The Sentinel-3 Topography Mission: Current Status

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Ocean SAR altimetry expert group meeting, 26-27th June 2013, National Oceanography Centre, UK.

Global Monitoring for Environment and Security

Outline

- Sentinel-3 Mission Summary

- Sentinel-3 Topography Mission

- Status of the Mission

- Recent developments

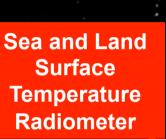# Sentinel-3: Continuity of ENVISAT Land and Ocean Observations

Main satellite characteristics

- **1250 kg maximal mass**
- **Volume in 3.89 m x 2.202 m x 2.207 m**
- **Average power consumption of 1100 W**
- **7.5 years lifetime (fuel for 5 add. years)**
- **Large cold face for optical instruments thermal control**
- **Modular accommodation for a simplified management of industrial interfaces**
- **Launch S3A April 2014**
- **Launch S3B later**

Observation Data Management:
- **21.25 Gb (170 Gbit) of observation data per orbit**
- **Space to ground data rate 2 x 280 Mbps X-Band**
- **1 ground contact per orbit**
- **3h delivery timeliness (from satellite sensing)**

Microwave Radiometer

Ocean and Land Colour Instrument

Sea and Land Surface Temperature Radiometer

GPS

X-band Antenna

DORIS Antenna

Laser retro-reflector
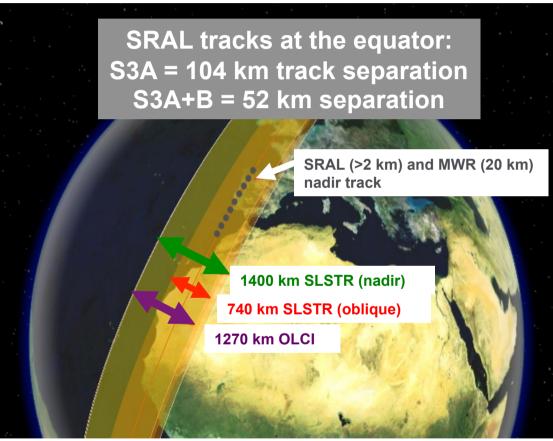
S-band Antenna

SAR Radar Altimeter

Sentinel-3: Instrument Swath and Satellite Orbit
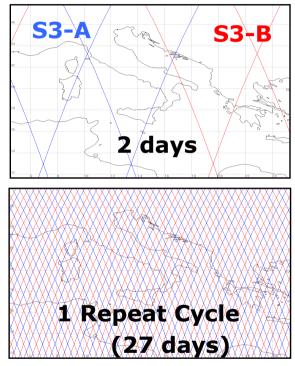
Instrument Swath Patterns

SRAL tracks at the equator:
S3A = 104 km track separation
S3A+B = 52 km separation

SRAL (>2 km) and MWR (20 km) nadir track

1400 km SLSTR (nadir)
740 km SLSTR (oblique)
1270 km OLCI

Orbit type	Repeating frozen SSO
Repeat cycle	27 days (14 + 7/27 orbits/day)
LTDN	10:00
Average altitude	815 km
Inclination	98.65 deg

Ground Track Patterns

S3-A   S3-B

2 days

1 Repeat Cycle (27 days)

SRAL orbit drivers:

- **Ground track repeatability,**
- **Dense spatial sampling**

Orbit control requirement:

- **Ground track dead-band ±1km**

Sentinel-3 Status: A-Satellite starting instrument integration

- ➢ Sentinel-3A platform integration completed

- ➢ DORIS and LRR (Laser Retro Reflectors) flight models delivered and being mechanical integrated

- ➢ SRAL PFM final tests performed: delivery on 11th of July

- ➢ MWR PFM started environmental testing: delivery by end of August

- ➢ OLCI and SLSTR instrument being integrated, for a delivery by end of the year

- ➢ **Instrument integration and testing should be completed by Jan. 2014, allowing start of environmental campaign**

- ➢ **Sentinel-3B Platform under integration: activities completion and delivery to Prime by end of the year**

S3A alignment checks before starting with instrument integration

Ref.	Type	Sentinel-3 Objectives
S3-OB-1	Primary	Sentinel-3 shall provide continuity of an ENVISAT type ocean measurement capability for GMES Services with a consistent quality, a very high level of availability (>95%), high accuracy and reliability and in a sustained operational manner for GMES users, including: • Ocean, inland sea and coastal zone colour measurements to at least at the level of quality of MERIS on Envisat; • Sea surface temperature measurements to at least at the level of quality of AATSR on Envisat; • Sea surface topography measurements to at least at the level of quality of the Envisat altimetry system, including an along-track SAR capability of CryoSat heritage for improved measurement quality in coastal zones and over sea ice.
S3-OB-2	Primary	Sentinel-3 shall provide continuity of medium resolution ENVISAT-type land measurement capability in Europe to determine land-surface temperature and land-surface colour with a consistent quality, a very high level of availability (>95%), high accuracy and reliability and in a sustained operational manner for GMES users.
S3-OB-3	Primary	Sentinel-3 shall provide, in a NRT operational and timely manner, L1b visible, shortwave and thermal infrared radiances and L2 topography products for use by GMES Services with a consistent quality, a very high level of availability (>95%), high accuracy and reliability and in a sustained operational manner for GMES users.
S3-OB-4	Primary	Sentinel-3 shall provide, in a NRT operational and timely manner, a generalised suite of high-level **primary** geophysical products with a consistent quality, a very high level of availability (>95%), high accuracy and reliability and in a sustained operational manner for GMES users. Products shall include as priority: • Global coverage Sea Surface Topography (SSH) for ocean and coastal areas, • Enhanced resolution SSH products in the Coastal Zones and sea ice regions, • Global coverage Sea-Surface (SST) and sea ice surface temperature (IST), • Global coverage Ocean Colour and Water Quality products, • Global coverage Ocean Surface Wind Speed measurements, • Global coverage Significant Wave Height measurement, • Global coverage atmospheric aerosol consistent over land and ocean, • Global coverage Vegetation products, • Global coverage Land Ice/Snow Surface Temperature products, • Ice products (e.g., ice surface topography, extent, concentration)
S3-OB-5	Secondary	Sentinel-3 shall provide continuity of medium resolution SPOT Vegetation P-like products by providing similar products over land and ocean with a consistent quality, a very high level of availability (>95%), high accuracy and reliability and in a sustained operational manner for GMES users.
S3-OB-6	Secondary	Sentinel-3 shall provide in an operational and timely manner, a generalised suite of high-level **secondary** geophysical products with a consistent quality, a very high level of availability (>95%), high accuracy and reliability and in a sustained operational manner for GMES users. Products shall include as priority: • Global coverage Fire monitoring products (FRP, burned area, risk maps etc), • Inland water (lakes and rivers) surface height data.

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S3 SAR RADAR Altimeter

- ## Dual frequency Ku/C band Radar Altimeter
  - CryoSat and Jason heritage
  - High horizontal resolution (~300m in SAR mode)
- ## SRAL Radar features:
  - Ku-Band (13.575 GHz) : main frequency
  - C-Band (5.41 GHz) : ionosphere corrections
  - Fully redundant electronics
- ## Measurement modes:
- ## 2 radar modes:
  - Low Resolution Mode (LRM) and
  - High Resolution SAR mode
- ## 2 tracking modes:
  - Closed-loop (traditional) and
  - Open-loop tracking modes over rough surfaces (DEM onboard)
- ## Any radar mode can be combined to any tracking mode
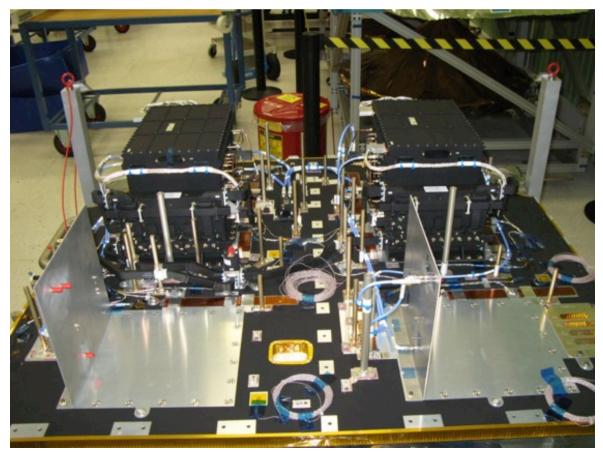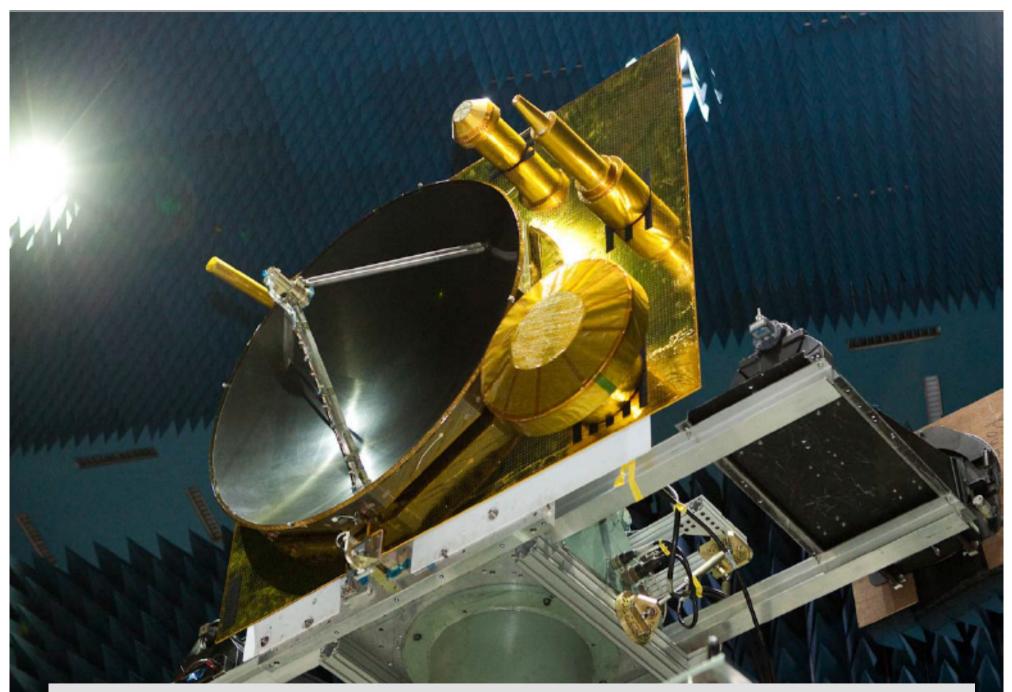
Objective: To retrieve orbit altitude information with an end-to-end accuracy of 3 cm (Ocean)

Supported by MWR, GPS, LRR and DORIS
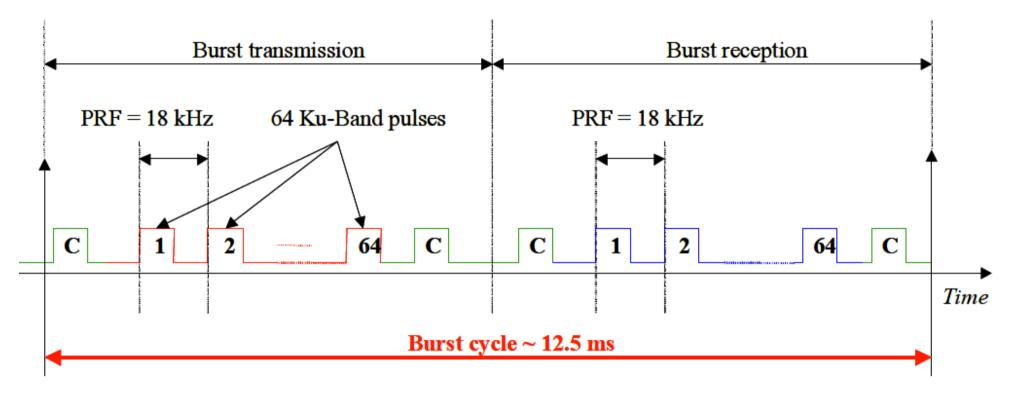
PFM SRAL antenna (without sunshield) during the antenna pattern measurement

SRAL Chronograms
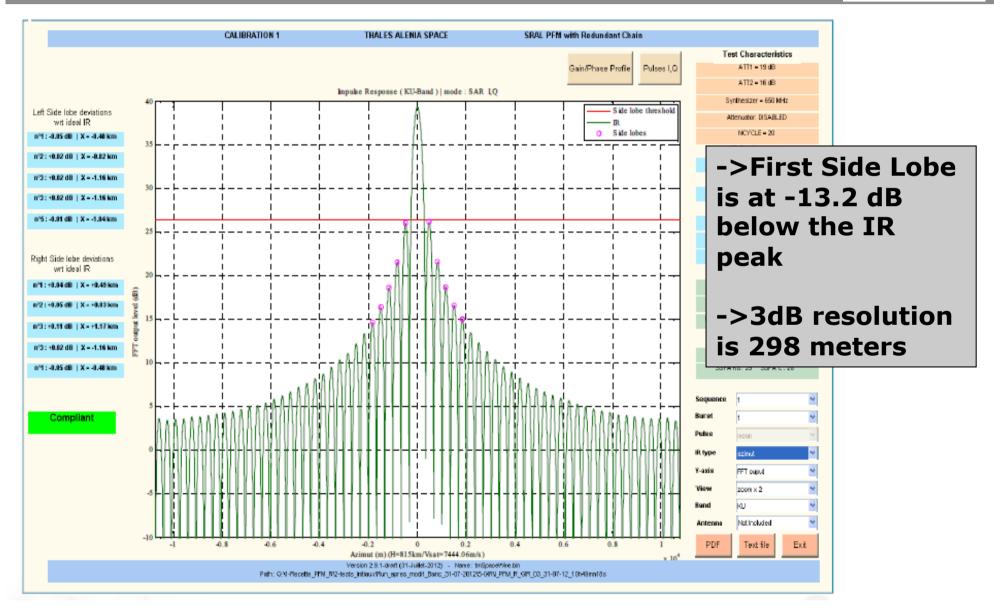
SAR burst pattern
4-burst cycle is ~LRM cycle of 50 ms.

SRAL PFM Instrument Azimuth Impulse Response

->First Side Lobe is at -13.2 dB below the IR peak

->3dB resolution is 298 meters

S3 SRAL Instrument Status June 2013

- **SRAL PFM Instrument Test Campaign now completed**

- **All Instrument Performances are fully compliant to the Sentinel-3 mission requirements**

- **All results are in line with the EM Instrument measurements**

- **The SRAL PFM Instrument will be shipped to Prime by mid-July. The SRAL PFM antenna was sent in advance for its integration on the platform (it will take place early July)**

- **The SRAL FM Instrument for S3B is progressing nominally**

Sentinel-3 STM: PDGS Product List (Current baseline – see later)

STM User Products →

S-3 SRAL Products Levels			
Product Type	**Product Level**	**Description**	**Distribution**
SR_0_SRA___	0	ISPs raw data (everything but calibration ISPs)	Internal
SR_0_CAL___	0	Calibration from SRAL ISPs	Internal
SR_1_SRA___	1	Echos for LRM and SAR mode	Internal / CalVal user
SR_1_CAL___	1	Level 1 SRAL calibration parameters	Internal / CalVal user
SR_2_LAN___	2	1-Hz and 20-Hz Ku and C bands parameters (LRM/SAR), waveforms. Over Land	User / CalVal user
SR_2_WAT___	2	1-Hz and 20-Hz Ku and C bands parameters (LRM/SAR), waveforms. Over Water	User / CalVal user

S-3 MWR Products Levels			
MW_0_MWR___	0	Observation, calibration and monitoring parameters from MWR ISPs	Internal
MW_1_MWR___	1	Level 1 observation data	Internal / CalVal user

S-3 GNSS Products Levels			
GN_0_GNS___	0	GNSS ISP	Internal
GN_1_GNS___	1	Rinex	Internal / CalVal user

S-3 DORIS Products Levels			
DO_0_DOP___	0	Measurements packets including Doppler, datation and test packets	Internal
DO_0_NAV___	0	Navigation packets including ITRF, geodetic and J2000	Internal
DO_1_DOP__	1	DORIS Level 1B	Internal / CalVal user

But also NRT, MOE & POE orbit products

S-3 STM PDGS product list

Sentinels Core Products Volume
(Current baseline - see later)

SRAL+MWR Data				
Product Type	Data volume (GByte/orbit)	Data volume per day (GByte)	Data volume per week (GByte)	Data volume per year (TByte)
SR_0_SRA___	5.82	82.98	580.87	29.58
MW_0_MWR___	0.003	0.04	0.28	0.014
MW_1_MWR___	0.003	0.04	0.28	0.014
SR_1_SRA___	0.12	1.65	11.54	0.59
SR_2_WAT___	0.09	1.31	9.16	0.47
SR_2_LAN___	0.07	1.00	7.01	0.36
TOTAL	6.10	87.02	609.13	31.02

S-3 STM Level 2 product volume:

Reduced 0.60 MB / orbit

Standard 40 MB / orbit

Enhanced 160 MB / orbit
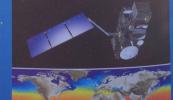
< 1 Tbyte / year for the overall S-3 STM L2 user data set

With inclusion of PLRM

SENTINEL-3 CALIBRATION AND VALIDATION PLANNING MEETING

20-22 March 2012 | ESA-ESRIN | Frascati (Rome), Italy

Building 1

- 22 March 2012 08:17

esa
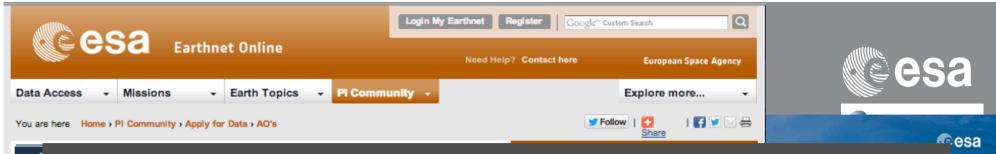
GMES Sentinel-3 Calibration and Validation Planning Meeting

ESA/ESRIN, Frascati, Italy, 20-22nd March 2012
http://congrexprojects.com/12m17

Sentinel-3 S3VT Selection and Planning Meeting
ESTEC, 29th January 2013

GMES
Observing our planet for a safer world

Recent Developments

SRAL SAR baseline operational scenario and requested modification

Current operational baseline

Proposed baseline
- 100% SAR mode

Note: it is assumed that the LRM shall be kept as a back-up to reduce operational risks and to allow a possible switch to the LRM scenario if necessary

Summary of current position

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- **MyOcean request to EC for having Sentinel-3 SRAL SAR mode over open ocean, after Cryosat results highlighted considerable, unexpected benefits of this mode for the oceanographic community (Sept, 2012) .**

- **EC request to ESA (Nov. 22, 2012) to analyse new options for the operations of Sentinel 3 with respect to:**

  - **SRAL SAR operational scenario", to cope with an extended usage of SAR mode for the S3 SRAL instrument up to 100% of Earth coverage;**

  - **"Requirements for atmosphere monitoring", to add AOD and FRP as operational products**

  - **Additional option: to make SRAL additional L1 SAR products available to users**

CURRENT SITUATION

- **ESA preliminary feasibility analysis showed no technical show-stopper for the analysed options**

- **Programmatic feasibility currently being assessed by the EC together with the GMES Committee (EC proposal to the Committee is to proceed with all the above mentioned options)**

S3 full SAR Scenario: technical impact assessment (requested by EC)

ESA analysis includes impact assessment with respect to:
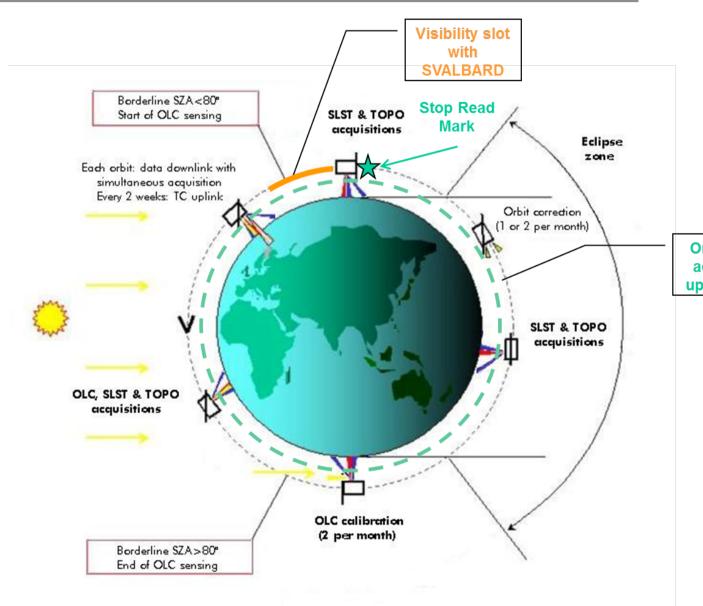
- ***Space Segment:***
  - » Measurement data volume
  - » Measurement data dumping time
  - » Data acquisition and download strategy
  - » Spacecraft Power consumption
  - » Spacecraft Thermal Dissipation
  - » Spacecraft Operations (Impact on the Orbit Position Schedule)
- ***Ground Segment:***
  - » SAR over ocean algorithm evolution
  - » Core GS evolution
  - » New L1 products

Data volumes, dump duration, data acquisition and download strategy (1/3)

Data type	BASE LINE scenario	SRAL 100% scenario
SRAL Data volume / orbit	50 Gb	66.6 Gb
SRAL Dump duration at 520 Mbps	96.14 s	127.84 s
S3 TOTAL Data volume / orbit	172.6 Gb	189.2 Gb
S3 TOTAL Dump duration	332.6 s	364.2 s
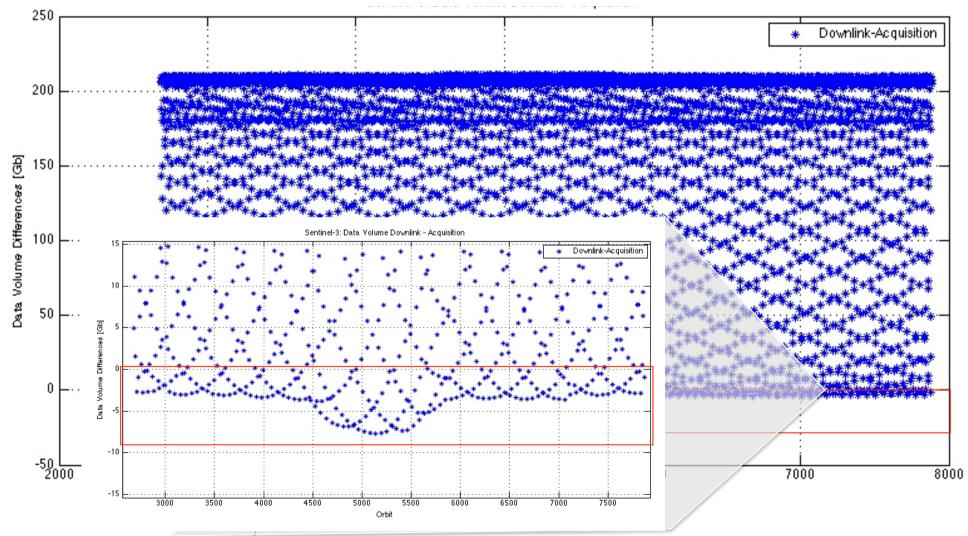
- **% net increase: 9.6%**

- **Dump duration increase at (Svalbard) station: 31.6 sec.**

Data volumes, dump duration, data acquisition and download strategy (2/3)

Available downlink data in orbit N+1 versus acquired data throughout a full year

Insufficient Data Downlink Time

Summary impact on data acquisition and download strategy from ESA simulations:

- In some cases the data download cannot be completed in the same pass (worst case: summer, 8Gb/orbit)

- Data download can always be completed at the next overpass (i.e. <u>no data loss, but delay on some orbits)</u>

- A number of possible modifications to the downlink strategy have been identified to mitigate this impact, e.g. re-adjustments to the downlink commands wrt other S3 instruments ISPs. This will need to be validated during the Commissioning Phase.

SAR algorithm evolution and validation

Algorithm evolution and corresponding in-flight characterization and validation would be required with respect to current baseline for coastal areas, in particular for:

- A new Sigma-0 algorithm at Ku band to be used for wind speed computation over ocean (not part of current baseline for coastal areas)
- An extended Sea State Bias correction (to be evaluated for the full ocean).

Recommended 2-stage approach:

- **Algorithm definition (in close consultation with GMES user representatives and EC)**
- **Development, testing and deployment*.**

*Note: this shall not impact launch schedule ➜ ➜ SAR processing will be complemented within the NRT and off-line processing over the course of a ramp-up phase, keeping pseudo-LRM output as back-up solution until fully implemented.

Recommended option

S3 would be the first mission to provide 100% SAR altimetry coverage!!

SAR technology is new and complex ➔ ➔ Further work required to understand all in-orbit conditions and emerging processing systems. Noting CryoSat experience, **ESA considers beneficial that S3 SAR L1 products are made available to the users.**

Expected advantages:

- Foster a new generation of SAR altimetry specialists maintaining Europe at the competitive edge
- Enhance maintenance and development of existing and new products over the Earth surface (ocean, ice and land) within GMES
- Enhance uptake, application, and quality control (e.g. transponder calibration) of SRAL SAR data products by the GMES user community
- Possibly reduce large-scale reprocessing efforts (because starting from intermediate L1 products rather than from L0)

New L1 Products (TBC by EC)

- **The data identified to become Sentinel-3 operational products are the following:**
  - *L1A: Unpacked L0 complex echoes that have been sorted and calibrated.* Geo-location information is included. This product is equivalent to SAR processing ~~single-look~~ studies on SAR processing such as ~~superposed~~ beam formation and for calibration studies using ground-based Transponders.

    L1A: Engineers & Research specialists

  - *L1B-S: Geo-located, calibrated azimuth formed complex (I and Q) echoes after slant/Doppler range correction over a fixed point on the ground-track.* Relevant ancillary data (e.g. beam angles, calibration information) are included. There is no averaging of individual ~~looks~~ ancillary data (e.g. statistical ~~parameters of the multi-looked average/stack) etc) is included. This product is relevant to geophysical retrieval algorithm developers (over ocean, land and ice surfaces), surface characterisations studies (e.g. impact of sea state bias, wave directional effects etc) and Quality Control systems.

    L1B-S: Science users supporting operational users

  - *L1B: Geo-located, calibrated azimuth formed complex (I and Q) echoes after slant/Doppler range correction ~~after averaging (i.e multi-looked/ stacked) over a fixed point on the ground-track.~~* This product is relevant to geophysical retrieval algorithm developers and Quality Control systems.

    L1B: Operational users

Extended SAR mode: Conclusions

- Satellite lifetime remains unaffected, as no impacts on consumables budget (fuel, power) are identified.

- No impact on launch schedule expected, assuming full availability of products may occur during a ramp-up phase (algorithm and distribution of L1 products to be agreed)

- Impact on routine operations is considered minor

→ → No identified technical "show-stopper" for a 100% SAR Duty Cycle of the Sentinel-3 altimeter.

Summary

- Two Sentinel-3 satellites are being built now to provide **operational data streams required by EC GMES Services.**

- **The Topography Mission is a "state of the art" Mission**

- **SRAL PFM Instrument Test Campaign now completed**

- **All Instrument Performances are fully compliant to the Sentinel-3 mission requirements**

- **Major analysis has been conducted at ESA to confirm the viability of operating SRAL in SAR mode 100% of the time → No showstoppers**

  – The Topography mission baseline is in final review with the EC to change to 100% SAR operations (waiting for a response)

  – New L1a and L1b-S products have been proposed to the EC (waiting for a response)

- **S3A will launch at the end of 2014 (earliest) and S3B ~18 months later.**

Thank you - any questions?

For more information http://www.esa.int

See Donlon et al (2012) The GMES Sentinel-3 Mission, *Remote Sensing of Environment,* **http://dx.doi.org/10.1016/j.rse.2011.07.024**
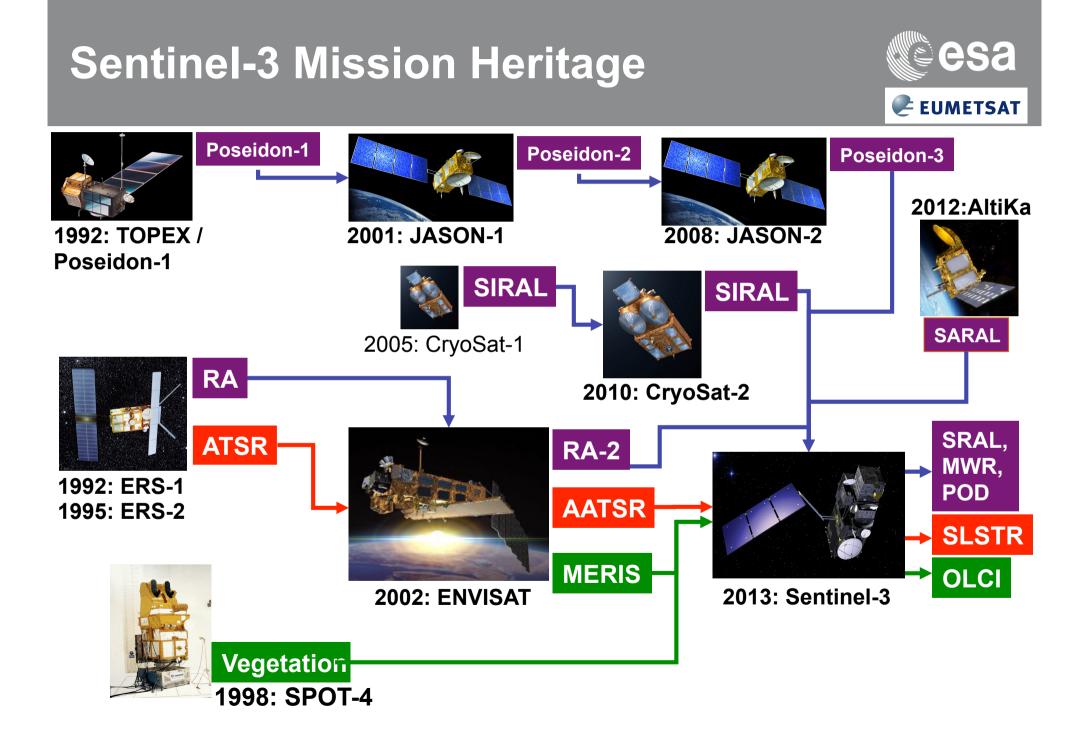
and the Mission Requirements Traceability Document (MRTD) at http://download.esa.int/docs/EarthObservation/GMES_Sentinel-3_MRTD_Iss-1_Rev-0-issued-signed.pdf
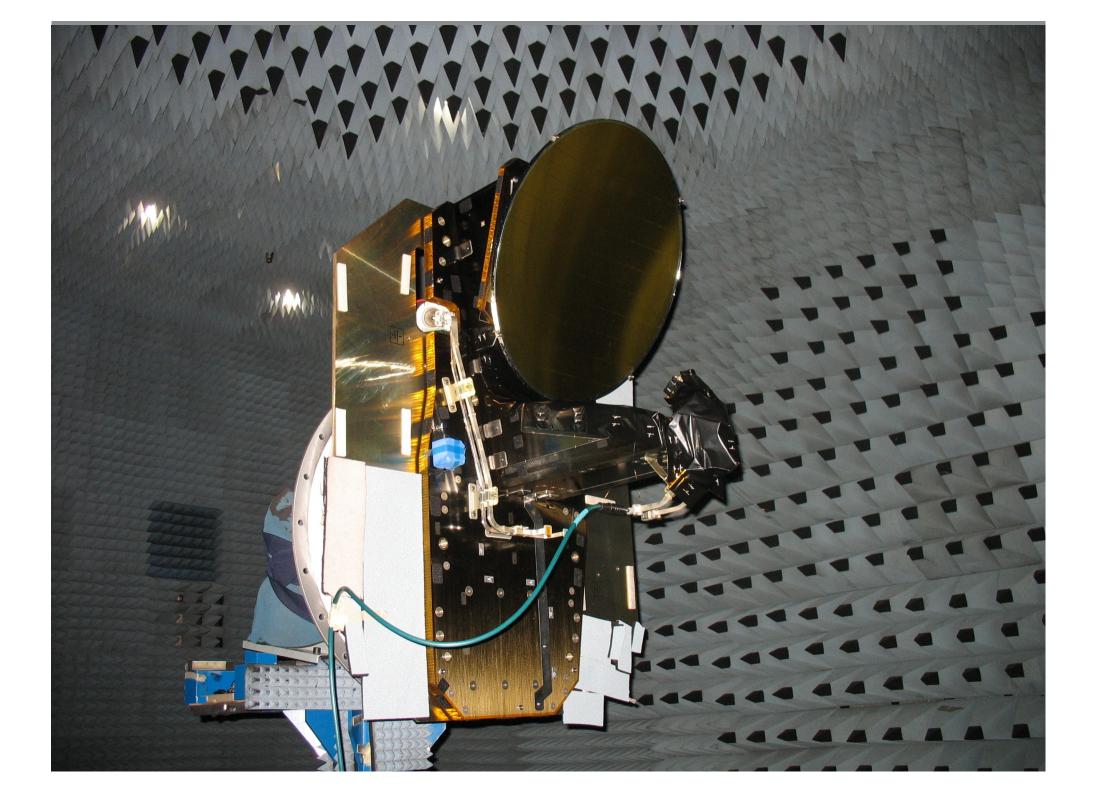
Contact: craig.donlon@esa.int

Sentinel-3 Mission Heritage

S3: Precise Orbit Determination (POD)

8 channel GPS receiver (~3m NRT, 2-3cm on ground)
- Satellite Navigation – AOCS (on-board – permanent function)
- Datation of scientific telemetry (on-board – permanent function)
- Control of SRAL open-loop tracking (on-board – commanded function)
- POD (on ground)
- USO frequency monitoring (on-ground)

DORIS Navigation receiver (~1 cm)
- Provide USO frequency to SRAL (on-board – permanent function)
- Control of SRAL open-loop tracking (on-board – commanded function)
- POD (on ground)
- USO frequency monitoring (on-ground)

Laser Retro-Reflector (<2 cm)
- Contribution to POD, validation of POD solution

POD radial accuracy requirements (rms)
- **Near Real Time (NRT < 3h): 10 cm (8 cm goal)**
- **Short Time Critical (STC < 48h): 4 cm (3 cm goal)**
- **Non Time Critical (NTC < 1 month): 3 cm (2 cm goal)**

Sentinel-3 SRAL: Open-loop vs Closed-loop echo tracking

Closed Loop Tracking

✓ Tracks echoes over most surfaces

✓ No priority
  – Land surface tracking instead of water surface

✓ Sensitive to echo shape
  – Loss of tracking

✓ Acquisition Phase is needed
  – At least 0.5s data gap

✓ Tried and tested on many altimeter mission

Open Loop Tracking
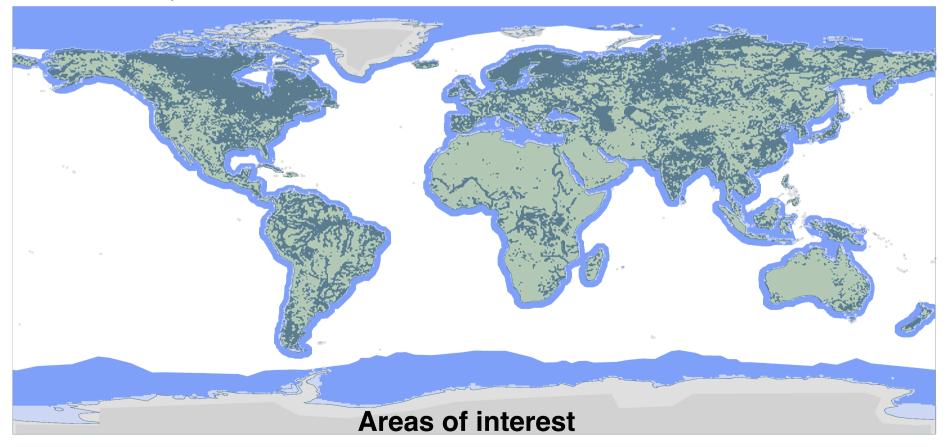
✓ Needs an accurate coding of surface elevation (accurate DEM, 1km) and Open Loop Tracking Commands

✓ If a point of the surface is not properly coded in the OLTC, the echo is lost (no echo received on board)

✓ Water Surface can be prioritized even over land surfaces

✓ Altimeter always in tracking mode (+ for coastal area, sloppy terrain, and small Inland Water)

✓ New approach with limited experience (Jason-2)

Sentinel-3 SRAL: Open-loop Tracking Commands (OLTC)

OLTC is generated by ESA/CNES using a tool developed by CNES for Jason-2 and adapted for Sentinel-3.

> A table stored on-board the SRAL, containing surface elevation information along the satellite track for the complete cycle (385 orbits), angular sampling: 0.01 degree (i.e. about 1 km)

Areas of interest
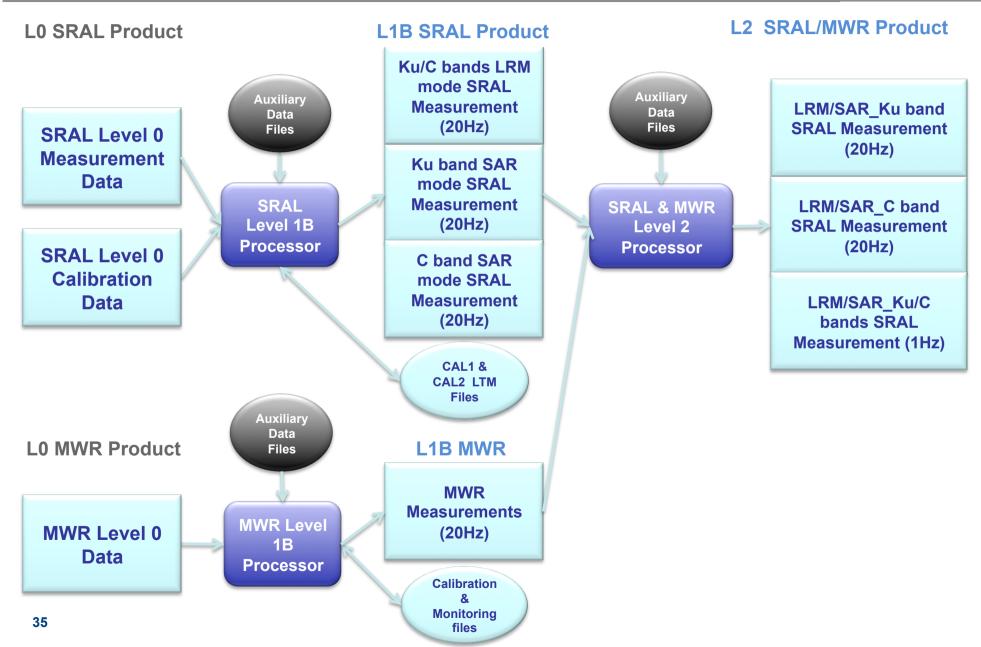
Sentinel -3 STM: Algorithms & Products Content

✓ **Algorithm heritage from ERS-1, T/P, ERS-2, Jason-1, Envisat, Cryosat, Jason-2**

✓ **Retrackers run in parallel in LRM and SAR mode**
   - MLE4 → Ocean LRM mode (OCE_01) → Ku/C bands
   - SAMOSA → Ocean SAR mode (OCE_02) → Ku band
   - **MLE4 → PLRM mode → Ku/C bands**
   - OCOG → Ice LRM/SAR mode (ICE_01) → Ku/C bands
   - MLE4 → Ice Sheet LRM mode (ICE_04) → Ku/C bands
   - Ice-margin SAR mode (ICE_05) → Ku band
   - Ice (erf) LRM → (ICE_02) → Ku/C bands
   - Sea-ice SAR mode → (ICE_03) → Ku band

✓ **Standard geophysical corrections/fields + …**
   - Sea-ice freeboard, new coastal composite and open ocean (using SST) wet tropospheric corrections, distance to the coast, enhanced 6-states sea-ice flag, continental ice classification, 6-states rain flag, …

✓ **State-of-the-art SAD & DAD files harmonized (where possible) with other operational products**
   - 2D & 3D ECMWF fields for wet and dry model corrections, 2 MSS (CLS11, DTU-10), MDT, …

MARINE & LAND L2 STM products WILL have the same Processing Baseline

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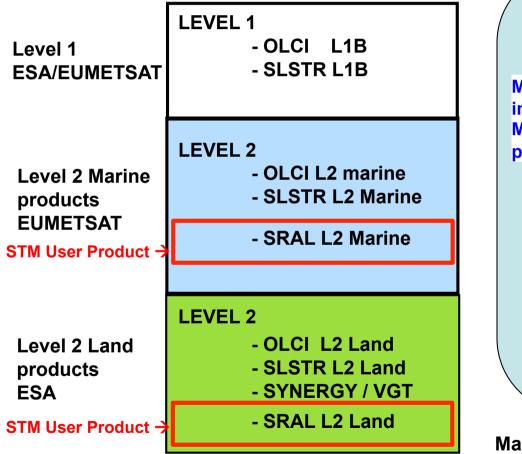
Sentinel-3 STM: L1B & L2 Processing Overview

L0 SRAL Product

- SRAL Level 0 Measurement Data
- SRAL Level 0 Calibration Data

Auxiliary Data Files

SRAL Level 1B Processor

L1B SRAL Product

- Ku/C bands LRM mode SRAL Measurement (20Hz)
- Ku band SAR mode SRAL Measurement (20Hz)
- C band SAR mode SRAL Measurement (20Hz)

CAL1 & CAL2 LTM Files

L2 SRAL/MWR Product

Auxiliary Data Files

SRAL & MWR Level 2 Processor

- LRM/SAR_Ku band SRAL Measurement (20Hz)
- LRM/SAR_C band SRAL Measurement (20Hz)
- LRM/SAR_Ku/C bands SRAL Measurement (1Hz)

L0 MWR Product

- MWR Level 0 Data

Auxiliary Data Files

MWR Level 1B Processor

L1B MWR

- MWR Measurements (20Hz)

Calibration & Monitoring files

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Sentinel-3 PDGS:
L1B & L2 Land / Marine Production

Level 1
ESA/EUMETSAT

LEVEL 1
- OLCI   L1B
- SLSTR L1B

Level 2 Marine products EUMETSAT

LEVEL 2
- OLCI L2 marine
- SLSTR L2 Marine

STM User Product →
- SRAL L2 Marine

Level 2 Land products ESA

LEVEL 2
- OLCI L2 Land
- SLSTR L2 Land
- SYNERGY / VGT

STM User Product →
- SRAL L2 Land

S-3 STM L2 production organisation

Measurements included in the MARINE product

Measurements included in the LAND product

Land and Water masks are in overlap to ensure analysis of transition and meaningful continuity of segments 300Km over ocean – few km over land

Marine product: information sensed over open ocean, coastal areas, sea-ice + mask margin

Land product: information sensed over land, coastal areas, land ice and inland water + mask margin

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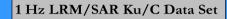# Sentinel-3 STM: Products Types (Baseline)

esa

TSAT

1 Hz LRM/SAR Ku/C Data Set
Sub-set of 1Hz Ku/C band parameters from SRAL measurements performed in LRM/SAR Modes

"Reduced" Measurement Data File

"Reduced" Measurement Data File

→ 1Hz

1 Hz LRM/SAR Ku/C Data Set
1Hz Ku/C band parameters from SRAL measurements performed in LRM/SAR Modes

20 Hz LRM/SAR_C Data Set
20Hz C band parameters from SRAL measurements performed in LRM/SAR Modes

20 Hz LRM/SAR_Ku Data Set
20Hz Ku band parameters from SRAL measurements performed in LRM/SAR Modes

"Standard" Measurement Data File

"Standard" Measurement Data File

→ 1Hz + 20 Hz

→ 1Hz + 20 Hz + WF

1 Hz LRM/SAR Ku/C Data Set
1Hz Ku/C band parameters from SRAL measurements performed in LRM/SAR Modes

PLRM Ku/C band measurement

20 Hz LRM/SAR_C Data Set
20Hz C band parameters from SRAL measurements performed in LRM/SAR Modes

PLRM Ku/C band measurement

20 Hz LRM/SAR_Ku Data Set
20Hz Ku band parameters from SRAL measurements performed in LRM/SAR Modes

Waveforms
waveforms and associated parameters to reprocess the data

PLRM waveforms
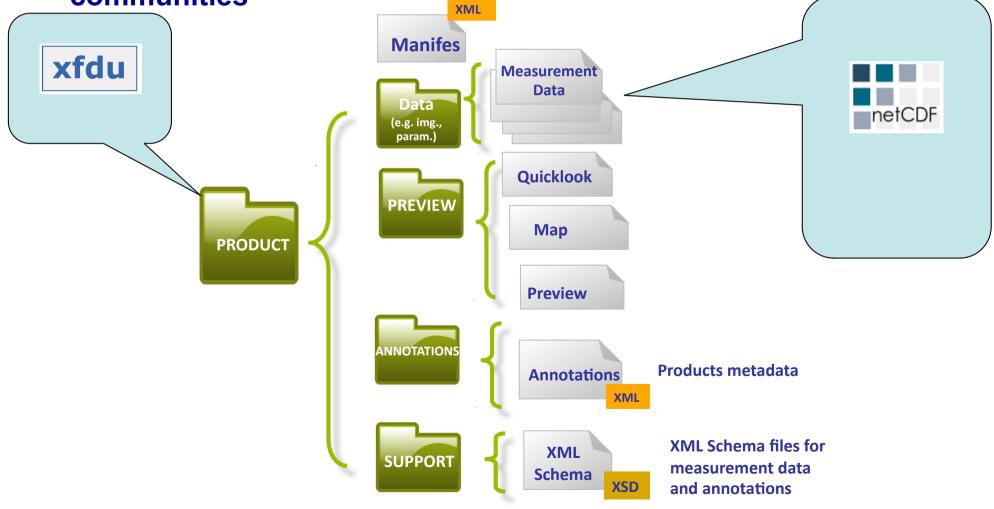
"Enhanced" Measurement Data File

"Enhanced" Measurement Data File

Sentinel Core Product Format
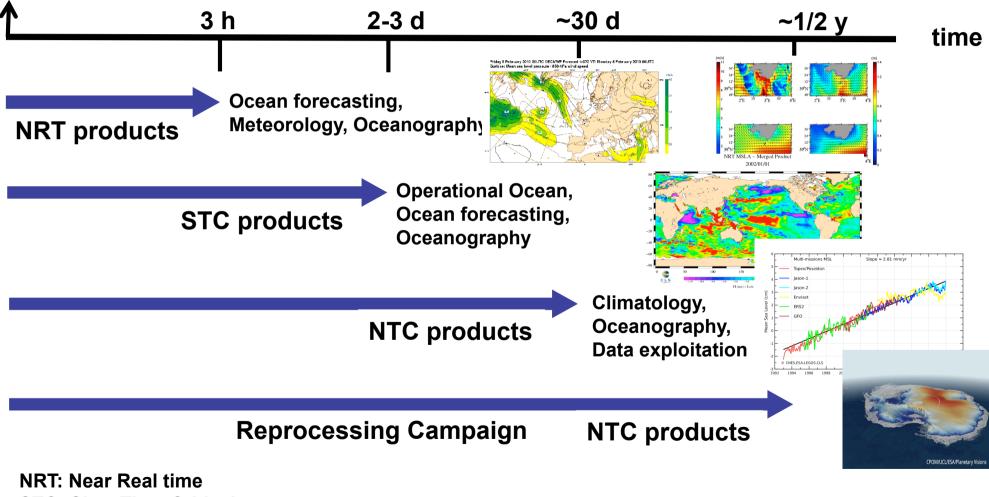
A unique packaging concept adapted to the different missions user communities

Sentinel-3 STM: Products Timeliness

T0 Sensing time

3 h 2-3 d ~30 d ~1/2 y time

NRT products → Ocean forecasting, Meteorology, Oceanography

STC products → Operational Ocean, Ocean forecasting, Oceanography

NTC products → Climatology, Oceanography, Data exploitation

Reprocessing Campaign **NTC products**

NRT: Near Real time
STC: Slow Time Critical
NTC: Non time Critical

S3 PDGS Data volume (uncompressed)

	Level 0 GB/Orbit	Level 1 GB/Orbit	Level 2 Marine GB/Orbit	Level 2 Land GB/Orbit
OLCI	9.5	29.6	35.5	7.8
SLSTR	4.8	45.6	5.8	2.8
SYN (OLCI +SLTSR)		55.8		31.2
SRAL + MWR	5.8	0.12	0.09	0.07
Total (GB/ orbit)	20.1	131.12	41.39	41.87

	Level 0			Level 1			Level 2 Marine			Level 2 Land		
	GB/Orbit	GB/Day	TB/Year	GB/Orbit	GB/Day	TB/Year	GB/Orbit	GB/Day	TB/Year	GB/Orbit	GB/Day	TB/Year
OLCI	9.47	134.98	48.11	29.60	422.07	150.45	35.50	506.20	180.43	7.82	111.51	39.75
SLSTR	4.80	68.40	24.38	45.60	650.22	231.77	5.80	82.65	29.46	2.81	40.11	14.30
SYN (OLCI+SLSTR)	0	0	0	55.80	795.67	283.61	0	0	0	31.21	452.70	161.64
SRAL	5.82	82.98	29.58	0.12	1.65	0.59	0.09	1.31	0.47	0.07	1.00	0.36
MWR	0.003	0.039	0.014	0.003	0.039	0.014	0	0	0	0	0	0
GNSS/DORIS	0.03	0.39	0.14	0	0	0	0	0	0	0	0	0
NavAtt	0.001	0.010	0.004	0	0	0	0	0	0	0	0	0
HKTM	0.044	0.631	0.225	0	0	0	0	0	0	0	0	0
TOTAL	20.16	287.43	102.45	131.12	1,869.65	666.43	41.39	590.16	210.36	41.91	605.32	216.04
	GB/Orbit	GB/Day	TB/Year	GB/Orbit	GB/Day	TB/Year	GB/Orbit	GB/Day	TB/Year	GB/Orbit	GB/Day	TB/Year

Conclusion: Sentinel-3 STM Core Products: Implementation Plans and Status

- **Altimetry core products Processing Baseline V1 completed**

- **V2 processing baseline to be delivered by end October 2012, which includes:**
  - → **SAMOSA ocean SAR Ku retracker**
  - → **Pseudo-LRM SAR Ku & C processing (RDSAR)**
  - → **Addition/Update of SAD files**

- **SAR Ocean processing baseline NOT complete (missing: SRAL SAR Ku Sigma0, SAR SSB correction)**

- **Operational processors development successfully kicked-off in Q2 2012**

- **Intended alignment of the Envisat Altimetry processing chain (content & format)**

ESA's Earth Observation data
Respective data policies

ERS an...   th

Earth ...

Sentin...

Contributing missions
(to GMES) and
Third Party Missions

Data Policy of individual
data providers

Sentinel Data Policy

Full and open access to Sentinel data to all
users

In practical terms

- Anybody has the right to access acquired
  Sentinel data
- Licenses for the Sentinel data are free of charge
- However the funding for the actual access in
  routine phase is under discussion with EU

Sentinel-3 Validation Team (S3VT)

- The **purpose** of the S3VT is:

  – *"To engage world-class expertise and activities, through mutual benefit collaboration, that support the implementation of the Sentinel-3 validation activities and ensure the best possible outcomes for the Sentinel-3 Mission"*

- *Validation* is the process of assessing, by independent means, the quality of the data products derived from the system outputs
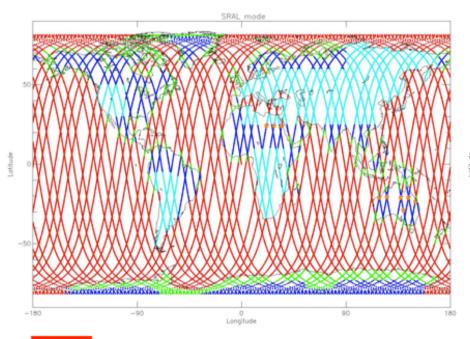
SRAL Mode Mask (Early 2012)
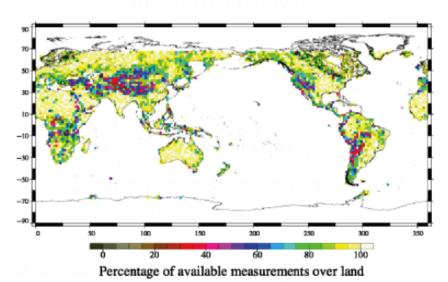
SAR "Ocean" Mission Scenario (TBC)

- **Maximizes the use of SAR capability over the ocean surface**
- **LRM over land (established)**
- **Urgently needs more verification using Cryosat**
- **This is NOT the Operational Baseline**

SAR Closed Loop
SAR Open Loop
LRM Closed Loop
LRM Open Loop

SAR "Land" Mission Scenario

- **Maximizes the use of SAR capability over the Land surface (unproven)**
- **SAR mode in coastal zones and EU Seas only**
- **LRM over open ocean**
- **This is assumed as the Operational Baseline**

Percentage of available measurements over land

JASON-2 altimeter tracking is less efficient in sloping terrain – potentially worse for S3 SAR mode as we have less echoes

Summary of identified impacts

Parameter	Impact (Negligible/Not Negligible/Important/Dramatic)
Measurement data volume	Not negligible (~10% volume increase)
Measurement data dumping time	Not negligible (~10% increase)
Space Segment	
On-board memory	Negligible (volume increase absorbed within margins)
Mission data download management	Not negligible for some orbits (recovery strategies identified to be validated during commissioning)
Spacecraft Power consumption	Negligible (<3W)
Spacecraft Thermal Dissipation	Acceptable (the RFU temperature stays in the [0-35°] design range)
Spacecraft Operations (Orbit Position Schedule)	Negligible (slightly positive in reduced OPS transitions)
Ground Segment	
Core GS evolution	Not negligible: additional SW/HW to be deployed in the Centres (i.e. Core Station, PACs, EUMETSAT), IPFs integration, revised mission planning strategy
Algorithm evolution and validation	Not negligible: algorithm evolution/implementation, incl. validation tests