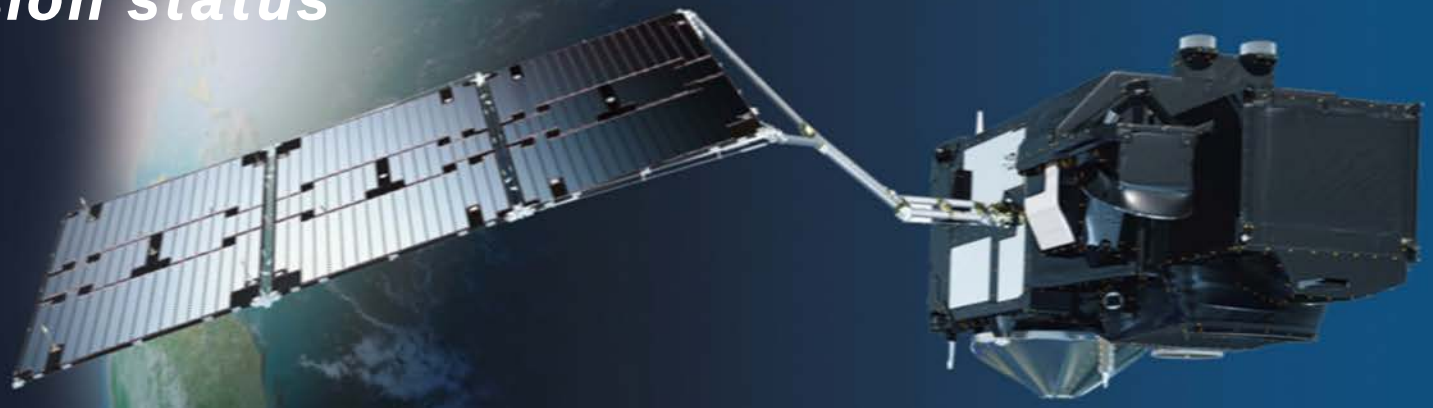
The Sentinel-3(A) Mission:

Mission status

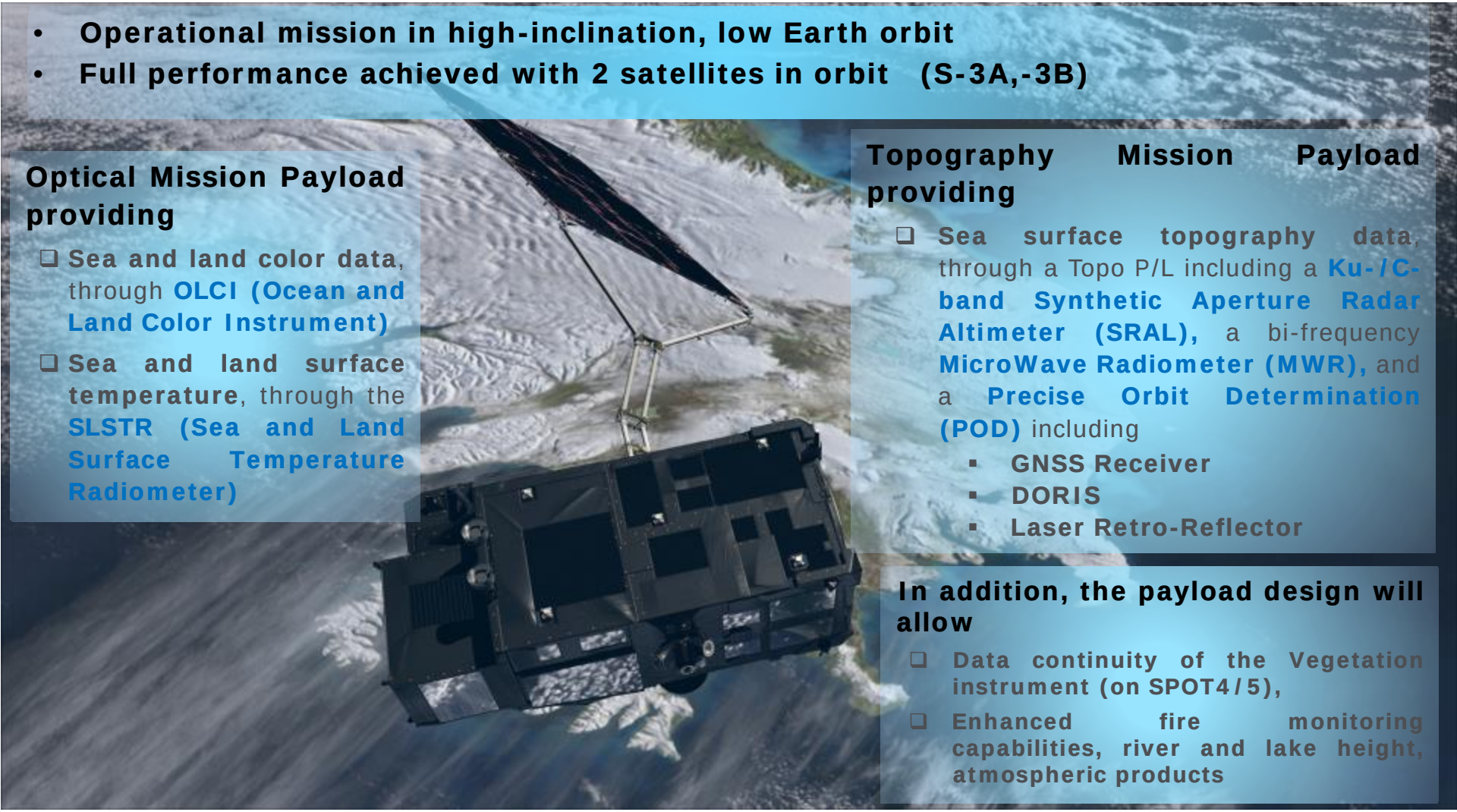


Steffen Dransfeld, ESA Sentinel-3 Data Quality Manager

ESA. MPC and EUMETSAT Sentinel-3 development and operations teams

SENTINEL-3 MISSION OVERVIEW

- **Operational mission in high-inclination, low Earth orbit**
- **Full performance achieved with 2 satellites in orbit (S-3A,-3B)**



Optical Mission Payload providing

- **Sea and land color data**, through **OLCI (Ocean and Land Color Instrument)**
- **Sea and land surface temperature**, through the **SLSTR (Sea and Land Surface Temperature Radiometer)**

Topography Mission Payload providing

- **Sea surface topography data**, through a Topo P/L including a **Ku-/C-band Synthetic Aperture Radar Altimeter (SRAL),** a bi-frequency **MicroWave Radiometer (MWR),** and a **Precise Orbit Determination (POD)** including
  - **GNSS Receiver**
  - **DORIS**
  - **Laser Retro-Reflector**

In addition, the payload design will allow

- **Data continuity of the Vegetation instrument (on SPOT4/5),**
- **Enhanced fire monitoring capabilities, river and lake height, atmospheric products**

NEW FEATURES

OPTICAL PAYLOAD

- **100% overlap** between SLSTR and OLCI
- **Increased number of bands** compared to both AATSR and MERIS allowing
  - Synergy between OLCI and SLSTR measurements
  - Enhanced fire monitoring capabilities
- **Broader swath**
  - OLCI: from 1150 km to 1270 km
  - SLSTR: Nadir view 500km → 1400km, Oblique view: 500km → 740km
- Optical payload **< 2 days global coverage** (with 2 Satellites) in view of the substantially increased swath
- **Increased spatial resolution**:
  - OLCI: 300m for land and ocean
  - SLSTR: 500m for VIS-SWIR, 1km for IR-Fire
- **Mitigation of sun glint** by tilting cameras 12.5 deg in westerly direction

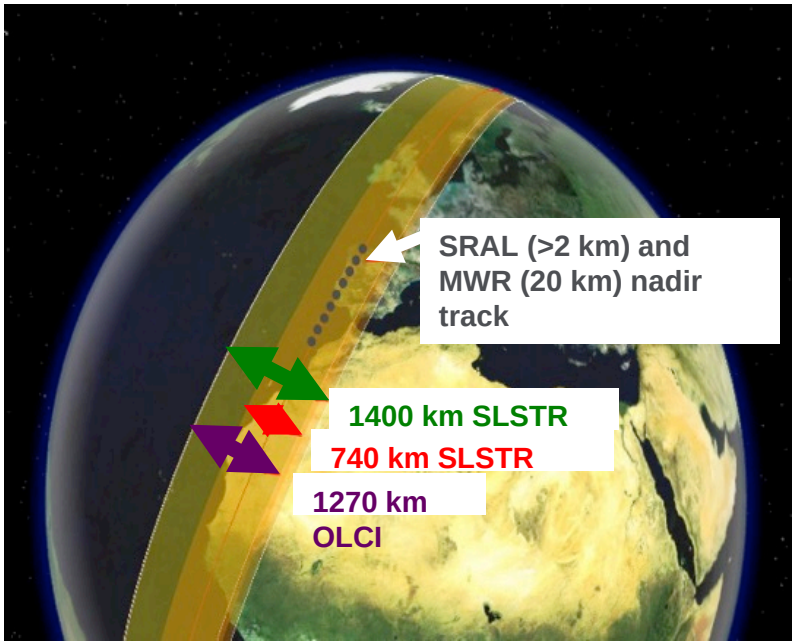
ALTIMETRY

- Improved altimetry mission with
  - 100% Along-track SAR topography
  - Open-loop tracking for rough zones
- Very accurate POD providing
  - A radial POD accuracy of 2-3 cm in ground processing.
  - On-board navigation solution (3m) for real time range control of SRAL (Open Loop)

ALL

- **Near-Real Time** (< 3 hr) availability of L2 core products

Instrument Swath Patterns

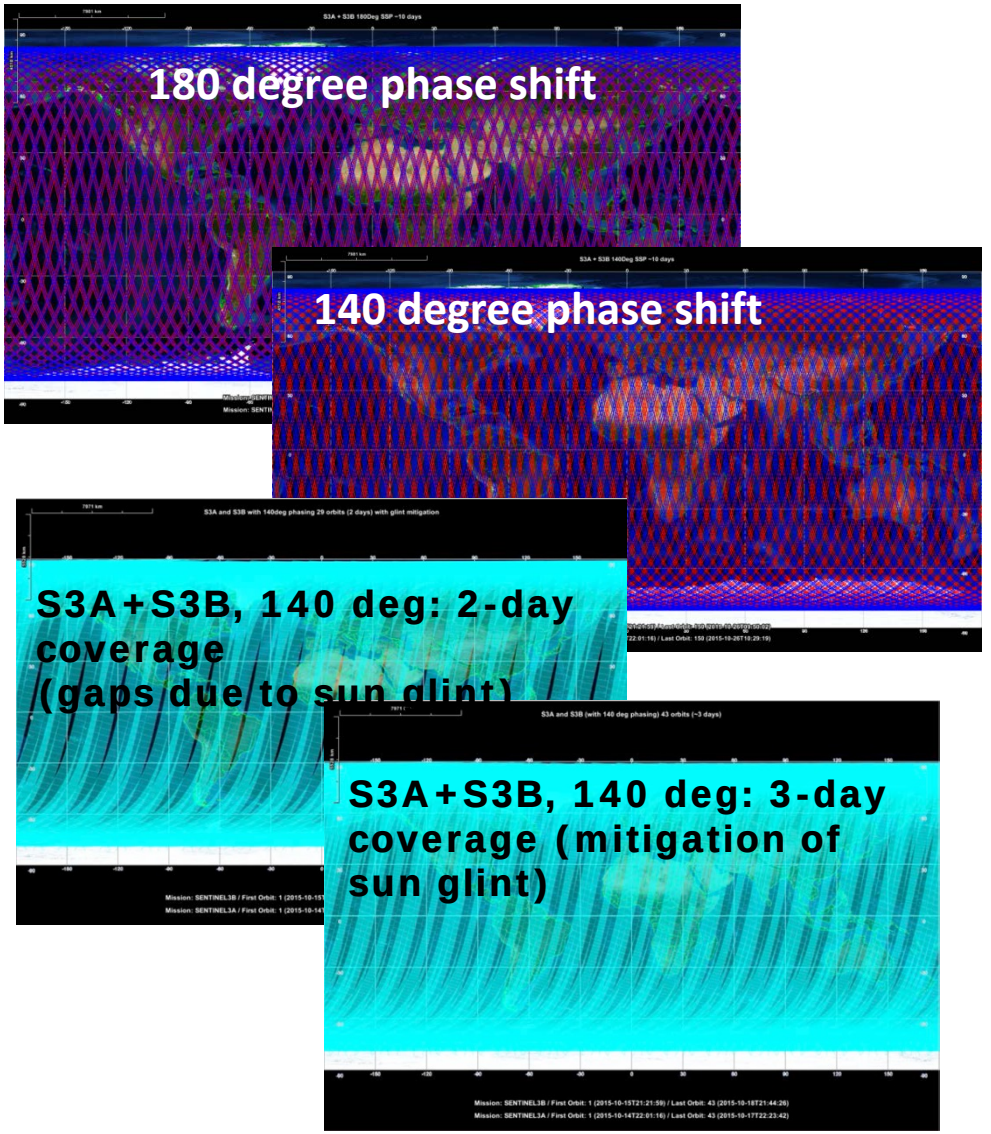


Orbit type	Repeating frozen SSO
Repeat cycle	27 days (14 + 7/27 orbits/day)
LTDN	10:00
Average altitude	815 km
Inclination	98.65 deg

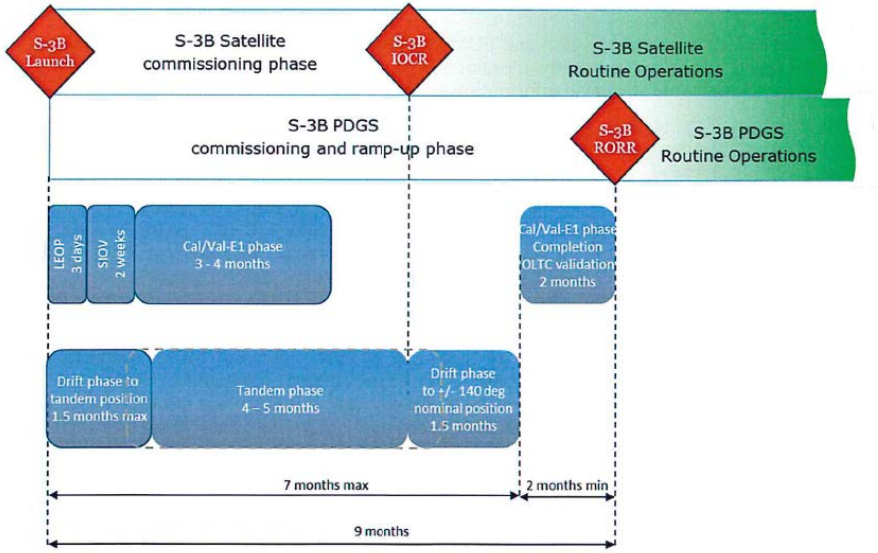
NEW: OPTIMISED ORBIT PHASING OF S3A/B AND C/D

- Copernicus Marine Environment Monitoring Service (CMEMS) asked for optimising orbit phase shift to **improve interleave between S3A and S3B for improved SRAL meso-scale sampling at 4-7 days**
- Solution of **140°** separation recommended by ESA, and confirmed by EUMETSAT assessment.
- EC has confirmed implementation for S3B

- **Minimal impact on optical mission**
  - **Over ocean**
    - OLCI: global coverage <2 days but parts of the swath will be impacted by sun-glint. Sun-glint free coverage by OLCI will be attained in ~3 days over the ocean.
    - SLSTR: coverage and revisit of the SLSTR remains compliant with requirements.
  - **Over land** (sun glint unproblematic, unless inland water) OLCI and SLSTR coverage is expected to remain compliant with requirements.



NEW: Sentinel-3A and -3B Tandem Phase



TECHNICAL PLANNING

- Operate S3A and S3B in Tandem for ~4-5 months at start of mission
- One satellite follows the other on the same ground track with a small 30 sec separation: minimum oceanographic and atmospheric variability reducing uncertainty in comparing measurements from both satellites
- Tandem and drift phase into final orbit separation of 140 degree between S3A/B separation completed by launch + 7 months
- Full operational capacity reached by launch + 9 months

MOTIVATION

GCOS Climate Monitoring Principles (GCMP): need to fully understand biases between satellite missions

- *"Take steps to make radiance calibration, calibration-monitoring and satellite-to-satellite cross-calibration of the full operational constellation a part of the operational satellite system"*
- *"A suitable period of overlap for new and old satellite systems should be ensured for a period adequate to determine inter-satellite biases and maintain the homogeneity and consistency of time - series observations"*

Improved data quality for climate (CDR) and operational applications alike

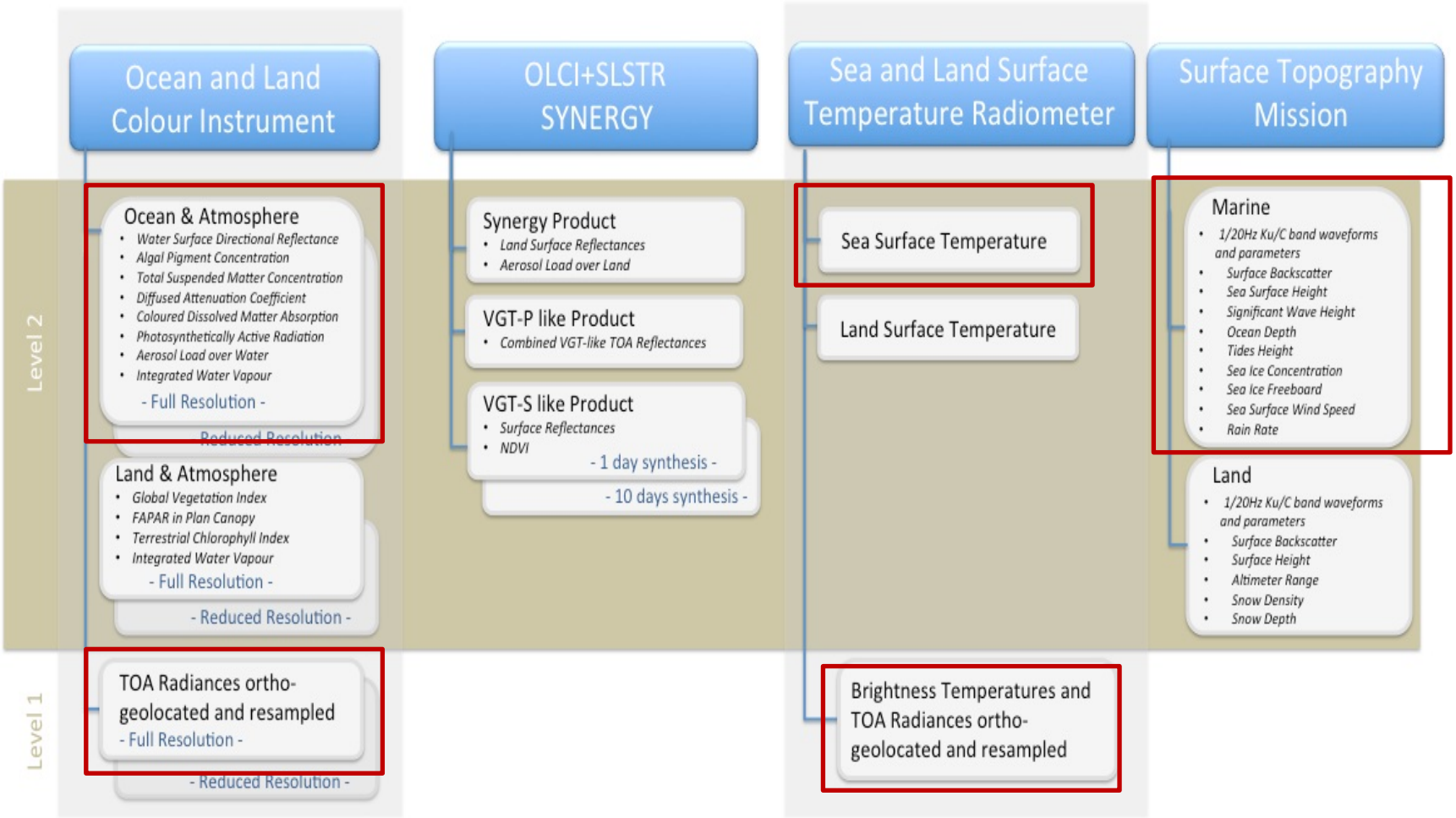
What happened since launch …

Sentinel-3A successfully launched from Plesetsk Cosmodrome (Russia) on 16 February 2016

Spacecraft and all instruments in nominal operational mode and functioning well.

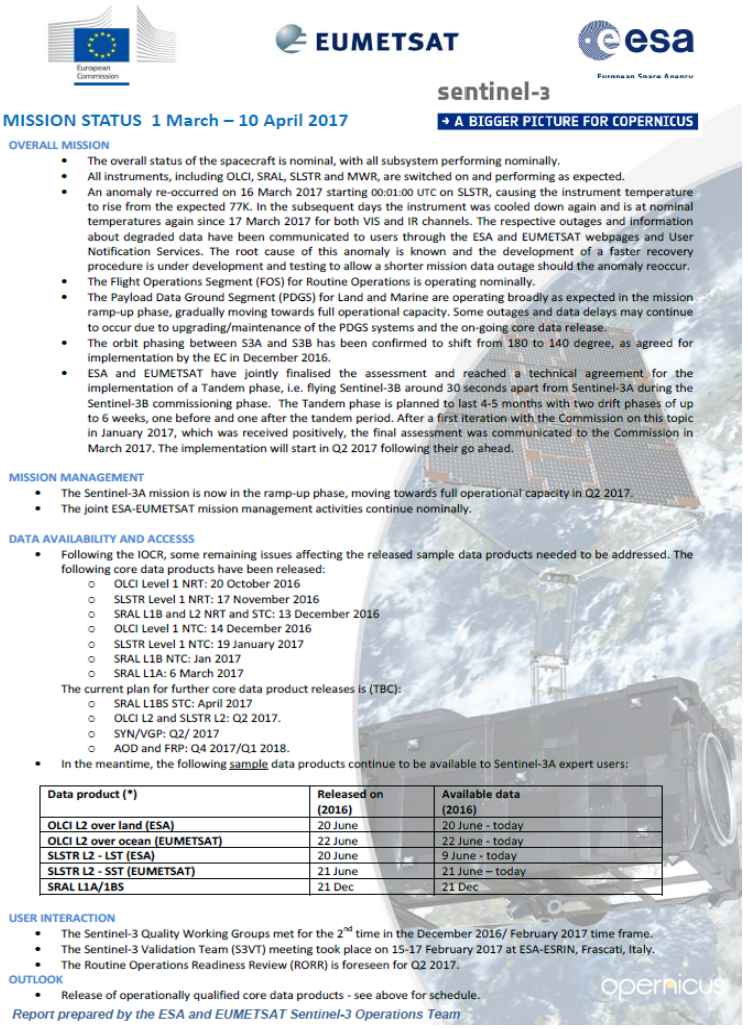
16 Feb	Successful Launch
18 Feb	LEOP phase concluded successfully ✓ Perfect orbit injection from the launcher ✓ Rapid and smooth Solar Array deployment ✓ Only one minor anomaly encountered (Star Tracker depointing due to incorrect quaternion data), rapidly identified and corrected
26 Feb	Platform In-Orbit Verification completed
4 March	Payload In-Orbit Verification completed ✓ All instrument ON and operating (except SLSTR in decontamination mode, as planned) ✓ Level-0 products being generated
7 March	Cal/Val Phase of S3 commences
April / May	Mid-Term-Reviews for OLCI, SLSTR and SRAL
mid- May	**Release of sample products to all users for familiarisation**
28-30 June	Expert users meeting – first feedback from S3 validation teams
11 / 12-July	In-Orbit Commissioning Review (IOCR)– **successful completion of commissioning phase, start of ramp-up phase (initial operations)**
13 July	ESA internal handover from development to operations team; Handover of flight operations from ESA to EUMETSAT
10 October	Handover of Marine PDGS from ESA to EUMETSAT
Q3 2016	**Progressive release of Level 1 data**
Till RORR	**Progressive release of Level 2 data**
Dec 2016	Mid-term review check point for ramp-up phase
June 2017	**Start of routine operations phase –** Routine Operations Readiness Review (RORR)

Sentinel-3: core data products *over ocean*



SENTINEL-3 CORE DATA PRODUCT RELEASE OVER OCEAN

- **All Level 1** have been released
- **Level 2**
  - SRAL over land and ocean released in Dec 2016
  - OLCI and SLSTR sample data products are available to expert users, official release planned for June 2017
- **Sample products** of not released core products available to expert users
- **Reprocessed data** sets for the Sentinel-3 Validation Team workshop released end of January 2017 available for following periods:
  - OLCI 25/04/16-14/08/16
  - SLSTR 12/07/16-15/11/16
  - SRAL 15/06/16- 15/11/16
- **Reprocessing of S3A full mission** data planned before end of 2017



EUMETSAT esa

sentinel-3

MISSION STATUS 1 March – 10 April 2017

→ A BIGGER PICTURE FOR COPERNICUS

OVERALL MISSION

- The overall status of the spacecraft is nominal, with all subsystem performing nominally.
- All instruments, including OLCI, SRAL, SLSTR and MWR, are switched on and performing as expected.
- An anomaly re-occurred on 16 March 2017 starting 00:01:00 UTC on SLSTR, causing the instrument temperature to rise from the expected 77K. In the subsequent days the instrument was cooled down again and is at nominal temperatures again since 17 March 2017 for both VIS and IR channels. The respective outages and information about degraded data have been communicated to users through the ESA and EUMETSAT webpages and User Notification Services. The root cause of this anomaly is known and the development of a faster recovery procedure is under development and testing to allow a shorter mission data outage should the anomaly reoccur.
- The Flight Operations Segment (FOS) for Routine Operations is operating nominally.
- The Payload Data Ground Segment (PDGS) for Land and Marine are operating broadly as expected in the mission ramp-up phase, gradually moving towards full operational capacity. Some outages and data delays may continue to occur due to upgrading/maintenance of the PDGS systems and the on-going core data release.
- The orbit phasing between S3A and S3B has been confirmed to shift from 180 to 140 degree, as agreed for implementation by the EC in December 2016.
- ESA and EUMETSAT have jointly finalised the assessment and reached a technical agreement for the implementation of a Tandem phase, i.e. flying Sentinel-3B around 30 seconds apart from Sentinel-3A during the Sentinel-3B commissioning phase. The Tandem phase is planned to last 4-5 months with two drift phases of up to 6 weeks, one before and one after the tandem period. After a first iteration with the Commission on this topic in January 2017, which was received positively, the final assessment was communicated to the Commission in March 2017. The implementation will start in Q2 2017 following their go ahead.

MISSION MANAGEMENT

- The Sentinel-3A mission is now in the ramp-up phase, moving towards full operational capacity in Q2 2017.
- The joint ESA-EUMETSAT mission management activities continue nominally.

DATA AVAILABILITY AND ACCESSS

- Following the IOCR, some remaining issues affecting the released sample data products needed to be addressed. The following core data products have been released:
  - OLCI Level 1 NRT: 20 October 2016
  - SLSTR Level 1 NRT: 17 November 2016
  - SRAL L1B and L2 NRT and STC: 13 December 2016
  - OLCI Level 1 NTC: 14 December 2016
  - SLSTR Level 1 NTC: 19 January 2017
  - SRAL L1B NTC: Jan 2017
  - SRAL L1A: 6 March 2017

  The current plan for further core data product releases is (TBC):
  - SRAL L1BS STC: April 2017
  - OLCI L2 and SLSTR L2: Q2 2017.
  - SYN/VGP: Q2/ 2017
  - AOD and FRP: Q4 2017/Q1 2018.
- In the meantime, the following sample data products continue to be available to Sentinel-3A expert users:

Data product (*)	Released on (2016)	Available data (2016)
OLCI L2 over land (ESA)	20 June	20 June - today
OLCI L2 over ocean (EUMETSAT)	22 June	22 June - today
SLSTR L2 - LST (ESA)	20 June	9 June - today
SLSTR L2 - SST (EUMETSAT)	21 June	21 June – today
SRAL L1A/1BS	21 Dec	21 Dec

USER INTERACTION

- The Sentinel-3 Quality Working Groups met for the 2nd time in the December 2016/ February 2017 time frame.
- The Sentinel-3 Validation Team (S3VT) meeting took place on 15-17 February 2017 at ESA-ESRIN, Frascati, Italy.
- The Routine Operations Readiness Review (RORR) is foreseen for Q2 2017.

OUTLOOK

- Release of operationally qualified core data products - see above for schedule.

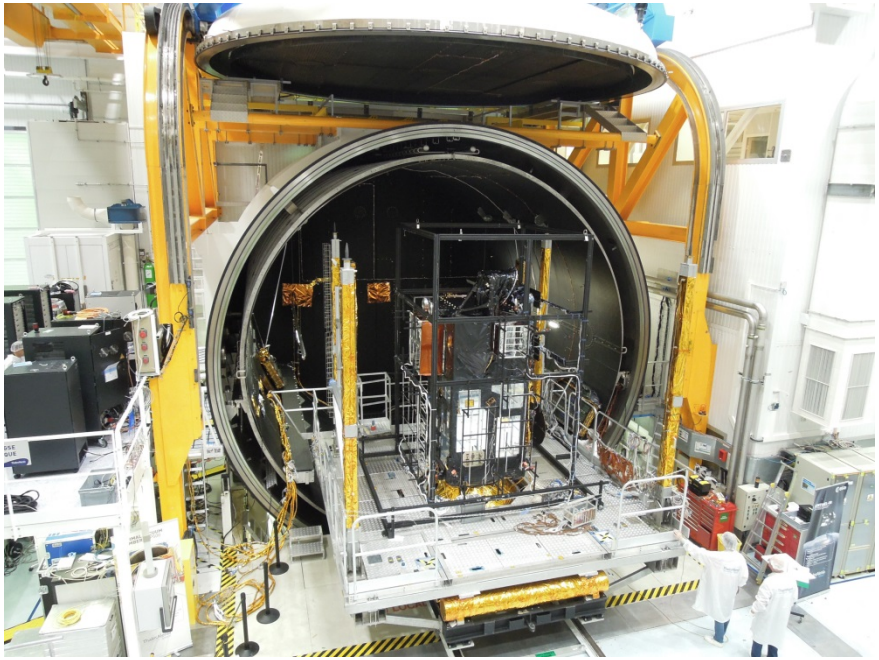
Report prepared by the ESA and EUMETSAT Sentinel-3 Operations Team

opernicus

Mission status reports on:
https://sentinel.esa.int/web/sentinel/missions/sentinel-3/mission-status

UPDATE ON SENTINEL-3B

- **Sentinel-3B activities restarted in Q2 2016** after Sentinel-3A launch in Feb 2016
- Implementation of Return of Experience (REX) from S3A on-going
- Instrument status
  - **Topography** payload fully available and integrated, no open issues
  - **SLSTR** Proto-Flight Model assembly and testing progressing according to plan: Instrument calibration tests successfully completed in Feb in RAL and instrument currently at TAS-F for integration.
  - **OLCI-B** model experienced major anomaly (same as for A instrument) during instrument TVAC in July 2016; decision to refurbish all 5 cameras, which are now available and tested with good performance results; delivery of OLCI-B for S/L integration by mid June 2017 confirmed



- In view of late delivery of OLCI, Sentinel-3B S/L Integration and test activities reorganised to fit launch schedule
- Sentinel-3B Flight Acceptance Review planned for end of 2017, launch date foreseen for March/April 2018 (TBC)

ESA SENTINEL DATA DISTRIBUTION - *CONFIGURATION*

spacedata.copernicus.eu

Copernicus Open Access Hub

- LATEST NEWS
- 78,112 Self registered Users
- 16,192,752 Products Downloaded
- 14.02 PB Volume Downloaded
- No Rolling Policy
- Sentinel-1 NTC
- Sentinel-2 L1C
- Sentinel-3 (preops)
- Max 2 concurrent Downloads

Collaborative Hub

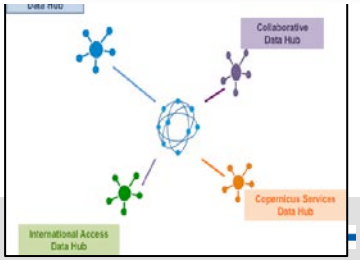
- LATEST NEWS
- 13 Collaborative GS
- 7 Data Hub Relays
- 6,810,570 Products Downloaded
- 6.84 PB Volume Downloaded
- Node1: 30 days
- Node2: 9 days
- Sentinel-1 NRT & NTC
- Sentinel-2 L1C
- Node1: Max 10 downloads
- Node2: No Limits

International Hub

- LATEST NEWS
- 4 International Agreements
- 2,284,381 Products Downloaded
- 2.07 PB Volume Downloaded
- 30 days
- Sentinel-1 NTC
- Sentinel-2 L1C
- Max 10 concurrent downloads

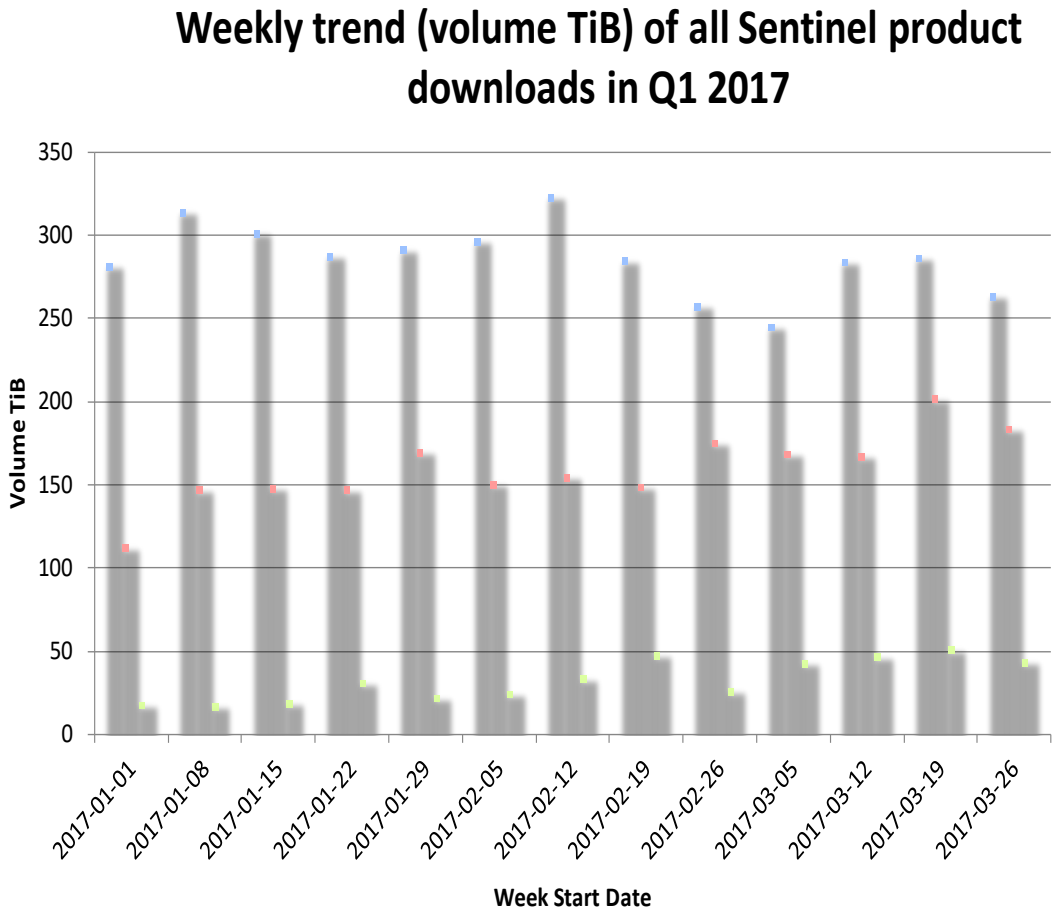
Copernicus Services Hub

- LATEST NEWS
- 185 Registered Users
- 913,170 Products Downloaded
- 704.1 TB Volume Downloaded
- No Rolling Policy
- Sentinel-1 NTC
- Sentinel-2 L1C
- Max 10 concurrent downloads



Statistics: 11 May 2017

ESA SENTINEL DATA DISTRIBUTION – *STATISTICS*

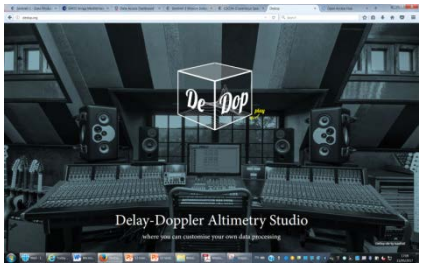


ESA SENTINEL-3 TOOLS OVER OCEAN

- **S3-View:** allow Sentinel-3 users to efficiently discover Sentinel-3 data product content and assess their suitability for further application; uses Syntool software developed by the SEOM Ocean Virtual Laboratory (OVL) project http://ovl.oceandatalab.com/

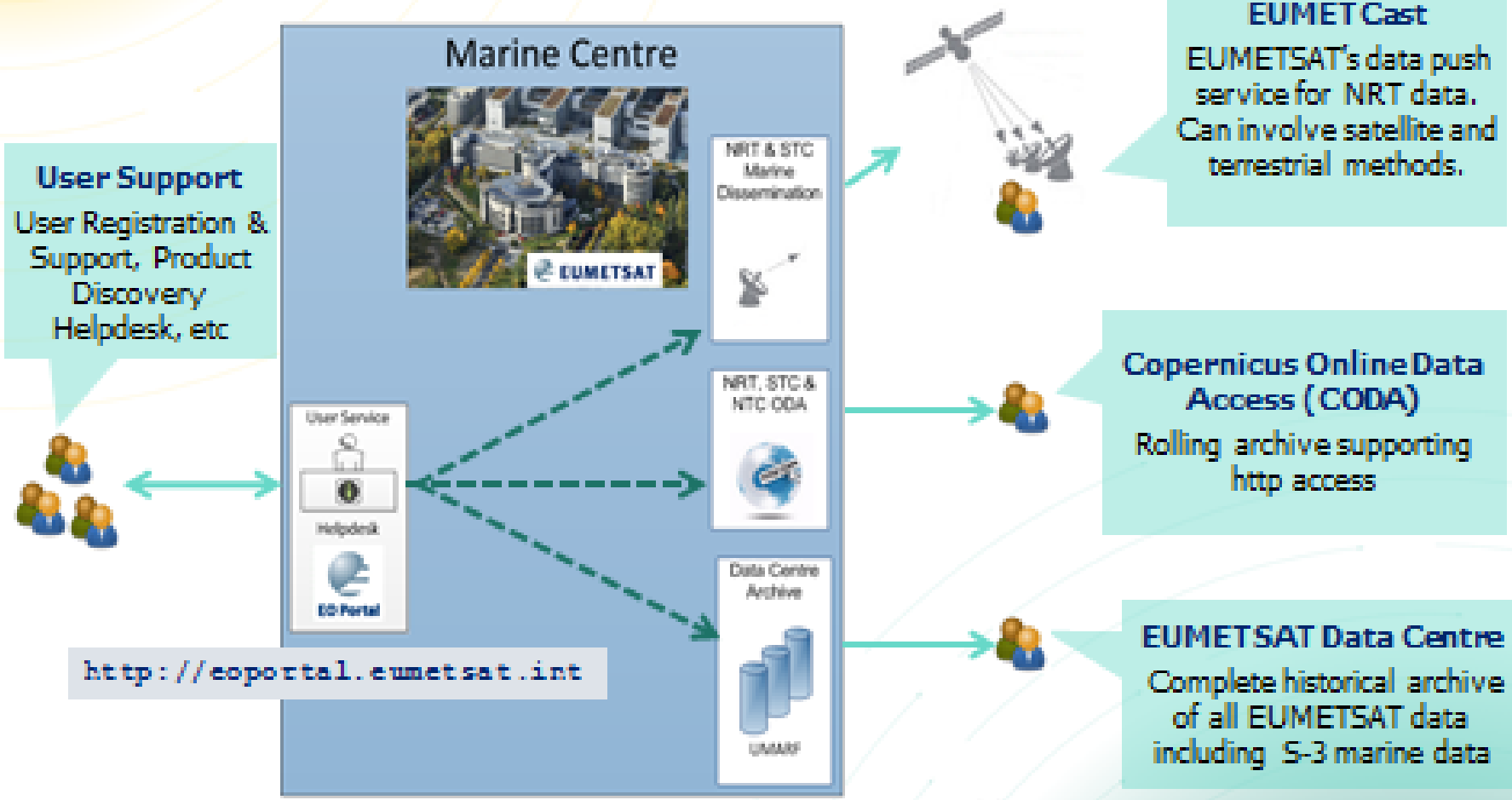
- **SNAP**: Visualisation & processing of Sentinel-3 OLCI and SLSTR data and other optical data; http://step.esa.int/

- **Delay-Doppler Altimetry Studio (DeDop)**: provide means to users to understand and use the low levels of Altimetry data and how these data are processed, by providing them with a Fully Adaptable and Configureable DDP and a friendly user interface. http://dedop.org/

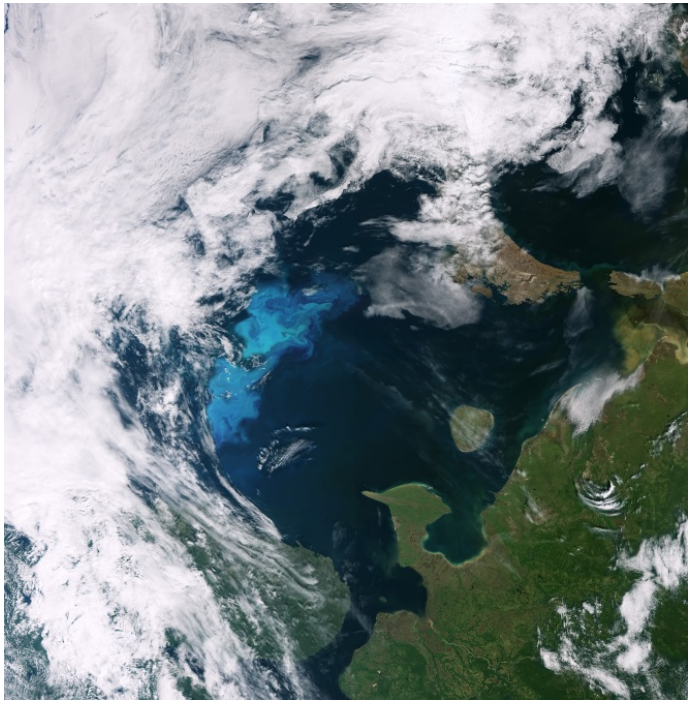


- **Broadview Radar Altimetry Toolbox (BRAT):** facilitates the processing of radar altimetry data; reads all previous and current altimetry missions' data; http://earth.esa.int/brat.

EUMETSAT S3 Marine Services & Data Access



SENTINEL-3 OLCI CORE DATA PRODUCTS
Level 1 TOA radiances



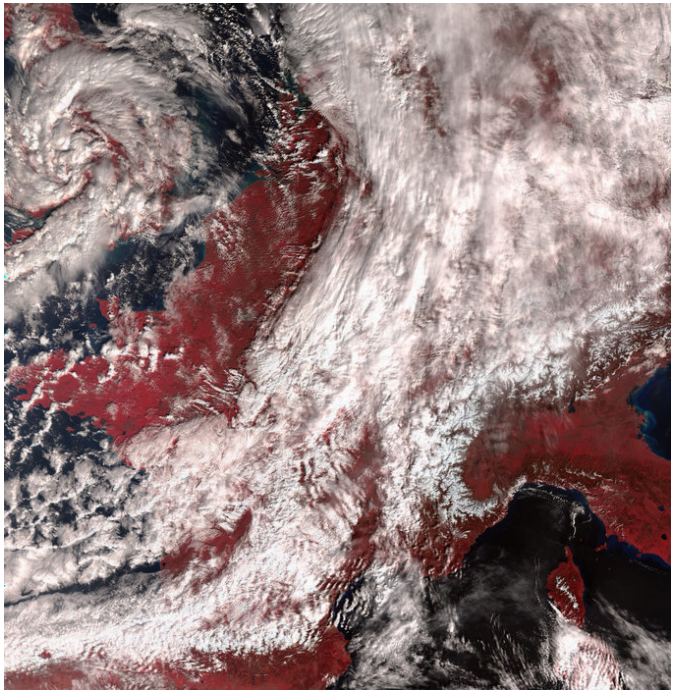
Switch on	**29 Feb 2016**
Sample L1/L2 data available	**May/June 2016**
L1 data release	**20 Oct 2016**
L2 data release	**Spring 2017**

- Ocean and Land Colour Instrument (OLCI) designed for observation with high absolute (relative) accuracy of 2 (1) % in reflectance, providing continuity for MERIS (Envisat)

- **Level 1 performance**

  - Radiometry: on-board radiometric calibration based; SNR is compliant with specification; calibration gains show some time variability but stability seems to improve with time; vicarious calibration shows spectrally/spatially/dynamically/X-track consistent results, however a ~+3% bias exists. Yaw steering manoeuvres have been performed for diffuser BRDF characterisation.
  - Spectrally: fully compliant; pre-flight characterisation confirmed for all cameras in-flight (<0.15nm); small temporal trends since beginning of the mission (comparable to MERIS)
  - Geometry: fully compliant (60m @ Nadir); bi-monthly check that thermo-elastic model is accounting for seasonal variations.

SLSTR: Status Level 1 (TOA radiances)



Switch on	**2 March 2016**
Sample L1/L2 data available	**May/June 2016**
L1 data release	**17 Nov 2016**
L2 data release	**Spring 2017**

- Sea and Land Surface Temperature Radiometer (SLSTR) designed for observations with high radiometric accuracy <2% (BOL)/<5% (EOL); < 0.2K (0.1K goal), providing continuity for(A)ATSR (Envisat); 100% overlap with OLCI
- Nighttime acquisitions for S1-S4 (“day channels”) over Siberia and Gulf of Guinea in Jan 2017 to be characterize gas flares (9 collocation with VIIRS)
- **Level 1 performance**
  - Corrections to Basic Cloud Screening - improved
  - SWIR calibration – improved, residual of 10%
  - Geometric calibration corrections in Nadir and Oblique –March 2017
  - Saturation thresholds – improved
  - Co-registration of fire channels and their nominal channels (F1/S7 and F2/S8)– end 2017
  - Co-registration of VIS and SWIR – March 2017

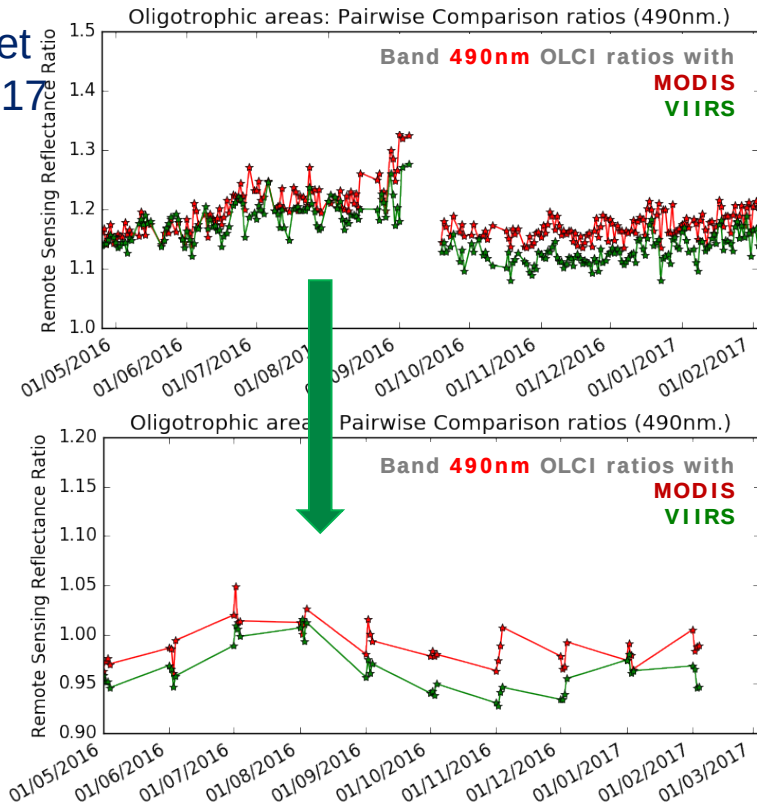
SENTINEL-3 OLCI CORE DATA PRODUCTS
Level 2 Ocean Colour

Status

- Available to the Sentinel-3 Validation Team since June 2016
- Improved processing available in reprocessed dataset (May-August 2016) and in NRT/NTC since 4 May 2017
- Calibration model update, system vicarious calibration, and cloud flag improvements ongoing

Issues

- Overestimation of water-leaving reflectance in VIS bands (blue > green > red)
- Underestimation of Chl
- Noise in water-leaving reflectance well above proportion of noise at TOA
- Many lesser issues *e.g.* “case 2” products, clouds

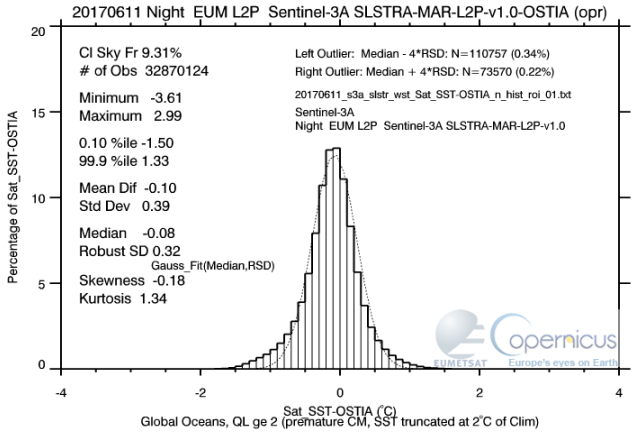


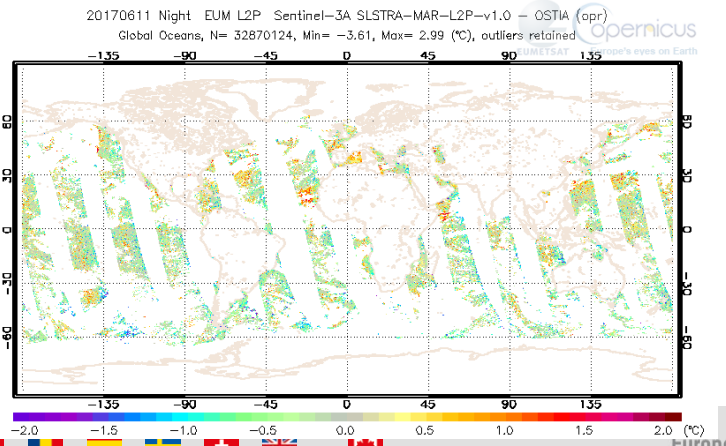
Outlook

- Application of updated radiometric calibration model including instrument temporal evolution
- System vicarious calibration to MOBY, BOUSSOLE and climatology brings water-leaving reflectance close to compliance with mission requirements
- Improvements in cloud screening and “case 2” products
- **Public Release end of June 2017**

SENTINEL-3 SLSTR CORE DATA PRODUCTS
Level 2 Sea Surface Temperature

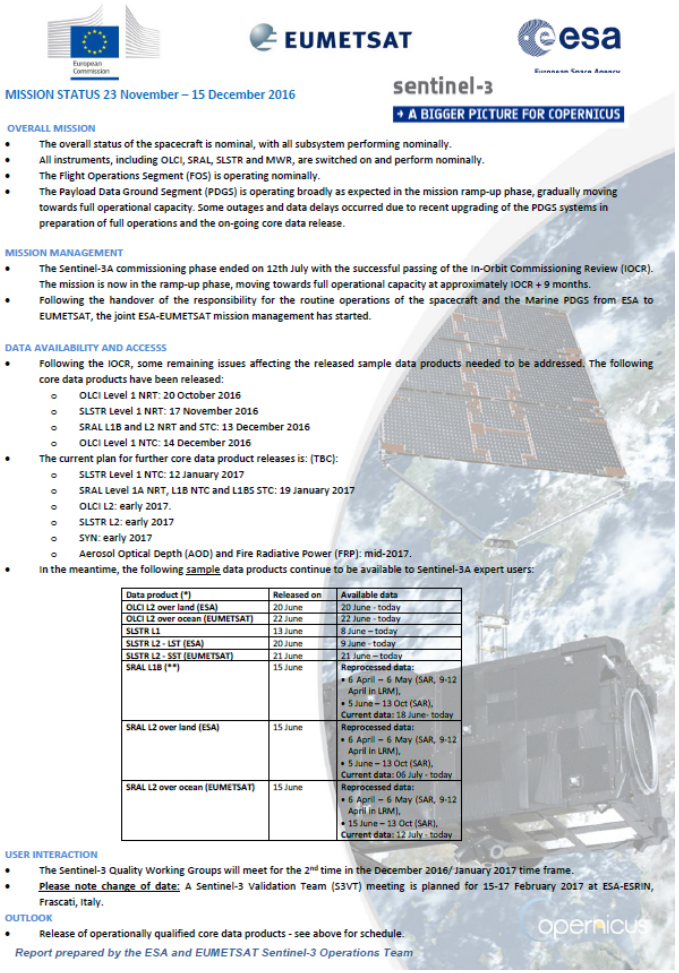
- Operational marine Level-2 data release planned for late June 2017 (NRT and NTC).
- Product validation status:
  - Reprocessed SST Level-2 products
    - Improvements include: theoretical uncertainty (hence quality level), correction of nedt bands, stratospheric aerosol flag incorrectly set influencing algorithm selection.
  - Experimental SLSTR L1/L2 matchup dataset collocated with in situ data for reprocessed period made available to S3VT on 7th February 2016
    - Was used in March by Reading University to adjust the inter-algorithm biases for the PB update on 5th May.
    - Was used in April by University of Leicester with EUMETSAT to derive the Sensor Specific Error Statistics (SSES) in preparation for the next PB update and Level-2 data release at the end of June.
  - PB update on 5th May included SLSTR L1 updates to oblique geolocation and co-registration to the nadir view and further cloud-screening updates.
  - PB update for Level-2 operational release at the end of June 2017 includes SSES, and check against dt_analysis of 5K to screen for remaining cloud issues.
  - SST algorithm improvements and Bayesian cloud implementation in Q4 2017.





MAIN MESSAGES

- S-3A now in ramp-up phase, following successful launch and commissioning phase
- All instruments are switched on and working well.
- Sample data products for expert users available since May/June.
- **Official data release**
  - OLCI Level 1 NRT: 20 October 2016
  - SLSTR Level 1 NRT: 17 November 2016
  - SRAL L1B and L2 NRT and STC: 13 December 2016
  - OLCI Level 1 NTC: 14 December 2016
  - SLSTR Level 1 NTC: 19 January 2017
  - SRAL L1B NTC: Jan 2017
  - SRAL L1A and L1BS STC: April 2017
  - OLCI L2 and SLSTR L2: May/June 2017.
  - SYN/VGP: Q2/ 2017
  - AOD and FRP: Q3/4 2017.
- **Data access in operations**
  - ESA through the Sentinel Data Hub, Copernicus Services Hub, Collab Hub etc
  - EUMETSAT's Earth Observation Portal (EUMETSAT's ODA, Data Centre, EUMETCast)
- **Sentinel-3B launch planned for end 2017/beginning 2018**



EUMETSAT esa

sentinel-3

→ A BIGGER PICTURE FOR COPERNICUS

MISSION STATUS 23 November – 15 December 2016

OVERALL MISSION

- The overall status of the spacecraft is nominal, with all subsystem performing nominally.
- All instruments, including OLCI, SRAL, SLSTR and MWR, are switched on and perform nominally.
- The Flight Operations Segment (FOS) is operating nominally.
- The Payload Data Ground Segment (PDGS) is operating broadly as expected in the mission ramp-up phase, gradually moving towards full operational capacity. Some outages and data delays occurred due to recent upgrading of the PDGS systems in preparation of full operations and the on-going core data release.

MISSION MANAGEMENT

- The Sentinel-3A commissioning phase ended on 12th July with the successful passing of the In-Orbit Commissioning Review (IOCR). The mission is now in the ramp-up phase, moving towards full operational capacity at approximately IOCR + 9 months.
- Following the handover of the responsibility for the routine operations of the spacecraft and the Marine PDGS from ESA to EUMETSAT, the joint ESA-EUMETSAT mission management has started.

DATA AVAILABILITY AND ACCESSS

- Following the IOCR, some remaining issues affecting the released sample data products needed to be addressed. The following core data products have been released:
  - OLCI Level 1 NRT: 20 October 2016
  - SLSTR Level 1 NRT: 17 November 2016
  - SRAL L1B and L2 NRT and STC: 13 December 2016
  - OLCI Level 1 NTC: 14 December 2016
- The current plan for further core data product releases is: (TBC):
  - SLSTR Level 1 NTC: 12 January 2017
  - SRAL Level 1A NRT, L1B NTC and L1BS STC: 19 January 2017
  - OLCI L2: early 2017.
  - SLSTR L2: early 2017
  - SYN: early 2017
  - Aerosol Optical Depth (AOD) and Fire Radiative Power (FRP): mid-2017.
- In the meantime, the following sample data products continue to be available to Sentinel-3A expert users:

Data product (*)	Released on	Available data
OLCI L2 over land (ESA)	20 June	20 June - today
OLCI L2 over ocean (EUMETSAT)	22 June	22 June - today
SLSTR L1	13 June	8 June – today
SLSTR L2 - LST (ESA)	20 June	9 June - today
SLSTR L2 - SST (EUMETSAT)	21 June	21 June – today
SRAL L1B (**)	15 June	Reprocessed data: • 6 April – 6 May (SAR, 9-12 April in LRM), • 5 June – 13 Oct (SAR). Current data: 18 June- today
SRAL L2 over land (ESA)	15 June	Reprocessed data: • 6 April – 6 May (SAR, 9-12 April in LRM), • 5 June – 13 Oct (SAR). Current data: 06 July - today
SRAL L2 over ocean (EUMETSAT)	15 June	Reprocessed data: • 6 April – 6 May (SAR, 9-12 April in LRM), • 15 June – 13 Oct (SAR). Current data: 12 July - today

USER INTERACTION

- The Sentinel-3 Quality Working Groups will meet for the 2nd time in the December 2016/ January 2017 time frame.
- Please note change of date: A Sentinel-3 Validation Team (S3VT) meeting is planned for 15-17 February 2017 at ESA-ESRIN, Frascati, Italy.

OUTLOOK

- Release of operationally qualified core data products - see above for schedule.

Report prepared by the ESA and EUMETSAT Sentinel-3 Operations Team

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Weekly mission status on https://sentinel.esa.int/web/sentinel/missions/sentinel-3/mission-status