The Copernicus Sentinel-3 Mission: Status

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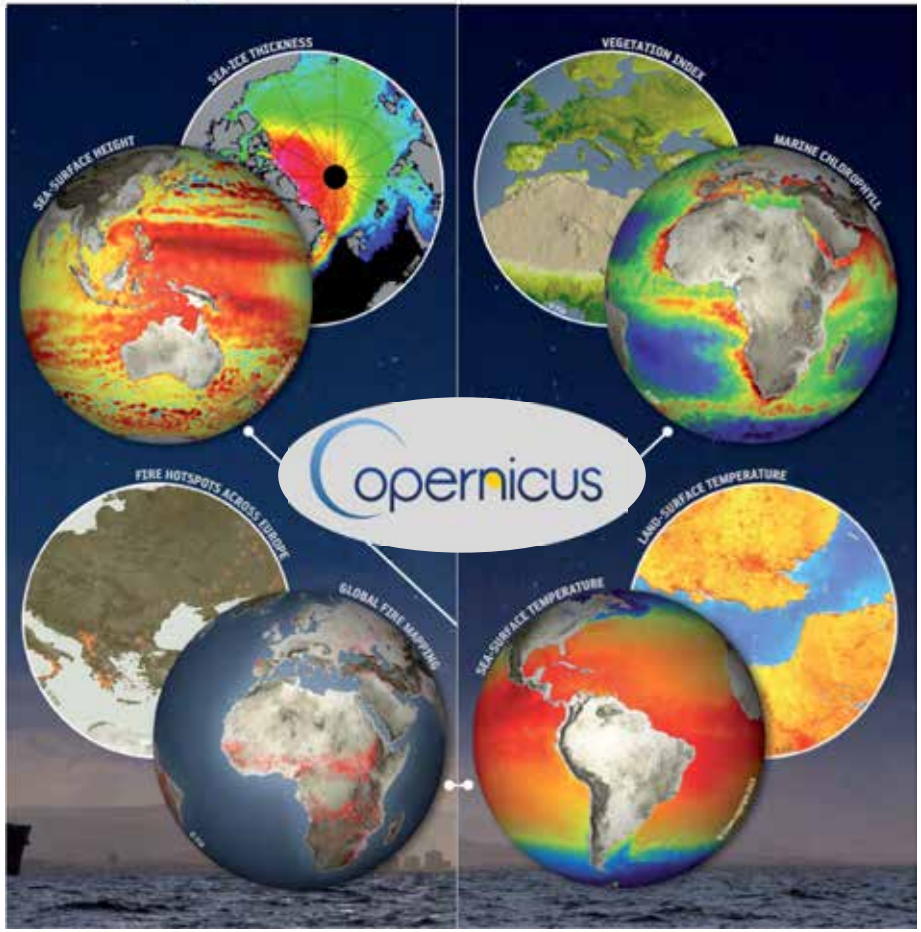
S. Mertikas (T. Univ. Crete], F. Boy (CNES), B. Seitz, B. Berutti (ESA/ESTEC).

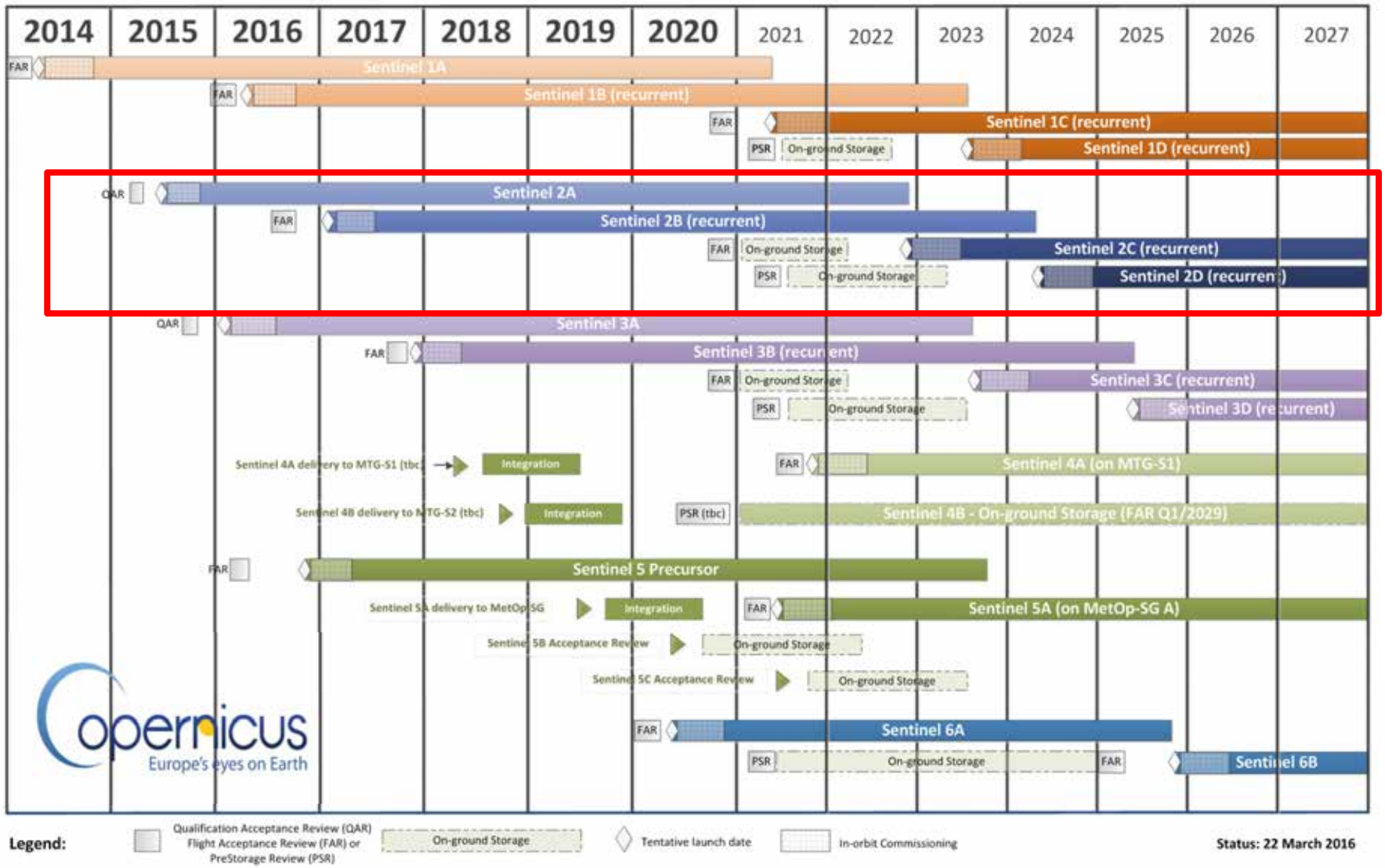
Ocean Surface Topography Science Team Meeting, 24-29 September, Ponta Delgarda, Azores, Portugal

Outline

- Status of the Sentinel-3A mission
- Status of Sentinel-3B satellite
- Sentinel-3 Tandem flight
- Status of Sentinel-3C&D
- Summary

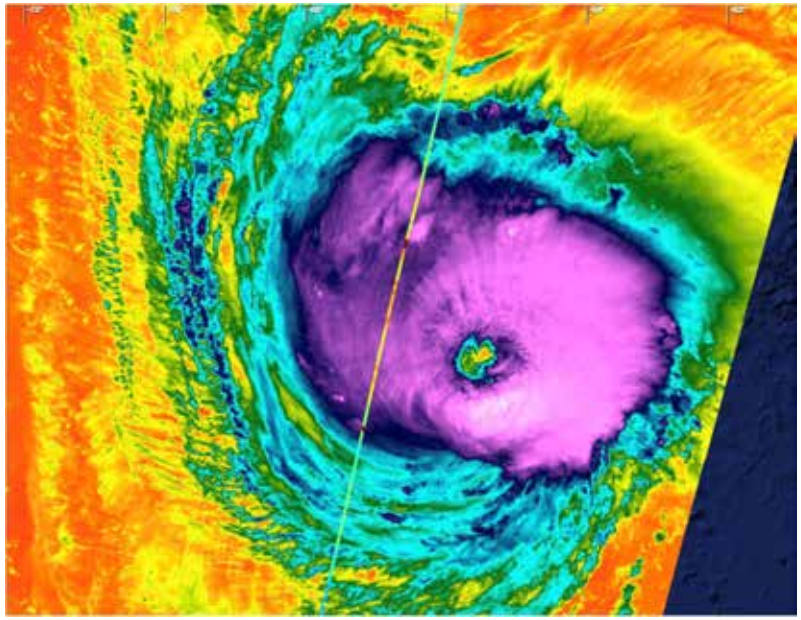


The Copernicus Sentinel Deployment Schedule

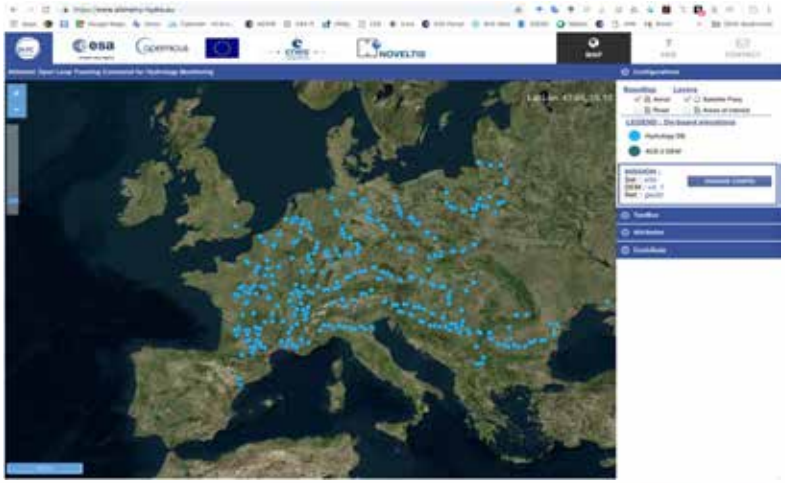


Status of Sentinel-3A

- **Spacecraft and all subsystem performing nominally.**
- **Payload and all subsystems performing nominally**
- Routine operations since October 2017.
- **SRAL full mission reprocessing** (starting from 1 March 2016) has been completed for both the Land and the Marine products available from EUMETSAT's CODAREP and ESA's open data hub.
- **A new Sentinel GNSS L1B RINEX user product** (includes dual frequency GPS receiver data) has been officially released for the Sentinel-1, -2 and -3A satellites from the Copernicus Data Hub service.
- **Rivers&Lakes:** www.altimetry-hydro.eu offers the possibility to display OLTC elevation tables on-board Sentinel3 SRAL altimeters.
- **NRT Visualization** of all S3A (and soon S3B) data via ESA S3VIEW portal https://s3view.oceandatalab.com

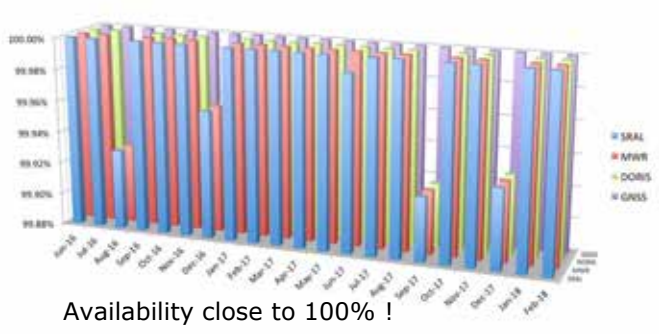


Hurricane Florence (S3A SLSTR 9um and SRAL Hs (11/09/2018)

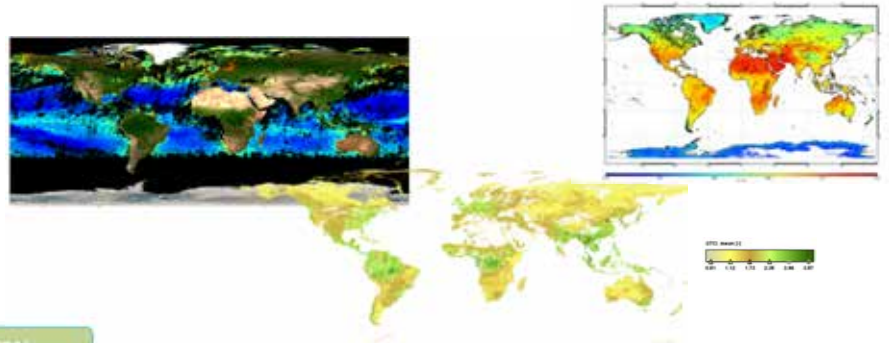


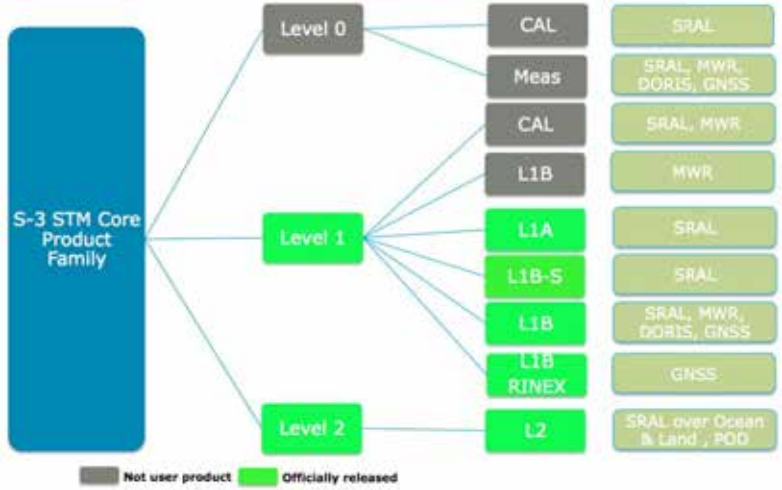
Sentinel-3A Status

- **S3A** is in Routine Operations Phase (ROP) - operational capacity since Oct 2017
- Ground segment operations all nominal. **Very good availability** of the S-3A Surface Topography Mission (STM) payload (close to 100%)
- **All STM L1 & L2 User Products freely and openly available** to the user community (including L1A & L1BS) from 1 March 2016



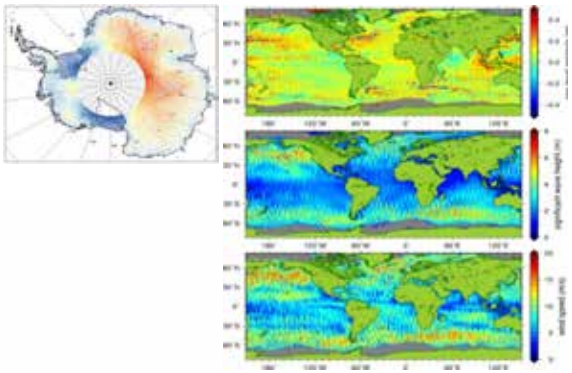
Availability close to 100% !



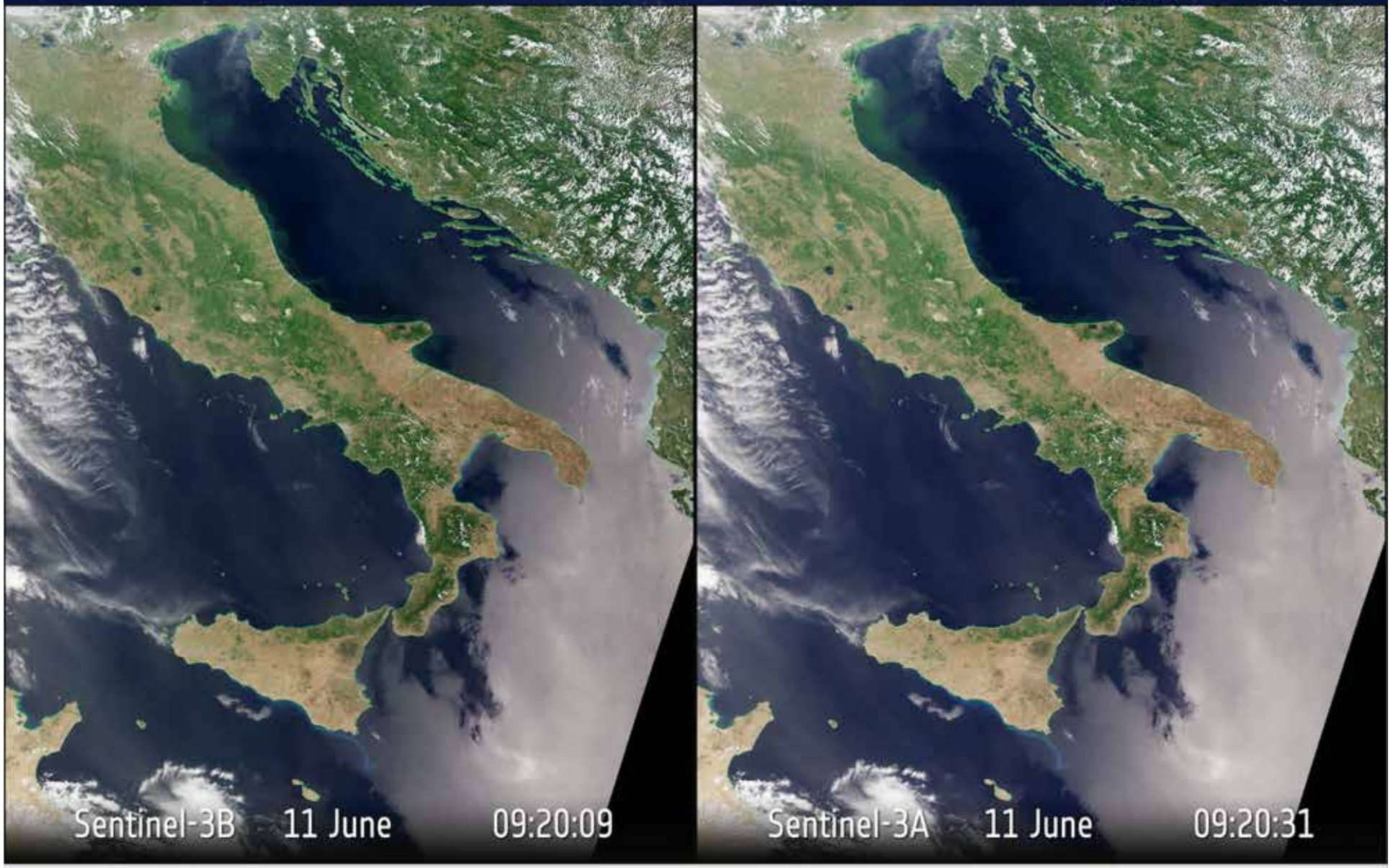


!! NEW !!

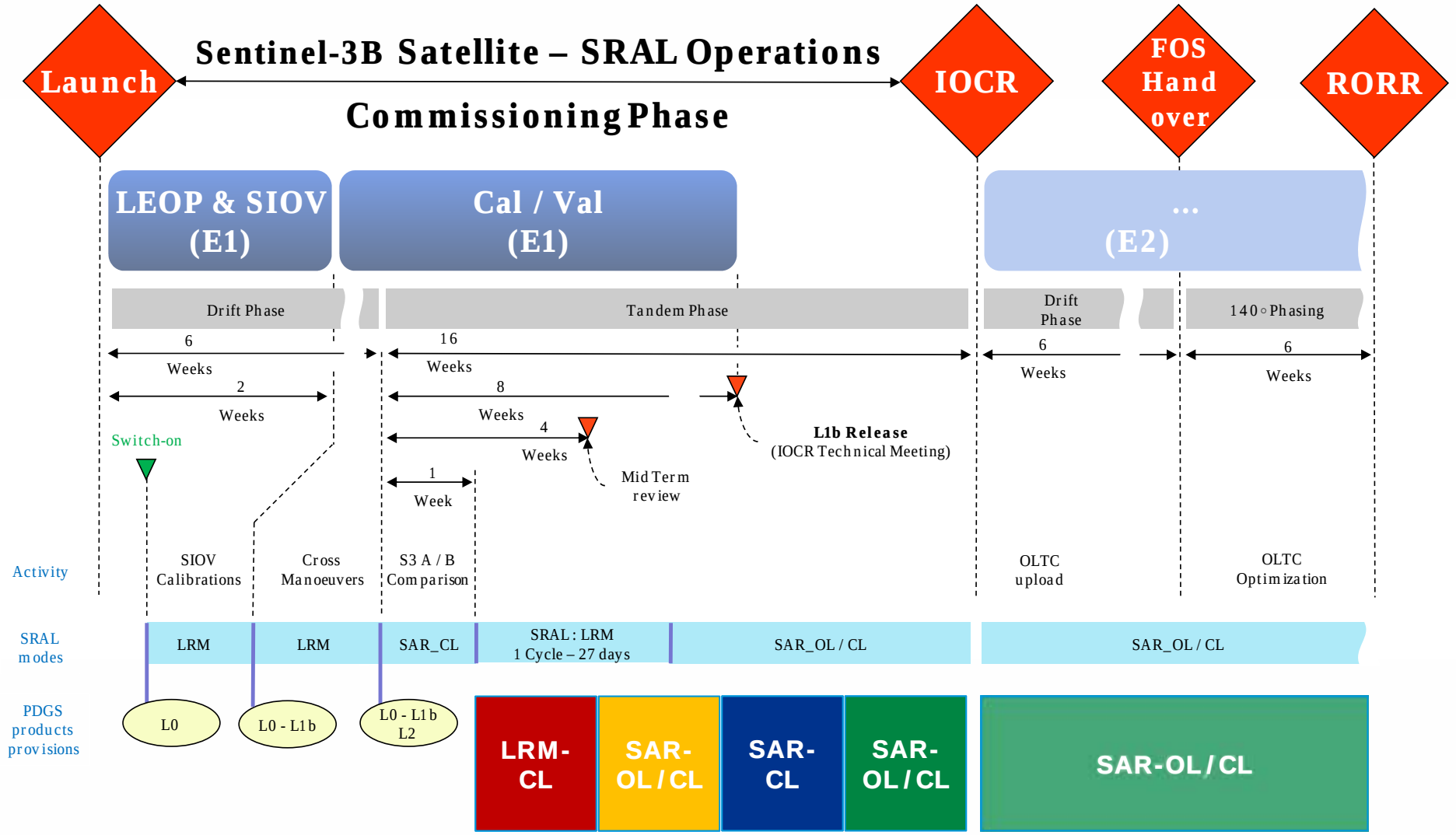
Sentinels **GNSS RINEX L1B** products available from ESA Open Access Hub since Feb 2018!



Sentinel-3B

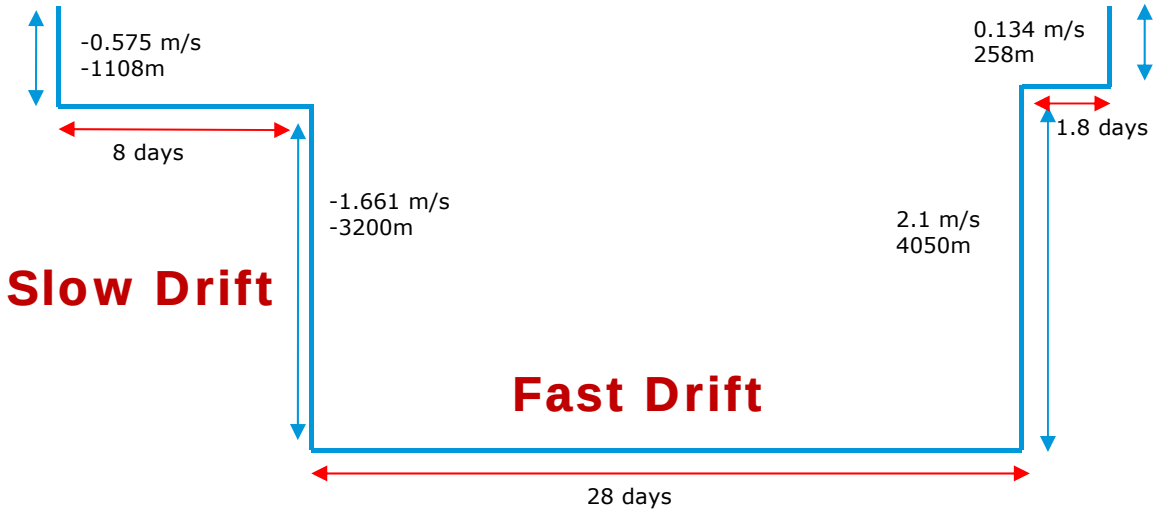


S3A and S3B tandem operations (SRAL focus)



S3B tandem: final drift to operational configuration

- After its launch, Sentinel-3B was brought into a tandem formation with Sentinel-3A.
- After four months of tandem, it is time to move it to its final position, 140deg apart from Sentiel-3A



Slow drift
The objective of this phase is to acquire data with the SLSTR nadir swath of Sentinel-3A and with the SLSTR oblique swath of Sentinel-3B within 30 seconds, during 3 days. These requirements define a unique drift profile.

Fast Drift
It is used to acquire the final position at 140 deg. Two plans will be shown, each of them with a different trade-off between the time to reach the position versus the delta-V and the ease of the operations.

- Expect to be in nominal 140 deg orbit phase position by end November 2018
- Commissioning of S3B OLTC expected to complete by end December 2018
- **Operations readiness by end January 2019**

Key Tandem dates

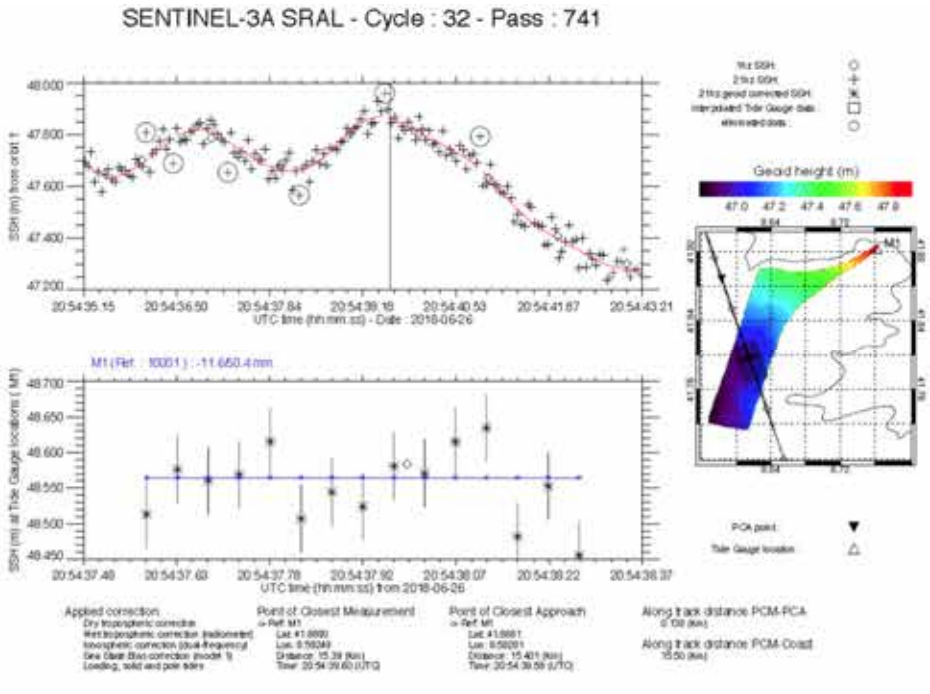
- Plan to start the drift back to the nominal position on **16 October**.
    - Between 15 and 22 October the FIDEX campaign around Skukuza, South Africa (Krueger national park) takes place. Controlled dedicated fire burns are planned specifically lit for cal/val purposes.
- It is foreseen to have **first a phase of 8 days with a slow drift (1.1 km lower orbit)** to allow the SLSTR-B oblique swath overlapping with the nadir swath of the SLSTR-A satellite, and then a second phase of 28 days with a faster drift (4.3 km lower orbit) to reach the target position.
- Then a fast phase approach is to **lower the orbit of S-3B to initiate the separation of the two satellites and then to raise it**, once the target position is reached.
- The target position is selected to be the **+140 deg position (S3B Ahead of S3A)** due to the shorter duration required to to reach position.
- The difference in actual **MLST to the reference MLST of 22:00:00 is only 15 seconds** which is well within the acceptable boundaries of +/- 2 minutes.

- The OLTC verification will start once the target position is reached and expected to be completed on 22 December.

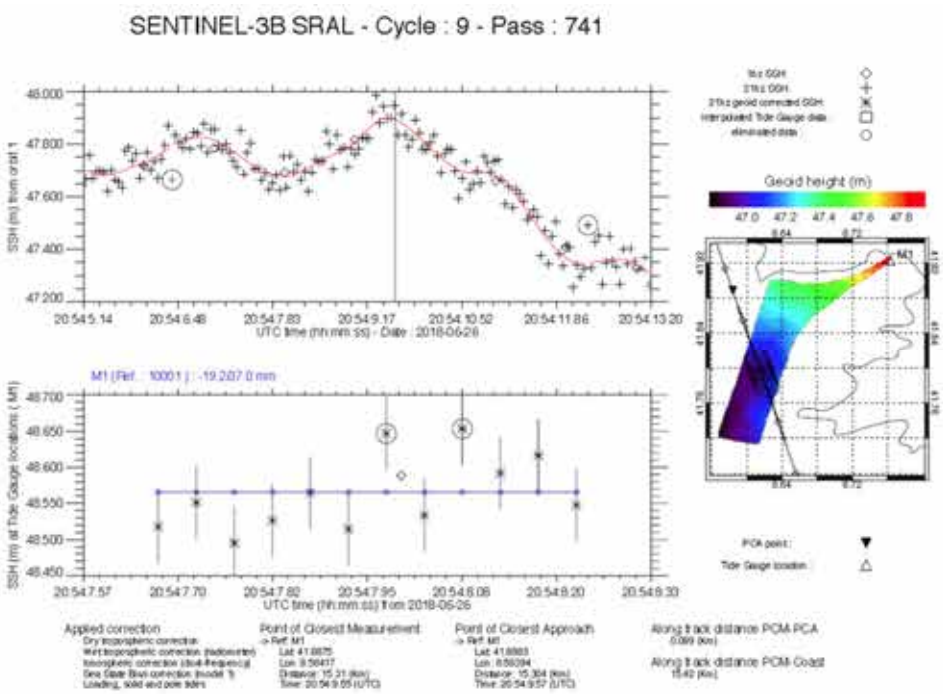
- RORR is planned for 25 January 2019.

S3A&S3B over Corsica facilities (June 26, 2018) (P. Bonnefond)

- **First Sentinel-3A&B tandem overflight over Corsica facilities on June 26, 2018:**
  - *Orbit - range difference (without corrections, includes contribution of orbit height error): -10.2 mm => **statistically zero!***

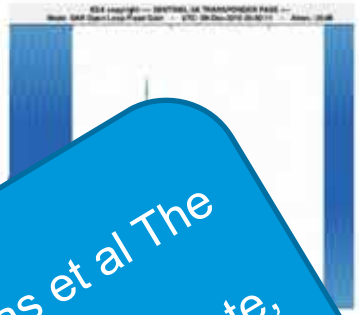


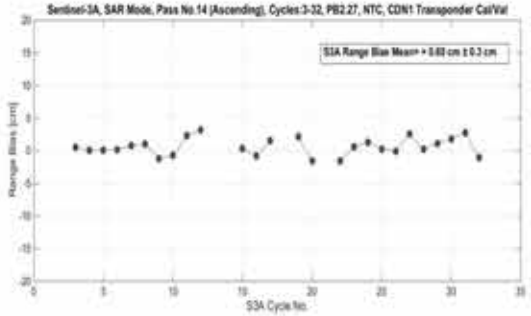
S3A in SAR



S3B in LRM

FRM Transponder Measurements in Crete (S. Mertikas et al)





Poster 179 Stelios Mertikas et al The Permanent Facility for Satellite Altimetry Calibration in Gavdos/Crete, Greece: Fifteen years of Cal/Val Service

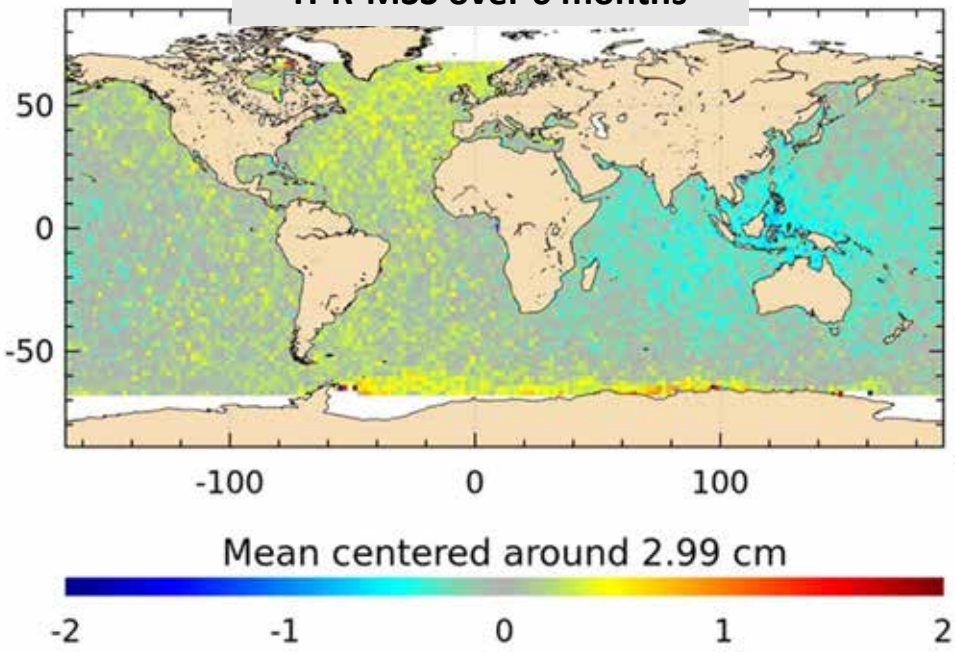
Satellite	Product[Cycles]			Average (Asc, Desc)
JA1, P18	GDR-E [7			
JA1, P109	GDR-E [		.3 cm	**JA1 = +4.10 cm**
JA2, P18	(S)GDR-D [		cm ± 0.3cm	
JA2, P109	GDR-D [2-30		+0.33 cm ± 0.2cm	**JA2 = +0.48 cm (SSH)** **JA2 = -1.20 cm (Range)**
JA3, P18	(S)GDR-D [1-80]	± 0.4 cm	-0.74 cm ± 0.4cm	
JA3, P109	GDR-D [1-80]	/A	-0.50 cm ± 0.4cm	**JA3 = -0.62 cm (SSH)** **JA3 = +0.76 cm (Range)**
S3A, P14	PB 2.27 NTC [3-32]	+0.60 cm ± 0.3 cm	+0.70 cm ± 0.5 cm	
S3A, P335	PB 2.27 NTC [3-32]	N/A	-1.20 cm ± 0.5 cm	**S3A = +0.70 cm (SSH)** **S3A = +0.60 cm (Range)**

* Cycles 265-303

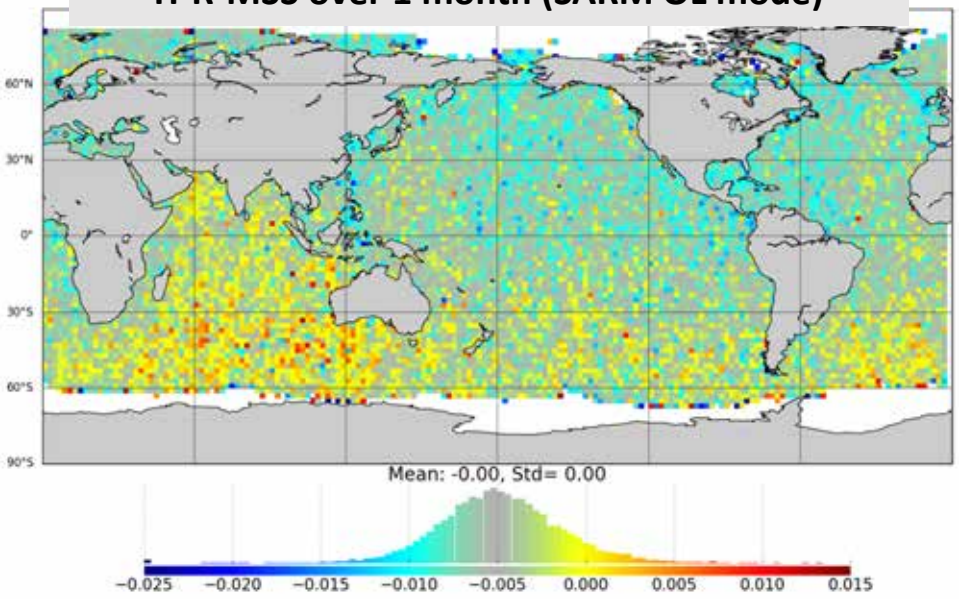
S3A/S3B Cross Comparison (S. Labrue MPC)

- One of the key approaches to verifying data quality in the continuity of the altimetry data record is accurate cross calibration during a tandem phase for Jason series and S3 series
- Requested by GCOS in the Climate Monitoring Principles

J3-J2 Tandem phase
H-R-MSS over 6 months



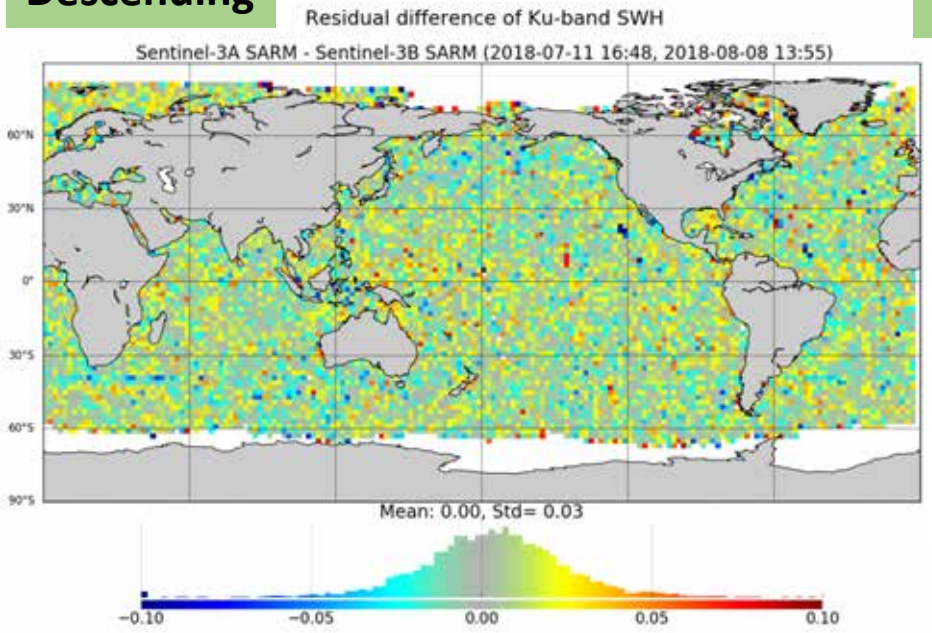
S3A-S3B Tandem phase
H-R-MSS over 1 month (SARM OL mode)



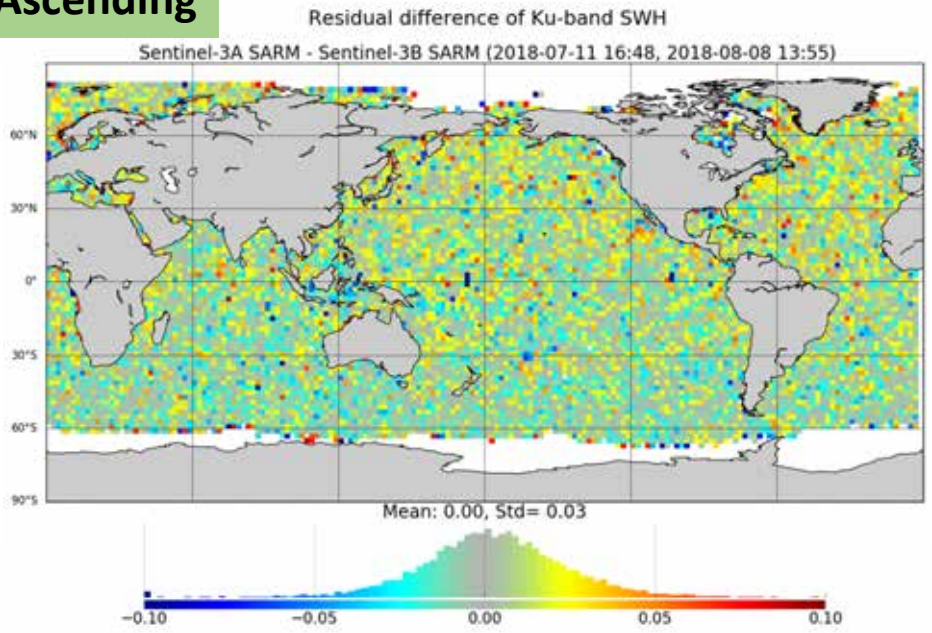
S3A/S3B Cross Comparison (S. Labrue MPC)

S3A-S3B Tandem phase
SWH over 1 month (SARM OL mode)

Descending



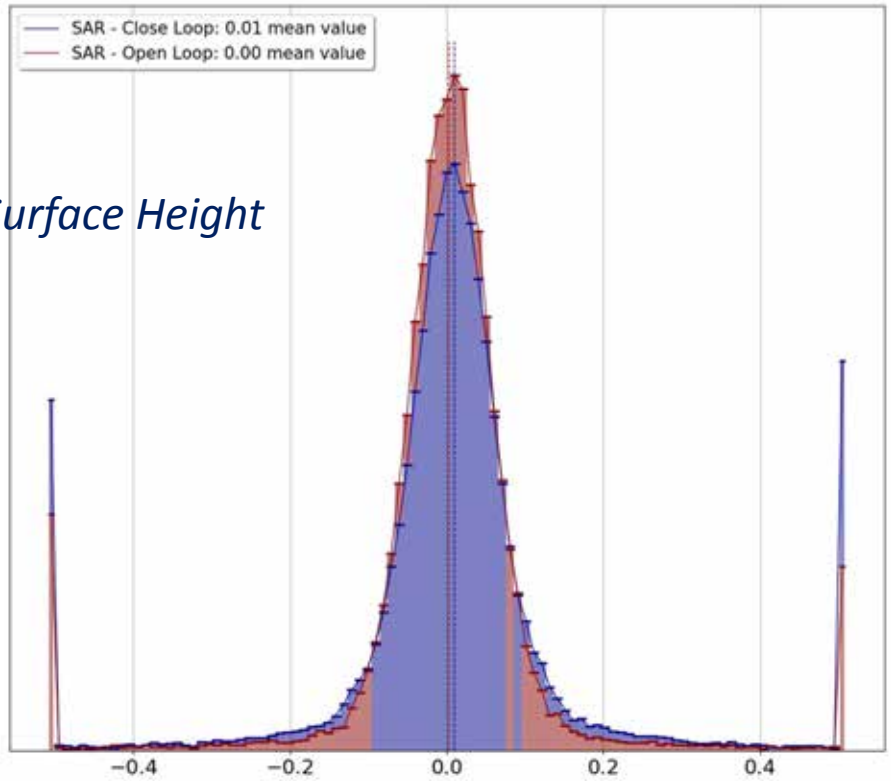
Ascending



Very close agreement between both satellites :
no significant spatial patterns on the map
Mean bias less than 1 cm.

S3A/S3B Cross Comparison (S. Labrue MPC)

Inland Water Surface Height



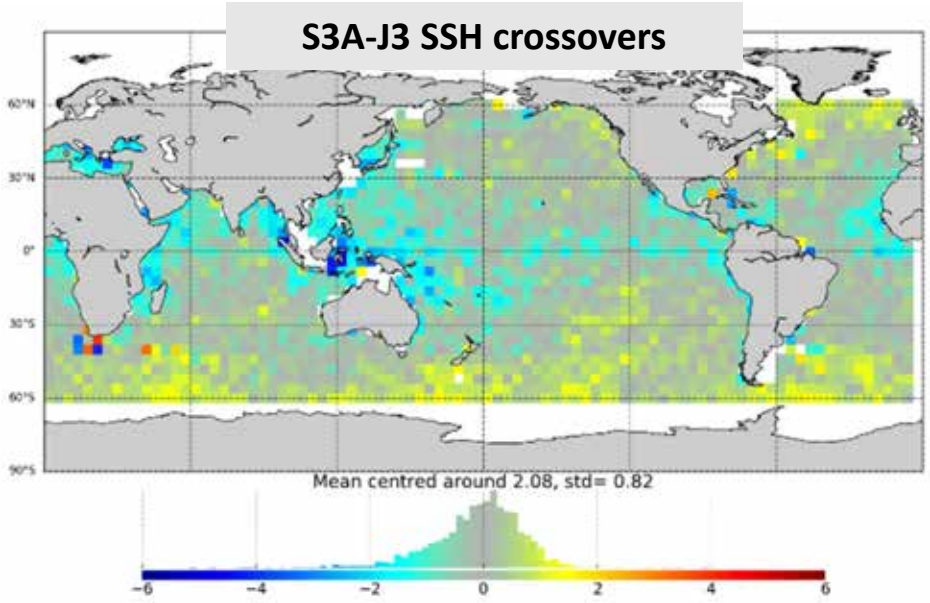
Difference of Inland Water Surface Height between Sentinel-3b and Sentinel-3a (m). Only SARM measurements are compared, for Open Loop and Close Loop Tracking Modes separately. Analysis period: S3B cycles 9-12

S3A/S3B Cross Comparison (S. Labrue MPC)

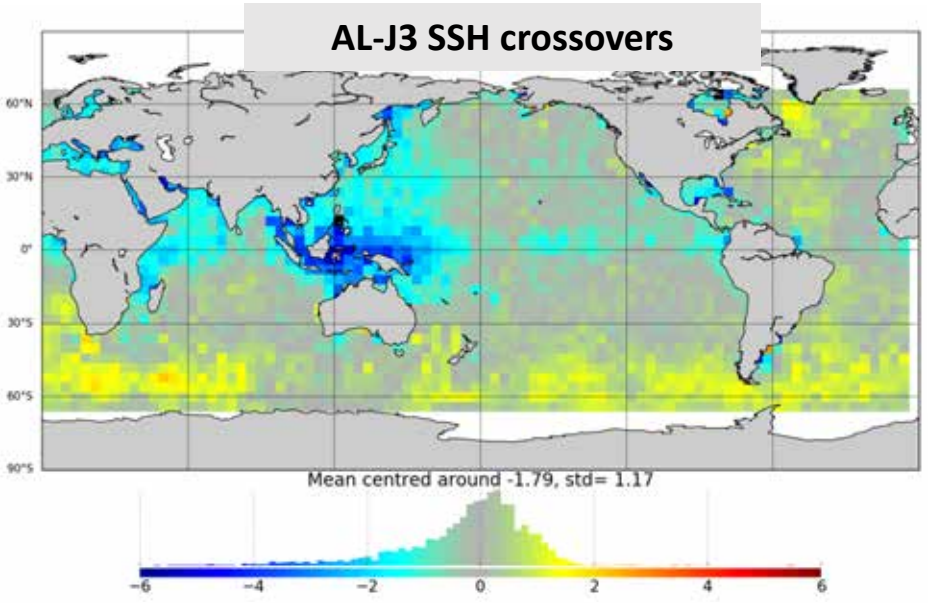
Temporal scales < 10 days | Spatial scales > 100 km | Spatial scales < 100 km | Climate scales

Cross calibration with Jason-3 for AltiKa and Sentinel-3A

S3A-J3 SSH crossovers



AL-J3 SSH crossovers



Summary of results so far

- Very good data quality few months after the launch
  - No significant anomaly was detected trough the analysis of the retrieved L2 parameters.
  - The S3B dataset quality is within the requirements when compared to S3A.
  - The tandem phase provides a wealth of information that will be used extensively to study S3 SRAL measurements
  - The excellent agreement between S3A and s3B will facilitate an easy integration of Sentinel3B into CMEMS and other operational systems.

- Unexpected and small discrepancies are observed between S3A and S3B depending on the tracking mode (OL vs CL)
  - Further work needed to understand differences

- Tandem data analysis is still in its infancy – we expect definitive results in early
- 2019
- More information at https://s3tandem.eu/ and https://sentinel.esa.int/web/sentinel/missions/sentinel-3

Sentinel-3C and Sentinel-3D are coming soon…

Sentinel-3C & Sentinel-3D: Status

- **Sentinel-3C and Sentinel-3D development is proceeding well.**
  - S3C electrical integration underway
  - SRAL-C instrument delivery in mid 2019
  - S3D SRAL instrument delivery ion early 2020
- **For S3C a target launch date of Q1 2023, followed by S3D ~2 years after**
- **Future plans for the C and D models are addressed in the Copernicus Space Component Long Term Scenario CSC-LTS)**
  - Discussion regarding the launch of Sentinel 1 to 3 C/D units to be launched as early as possible in the next decade, pending approval by the EC

S3C @TAS-Rome pre Electrical AIT September 2018

Summary

- Sentinel-3 mission is now rapidly approaching the full operational phase
  a. Sentinel-3A is operating smoothly.
  b. Sentinel-3B payload commissioning has been successful
  c. Sentinel-3 Tandem phase fully implemented
     a. S3B drift to operational position prepared Tandem to be completed in October 2018
     b. S3B operations on nominal 140deg phase orbit expected to commence in early 2019.
- Very good data quality from S3B in the few months after launch
  - No significant anomaly was detected from initial analysis of retrieved L2 parameters.
  - Whatever the mode is, the S3B dataset quality is within the requirements.
  - S3A and S3B tandem configuration has brought a distinct benefit for the E1 commissioning
  - Further activities within the Sentinel-3 for Tandem Science Study and Mission Performance Centre activities.
- Sentinel-3C/-3D development entered the AIT phase at Platform level and has started.


Thank You –
any Questions
Contact: Craig.Donlon@esa.int

ESA S3 intended ITTs

Title: **Sentinel-3 Topography mission Assessment through Reference Techniques (S^{t}3TART)**

Objective: Perform Cal/Val activities and enhance the exploitation of the High Resolution (HR) measurements of the S3 SAR altimeter data products through Reference Cal/Val Techniques and Fiducial Reference Measurements (FRM) carried out over coastal, inland waters, sea-ice and land ice areas

ITT Publication: Q4 2018 - Q1 2019

Duration: ~3 years

Price range: > 2MEuro

Department: ESA ESRIN Ground Segment Dept / EOP-G

ESA S3 intended ITTs

nb 197

Title: **FDR4ALT (Fundamental Data Record for Altimetry)**

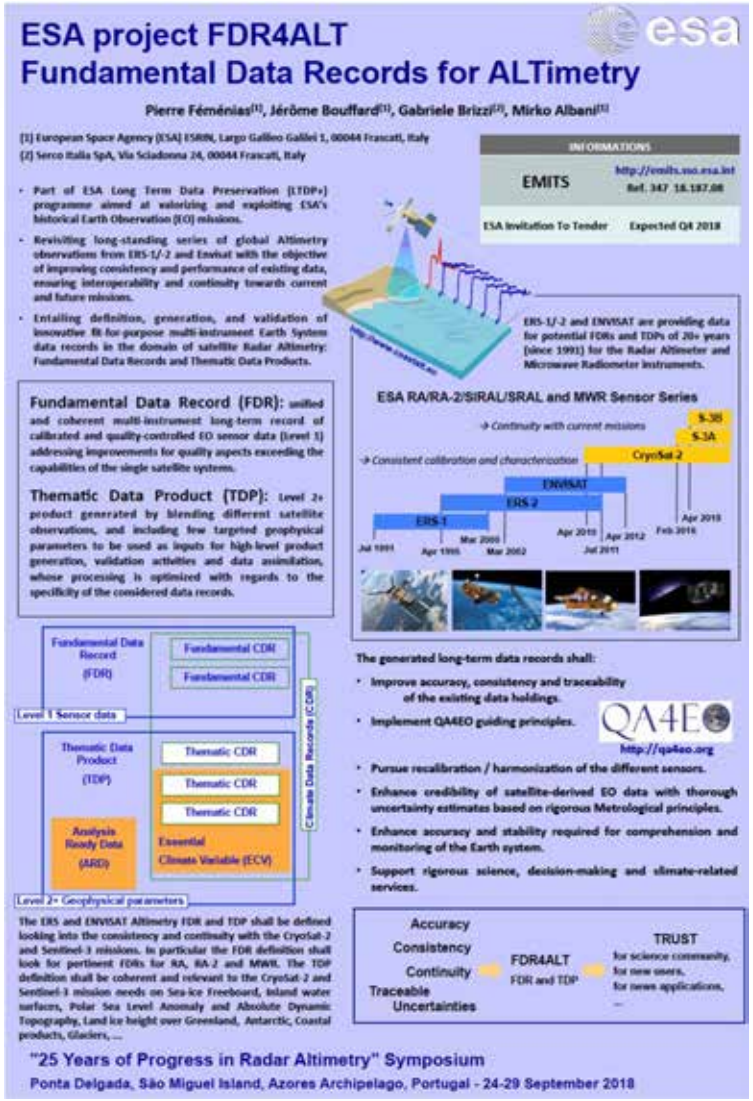
Objective: Valorization and exploitation of the long-standing record of global altimetry measurements from ESA ERS-1, ERS-2 and ENVISAT heritage missions. Definition and generation of Fundamental Data record (FDR) & Thematic Data Products (TDP)

ITT Publication: Q4 2018

Duration: ~1 + 2 years

Price range: > 1.5 MEuro

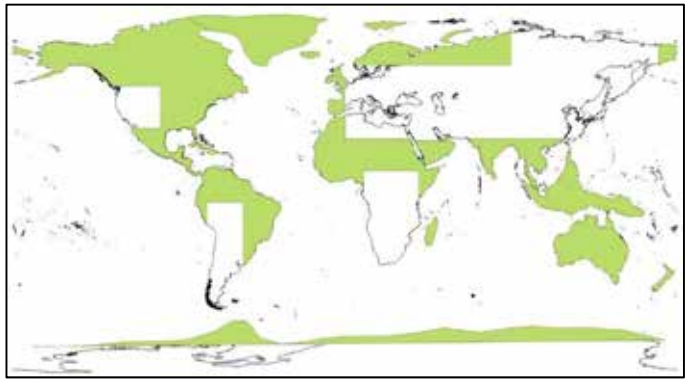
Department: ESA ESRIN Ground Segment Dept / EOP-G



S3A and S3B tandem : Open/closed loop masks

- On S-3A, OL commanding has improved the measurement return for the surfaces for which the OLTC was correctly defined
- Ice margins are commanded in SAR-CL
- For S-3B, the OLTC coverage has been increased to include all Land area up to +/- 60 deg latitude

S-3A
white: SAR OL
green: SAR CL



S-3B
white: SAR OL
blue: SAR CL