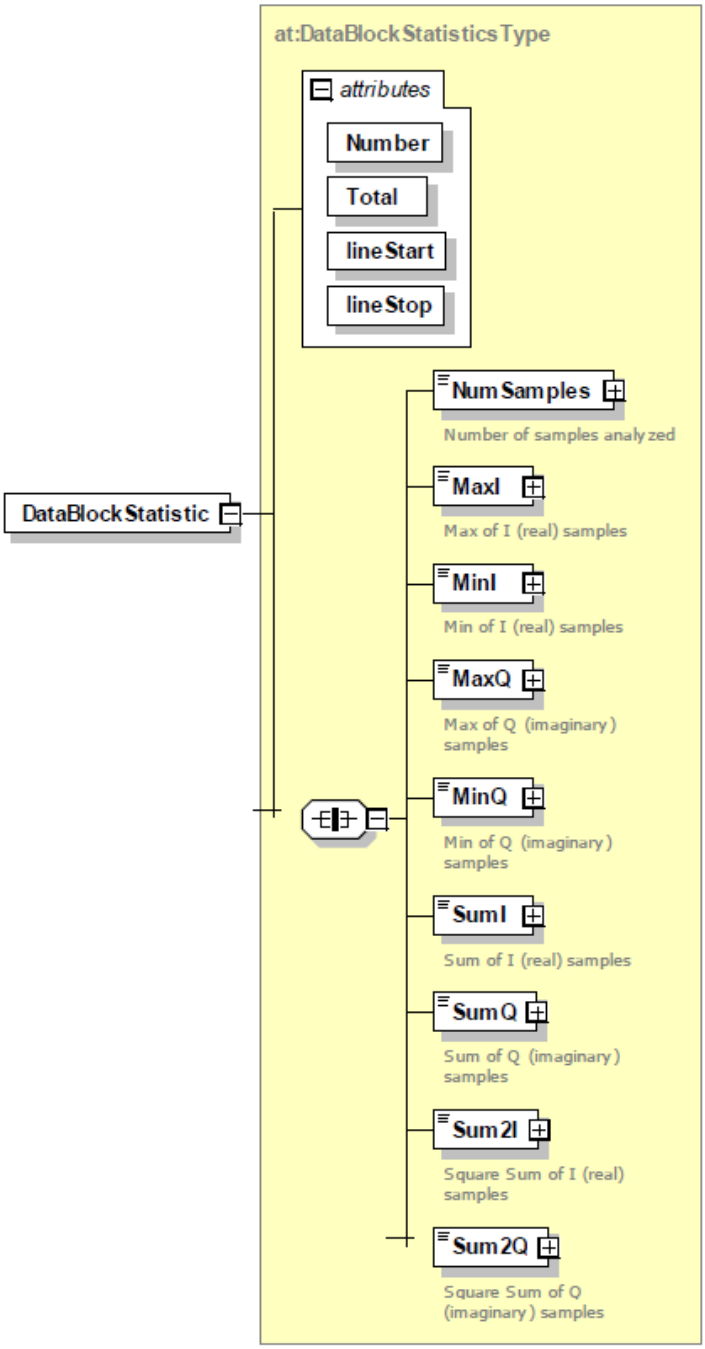


Table 66: DataBlockStatistics element description.

7.2.7 BurstInfo

The BurstInfo information block contains information about the burst subdivision of the image.

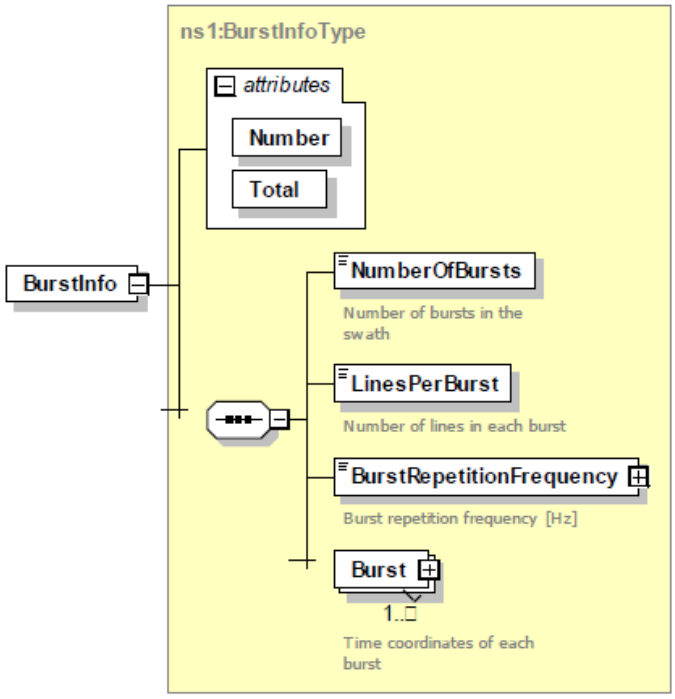


Table 67: BurstInfo element description.

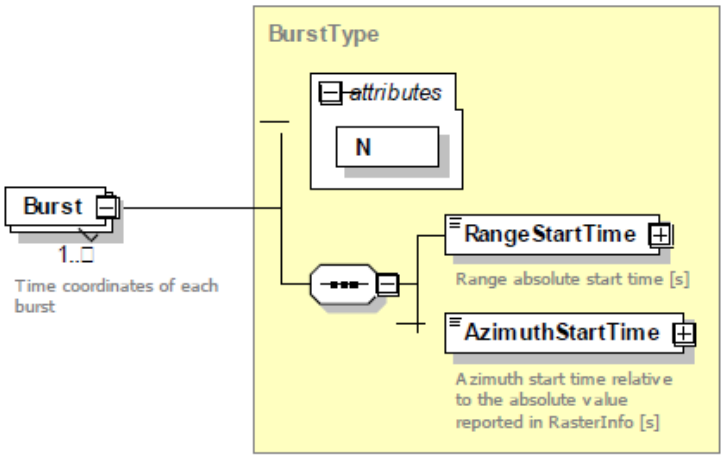


Table 68: BurstInfo/Burst complex type.

7.2.8 StateVectorData

The StateVectorData information block contains information regarding position and velocity of the sensor along the orbit.

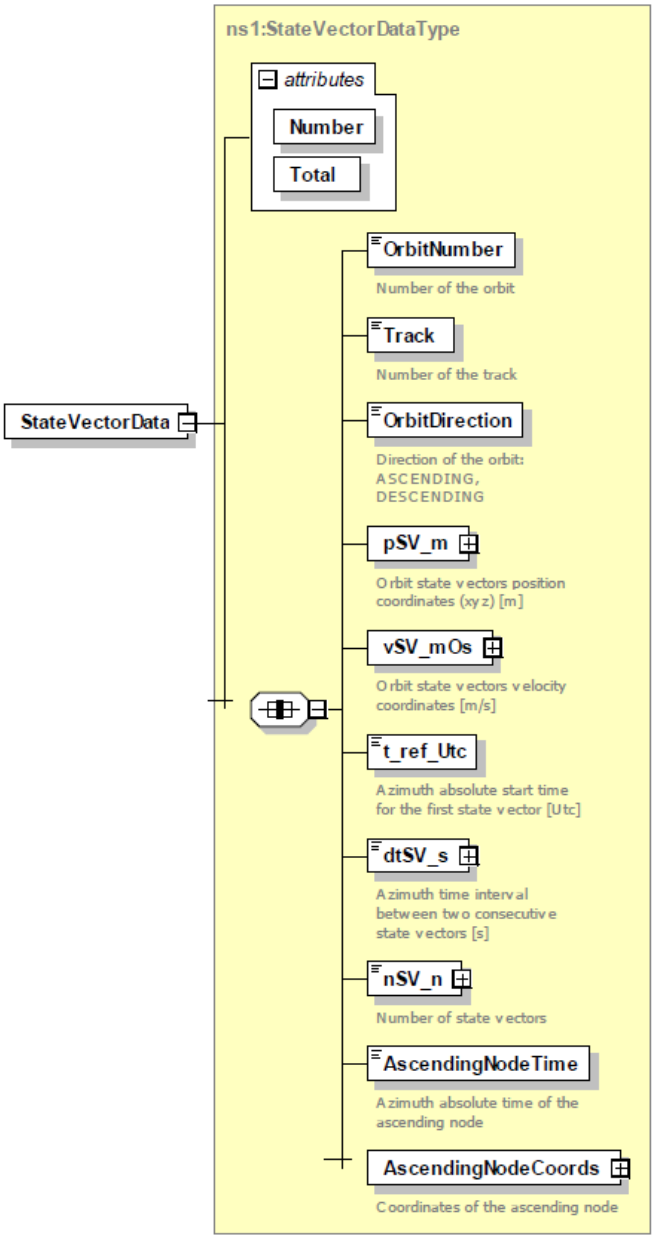


Table 69: StateVectorData element description.

7.2.9 DopplerCentroid

The DopplerCentroid information block contains information about the Doppler centroid frequency

polynomial. If present, one or more instances of DopplerCentroid blocks are allowed to be stored in the header.

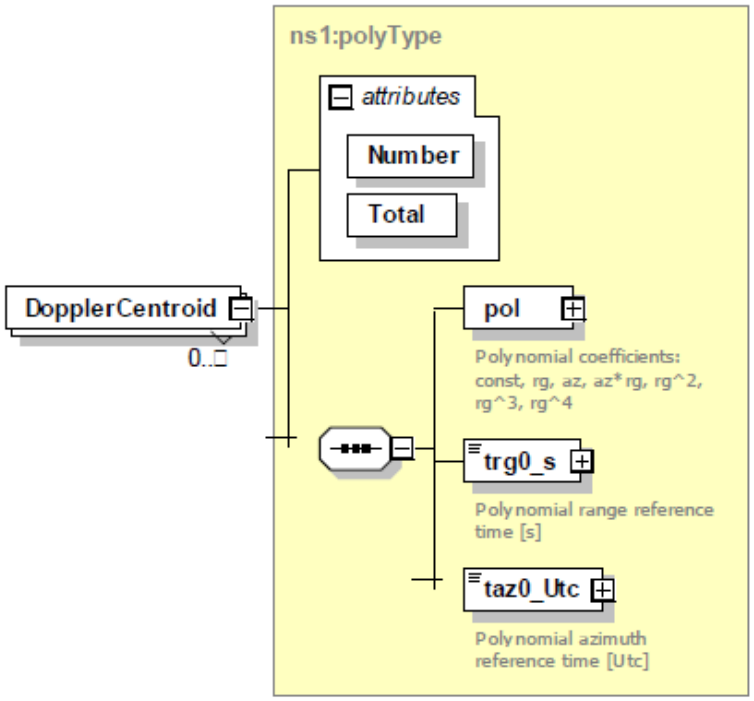


Table 70: DopplerCentroid element description.

7.2.10 DopplerRate

The DopplerRate information block contains information about the Doppler rate polynomial. If present, one or more instances of DopplerRate blocks are allowed to be stored in the header.

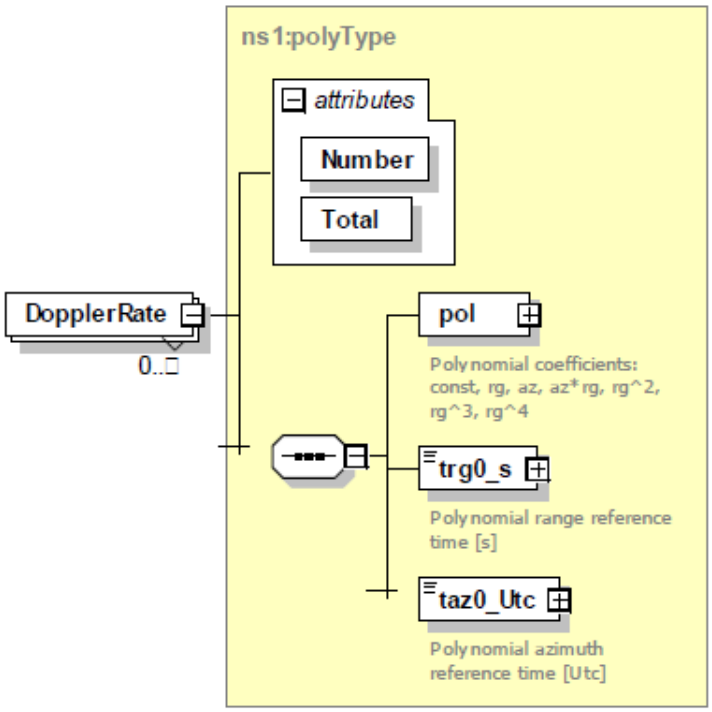


Table 71: DopplerRate element description.

7.2.11 SlantToGround

The SlantToGround information block contains the polynomial to pass from Slant-range coordinates to Ground-range coordinates. If present, one or more instances of SlantToGround blocks are allowed to be stored in the header.

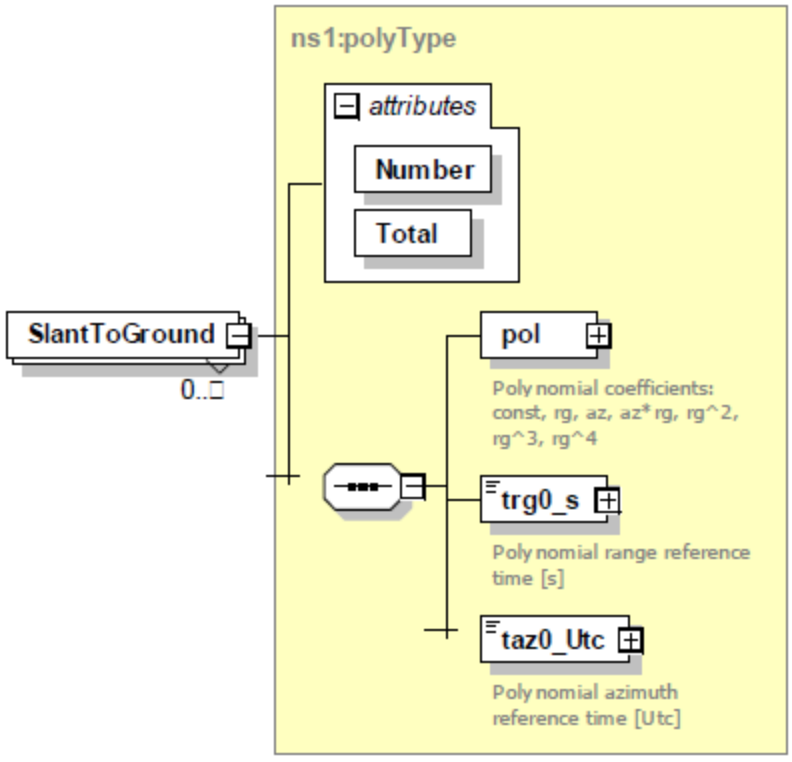


Table 72: SlantToGround element description.

7.2.12 GroundToSlant

The GroundToSlant information block contains the polynomial to pass from Ground-range coordinates to Slant-range coordinates. If present, one or more instances of GroundToSlant blocks are allowed to be stored in the header.

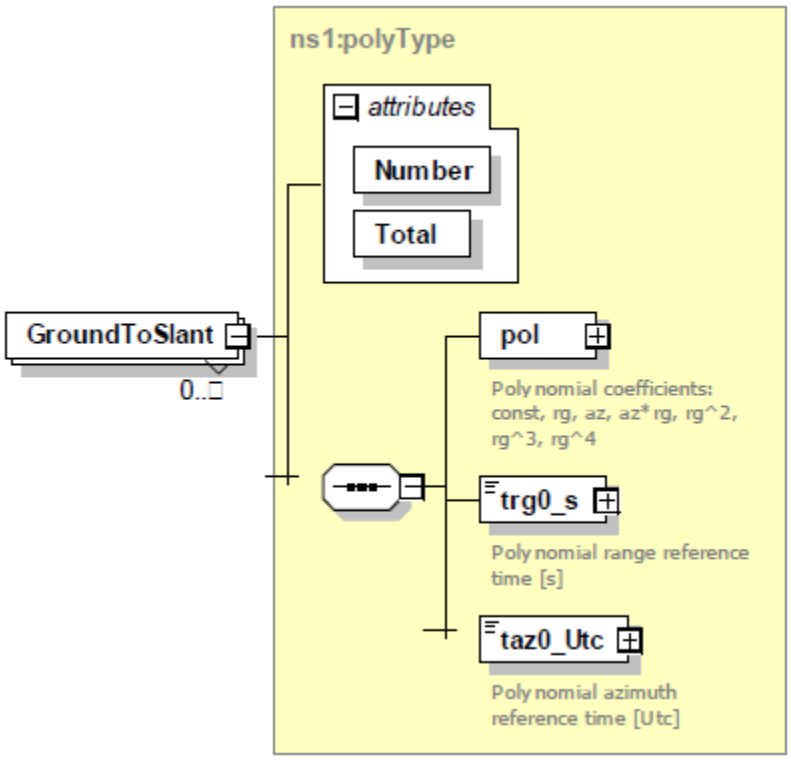


Table 73: GroundToSlant element description.

7.2.13 AttitudeInfo

This complex type contains information regarding the sensor attitude.

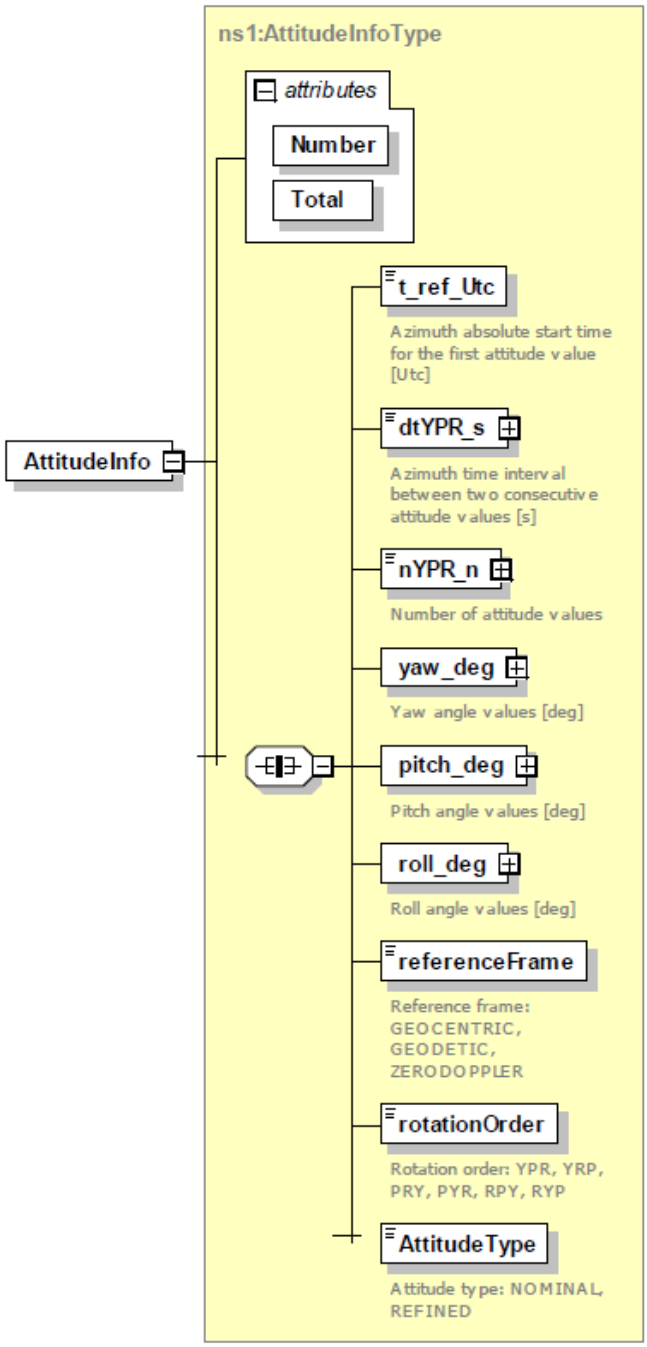


Table 74: AttitudeInfo element description.

7.2.14 GroundCornersPoints

This complex type contains information about the ground positioning of the image. If present, only one instance will be available per swath.

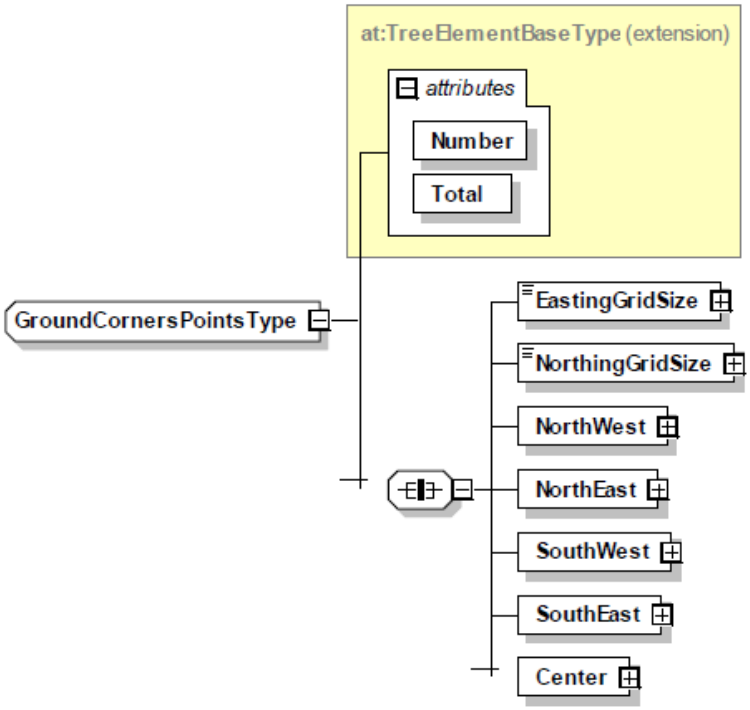


Table 75: GroundCornerPoints element description.

7.2.15 Pulse

The Pulse information block contains information regarding the parameters of the nominal chirp replica associated to the current image.

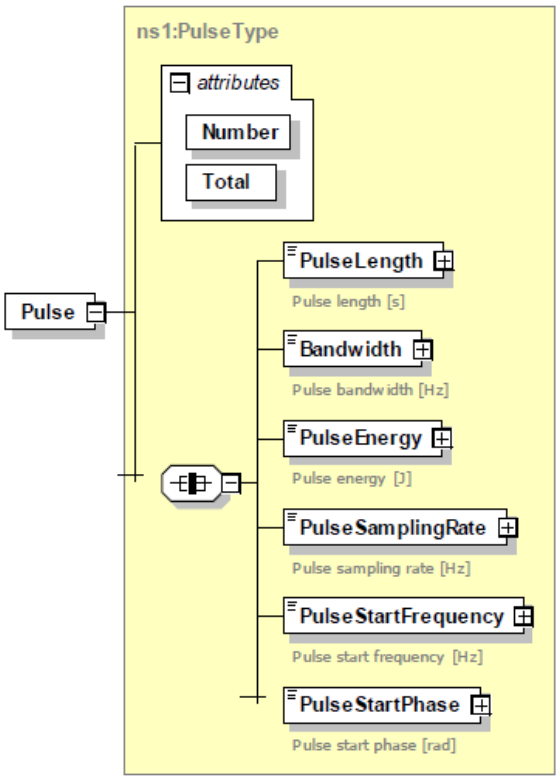


Table 76: Pulse element description.

8 HIGH LEVEL PRODUCTS

8.1 Interferometric Products

8.1.1 Input

Interferometric products are obtained from a pair of SAOCOM STRIPMAP Level-1A (SLC) images with the same acquisition mode and same polarization, admitting Single Polarization, Dual Polarization or Quad Polarization products. This pair of images will be referred to as a master-slave pair.

Interferometric products are generated from a predefined list of workflows:

- interfero_flat
- interfero_dif
- coregistered_stack

And are processed according to the following user-selectable parameters related to the geographic projection:

a. No projection (i.e. slant range geometry)
b. Latitude/Longitude cartographic projection

Note: geographic projections are made using SRTM DEM.

8.1.2 Output

The Interferometric products that will be delivered depends on the selected workflow:

8.1.2.1 Corregister_stack workflow

The coregistered_stack workflow generates a stack of N SLC images co-registered with sub-pixel accuracy with respect to a common master.

Product	Description	File Format
Master	Master SLC image	BINARY. Each pixel is a FLOAT_COMPLEX (32 bits real, 32 bits imaginary).
Slave[1...N]	Slave SLC image co-registered with Master with sub-pixel accuracy.	BINARY. Each pixel is a FLOAT_COMPLEX (32 bits real, 32 bits imaginary).
Master.tif	[Optional] Master amplitude image geoprojected using SRTM DEM	GeoTIFF
Slave[1...N].tif	[Optional] Slave amplitude image (co-registered with Master) geoprojected using SRTM DEM	GeoTIFF
Master.kmz	Master amplitde geoprojected kmz	KMZ
Slave[1...N].kmz	[Optional] Slave amplitude (co-registered with Master) geoprojected kmz	KMZ
Master.png	Master amplitude quicklook in slant range geometry	PNG
Slave[1...N].png	Slave amplitude quicklook in slant range geometry (co-registered with Master)	PNG
Coregistered_stack.xml	XML Header file with metadata	XML

Table 77: Coregistered_stack workflow products

How to read binary files

The file **Coregistered_stack .xml** contains the metadata of coregistered_stack workflow's products:

- **RasterInfo**: this section of the metatada contains all the necessary information to open images in any external program.

    - **Lines**: number of pixels on azimuth dimension
    - **Samples**: number of pixels on range dimension
    - **LinesStep**: step in seconds between two consecutive pixels in azimuth direction.
    - **SamplesStep**: step in seconds between two consecutive pixels in range direction.
    - **LinesStart**: UTC time of first azimuth pixel.
    - **SamplesStart**: Time in seconds of first range pixel

Note: Each binary product format is described in table above in the column "File Format". In order to read the product, you should use this information and **Lines, Samples** from metadata. For example: If you want to read the Slave1 product: this file is a binary FLOAT_COMPLEX of (Samples x Lines) dimension

- **Slaves**: This section of the metadata contain information about baselines between slaves and master image

8.1.2.2 Interfero_flat workflow

The interfero_flat workflow generates an interferogram with subtraction of ellipsoid WGS84 reference phase ant the interferometric coherence map.

The products generated by the interfero_flat workflow are detailed in the following table

Product	Description	File Format
Interferogram_flat	Complex Interferogram with substraction of ellipsoid phae (WGS84) in slant range geometry of the master image	BINARY. Each pixel is a FLOAT_COMPLEX (32 bits real, 32 bits imaginary).
Coherence	Complex Coherence map in slant range geometry of the master image	BINARY. Each pixel is a FLOAT_COMPLEX (32 bits real, 32 bits imaginary).

Reference_phase	Ellipsoid reference phase (WGS84) in slant range geometry of the master image	BINARY. Each pixel is a FLOAT 32 bits real.
Coherence.png	Coherence map amplitude quicklook in slant range geometry of the master image	PNG
Interferogram_flat.png	Interferogram flat phase quicklook in slant range geometry of the master image	PNG
Coherenze.tif	[Optional] Coherence map amplitude geoprojected using SRTM DEM	GeoTIFF
Interferogram_flat.tif	[Optional] Interferogram flat phase geoprojected using SRTM DEM	GeoTIFF
Coherence.kmz	[Optional] Coherence map amplitude geoprojected kmz	KMZ
Interferogram_flat.kmz	[Optional] Interferogram flat phase geoprojected kmz	KMZ
Interferogram_flat.xml	XML Header file with metadata of Interferogram_flat and Coherence products	XML

Table 78: Interfero_flat workflow products

How to read binary files

The file **Interferogram_flat.xml** contains the metadata of interfeo_flat workflow's products:

- **RasterInfo**: this section of the metatada contains all the necessary information to open images in any external program.
    - **Lines**: number of pixels on azimuth dimension
    - **Samples**: number of pixels on range dimension
    - **LinesStep**: step in seconds between two consecutive pixels in azimuth direction.
    - **SamplesStep**: step in seconds between two consecutive pixels in range direction.

- **LinesStart**: UTC time of first azimuth pixel.
- **SamplesStart**: Time in seconds of first range pixel

Note: Each binary product format is described in table above in the column "File Format". In order to read the product, you should use this information and **Lines, Samples** from metadata. For example: If you want to read the Interferogram_flat product: this file is a binary FLOAT_COMPLEX of (Samples x Lines) dimension.

Note: In order to get phase information from Interferogram_flat file you should get the phase of the complex number on each pixel of the image.

- **Slaves**: This section of the metadata contain information about baselines between slaves and master image

8.1.2.3 Interfero_dif workflow

The interfero_dif workflow generates an interferogram with subtraction of SRTM DEM reference phase and the interferometric coherence map.

The products generated by the interfero_dif workflow are detailed in the following table

Product	Description	File Format
Interferogram_dif	Complex Interferogram with substraction of SRTM DEM reference phase in slant range geometry of the master image	BINARY. Each pixel is a FLOAT_COMPLEX (32 bits real, 32 bits imaginary).
Coherence	Complex Coherence map in slant range geometry of the master image	BINARY. Each pixel is a FLOAT_COMPLEX (32 bits real, 32 bits imaginary).
Reference_phase	SRTM DEM reference phase in slant range geometry of the master image	BINARY. Each pixel is a FLOAT 32 bits real.

Coherence.png	Coherence map amplitude quicklook in slant range geometry of the master image	PNG
Interferogram_flat.png	Interferogram dif phase quicklook in slant range geometry of the master image	PNG
Coherenze.tif	[Optional] Coherence map amplitude geoprojected using SRTM DEM	GeoTIFF
Interferogram_dif.tif	[Optional] Interferogram dif phase geoprojected using SRTM DEM	GeoTIFF
Coherence.kmz	[Optional] Coherence map amplitude geoprojected kmz	KMZ
Interferogram_dif.kmz	[Optional] Interferogram dif phase geoprojected kmz	KMZ
Interferogram_dif.xml	XML Header file with metadata of Interferogram_dif and Coherence products	XML

Table 79: Interfero_dif workflow products

How to read binary files

The file **Interferogram_dif.xml** contains the metadata of interfeo_dif workflow's products:

- **RasterInfo**: this section of the metatada contains all the necessary information to open images in any external program.
    - **Lines**: number of pixels on azimuth dimension
    - **Samples**: number of pixels on range dimension
    - **LinesStep**: step in seconds between two consecutive pixels in azimuth direction.
    - **SamplesStep**: step in seconds between two consecutive pixels in range direction.
    - **LinesStart**: UTC time of first azimuth pixel.
    - **SamplesStart**: Time in seconds of first range pixel

Note: Each binary product format is described in table above in the column “File Format”. In order to read the product, you should use this information and **Lines, Samples** from metadata. For example: If you want to read the Interferogram_dif product: this file is a binary FLOAT_COMPLEX of (Samples x Lines) dimension

Note: In order to get phase information from Interferogram_dif file you should get the phase of the complex number on each pixel of the image.

- **Slaves**: This section of the metadata contain information about baselines between slaves and master image

8.2 Surface Soil Moisture (SSM) Products

The process of retrieving soil moisture, based on a radiative transfer model, allows the extraction of additional variables. The retrieval process is performed using synthetic data (*DATA CUBES*), which correlate full polarimetric backscatter with soil moisture and crop variables. These *DATA CUBES* were generated through simulations based on a radiative transfer model, considering Argentina's most important crops. Three products associated with soil moisture retrieval are available: SSMH, SSMF, and SSMW.

The structure is similar in all products:

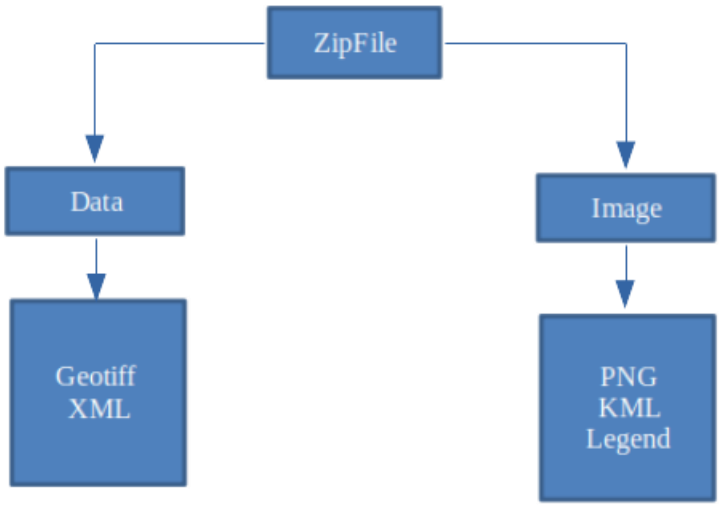


Figure 7: SSM Product content

8.2.1 Surface Soil Moisture H (SSMH)

The SSMH product represents the average soil moisture in the top 5 cm of soil. This product is derived from the LCC classification map, the associated backscatter of the image, and a physical radiative transfer model. These inputs, together with a data cube model generated for each crop through the radiative transfer model, allow for the generation of the soil moisture map as one of the outputs of the process.

It is worth noting that the inversion of the map is performed in slant range for soybeans, maize, wheat, sunflower, peanut, and fallow. Subsequently, using the incidence angle on the ellipsoid and a digital elevation model, the map is projected to ground range. For the remaining land areas, the inversion is conducted directly in ground range since the land cover map is provided in ground range geometry.

8.2.2 Product Content Description

Geotiff : Georeferenced raster in float32 format
XML : Metadata with product information
PNG : Thematic map of soil moisture at the top of 5 centimeters
KML : File to display the thematic map in Google Earth

Legend : Legend of the product whose color scale goes from red (dry soil) to more blue (wet soil). The variation range is from 5% to 45%`

Product ID	**SSMH**
Product Type	SSM, Geocoded, Terrain Corrected.
Main product Characteristics for Stripmap mode	
Pixel Value	Soil Moisture [cm^3/cm^3]: from 5 to 45%
No data value	NaN
Coordinate System	Latitude/Longitude
Bits Per Pixel	32
Data Type	Float single precision
Spatial Resolution in range [m]	210
Spatial Resolution in azimuth [m]	198
Latitude Pixel Spacing [deg]	2.8E-04
Longitude Pixel Spacing [deg]	2.8E-04
Incidence Angle [deg]	23.2 to 33.0
Main product Characteristics for Topsar mode	
Pixel Value	Soil Moisture [cm^3/cm^3]: from 5 to 45% No data: NaN
Coordinate System	Latitude/Longitude
Bits Per Pixel	32
Data Type	Float single precision
Spatial Resolution in range [m]	1120
Spatial Resolution in azimuth [m]	700
Latitude Pixel Spacing [deg]	2.8E-04
Longitude Pixel Spacing [deg]	2.8E-04

Incidence Angle [deg]	From 17.6 to 25.3 (TNA) and 27.2 to 34.5(TNB)

Table 80: SSMH Product specifications for layer 1

8.2.2.1 SSMH Thematic Map Description layer 1

The color scale of the map ranges from 5 to 45 % m^3/m^3, using colors red to blue as its shown in figure.

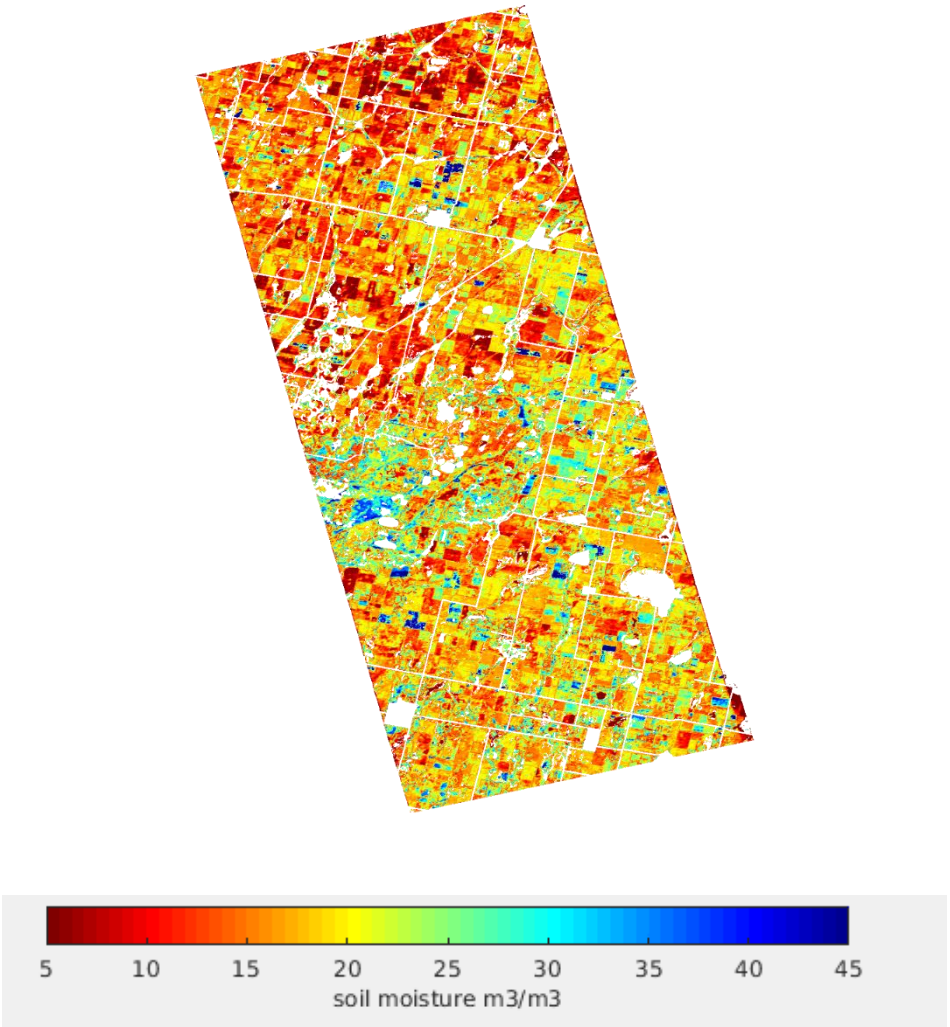
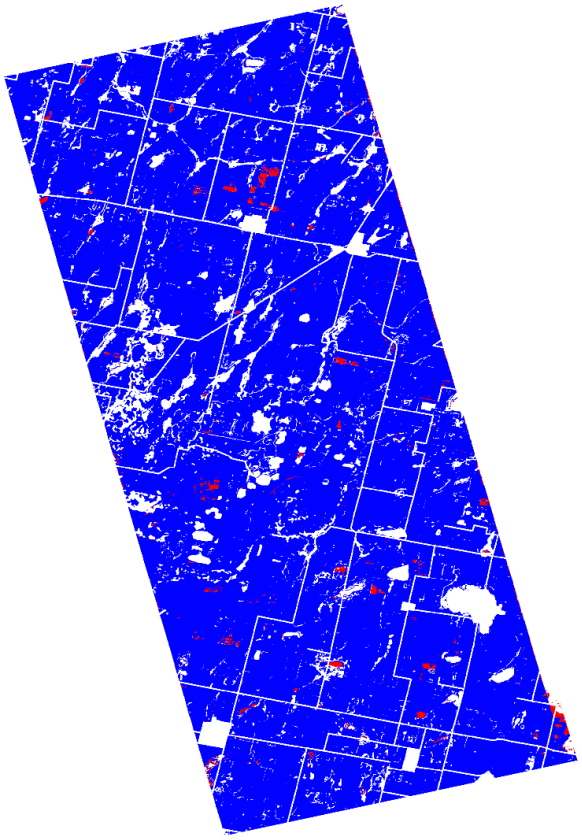


Figure 8: SSMH Thematic Map

8.2.2.2 SSMH Thematic Map Description layer 2

This layer contains information about the quality of soil moisture humidity value.



1

All soil moisture values were obtained through the inversion of the data cube model. In the case of soybeans, maize, wheat, sunflower, and fallow, these values were validated using data from extensive field campaigns. Below, we explain the meaning of the quality layer:

- **Value 0**: Indicates no data is available.
- **Value 1**: Indicates that soil moisture retrieval has an error below the threshold, and the data cube was validated through field campaigns.
- **Value 2**: Indicates that soil moisture retrieval has an error above the threshold, but the data cube was validated through field campaigns.
- **Value 3**: Indicates that the soil moisture value was retrieved from a data cube model that was not validated, regardless of the error.

Product ID	SSMH

1

Product Type	SSM, Geocoded, Terrain Corrected.
Main product Characteristics for Stripmap mode	
Pixel Value	Soil Moisture quality map 0-3
No data value	0
Coordinate System	Latitude/Longitude
Bits Per Pixel	32
Data Type	Float single precision
Spatial Resolution in range [m]	210
Spatial Resolution in azimuth [m]	198
Latitude Pixel Spacing [deg]	2.8E-04
Longitude Pixel Spacing [deg]	2.8E-04
Incidence Angle [deg]	23.2 to 33.0
Main product Characteristics for Topsar mode	
Pixel Value	Quality-value 1 - 3
No data value	0
Coordinate System	Latitude/Longitude
Bits Per Pixel	32
Data Type	Float single precision
Spatial Resolution in range [m]	1120
Spatial Resolution in azimuth [m]	700
Latitude Pixel Spacing [deg]	2.8E-04
Longitude Pixel Spacing [deg]	2.8E-04
Incidence Angle [deg]	From 17.6 to 25.3 (TNA) and 27.2 to 34.5(TNB)

Table 81: SSMH Product specifications for layer 2

8.2.3 Description of xml structure

Next we will give a detailed description of all xml tags linked to the SSMH product

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Element	Description	Data Type	Example
<oxmlh><NumberOfChannels>	Number of channels in the dataset.	Integer	2
<oxmlh><VersionNumber>	Version of the XML structure.	Decimal	2.1
<oxmlh><Description><Humedad_Suelo>	Units of raster image	String	m3/m3
<oxmlh><Channel><RasterInfo><LatitudeLimits>	Latitude boundaries of the raster image.	Array	[-33.7441673278809 -32.8466682434082]
<oxmlh><Channel><RasterInfo><LongitudeLimits>	Longitude boundaries of the raster image.	Array	[-63.1208343505859 -62.3858337402344]
<oxmlh><Channel><RasterInfo><RasterSize>	Dimensions of the raster image.	Array	[3232 2647]
<oxmlh><Channel><RasterInfo><RasterInterpretation>	Interpretation of the raster image	String	Rastercells
<oxmlh><Channel><RasterInfo><ColumnsStartFrom>	Starting direction of the columns in the raster data	String	north
<oxmlh><Channel><RasterInfo><RowsStartFrom>	Starting direction of the rows in the raster data	String	west
<oxmlh><Channel><RasterInfo><CellExtentInLatitude>	Latitude extensión of one pixel	Float	0.000277691548413569
<oxmlh><Channel><RasterInfo><CellExtentInLongitude>	Longitude extensión of one pixel	Float	0.00027767306775654
<oxmlh><Channel><RasterInfo><RasterExtentInLatitude>	Extension of raster image in Latitude	Float	0.897499084472656
<oxmlh><Channel><RasterInfo><RasterExtensionInLongitude>	Extension of raster in Longitude	Float	0.735000610351562
<oxmlh><Channel><RasterInfo><XIntrinsicLimits>	Intrinsic limits along the X-axis of the raster grid	Array	[0.5 2647.5]
<oxmlh><Channel><RasterInfo><YIntrinsicLimits>	Intrinsic limits along the Y-axis of the raster grid	Array	[0.5 3232.5]
<oxmlh><Channel><RasterInfo><CoordinateSystemType>	Coordinate system	String	geographic

<oxmlh><Channel><RasterInfo><AngleUnit>	Unit of measurement used for angles in the raster's coordinate	String	degree
<oxmlh><Channel><NameImage>	Name of the raster image.	String	GI_20240401104214_SAOCOM_SAR_SSMH
<oxmlh><Channel><DataSetInfo><SensorName>	Name of the sensor used for data acquisition.	String	SAO1A
<oxmlh><Channel><DataSetInfo><Description>	Name of the product	String	SAOCOM SSM Product
<oxmlh><Channel><DataSetInfo><SenseDate>	Date of data acquired	String	2024-APR-01
<oxmlh><Channel><DataSetInfo><AcquisitionMode>	Acquisition mode of input image	String	STRIPMAP
<oxmlh><Channel><DataSetInfo><ImageType>	Generic name of the image	String	SOIL MOISTURE MAP
<oxmlh><Channel><DataSetInfo><Projection>	Geometry of the raster image	String	Ground Terrain Corrected Image
<oxmlh><Channel><DataSetInfo><AcquisitionStation>	Station where was input data acquired	String	ETT
<oxmlh><Channel><DataSetInfo><ProcessingCenter>	Name of processing center	String	L0FSW TEST SITE
<oxmlh><Channel><DataSetInfo><ProcessingDate>	Date of data processing.	Date-Time	01-Apr-2024 22:19:01
<oxmlh><Channel><DataSetInfo><ProcessingSoftware>	Software procesing version	String	SSMv4.2.5.1
<oxmlh><Channel><DataSetInfo><fc_hz>	Frequency of Saocom sensor	Float	1275000000
<oxmlh><Channel><DataSetInfo><SideLooking>	Direction of radar view	Float	RIGHT
<oxmlh><Channel><SwathInfo><Swath>	Swath of image	String	QS5
<oxmlh><Channel><SwathInfo><Rank>	Acquisition rank	Int	17
<oxmlh><Channel><Band1><DataStatistics><Maximun>	Maximun of band 1 image	Float	45
<oxmlh><Channel><Band1><DataStatistics><Minimun>	Minimun of band 1 image	Float	5
<oxmlh><Channel><Band1><DataStatistics><Mean>	Average of band 1 image	Float	17.8393211364746

<oxmlh><Channel><Band1><DataStatistics><StdDev>	Estándar deviation of band 1 image	Float	6.31837749481201
<oxmlh><Channel><Band1><DataStatistics><NoDataValue>	No data value for band 1	String	NaN
<oxmlh><Channel><Band2 ><Nodata>	No data value for band 2	Int	0
<oxmlh><Channel><Band2><PixelValueInsideDatacube>	Indicates that the soil moisture value for the pixel was correctly inverted from data cubes validated through field campaigns.	Int	1
<oxmlh><Channel><Band2><PixelValueOutsideDatacube>	Indicates that the soil moisture pixel has an error exceeding the limits of cube values validated through field campaigns.	Int	2
<oxmlh><Channel><Band2><PixelValueNoDataCubeClass>	Indicates that the soil moisture value from the data cube was not validated through field campaigns.	Int	3
<oxmlh><Channel><StateVectorData><OrbitNumber>	Orbital data for the acquisition.	String	NOT_AVAILABLE
<oxmlh><Channel><StateVectorData><OrbitDirection>	Direction of image for the acquisition	String	ASCENDING
<oxmlh><Channel><StateVectorData><t_ref_Utc>	Time reference in UTC	String	01-APR-2024 10:40:32.010000000000
<oxmlh><CellType>	Presition of raster data	String	FLOAT32
<oxmlh><RasterFormat>	Formato of raster data	String	DATA_GEOTIFF

Table 82: Description of XML structure for SSMH

8.2.4 Vegetation Water Content Product (SSMW)

The Vegetation Water Content (VWC) represents the amount of water accumulated in vegetation per unit area, expressed in units of kg/m². This product is provided in GeoTIFF format, accompanied by an associated XML file. The XML file contains all relevant information about the georeferencing of the GeoTIFF image, including the projection type, acquisition start time, and key image statistics such as mean, standard deviation, maximum, and minimum values.

8.2.5 Product Content Description

Geotiff : Georeferenced raster in float32 format
XML : Metadata with product information

PNG : Thematic map of water content in vegetation

KML : File to display the thematic map in Google Earth

Legend : Product legend whose color scale represents the intensity of the water content in vegetation. The maximum scales vary according to the type of crop.

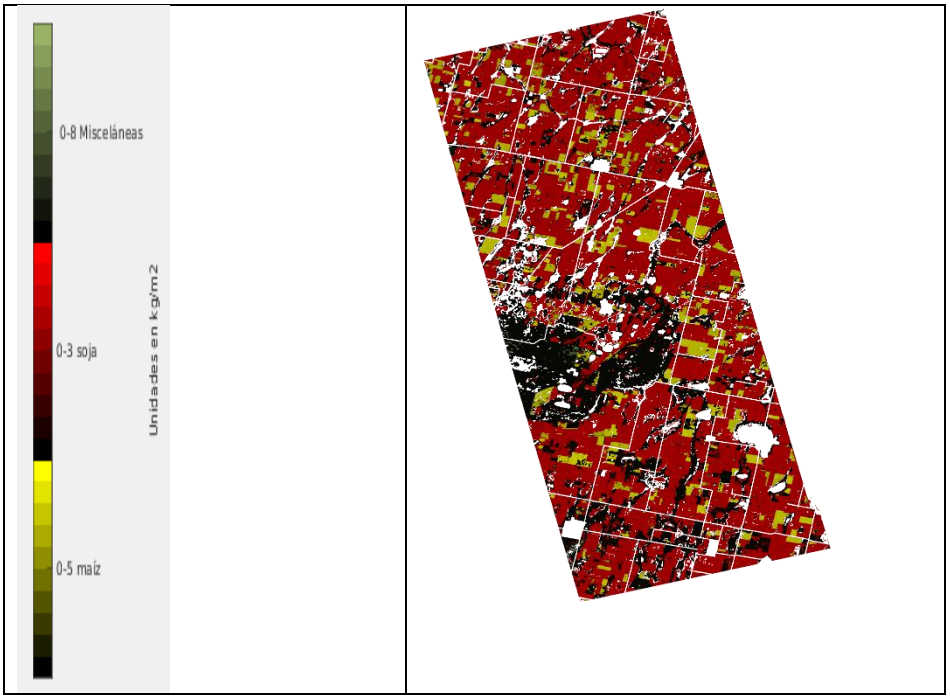
Product ID	**SSMW**
Product Type	SSM, Geocoded, Terrain Corrected.
Product Name	GI_USS_raster_SSMW_YYYY-MM-DDThhmmss YYYY : acquisition year MM : acquisition month DD : acquisition day hhmmss : acquisition start time in hour, minute and second
Main product Characteristics for Stripmap mode	
Pixel Value	Vegetation Water Content [kg/m^2]
No data value	NaN
Coordinate System	Latitude/Longitude
Bits Per Pixel	32
Data Type	Float single precisión
Spatial Resolution in range [m]	210
Spatial Resolution in Azimuth [m]	198
Latitude Pixel Spacing [deg]	2.8E-04
Longitude Pixel Spacing [deg]	2.8E-04
Incidence Angle [deg]	23.2 to 33.0
Main product Characteristics for Topsar mode	
Pixel Value	Vegetation Water Content [kg/m^2]

No data value	NaN
Coordinate System	Latitude/Longitude
Bits Per Pixel	32
Data Type	Float single precisión
Spatial Resolution in range [m]	1120
Spatial Resolution in Azimuth [m]	700
Latitude Pixel Spacing [deg]	2.8E-04
Longitude Pixel Spacing [deg]	2.8E-04
Incidence Angle [deg]	From 17.6 to 25.3 (TNA) and 27.2 to 34.5(TNB)

Table 83: SSMW Product specifications

8.2.6 SSMW Thematic Map Description

Each crop has its own color scale: from black to red for soybeans, with a maximum value of 3; from black to yellow for corn, with a maximum value of 5; and from black to gold for wheat, with a maximum value of 2, and so on for the remaining crops. This means that a raster pixel will be represented with a saturated color on the thematic map when its physical value exceeds the maximum for the corresponding crop. The map colors follow the same color convention as the LCC product.



The following table give us the range of each crop

Crop	Leyend reference	Range in kg/m^2
Soybean	Soja	0 - 3
Maize	Maíz	0 -5
Wheat	Trigo	0 - 2
Sunflower	Girasol	0 - 5
Peanut	Maní	0 - 3
Fallow, grassland, shrubland, woodland	Misceláneas	0 - 8

Figure 9: SSMW Thematic Map

8.2.6.1 Description of xml structure

Next, we will give a detailed description of all xml tags linked to the SSMW product.

Element	Description	Data Type	Example

<oxmlvwc><NumberOfChannels>	Number of channels in the dataset.	Integer	1
<oxmlvwc><VersionNumber>	Version of the XML structure.	Decimal	2.1
<oxmlvwc><Description><Agua_Planta>	Units of raster image	String	Kg/m^2
<oxmlvwc><Channel><RasterInfo><LatitudeLimits>	Latitude boundaries of the raster image.	Array	[-33.7441673278809 -32.8466682434082]
<oxmlvwc><Channel><RasterInfo><LongitudeLimits>	Longitude boundaries of the raster image.	Array	[-63.1208343505859 -62.3858337402344]
<oxmlvwc><Channel><RasterInfo><RasterSize>	Dimensions of the raster image.	Array	[3232 2647]
<oxmlvwc><Channel><RasterInfo><RasterInterpretation>	Interpretation of the raster image	String	Rastercells
<oxmlvwc><Channel><RasterInfo><ColumnsStartFrom>	Starting direction of the columns in the raster data	String	north
<oxmlvwc><Channel><RasterInfo><RowsStartFrom>	Starting direction of the rows in the raster data	String	west
<oxmlvwc><Channel><RasterInfo><CellExtentInLatitude>	Latitude extensión of one pixel	Float	0.000277691548413569
<oxmlvwc><Channel><RasterInfo><CellExtentInLongitude>	Longitude extensión of one pixel	Float	0.00027767306775654

<oxmlvwc><Channel><RasterInfo><RasterExtentInLatitude>	Extension of raster image in Latitude	Float	0.897499084472656
<oxmlvwc><Channel><RasterInfo><RasterExtensionInLongitude>	Extension of raster in Longitude	Float	0.735000610351562
<oxmlvwc><Channel><RasterInfo><XIntrinsicLimits>	Intrinsic limits along the X-axis of the raster grid	Array	[0.5 2647.5]
<oxmlvwc><Channel><RasterInfo><YIntrinsicLimits>	Intrinsic limits along the Y-axis of the raster grid	Array	[0.5 3232.5]
<oxmlvwc><Channel><RasterInfo><CoordinateSystemType>	Coordinate system	String	geographic
<oxmlvwc><Channel><RasterInfo><AngleUnit>	Unit of measurement used for angles in the raster's coordinate	String	degree
<oxmlvwc><Channel><NameImage>	Name of the raster image.	String	GI_20240401104214_SAOCOM_SAR_SSMW
<oxmlvwc><Channel><DataSetInfo><SensorName>	Name of the sensor used for data acquisition.	String	SAO1A
<oxmlvwc><Channel><DataSetInfo><Description>	Name of the product	String	SAOCOM VWC Product
<oxmlvwc><Channel><DataSetInfo><SenseDate>	Date of data acquired	String	2024-APR-01
<oxmlvwc><Channel><DataSetInfo><AcquisitionMode>	Acquisition mode of input image	String	STRIPMAP
<oxmlvwc><Channel><DataSetInfo><ImageType>	Generic name of the image	String	VEGETATION WATER CONTENT MAP
<oxmlvwc><Channel><DataSetInfo><Projection>	Geometry of the	String	Ground Terrain Corrected Image

	raster image		
<oxmlvwc><Channel><DataSetInfo><AcquisitionStation>	Station where was input data acquired	String	ETT
<oxmlvwc><Channel><DataSetInfo>< ProcessingCenter>	Name of processing center	String	L0FSW TEST SITE
<oxmlvwc><Channel><DataSetInfo><ProcessingDate>	Date of data processing .	Date-Time	01-Apr-2024 22:19:01
<oxmlvwc><Channel><DataSetInfo><ProcessingSoftware>	Software procesing version	String	SSMv4.2.5.1
<oxmlvwc><Channel><DataSetInfo><fc_hz>	Frequency of Saocom sensor	Float	1275000000
<oxmlvwc><Channel><DataSetInfo><SideLooking>	Direction of radar view	Float	RIGHT
<oxmlvwc><Channel><SwathInfo><Swath>	Swath of image	String	QS5
<oxmlvwc><Channel><SwathInfo><Rank>	Acquisition rank	Int	17
<oxmlvwc><Channel><DataStatistics><Maximun>	Maximun of band 1 image	Float	8.46100044250488
<oxmlvwc><Channel><DataStatistics><Minimun>	Minimun of band 1 image	Float	0.112000003457069
<oxmlvwc><Channel><DataStatistics><Mean>	Average of band 1 image	Float	1.67298293113708
<oxmlvwc><Channel><DataStatistics><StdDev>	Estándar deviation of band 1 image	Float	0.870841920375824
<oxmlvwc><Channel><DataStatistics><NoDataValue>	No data value for band 1	String	NaN
<oxmlvwc><Channel><StateVectorData><OrbitNumber>	Orbital data for the acquisition .	String	NOT_AVAILABLE
<oxmlvwc><Channel><StateVectorData><OrbitDirection>	Direction of image for the acquisition	String	ASCENDING

<oxmlvwc><Channel><StateVectorData><t_ref_Utc>	Time reference in UTC	String	01-APR-2024 10:40:32.010000000000
<oxmlvwc><CellType>	Presition of raster data	String	FLOAT32
<oxmlvwc><RasterFormat>	Formato f raster Data	String	DATA_GEOTIFF

Table 84: Description of XML structure for SSMW

8.2.7 Phenological Growth Stage Product (SSMF)

The growth stage of a crop is a scale that corresponds to the different physiological stages during the crop's development. This scale varies for each crop. For soybeans and corn, the stages are divided into vegetative and reproductive phases, while for wheat, a single scale (the Zadoks Growth Scale) is used to describe the entire growth period. This product is provided in GeoTIFF format, accompanied by an associated XML file. The XML file contains all relevant information about the georeferencing of the GeoTIFF image, including the projection type, acquisition start time, and key image statistics such as mean, standard deviation, maximum, and minimum values.

8.2.7.1 Product Content Description

Geotiff : Georeferenced raster in float32 format
XML : Metadata with product information

PNG : Thematic map of water content in vegetation

KML : File to display the thematic map in Google Earth

Legend : Product legend whose color scale represents the growth stages. The maximum scales vary according to the type of crop.

Product ID	**SSMF**
Product Type	SSM, Geocoded, Terrain Corrected.
Product Name	GI_USS_raster_SSMW_YYYY-MM-DDThhmmss YYYY : acquisition year MM : acquisition month DD : acquisition day hhmmss : acquisition start time in hour, minute and second

Main product Characteristics for Stripmap mode	
Pixel Value	Growth Stage : 0 - 100
No data value	NaN
Coordinate System	Latitude/Longitude
Bits Per Pixel	32
Data Type	Float single precisión
Spatial Resolution in range [m]	210
Spatial Resolution in Azimuth [m]	198
Latitude Pixel Spacing [deg]	2.8E-04
Longitude Pixel Spacing [deg]	2.8E-04
Incidence Angle [deg]	23.2 to 33.0
Main product Characteristics for Topsar mode	
Pixel Value	Growth Stage : 0 - 100
No data value	NaN
Coordinate System	Latitude/Longitude
Bits Per Pixel	32
Data Type	Float single precisión
Spatial Resolution in range [m]	1120
Spatial Resolution in Azimuth [m]	700
Latitude Pixel Spacing [deg]	2.8E-04
Longitude Pixel Spacing [deg]	2.8E-04
Incidence Angle [deg]	From 17.6 to 25.3 (TNA) and 27.2 to 34.5(TNB)

Table 85: SSMF Product specifications

8.2.7.2 SSMF Thematic Map Description

Each crop has its own color scale ranging from black to red in the case of soybeans with a maximum value of R8, from black to yellow in the case of maize with a maximum of R8 and from black to gold in the case of wheat with a maximum value of Z99. This implies that a pixel of the raster will be represented with a saturated color on the thematic map when its physical value exceeds the maximum of the corresponding crop.

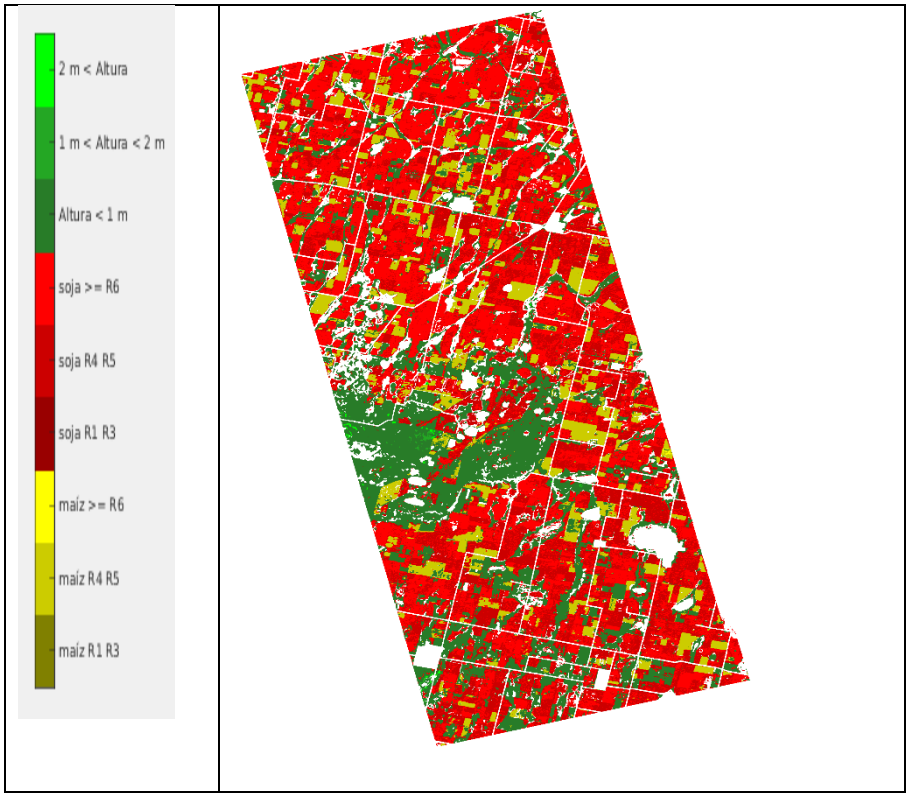


Figure 10: SSMF Thematic Map

The map shows the values on their corresponding scale. However, each pixel in the tiff image has a numerical scale that must be associated with its corresponding phenological stage. The relationship is as follows:

A pixel value x between 1 and 9 corresponds to a Vx stage; if the value is 10, it corresponds to Vt; and for values 1x (where x is in the range 1–8), it corresponds to the Rx stage. In the case of wheat, the value x in the range 1–99 corresponds to Zx.

For example, for soybean, a pixel value of 15 corresponds to stage R5.

For pixels corresponding to fallow, grassland, shrubland, or woodland, the value represents the average height in centimeters, ranging from 0 to 200. It is worth mentioning that, in the thematic map, this is shown in units of meters. Heights from 0–100 cm are displayed in dark green, from 100–200 cm in medium green, and values above 200 cm in bright green.

CROP TYPE	Ref Legend	Pixel value	Phenological stage
Soybean, Maize, Sunflower and Peanut	**Soja, Maíz, Girasol, Maní**	1-9 10 11-18	V1-V9 Vt R1-R8
Wheat	**Trigo**	1-99	Z1-Z99

Table 86: Pixel values relation to Phenological stages for SSMF Product

8.2.7.3 Description of xml structure

Next, we will give a detailed description of all xml tags linked to the SSMF product.

Element	Description	Data Type	Example
<oxmlef><NumberOfChannels>	Number of channels in the dataset.	Integer	1
<oxmlef><VersionNumber>	Version of the XML structure.	Decimal	2.1
<oxmlef><Description><Estadio>	Crop stage	String	fases
<oxmlef><Channel><RasterInfo><LatitudeLimits>	Latitude boundaries of the raster image.	Array	[-33.7441673278809 -32.8466682434082]
<oxmlef><Channel><RasterInfo><LongitudeLimits>	Longitude boundaries of the raster image.	Array	[-63.1208343505859 -62.3858337402344]
<oxmlef><Channel><RasterInfo><RasterSize>	Dimensions of the raster image.	Array	[3232 2647]
<oxmlef><Channel><RasterInfo><RasterInterpretation>	Interpretation of the raster image	String	Rastercells

<oxmlef><Channel><RasterInfo><ColumnsStartFrom>	Starting direction of the columns in the raster data	String	north
<oxmlef><Channel><RasterInfo><RowsStartFrom>	Starting direction of the rows in the raster data	String	west
<oxmlef><Channel><RasterInfo><CellExtentInLatitude>	Latitude extensión of one pixel	Float	0.000277691548413569
<oxmlef><Channel><RasterInfo><CellExtentInLongitude>	Longitude extensión of one pixel	Float	0.00027767306775654
<oxmlef><Channel><RasterInfo><RasterExtentInLatitude>	Extension of raster image in Latitude	Float	0.897499084472656
<oxmlef><Channel><RasterInfo><RasterExtensionInLongitude>	Extension of raster in Longitude	Float	0.735000610351562
<oxmlef><Channel><RasterInfo><XIntrinsicLimits>	Intrinsic limits along the X-axis of the raster grid	Array	[0.5 2647.5]
<oxmlef><Channel><RasterInfo><YIntrinsicLimits>	Intrinsic limits along the Y-axis of the raster grid	Array	[0.5 3232.5]
<oxmlef><Channel><RasterInfo><CoordinateSystemType>	Coordinate system	String	geographic
<oxmlef><Channel><RasterInfo><AngleUnit>	Unit of measurement used for angles in the raster's coordinate	String	degree

<oxmlef><Channel><NameImage>	Name of the raster image.	String	GI_20240401104214_SAOCOM_SAR_SSMF
<oxmlef><Channel><DataSetInfo><SensorName>	Name of the sensor used for data acquisition.	String	SAO1A
<oxmlef><Channel><DataSetInfo><Description>	Name of the product	String	SAOCOM GS Product
<oxmlef><Channel><DataSetInfo><SenseDate>	Date of data acquired	String	2024-APR-01
<oxmlef><Channel><DataSetInfo><AcquisitionMode>	Acquisition mode of input image	String	STRIPMAP
<oxmlef><Channel><DataSetInfo><ImageType>	Generic name of the image	String	GROWTH STAGE MAP
<oxmlef><Channel><DataSetInfo><Projection>	Geometry of the raster image	String	Ground Terrain Corrected Image
<oxmlef><Channel><DataSetInfo><AcquisitionStation>	Station where was input data acquired	String	ETT
<oxmlef><Channel><DataSetInfo><ProcessingCenter>	Name of processing center	String	L0FSW TEST SITE
<oxmlef><Channel><DataSetInfo><ProcessingDate>	Date of data processing.	Date-Time	01-Apr-2024 22:19:01
<oxmlef><Channel><DataSetInfo><ProcessingSoftware>	Software procesing version	String	SSMv4.2.5.1
<oxmlef><Channel><DataSetInfo><fc_hz>	Frequency of Saocom sensor	Float	1275000000
<oxmlef><Channel><DataSetInfo><SideLooking>	Direction of radar view	Float	RIGHT
<oxmlef><Channel><SwathInfo><Swath>	Swath of image	String	QS5
<oxmlef><Channel><SwathInfo><Rank>	Acquisition rank	Int	17

<oxmlef><Channel><DataStatistics><Maximun>	Maximun of band 1 image	Float	8.46100044250488
<oxmlef><Channel><DataStatistics><Minimun>	Minimun of band 1 image	Float	0.112000003457069
<oxmlef><Channel><DataStatistics><Mean>	Average of band 1 image	Float	1.67298293113708
<oxmlef><Channel><DataStatistics><StdDev>	Estándar deviation of band 1 image	Float	0.870841920375824
<oxmlef><Channel><DataStatistics><NoDataValue>	No data value for band 1	String	NaN
<oxmlef><Channel><StateVectorData><OrbitNumber>	Orbital data for the acquisition.	String	NOT_AVAILABLE
<oxmlef><Channel><StateVectorData><OrbitDirection>	Direction of image for the acquisition	String	ASCENDING
<oxmlef><Channel><StateVectorData><t_ref_Utc>	Time reference in UTC	String	01-APR-2024 10:40:32.010000000000
<oxmlef><CellType>	Presition of raster data	String	FLOAT32
<oxmlef><RasterFormat>	Formato f raster Data	String	DATA_GEOTIFF

Table 87: Description of XML structure for SSMF

8.3 Risk and Hydrological Emergency Management (HEM) Products

8.3.0 Description

This application will generate products for hydrologic simulation and forecast, in an operational fashion. The application will be capable of processing the following three products:

- Flood Guidance (FLG): the amount (in mm) of total rainfall to be accumulated during a time interval T over a given basin with a certain soil moisture content, required for causing

bank-full flow at its outlet. Comparison of the quantitative precipitation forecast for the subsequent time interval T (QPF_T) over a given basin with its current FLG_T will determine the need of a warning.

- Deterministic Hydrologic Forecast (DHF): Continuous physically-inspired lumped conceptual hydrologic models perform the soil moisture accounting in the soil, for assessing the rainfall-runoff transformation. Fed with the QPF_T, the resulting hydrograph constitute a deterministic forecast and will allow checking for emergency threshold exceedances (time of occurrence and duration above) and therefore will determine the need of issuing a warning.
- Medium and Long Term Probabilistic Forecast (MPF): Medium and long term probabilistic hydrologic forecasts are used for decision making. Probabilistic forecast with the ESP technique consists in fitting a probability distribution function of the hydrologic variable under study for each future time. For instance, the distributions may be fitted for each one of the 53 weeks (covering one year) subsequent to the elaboration of the forecast. The sample to be fitted for each interval is obtained by means of an ensemble of traces, resulting from modeling historical records of rainfall (1-year long), sampled at the selected interval, as inputs to the continuous model with the state variables set in current values as the initial condition.

8.3.1 Specification

Specification of the application and its three products are presented in the following table:

Application ID	HEM
Operation mode & Operating System	Batch components run under Linux OS
Areal coverage	Basins within the Argentine fraction of the Del Plata Basin (~150,000 km2)
Basins	Gualeguay, Arrecifes, Salado Norte, Areco, Luján, Matanza-Riachuelo , Gualeguaychú, Feliciano, Carcarañá rivers
Forecast points, Gualeguay	Federal, Gualeguay at Villaguay, Rosario Tala, Villaguay at Villaguay
Forecast points, Arrecifes	Pergamino, Gral. Urquiza, Colón, Rojas, Salto, Arrecifes
Forecast points, Salado Norte	Recreo (RP70)

Forecast points, Areco	Carmen de Areco, San Antonio de Areco
Forecast points, Luján	Mercedes, Jáuregui
Forecast points, Matanza-Riachuelo	Ricchieri Highway
Forecast points, Gualeguaychú	Paso Gualeguaychú
Forecast points, Feliciano	Paso Medina
Forecast points, Carcarañá	Pueblo Andino
Direct user	Hydrological Warning System, National Water Institute of Argentina
Production & issuance frequency	Daily
Delivery mode	Via FTP to the direct user
Product type & format	Tables and charts of time series, probabilities (box plots), and bar charts. Maps.
Underlying model type	Continuous, conceptual hydrologic model (lumped or semidistributed)
Hydrologic Model	Simplified SAC-SMA, and Semidistributed SAC-SMA by isochrones
Model time step	1 day
Model forcing variables	Precipitation [mm] and Potential Evapotranspiration [mm], both areally averaged
Model assimilation variables	Soil moisture content [vol/vol], observed basin-outlet flow rate [cumecs]
Model output variable	Basin-outlet flow rate [cumecs]
SAOCOM soil moisture and observed discharge assimilation technique	Ensemble Kalman Filter
Lead time for DHF	5.5 days
Lead time for MPF	53 weeks
Lead time for FLG	2.0 days
Source of precipitation	National Weather Service of Argentina (SMN). CONAE
Source of potential evapotranspiration	National Weather Service of Argentina (SMN)
Source of discharge	Water Resources Secretary, Argentina. CONAE. National Water Institute
Source of QPF for the lead time	from GFS model runs provided by the National Weather Service of Argentina (SMN), in GRIB format

Table 88: Risk and Hydrological Emergency Management Product specification

8.3.2 Product type & format

This section presents examples of graphical results for the HEM products in the following three figures.

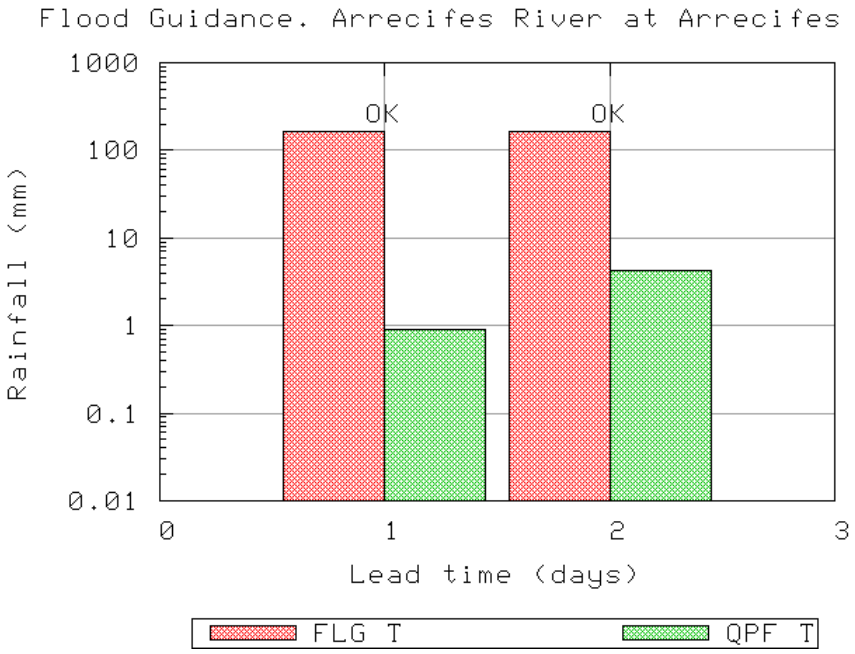


Figure 11: Comparison of flood guidance and QPF for one and two day lead time (FLG)

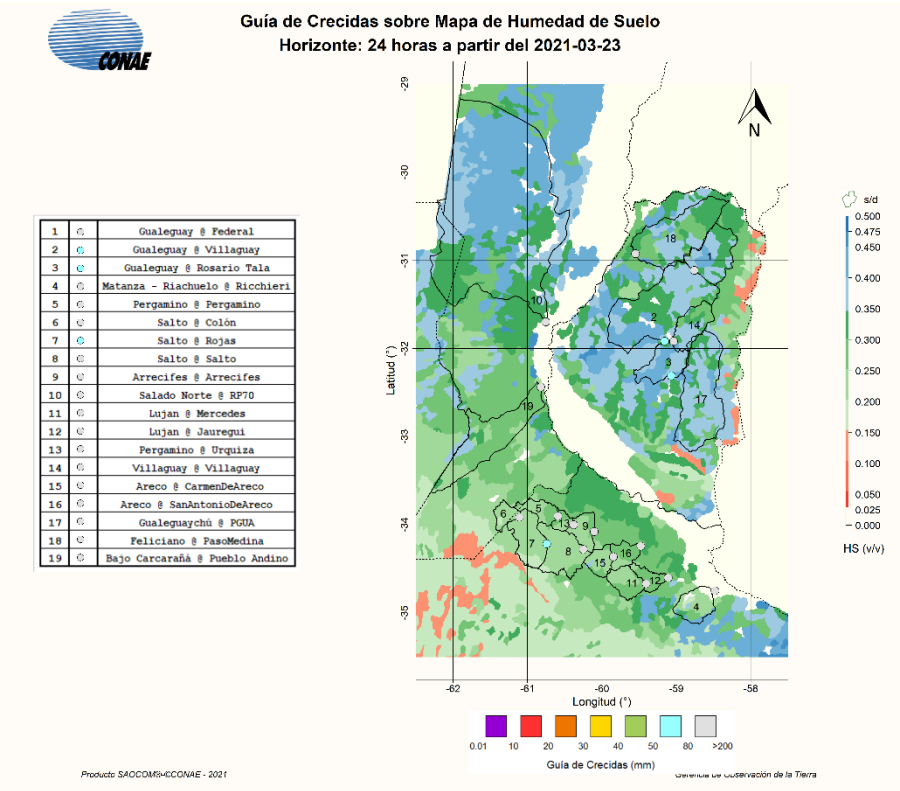


Figure 12: 24-h Flood guidance on soil moisture map

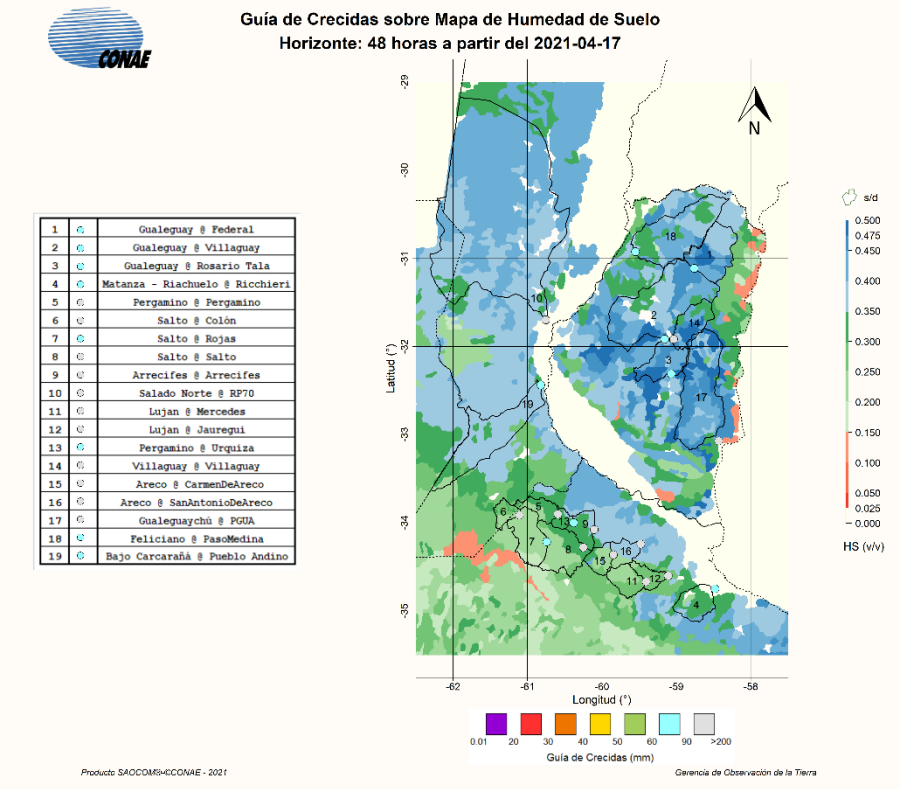


Figure 13: 48-h Flood guidance on soil moisture map

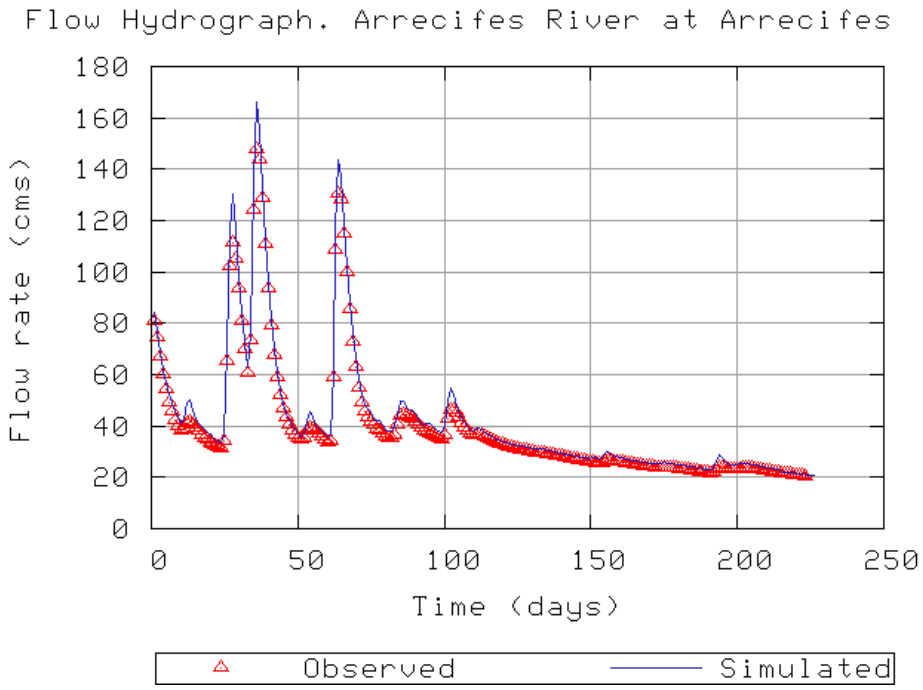


Figure 14: Observed and simulated flow hydrographs (DHF)

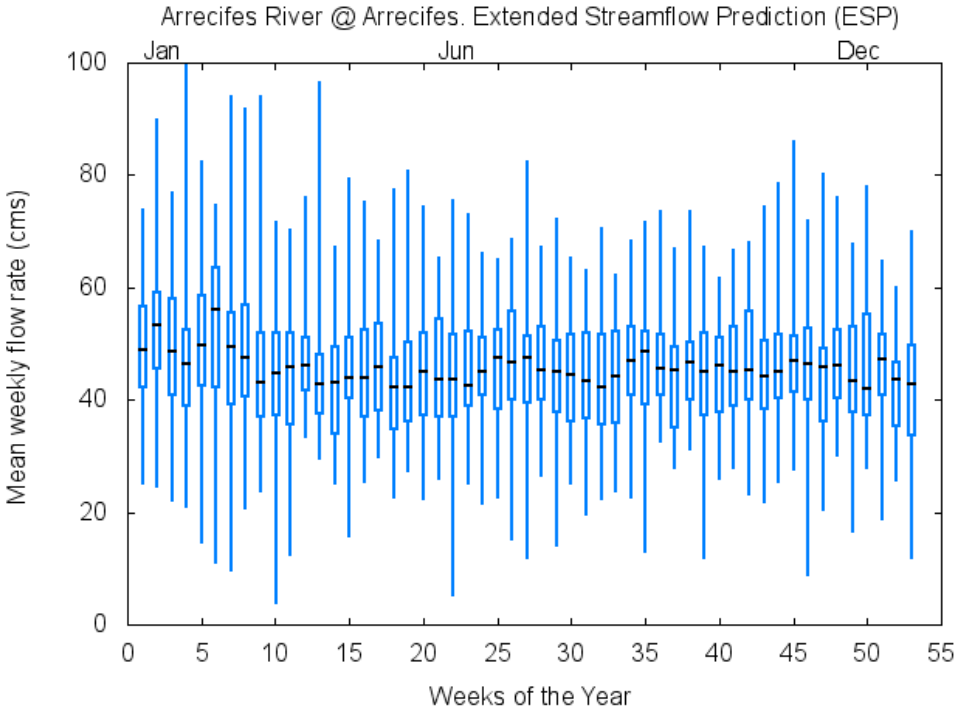


Figure 15: Box plots for the subsequent 53 weeks after forecast session date (MPF)

8.4 Support System for Decision Making in Agriculture (DSS) Product

8.4.1 Description

The Support System for Decision Making in Agriculture Strategic Application (DSS-SA) product seeks to help farmers in the decision making process so as to reduce the inherent risks of the activity and to optimize fertilizer applications. This product is mainly intended for farmers who will test and analyze different crop management and fertilization proposals using simulated

results of crop growth, development and yields for wheat, maize, sunflower and soybean based on the assimilation of the SSM product.

This product was originally conceived as an Internet application whose correct design was known to be crucial for achieving a good adoption by final users, and the information provided must have the potential to alter a decision.

8.4.2 Specifications

The product must provide certain characteristics that in general any decision support system should have: to be user friendly; to use available inputs; to be focused on an area of potentially large cost benefits.

Product ID	**DSS**
Product Type	Web product
Main product characteristics	
Available regions	Buenos Aires, Córdoba, Entre Ríos, La Pampa, Santa Fe
Coverage área	Local (plot, farm, sites)
Reference System	WGS 84
Data Type	Yield estimates in units of kg per hectare for wheat, maize, sunflower and soybean
Data time step	Daily

Table 89: Support System for Decision Making in Agriculture product specifications

This product is a complete support system which means that the user would be able to generate answers according to his needs and particular questions. It enables to change important parameters in the decision making process such as crop species and cycle, date of sowing, sowing density, fertilizer and irrigation applications. The product generates a set of different scenarios according to the user inputs. It allows the farmer to assess possible management strategies and to evaluate the risk of applying each of them.

Among the possibilities that are offered by the product we can mention:

- To analyze and design an adequate seed variety, sowing date and plant population election according to the results generated in different scenarios for a selected site.
- To analyze and design an adequate fertilization plan according to the results generated in different scenarios for a selected site.
- To analyze and design an adequate irrigation plan according to the results generated in different scenarios for a selected site.
- To gather enough information to analyze the risk associated to decisions on several management practices.

The model simulates the answer of the crop according to the availability of nitrogen and water in the soil profile, in any point of the crop cycle.

This product intends to be an assistant to the decision making process offering enough information and data in order to make decisions in a certain site with a set of management specifications. Its purpose is not to give an explicit answer or recipe to how to act. The outputs may be analyzed by the user who is in charge of opting how to use the information given in the scenarios. This product and the outputs generated by it are not intended to give an economic assistant. The product does not take into account the effects of plagues, illness, weeds, climatic adversities or other nutrients deficiency over the crop yield.

8.4.3 Interface

The user interface of the product will be via web. The display of the interface will be similar to the one shown in Figure 16

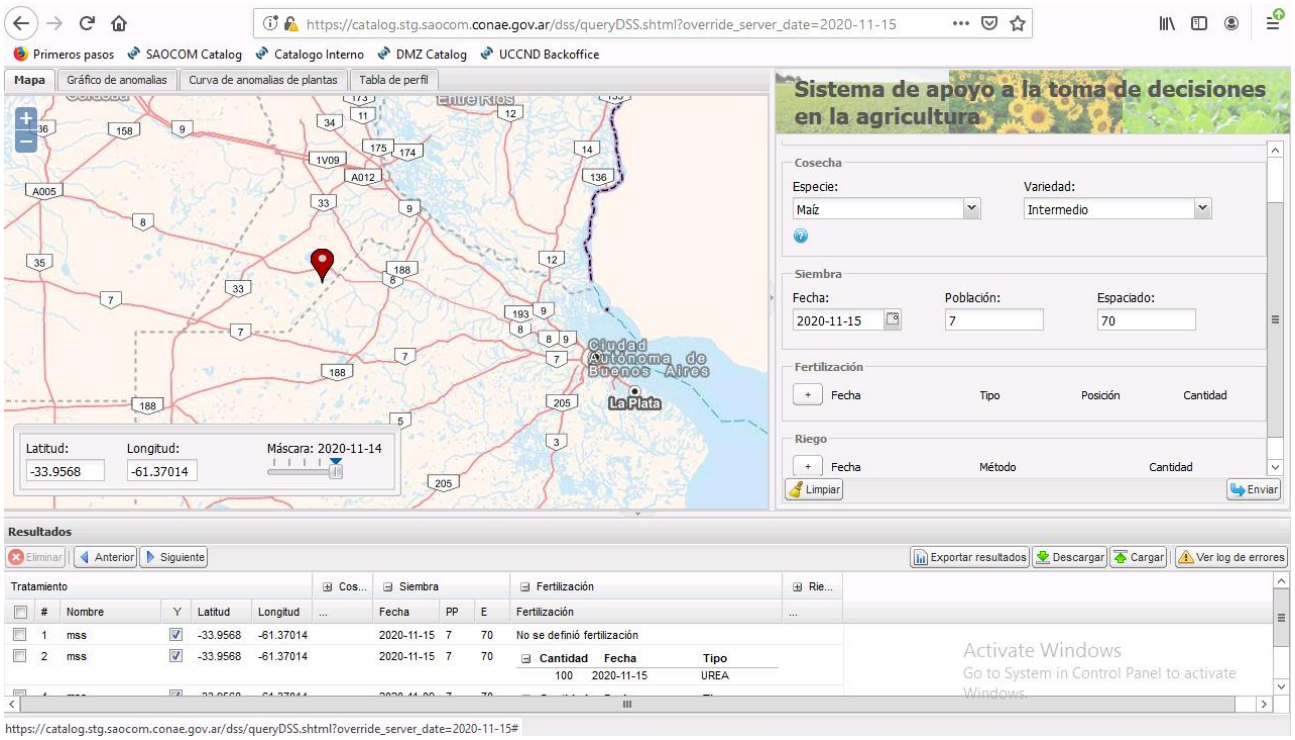


Figure 16: DSS-SA product web form

The form has three mandatory sections that users must fill in (Location, Crop and Sowing) and two optional ones (Fertilization and Irrigation).

Location: Refers to the place where the user wants to run the simulation tool. Plot coordinates can be entered either by clicking in the map (Figure 16) or by typing the latitude and longitude of the center of the chosen plot.

Crop: Refers to the crop selection. Users must choose from a drop down menu the crop and the variety that is intended to be sown in the selected plot.

Sowing: Asks values for three parameters: date, plant population and row spacing. The date field can be entered selecting the date in a pop-up calendar or typing it complying with the format yyyy-mm-dd (Figure 16).

Fertilization: Enables to test fertilizer treatments as it allows for comparing and analyzing possible scenarios of different fertilization practices. Four input boxes must be filled: application date, fertilizer type, position and amount of dosage.

Irrigation: Enables to incorporate and test irrigation schedules. Three input boxes must be filled in: date, type and amount.

In the right side of the web page there is a menu that includes the following options:

- Send: This is used to send the already entered data and to trigger the simulation process.
- Clear: This is used to clear the entered information, leaving the page in blank
- Download: This option is used to download the generated results in JSON format.
- Upload: This option is used to upload previous treatments and generated scenarios.
- Export: This option allows to export graphs and values for the simulated treatments in a text report.
- Log errors: This option is used in case of requiring more information about unexpected errors.

8.4.4 Outputs

Different stakeholders may require the same information presented in different formats to ensure that the dissemination pathway is tuned to their particular circumstances.

8.4.4.1 Graphics of yield scenarios

Yield scenarios are computed with 30 years of climatic historic records. Their medians are compared to a median production computed between 1990 and 2019. A value of 100 represents the production for a normal year. Rescaled yield distribution is shown with box plots. The box base and top correspond to 15th and 85th percentiles respectively, and the median is also shown within the box. Additionally, whiskers are drawn for 3rd and 97th percentiles (Figure 17).

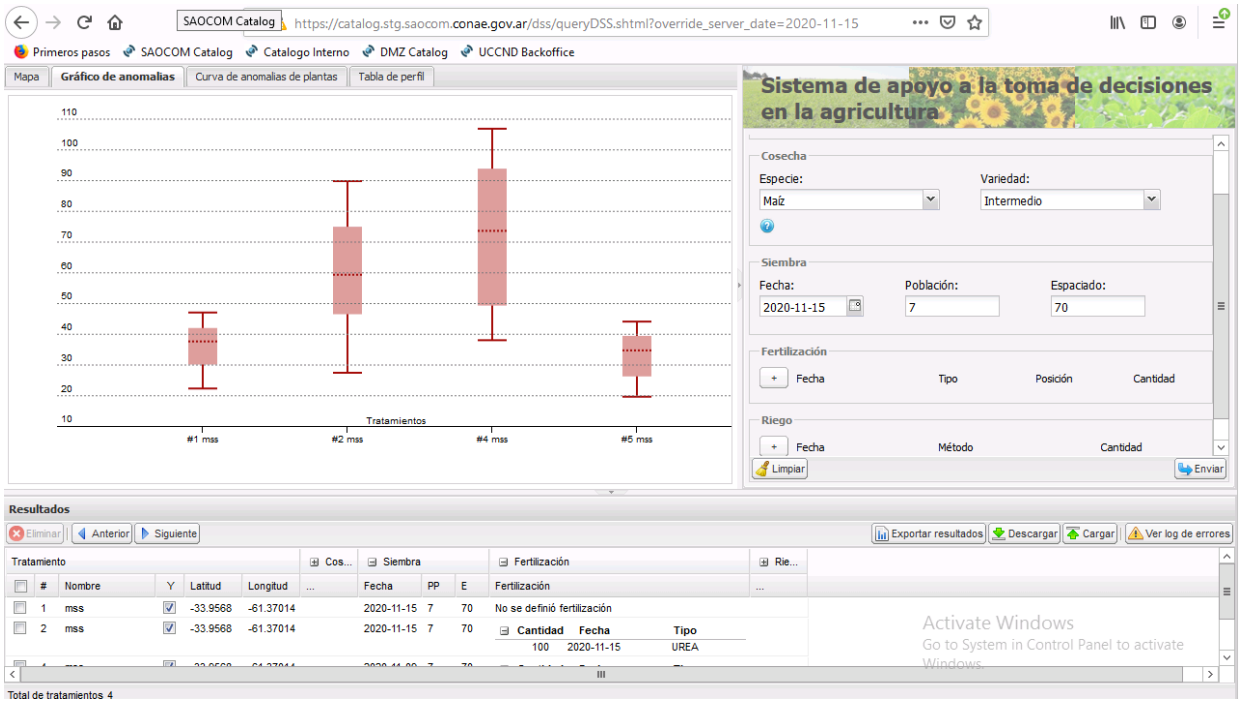


Figure 17: Box plot that shows rescaled yield distribution per treatment

The evolution of the rescaled weights of dry seeds is also sketched for the five mentioned percentiles: 3rd, 15th, 50th, 85th, and 97th (Figure 18).

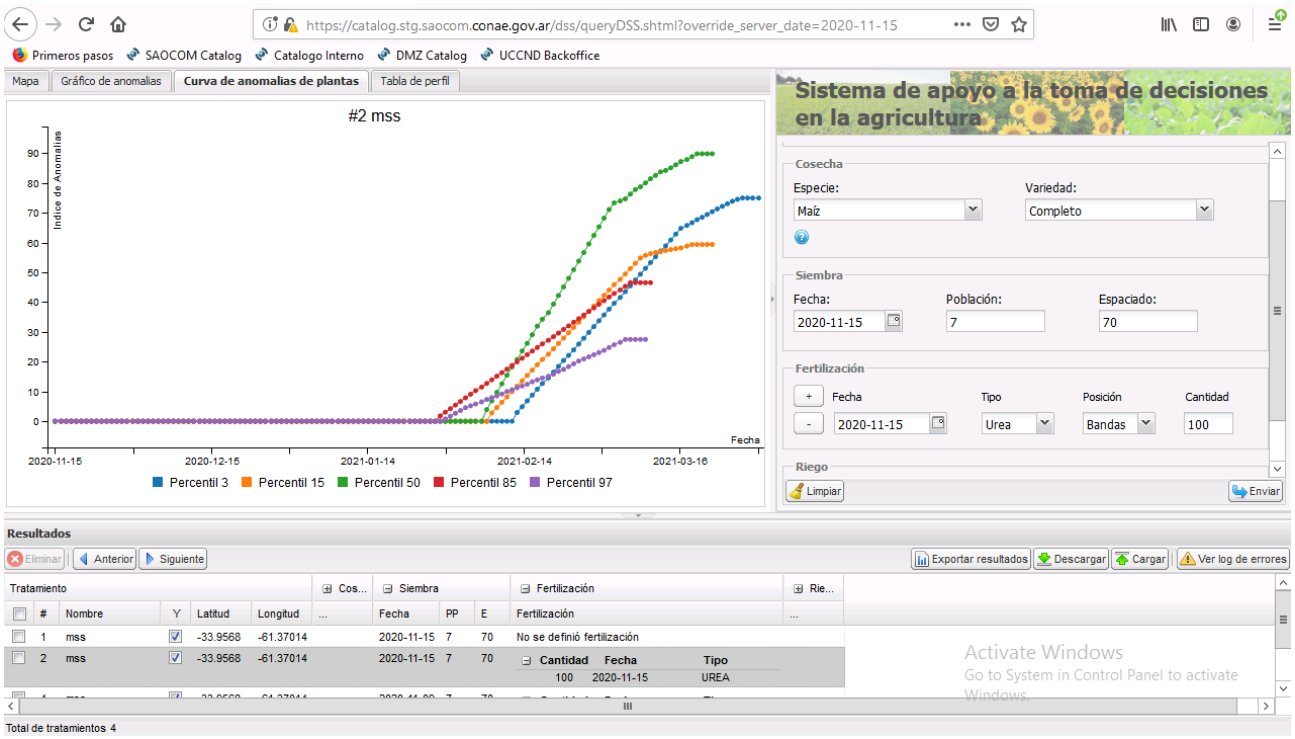


Figure 18: Evolution of the rescaled grain dry weight

8.4.4.2 Tables

A table with all the selected input data and the processed data will be shown at the bottom of the page and it will be also available for download for further analysis. This is quite important considering that the user can keep this information to analyze it later (bottom of Figure 18).

8.4.4.3 Soil water profile

The DSS-SA product produces the soil water profile for the selected site after running the simulation. This information will allow the user to know the updated soil moisture status of the

selected plot. Figure 19 shows the volumetric soil water content per each soil layer. In the left side of the graphic depth is presented, while in the right side it is indicated the soil moisture scale.

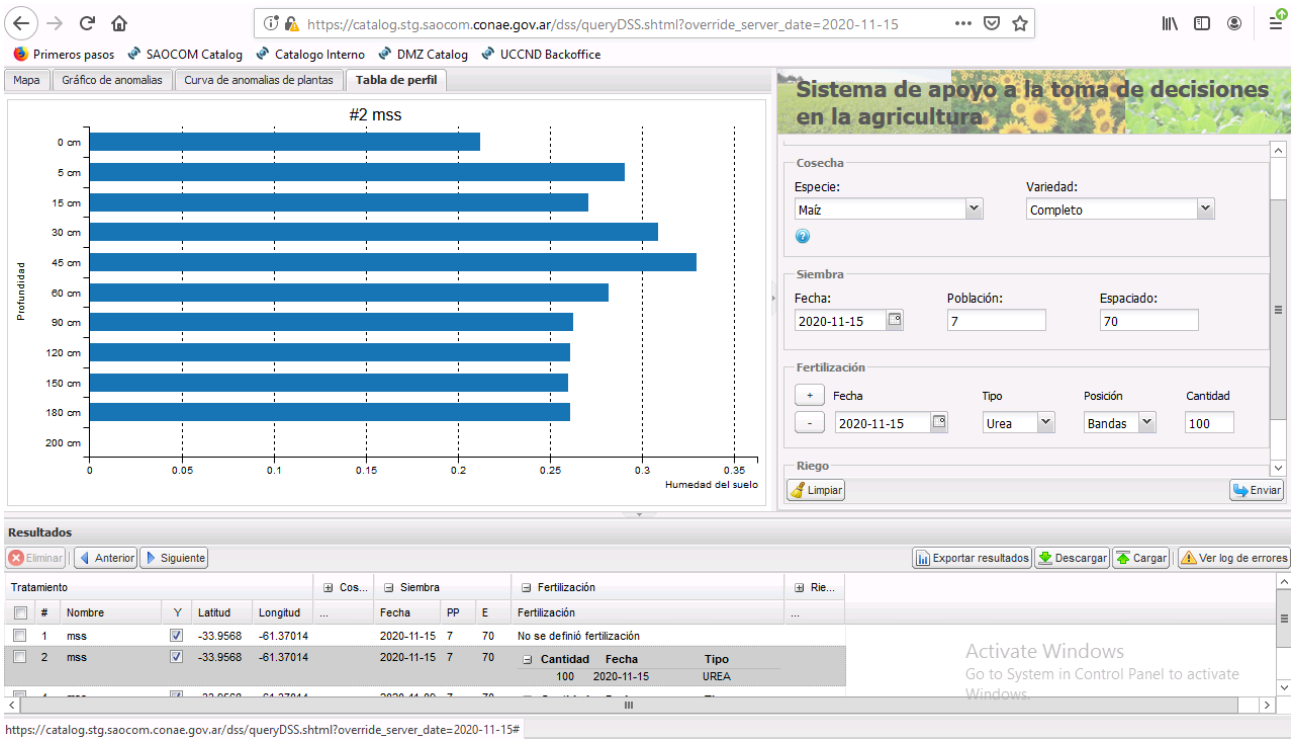


Figure 19: Soil water profile calculated with up-to-date values.

8.5 Fusarium Wheat Head Blight Disease (FIM) Products

8.5.1 Introduction

The Fusarium Wheat Head Blight Disease Strategic Application (FIM-SA) has two products that seek to help farmers in the decision making process of controlling fusariosis with chemical

applications. This product is mainly intended for farmers who could have an estimate of the incidence of the disease through thematic maps or posing a specific query through a Web page.

8.5.2 Specifications

The product must provide certain characteristics that in general any decision support system should have: to be user friendly; to use available inputs; to be focused on an area of potentially large cost benefits.

Product ID	**PCP**
Product type	**map**
Main product characteristics	
Pixel Value	FIM Index: from 1 to 100 No data: 0
Reference system	WGS 84
Bits Per Pixel	8
Data Type	Byte
Format	GeoTiff
Grid Size[rows and columns]	1300 x 1200
Spatial Resolution [degrees]	0.01
Area	Lat: from -28 to -41, Lon: from -56.5 to -68.5
Computed regions	Buenos Aires, Córdoba, Entre Ríos, La Pampa, Santa Fe
Product ID	**UFC**
ProductType	Web product
Main product Characteristics	
Available regions	Buenos Aires, Córdoba, Entre Ríos, La Pampa, Santa Fe
Coverage area	Local (plot, farm, sites)
Reference System	WGS 84
Data Type	Integer that estimates fusariosis incidence
Data time step	daily

Table 90: FIM-SA product specifications

8.5.3 Interface

The user interface of the product will be via web. The display of the interface will be similar to the one shown in Figure 20.

The interface has two data blocks: The first shows the PCP product for a chosen date over a geographic layer. The second block is a form similar to the DSS product where the user could enter the parameters representing the management chosen for his wheat plot.

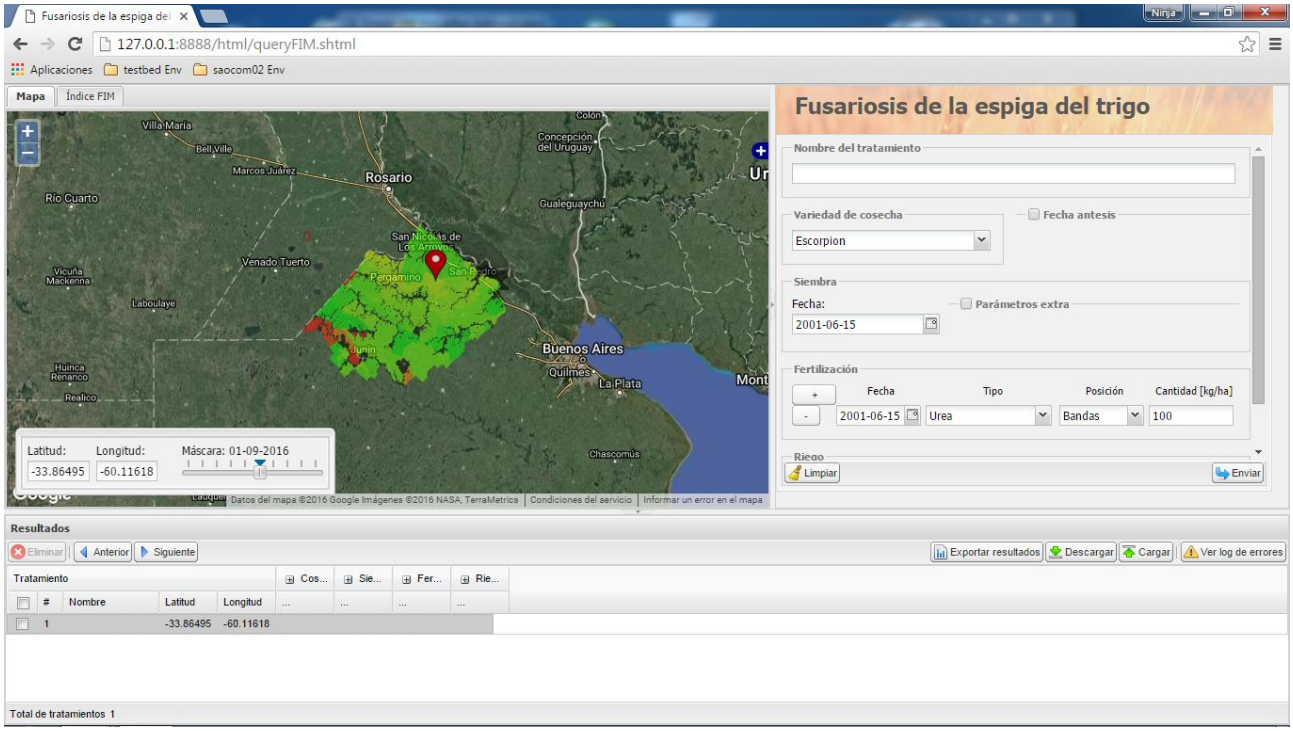


Figure 20: FIM-SA map and web form

The form has three mandatory sections that users must fill in (Location, Crop and Sowing) and two optional ones (Fertilization and Irrigation).

Location: Refers to the place where the user wants to run the simulation tool. Plot coordinates can be entered either by clicking in the map (Figure 20) or by typing the latitude and longitude of the center of the chosen plot.

Crop: Refers only to the variety selection due to UFC product is computed only for wheat.

Sowing: Asks values for three parameters: date, plant population and row spacing. The date field can be entered selecting the date in a pop-up calendar or typing it complying with the format yyyy-mm-dd (Figure 20).

Fertilization: Enables to enter fertilizer treatments in order to be taken into account in the simulation of the crop growth and development. Four input boxes must be filled: application date, fertilizer type, position and amount of dosage.

Irrigation: Enables to incorporate irrigation schedules in order to be taken into account in the simulation of the crop growth and development. Three input boxes must be filled in: date, type and amount.

In the right side of the web page there is a menu that includes the following options:

- Send: This is used to send the already entered data and to trigger the simulation process.
- Clear: This is used to clear the entered information, leaving the page in blank
- Download: This option is used to download the generated results in JSON format.
- Upload: This option is used to upload previous treatments and generated scenarios.
- Export: This option allows exporting graphs and values for the simulated treatments in a text report.
- Log errors: This option is used in case of requiring more information about unexpected errors.

8.5.4 PCP product

The PCP product will be shown on the main page. It corresponds to a thematic map where through a simple color table the user will grasp a regional understanding about the incidence of the disease. (Figure 20)

8.5.5 UFC Product

Daily evolution of FIM index is computed and it is shown in a graph for a specific plot. According to the index value, the line color is changed from green to yellow, and finally to red in order to reflect the infection risk level.

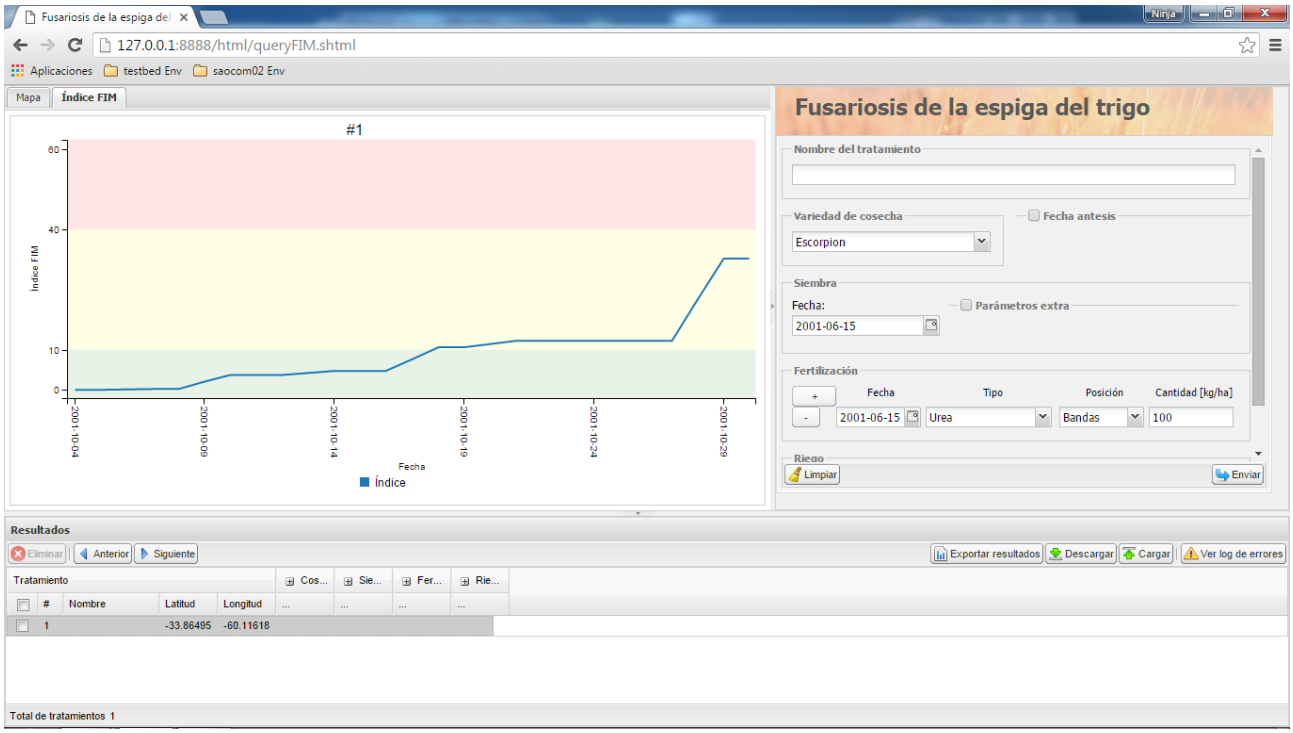


Figure 21: Evolution of the FIM index over time

A table with all the selected input data and the computed FIM index will be displayed at the page bottom and it will be also available for download for further analysis. This is quite important considering that the user can keep this information to analyze it later (Figure 21)

8.6 Land Cover Classification (LCC) Product

8.6.1 Introduction

Land Cover Classifiction (LCC) and PAULI products identifies the land cover and the coherent decompositions by scattering matrix from SAOCOM STRIPMAP/TOPSAR Level-1A (SLC) Quad Pol images. Some LCC class like mount, bush and pastureland were obtained from temporary images optical, the rest of the coverages such as soybean, maize, wheat, etc. were classified from SAOCOM. Both products have KML, XML and PNG files associated to image. The XML file contains all the metadata associated for each product.

8.6.2 Specifications

Product ID	**LCC-PAULI**	
Product Type	LCC, PAULI. Ground Terrain Corrected.	
Main product Characteristics		
Coordinate System	Latitude/Longitude	
Data Type	KML	PNG
BitDepth		32
ColorType		Truecolor
Transparency		Alpha

Table 91: LCC Product specifications

8.6.2.1 Product Content Description

XML : Metadata with product information

PNG : Thematic map for Land Cover Classification.

The XML file contains as main information, the values (pixels) of the tiff image corresponding to the names of the classified crops. For example, Class_1 from item Classification_Index is associate to the value of pixel (1) of the tiff image to the class soy (soja) classified (**Error! Reference source not found.**)

GI_20200106103519_SAOCOM_S...

```
<?xml version="1.0" encoding="utf-8"?>
<oxml>
  <NumberOfChannels>
    1
  <VersionNumber>
    2.1
  <Description>
    <item>
      <Classification_Index>
        <item>
          Class_1
        <item>
          soja
        <item>
          area= 1173986.63 (ha)
    <item>
      <Classification_Index>
        <item>
          Class_2
        <item>
          maiz
        <item>
          area= 473189.62 (ha)
    <item>
      <Classification_Index>
        <item>
          Class_3
        <item>
          rastrojo
        <item>
          area= 12361.10 (ha)
    <item>
      <Classification_Index>
        <item>
          Class_4
        <item>
          pastizal
        <item>
          area= 876087.22 (ha)
    <item>
      <Classification_Index>
        <item>
          Class_5
        <item>
          matorral
        <item>
          area= 3195.00 (ha)
    <item>
      <Classification_Index>
        <item>
          Class_6
        <item>
          monte
        <item>
          area= 14392.44 (ha)
```

Figure 22: LCC Producto, XML file with classified crops

8.6.2.2 LCC Thematic Map

The Land Cover Classification product is presented with a color scale as it is shown in Figure 23

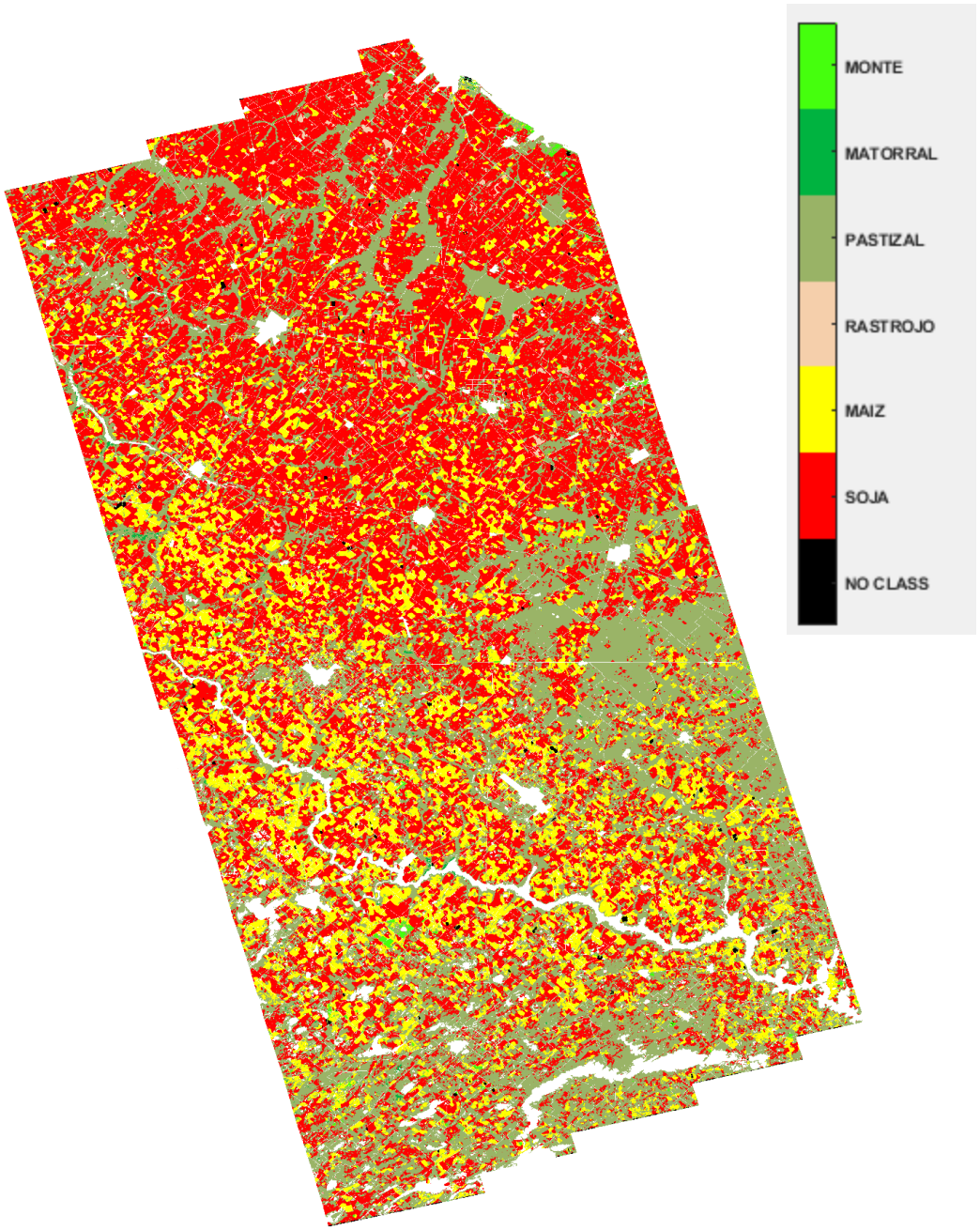


Figure 23: LCC Thematic Map
