

Sentinel-6/Jason-CS Altimeter Products and Performance Budget

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Introduction

The **Sentinel-6** mission will be developed and implemented through a **partnership between the EU, ESA, EUMETSAT and NASA**. Its aim is to secure the continuity until 2030+ of critical high precision observations of ocean surface topography beyond Jason-3. The European contribution will be implemented through the combination of the ESA Copernicus Space Component, the EUMETSAT Jason-CS optional programme, and the EU Copernicus programme, for the joint benefits of the meteorological and Copernicus user communities in Europe. **NOAA and CNES** will be supporting partners.

The mission will start with the launch of **Jason-CS A** in 2020, followed by **Jason-CS B** in 2025.



Continuity between Jason missions

What's in a Name?

- **Mission name:** Sentinel-6
- **Satellite name:** Jason-CS A (launch 2020) and Jason-CS B (launch 2025)

Jason-1/2/3 Products

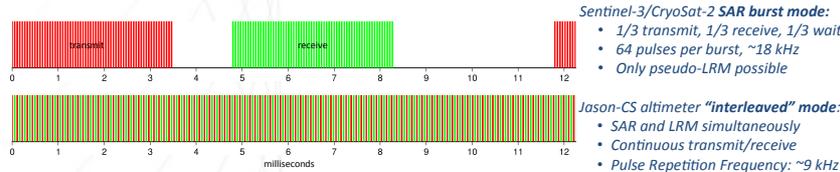
- **OGDR:** Operation Geophysical Data Record
- **IGDR:** Interim Geophysical Data Record
- **GDR:** Geophysical Data Record

Sentinel-3/6 Products

- **NRT:** Near Real Time
- **STC:** Short Time Critical
- **NTC:** Non Time Critical

Altimeter Operation

- The Sentinel-6 mission will be **unique** in the Jason-series of altimeters.
- Jason-CS will fly in the **same orbit** as its predecessors (TOPEX/Poseidon, Jason-1, Jason-2, Jason-3).
- It will be the first of the "reference missions" outfitted with a **high-resolution (SAR)** altimeter.
- It carries the first altimeter that operates in a **continuous high-rate pulse mode**.
- **No longer waiting 2/3 of the time** for pulses to be received, while transmitting only 1/3 of the time, like the altimeters of CryoSat-2 and Sentinel-3.
- Sentinel-6 will be operating in this mode over **100% of all surfaces** up to 66° latitude.
- Allows simultaneous production of **low-resolution mode (LRM)** measurements **on-board** as well as the processing of **high-resolution (SAR)** echoes on-ground.
- **High-resolution and low-resolution** measurements will be provided in **separate** Sentinel-6 altimeter data products.

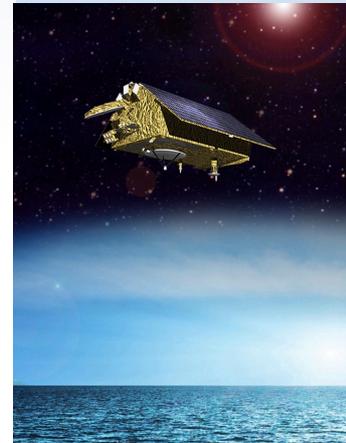


Sentinel-3/CryoSat-2 SAR burst mode:

- 1/3 transmit, 1/3 receive, 1/3 wait
- 64 pulses per burst, ~18 kHz
- Only pseudo-LRM possible

Jason-CS altimeter "interleaved" mode:

- SAR and LRM simultaneously
- Continuous transmit/receive
- Pulse Repetition Frequency: ~9 kHz



Sentinel-6 Product Analysis and Heritage

- A **product analysis** has been made to procure an adequate user products baseline for the Sentinel-6 altimetry mission given its objectives as described in the **Sentinel-6 End-User Requirements Document**.
- Specific elements in the product suite have been selected to ensure **seamless use** in follow-on of the Jason-1,2,3 (O,I)GDR's.
- For the most effective use of the **high-resolution altimetry** capabilities, a further alignment with the **Sentinel-3 user products** suite has been sought, taking into account the programme constraints.
- The development of **higher level products** (L2P, L3) has also been baselined.
- Three product latencies, similar to OGDR, IGDR, GDR:
 - **Near Real Time (NRT):** within 3 hours after sensing, mainly for for **marine meteorology, air-sea interaction studies and real time operational oceanography**.
 - **Short Time Critical (STC):** within 36 hours, supports **operational oceanography and numerical ocean prediction**.
 - **Non Time Critical (NTC):** within 60 days, supports **ocean and climate monitoring** services.

	Near-Realtime	Short Time Critical	Non Time Critical
	OGDR	IGDR	GDR
Jason-2	3-5 hours	1-2 days	60 days
Jason-2 and -3	3 hours	48 hours	60 days
	FDM (LRM only)	IOP (LRM only)	LRM and SAR
CryoSat-2	3 hours	48 hours	30 days
	NRT	STC	NTC
Sentinel-3	3 hours	48 hours	60 days
Sentinel-6/J-CS	3 hours	36 hours	60 days

Relation between altimetry products from Jason, CryoSat, Sentinel-3 and Sentinel-6 at various latencies

Sentinel-6 Performance Budget

- **User requirements** stipulate that the Jason-CS performances should be **at least as good as those of Jason-2**.
- Jason-CS requirements had to be set **sharper than** those from Jason-3.
- **Per-cycle** performance requirements for **valid over-ocean measurements** are given in the table below.
- **SSH drift requirements:** 1 mm/year globally, 5 mm/year regionally (40000 km²)

	Envisat*	Sentinel-3	Jason-2*	Jason-CS
	GDR	NTC	O/I/GDR	NRT/STC/NTC
Altimeter noise (LRM) (a)	1.8	1.7	1.8	1.7
Altimeter noise (SAR) (a)		1.3		0.8
Ionosphere (b)	0.5	0.5	0.3	0.5
Sea state bias	2.0	2.0	2.0	2.0
Dry troposphere	0.7	0.7	1.0/0.7/0.7	0.8/0.7/0.7
Wet troposphere	1.4	1.4	0.8	1.2/1.2/1.0
Orbit error (c)	1.9	1.9	3.0/1.5/1.0	3.0/1.5/1.2
SSH error (LRM)	3.6	3.6	4.3/3.3/3.1	4.3/3.4/3.2
SSH error (SAR)		3.5		4.0/3.0/2.8
SWH		20 cm or 4% (d)	15 cm or 5% (d)	15 cm + 5%
Wind speed		2 m/s	0.9 m/s	1.5 m/s
Sigma naught		1 dB	0.1 dB (e)	0.3 dB (e)

Jason-CS performance budget requirements, compared to requirements for Sentinel-3 and performances (*) from Envisat and Jason-2. Values in cm. Errors are RMS (1-sigma) to be determined over at least one cycle for **valid over-ocean measurements**.

- (a) After ground processing, averaged over 1 second, for 2 m average wave height.
- (b) From dual-frequency, smoothed over 200 km.
- (c) NRT/OGDR orbit from DORIS on-board ephemeris.
- (d) Whichever is greater.
- (e) After (cross)calibration.

Sentinel-6 Products Baseline

- **Low and High Res** products will be separate, to reduce latency.
- **NRT Level 2** product (OGDR) dissemination will be on **granule** basis.
- **STC and NTC Level 2** products (IGDR, GDR) dissemination will be on **pass** basis.
- **Level 2** product content will be **harmonized** between NRT, STC and NTC.
- **Level 1b** products will provide wave forms: low-res and high-res (I/Q).
- **Level 1a** products will be provided via ftp (TBC) and will include individual echoes.
- **Level 1b-5** products (like Sentinel-3) are **not** baselined. A tool will be provided for conversion from Level 1a to Level 1bs, creating echo stacks.
- All products are in **NetCDF4** format.
- **Level 2** products will be provided in **BUFR** format via the **GTS**, similar to Sentinel-3.
- Development of operational **Level 2P** and global **L3** will be based on **L2** products.

Resolution	Service Name	Format	User Data Access			
			EUMETCast	GTS	ftp (TBC)	Archive
Low (LRM)	NTC	NetCDF	-	-	-	L1b, L2
	STC	NetCDF	-	-	L1b	L1b, L2, L2P, L3
	NRT	NetCDF	L2 (std + red)	-	-	L0, L2
High (SAR)	NRT	BUFR	L2	L2	-	L2
	NTC	NetCDF	-	-	-	L1b, L2
	STC	NetCDF	-	-	L1a, L1b	L1a, L1b, L2, L2P, L3
High (SAR)	NRT	NetCDF	L2 (std + red)	-	-	L0, L2
	NRT	BUFR	L2	L2	-	L2

Planned product suite for Jason-CS. Lx = Level x. std = 1Hz and 20Hz. red = 1Hz only.

