

Copernicus POD Service

The ILRS Support to the Copernicus Sentinel-3 & -6 Missions

Presenter: Jaime Fernández (GMV)
M. Fernández (GMV), H. Peter (POSITIM)
P. Féménias (ESA/ESRIN), C. Nogueira (EUMETSAT)

22nd International workshop on laser ranging,
Guadalajara, Spain
7-11 November 2022



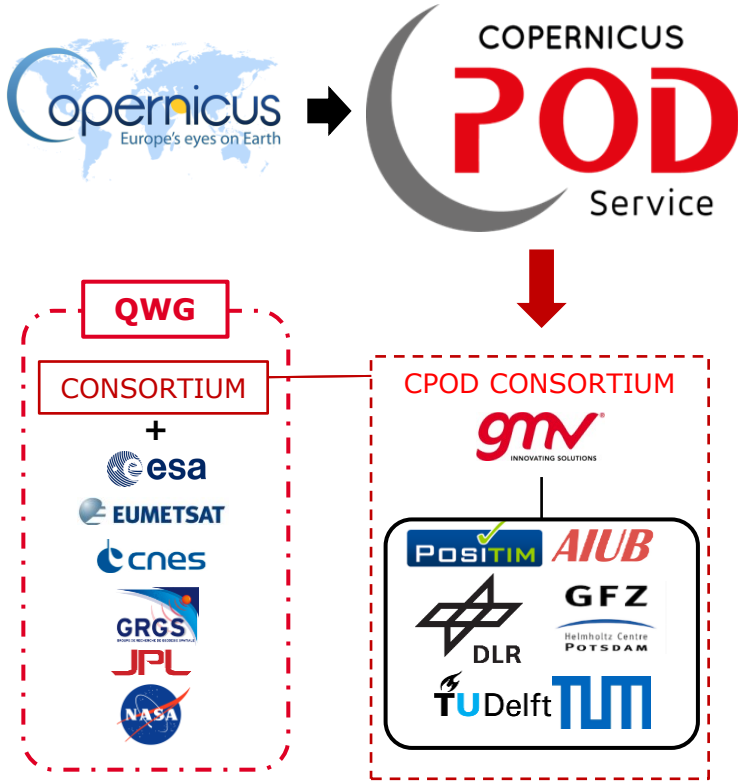
Agenda

1. Copernicus POD Service
2. Sentinel-3 & 6
3. ILRS support

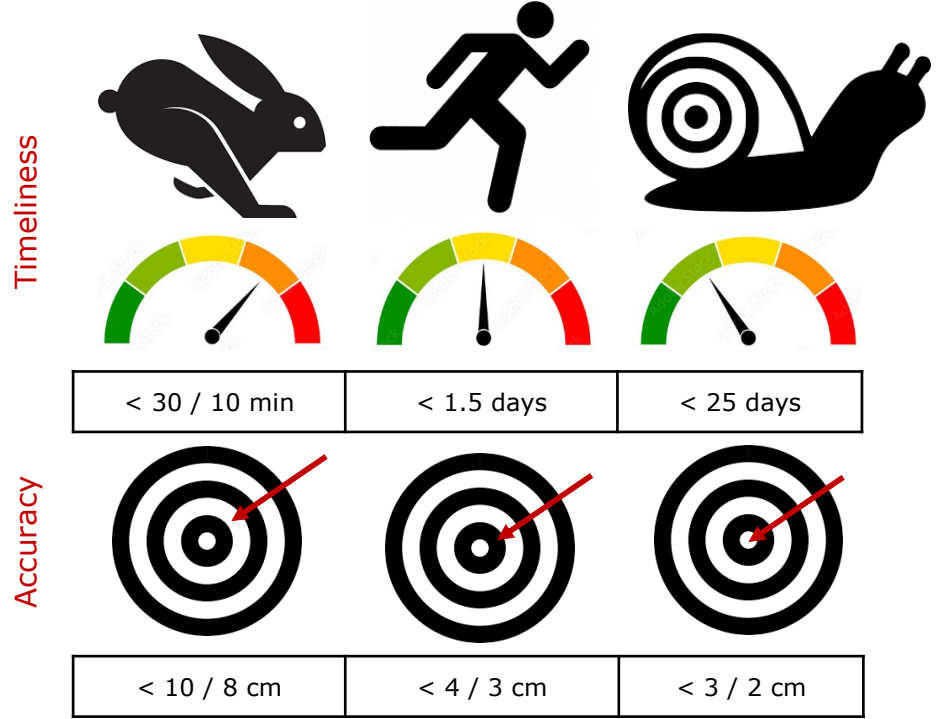
COPERNICUS POD SERVICE

INTRODUCTION TO CPOD SERVICE

PRODUCTS AND REQUIREMENTS

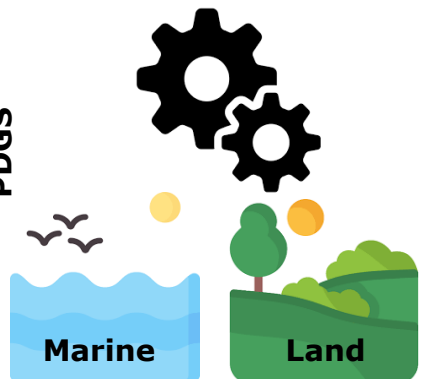








Near-Real Time Short-Time Critical Non-Time Critical



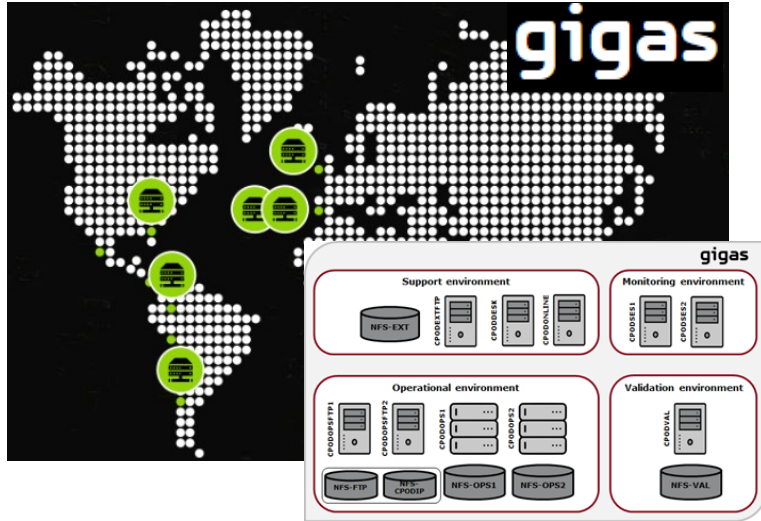
INTRODUCTION TO CPOD SERVICE

PRODUCTS AND REQUIREMENTS

<p>PDGS</p>  <p>Marine</p> <p>Land</p>	<p>Orbits</p>  <p>NRT (10 min) STC (36 h) NTC (25 d)</p>	<p>Platform / Attitude</p>  <p>NRT (10 min) STC (36 h) NTC (25 d)</p>	<p>GNSS Observations</p>  <p>Hourly Daily</p> 
	 <p>ILRS</p> <p>CPF</p>	<p>NRT (10 min) STC (36 h) NTC (25 d)</p>	<p>QUAT Daily</p>
<p>COAH</p> 	<p>NRT (10 min) STC (36 h) NTC (25 d)</p>	<p>QUAT Daily</p>	<p>Daily</p>

INTRODUCTION TO CPOD SERVICE

PHYSICAL ARCHITECTURE



10
Machines

80
CPU Cores

120 GB
RAM
MEMORY

1.2 TB
Hard disk
memory

10 TB
Archive
Space

4
Missions
(S1, S2, S3, S6)

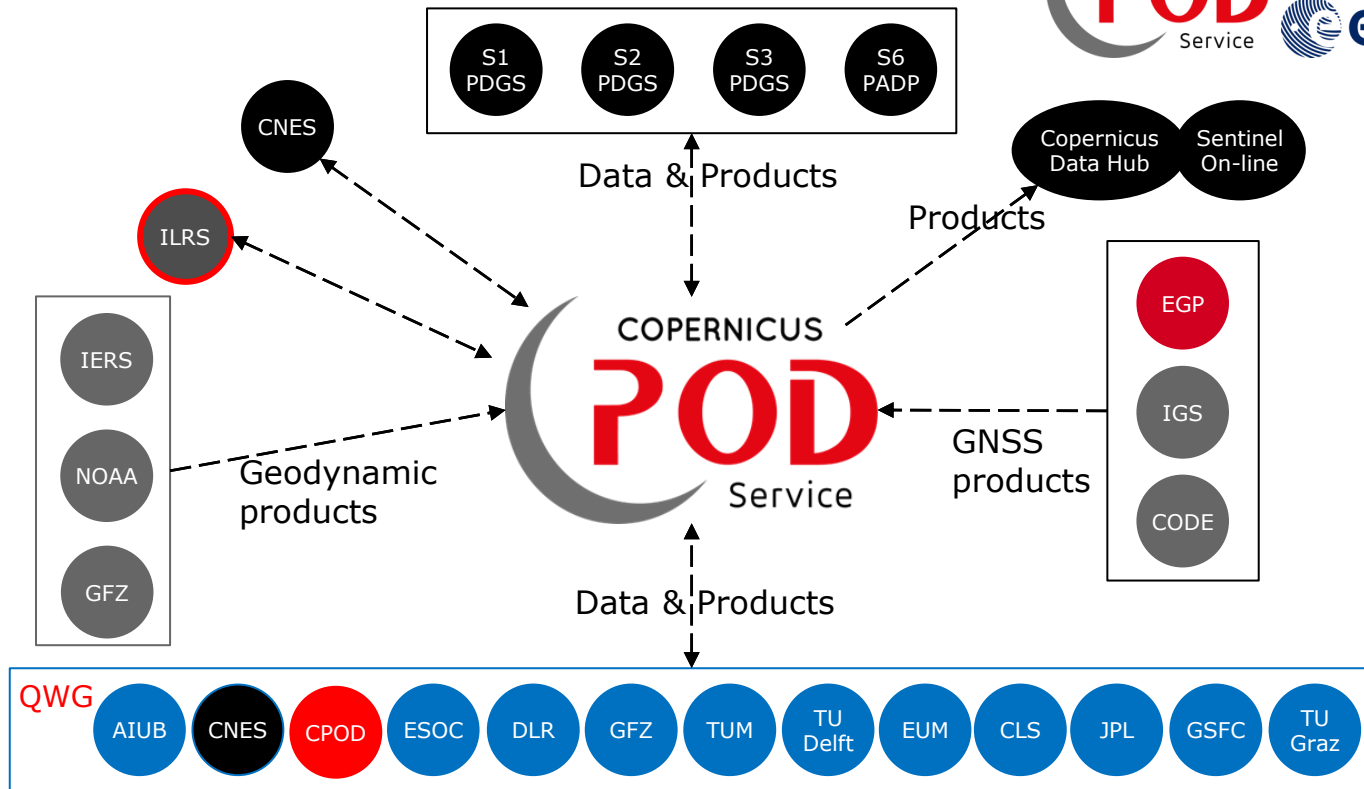
7
Satellites
(S-X A/B)

4
Timeliness
(PRE, NRT, STC, NTC)

100,000
Orbital
products/year

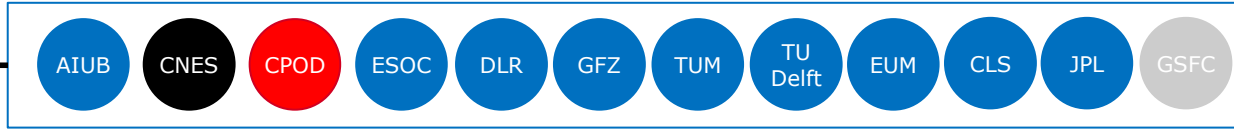


INTRODUCTION TO CPOD SERVICE



INTRODUCTION TO CPOD SERVICE

QUALITY WORKING GROUP – COMBINED SOLUTION



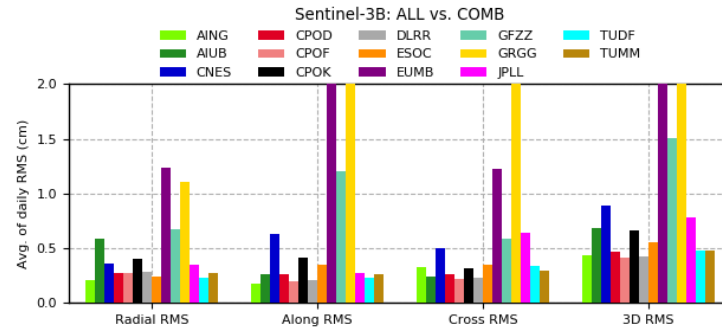
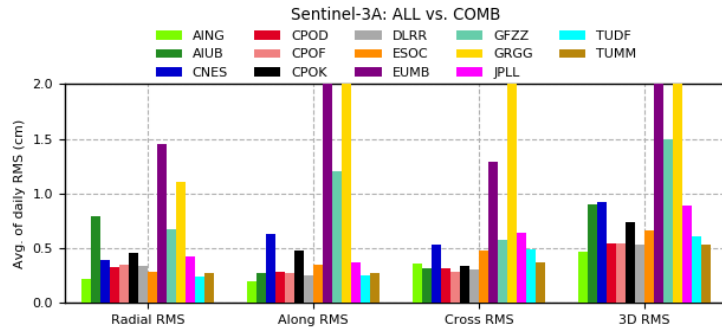
1st Step: Unweighted Mean

2nd Step: Daily weights as median of distances

2nd Step: Weighted Mean

$$SV_{comb_0}(t^*) = \frac{\sum_j SV_j(t^*)}{\sum_j 1} \rightarrow w_j = \text{median} |SV_{comb_0}(t^*) - r_j(t^*)| \rightarrow SV_{comb}(t^*) = \frac{\sum_j SV_j(t^*)/w_j}{\sum_j 1/w_j}$$

Q1 2022

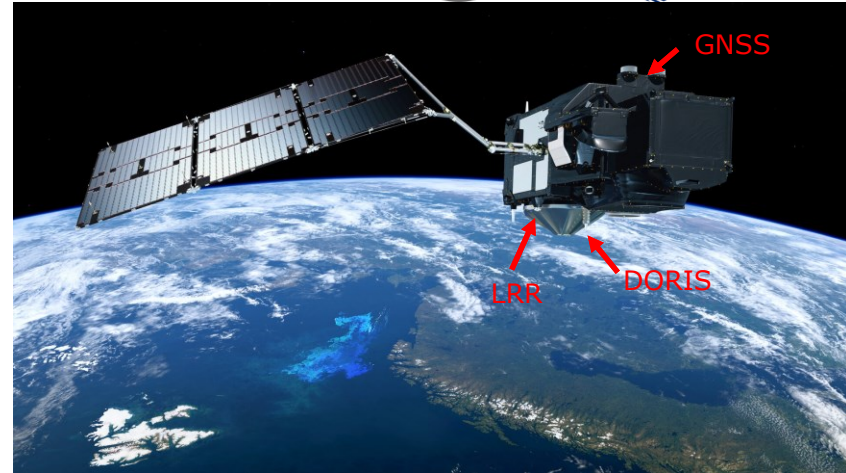


SENTINEL-3 & 6

SENTINEL-3 & -6

S-3 Mission

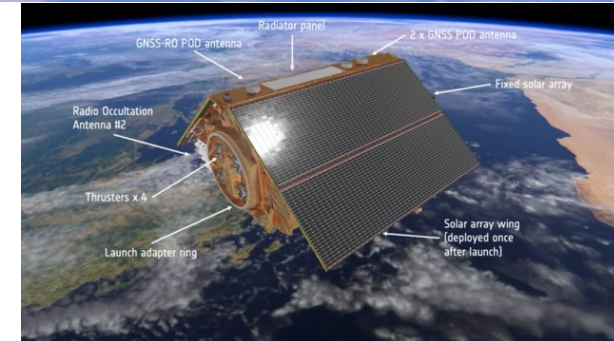
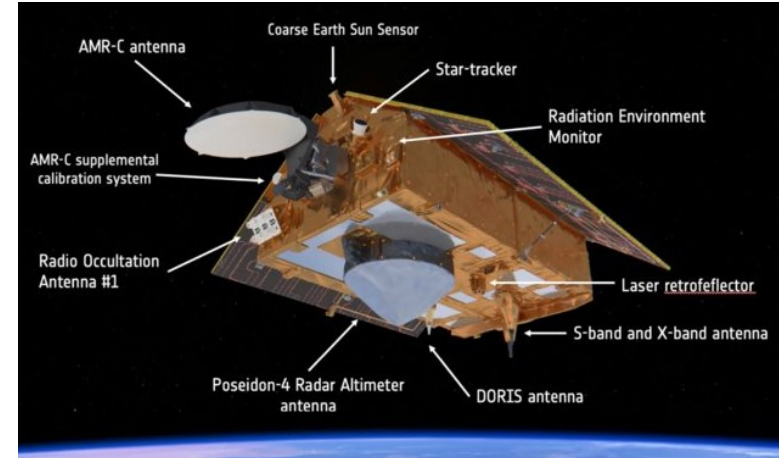
- Two satellites (S-3 A&B): 140 deg. separation.
 - S-3A: 16/02/2016
 - S-3B: 25/04/2018
- Altitude: 814 km (orbital period of 101 min)
- Inclination: 98.6 deg. (polar)
- Mass: 1250 kg
- Repeating cycle: 27 days
- Instruments:
 - Ocean and Land Colour Imager (OLCI) -> **Limit SLR tracking**
 - Sea and Land Surface Temperature Radiometer (SLSTR)
 - SAR (Synthetic Aperture Radar) Radar Altimeter (SRAL)
 - Microwave Radiometer (MWR)
 - GPS receiver (GPS+GAL in future C&D units)
 - DORIS receiver
 - **Laser Retroreflector (LRR)**



SENTINEL-3 & -6

Sentinel-6 Michael Freilich

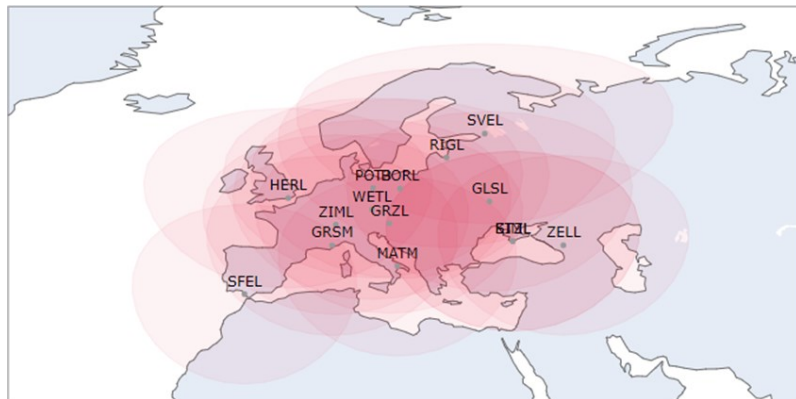
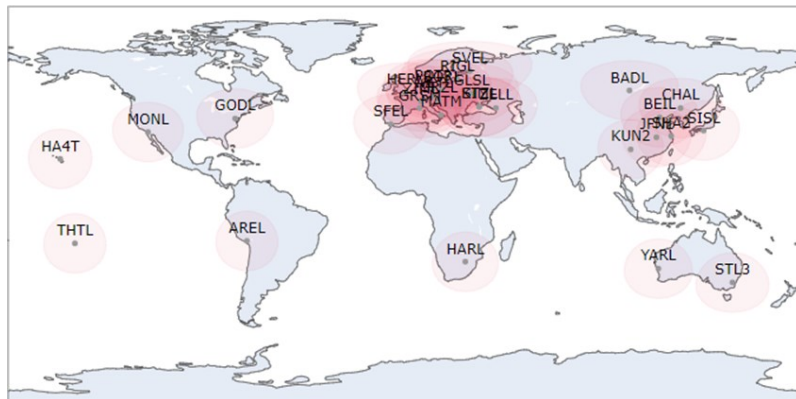
- One satellite (S-6A): 21/11/2020
- Altitude: 1336 km (orbital period of 112 min)
- Inclination: 66 deg.
- Mass: 1192 kg
- Repeating cycle: 9.9 days
- Instruments:
 - Radar altimeter (Poseidon-4)
 - Advanced Microwave Radiometer-C (AMR-C)
 - GNSS receiver (GPS+GAL)
 - GNSS Radio Occultation (GNSS-RO)
 - DORIS receiver
 - **Laser Retroreflector (LRR)**



ILRS SUPPORT

ILRS SUPPORT

ILRS NETWORK



The ILRS Support to the Copernicus Sentinel-3 & -6 Missions

Priority	Mission	ILRS Name	COSPAR ID	SIC	Sponsor	Altitude (km)	Inclination (degrees)	Comments
1	GRACE-FO-1/2	gracefo1 gracefo2	1804701 1804702	0123 0124	NASA JPL and the German Research Centre for Geosciences (GFZ)	500	89	1-month campaign
10	Sentinel-3B	sentinel3b	1803901	8011	ESA/EUMETSAT	814.5	98.65	Restricted tracking; authorization required
11	Sentinel-3A	sentinel3a	1601101	8010	ESA/EUMETSAT	814.5	98.65	Restricted tracking; authorization required
19	Sentinel-6A/Jason-CSA	sentinel6a	2008601	4380	NASA, ESA, EUMETSAT, NOAA, CNES	1339.4-1355.9	66.042	
20	Jason-3	jason3	1600201	4379	NASA, CNES, Eumetsat, NOAA	1,336	66.0	

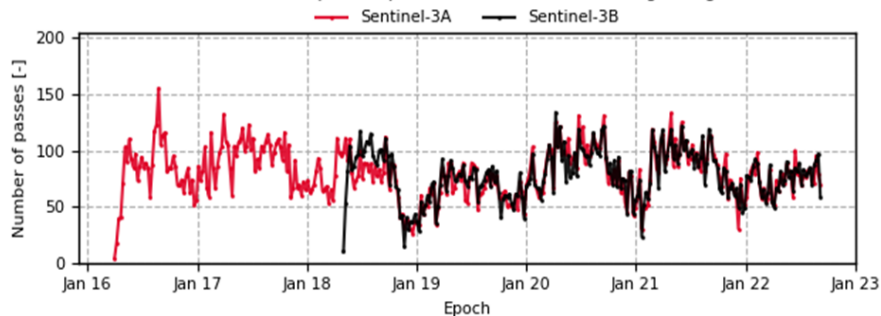
24 stations can track S-3 with power restrictions
 15 tracked S-3 during Q3 2022
 25 tracked S-6 during Q3 2022

ILRS SUPPORT

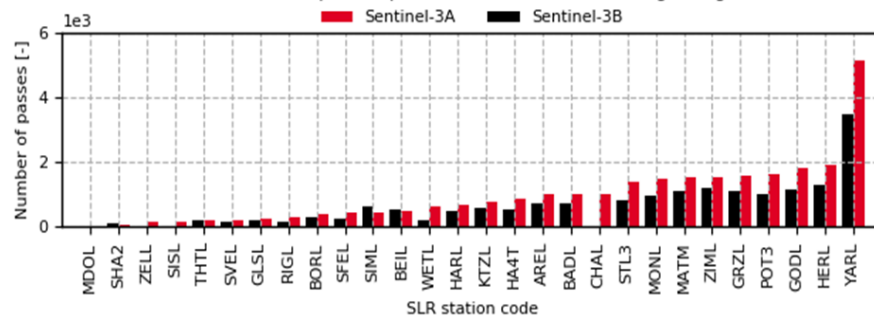
Sentinel-3



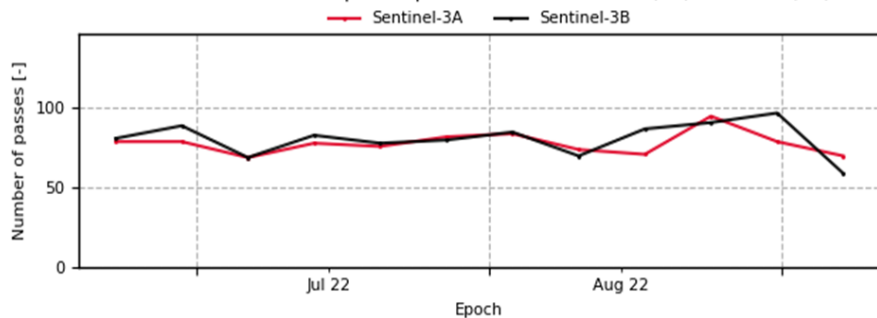
Total number of satellite passes per GPS Week since the beginning of the mission



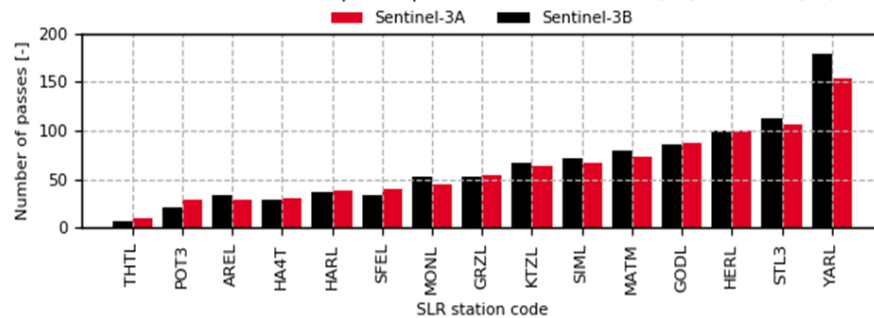
Total number of satellite passes per SLR station since the beginning of the mission



Total number of satellite passes per GPS Week from 2022/06/19 to 2022/09/10



Total number of satellite passes per SLR station from 2022/06/19 to 2022/09/10

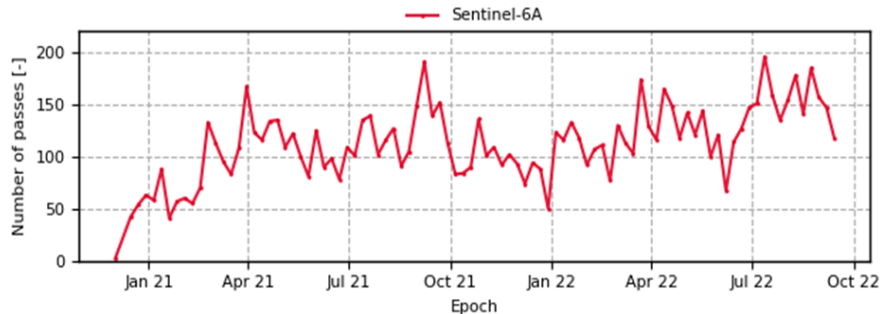


ILRS SUPPORT

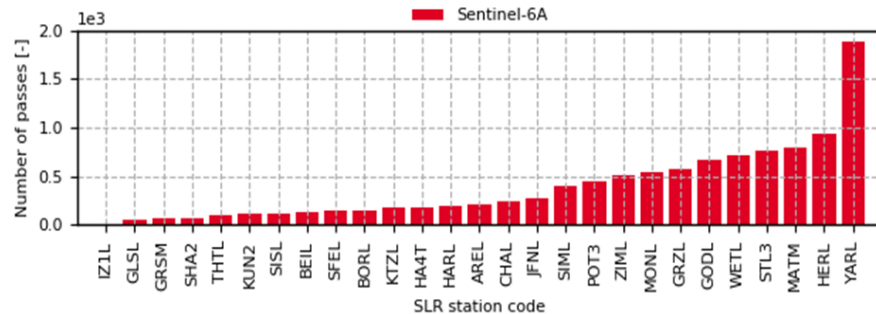
Sentinel-6



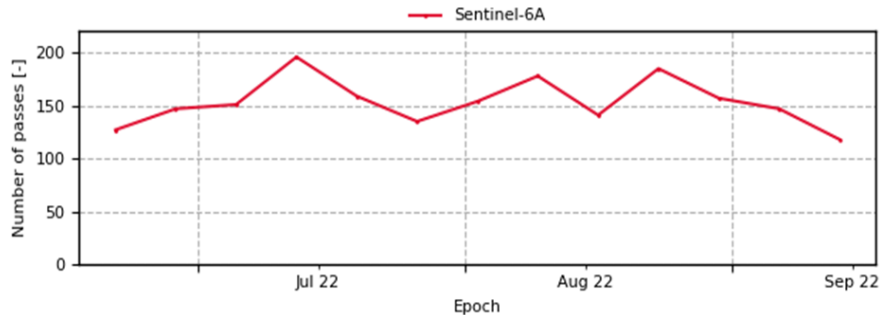
Total number of satellite passes per GPS Week since the beginning of the mission



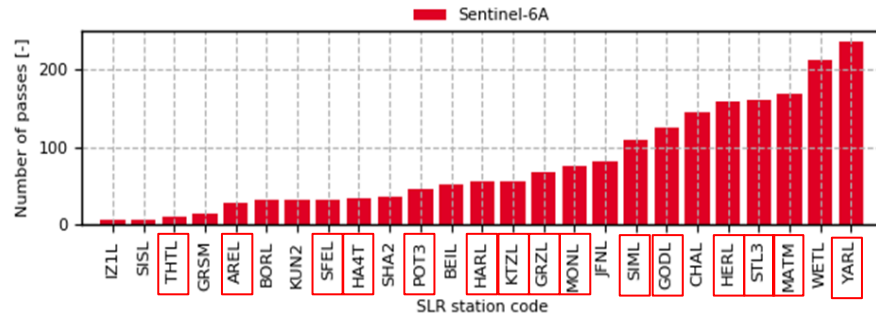
Total number of satellite passes per SLR station since the beginning of the mission



Total number of satellite passes per GPS Week from 2022/06/18 to 2022/09/16

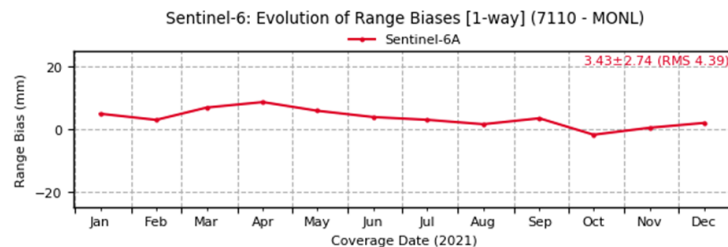
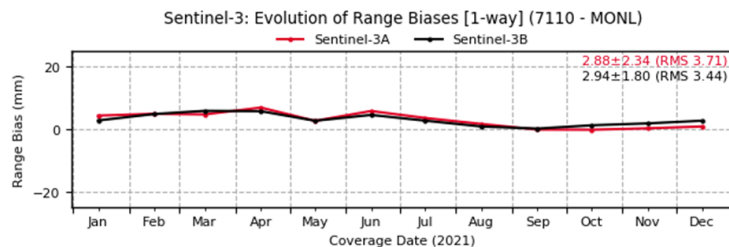
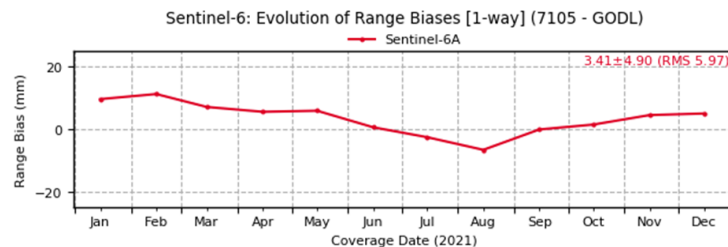
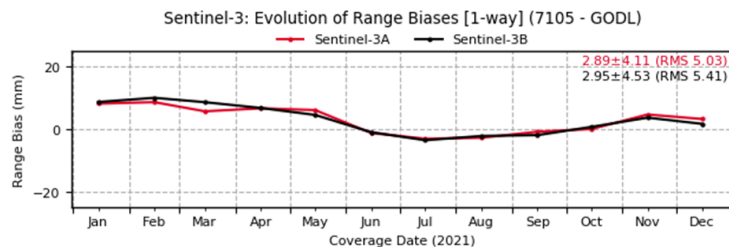
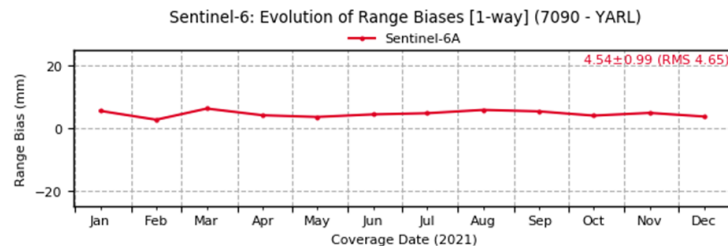
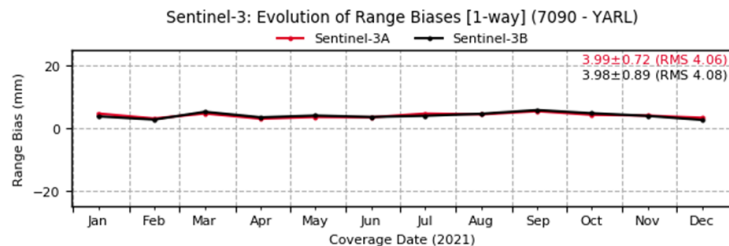


Total number of satellite passes per SLR station from 2022/06/18 to 2022/09/16



ILRS SUPPORT

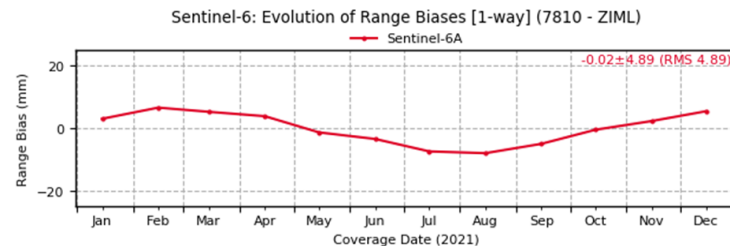
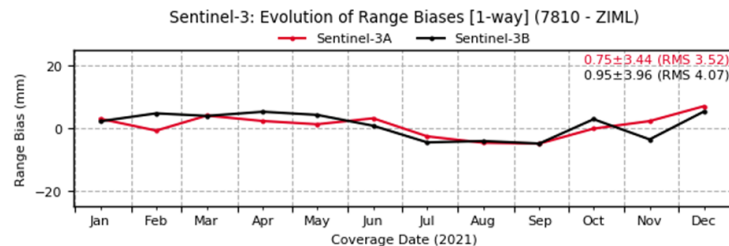
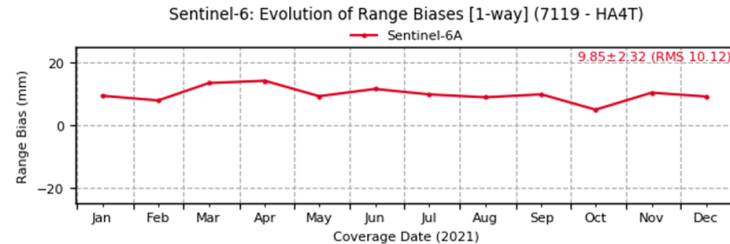
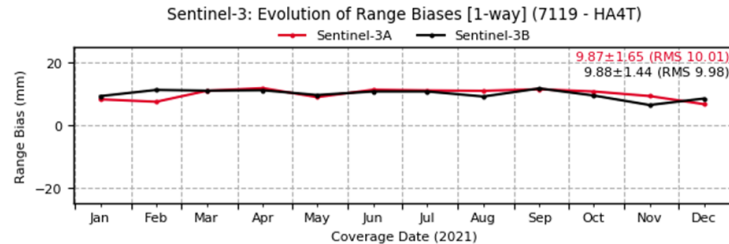
STATION BIASES



ILRS SUPPORT

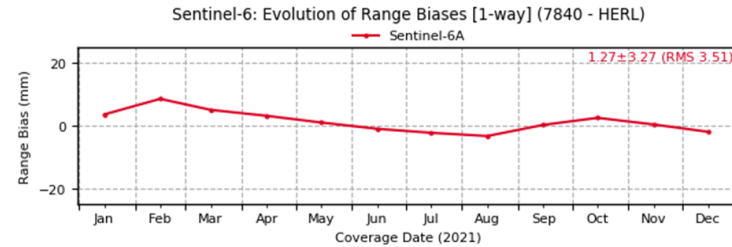
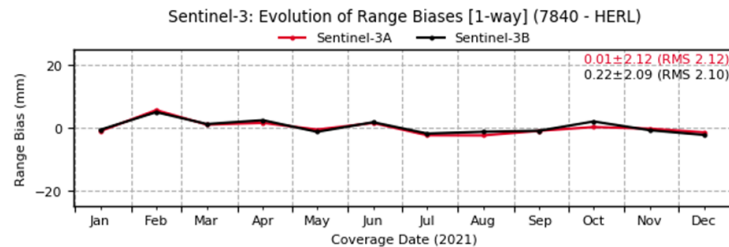
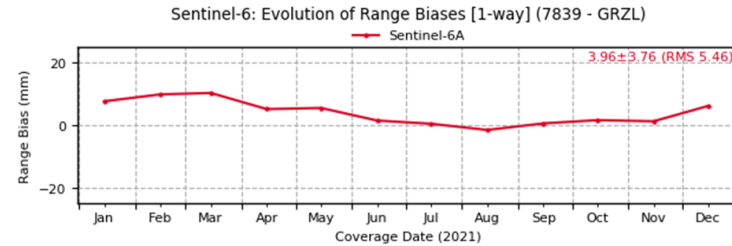
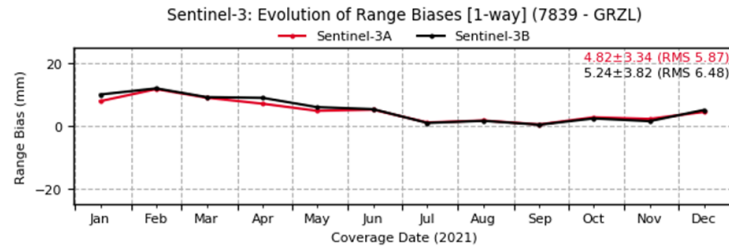
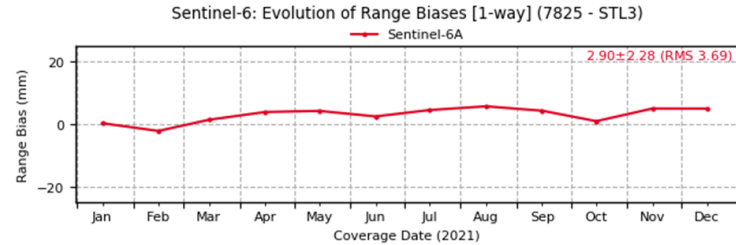
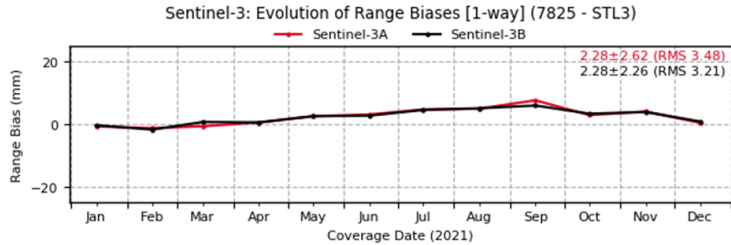
STATION BIASES

- Station range biases computed using **4 weeks** of data, and **fixing** a **combined** orbit solution, computed as a weighted mean of up to 10 different orbital solutions. An independent bias is computed **per satellite**.



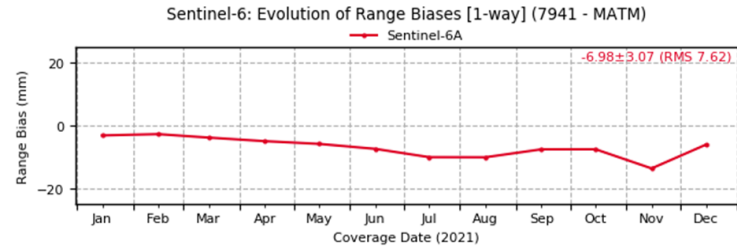
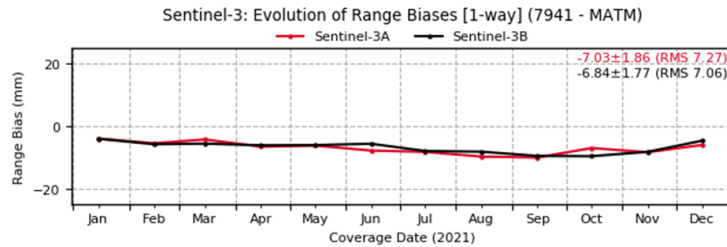
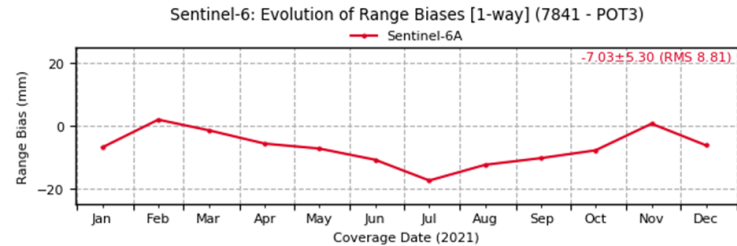
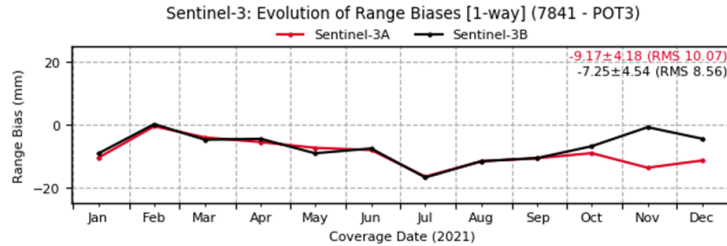
ILRS SUPPORT

STATION BIASES



ILRS SUPPORT

STATION BIASES

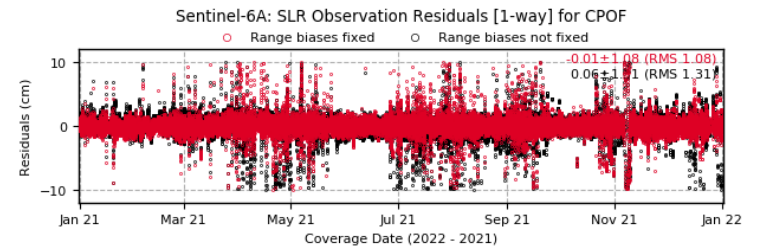
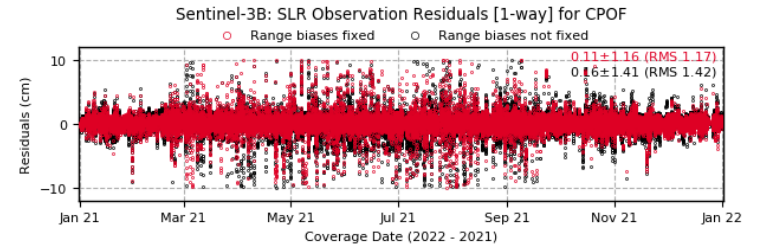
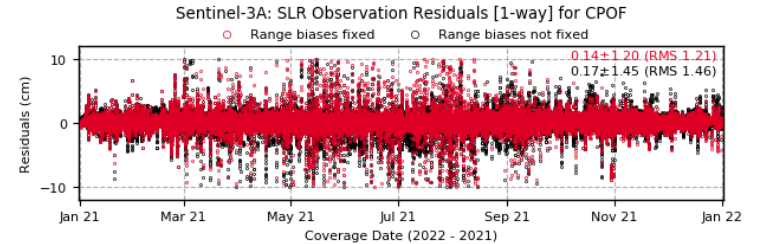
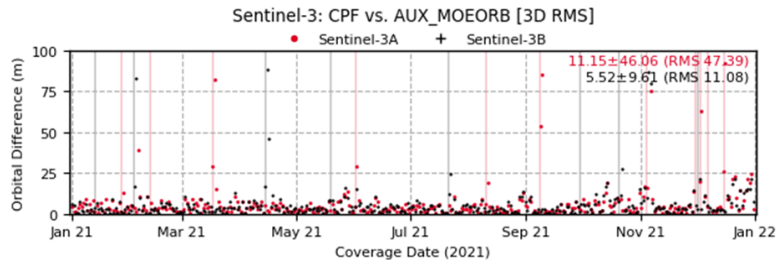


- See presentation by Daniel Arnold “Systematic errors in Satellite Laser Ranging validations of microwave-based low Earth orbiter solutions” (Tuesday @12:15) for a better approach to be adopted in the future.

ILRS SUPPORT

ORBIT ACCURACY VALIDATION

- After correcting by the estimated station range bias, the SLR residuals are recomputed and orbital accuracy statistics are derived.
- Yearly Sentinel-3 & -6 SLR reports can be found on:
 - <https://sentinels.copernicus.eu/web/sentinel/technical-guides/sentinel-3-altimetry/pod/documentation>
 - https://ilrs.gsfc.nasa.gov/missions/satellite_missions/current_missions/sn3a_general.html
- CPOD's Sentinel-3 CPF accuracy (2021):



CONCLUSIONS

CONCLUSIONS



- Sentinel-3 & -6 missions are very **important altimetry missions** that count on the invaluable support of ILRS → **Thanks for your support**

Thank you

Copernicus POD Service

Jaime Fernández (GMV)

Marc Fernández (GMV)

Heike Peter (POSITIM)

Pierre Féménias (ESA/ESRIN)

Carolina Nogueira Loddo (EUMETSAT)

