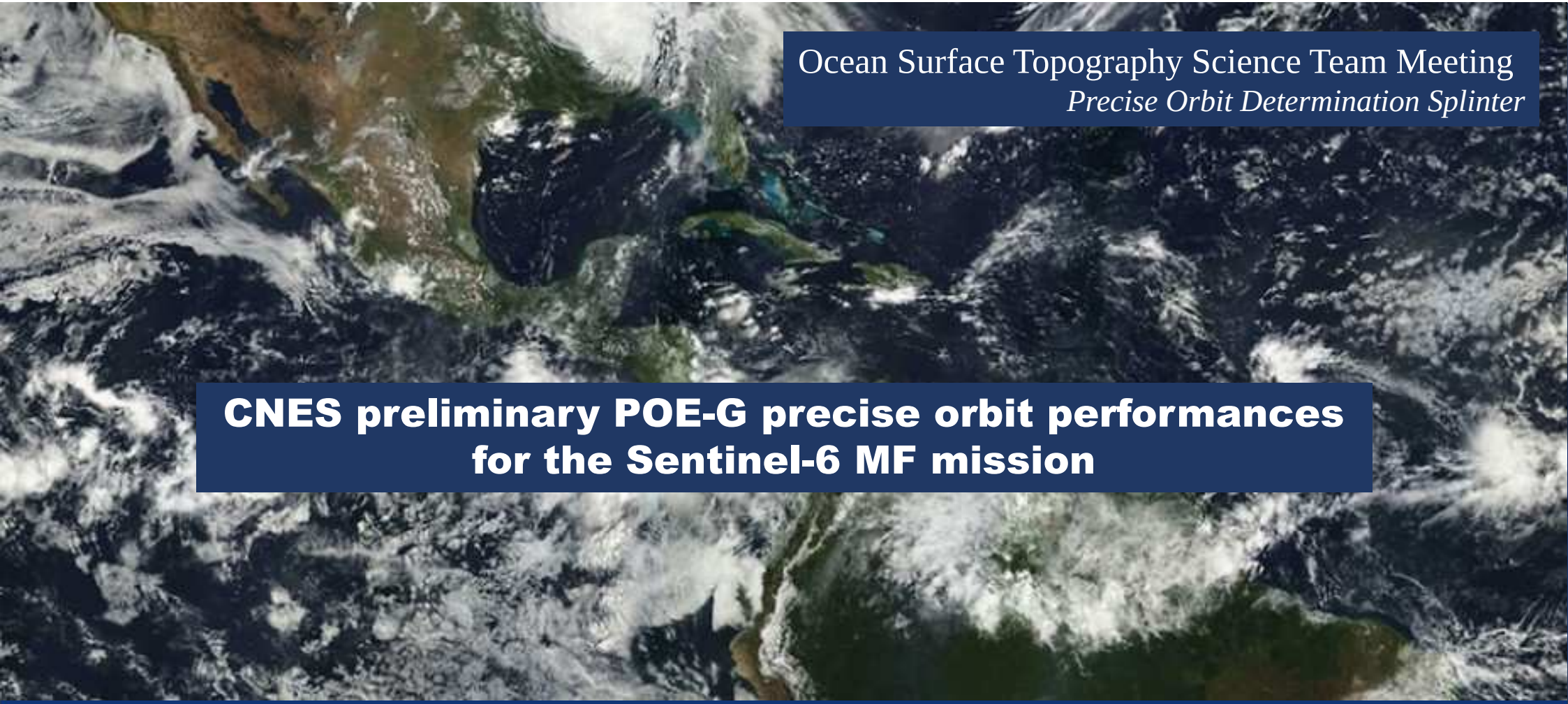


Ocean Surface Topography Science Team Meeting
Precise Orbit Determination Splinter

CNES preliminary POE-G precise orbit performances for the Sentinel-6 MF mission

J. Moyard, A. Couhert, F. Mercier, S. Houry (CNES, France)
E. Saquet, G. Katsigianni, M. Cherrier, A. Banos-Garcia (CLS, France)

08/11/2023
San Juan, PUERTO RICO

CONTENTS

POE-G STANDARD PROPOSAL

	POE-F	POE-G
Surface forces	Atmospheric model : DTM-13 for Sentinel-6A Calibrated solar radiation pressure model Knocke & Ries Earth radiation pressure model	Atmospheric model : **NRLMSIS 2.0** *Unchanged* **Earth radiation pressure model from ERA5 hourly fluxes (ECMWF climate reanalysis)**
Geopotential	EIGEN-GRGS.RL04-v1.MEAN-FIELD Non-tidal TVG: two annual, two semiannual, one bias and one drift terms for each year up to deg/ord 90 Atmospheric gravity: 3hr AOD1B RL06	**CNES_GRGS.RL05MF_combined_GRACE_SLR_MASCONS with DORIS+SLR mascons from January 1993 to March 2002** *Unchanged*

POE-G STANDARD PROPOSAL

	POE-F	POE-G
Geocenter	Full non-tidal geocenter motion derived from DORIS analysis, for DORIS/SLR/GNSS data Tidal: FES2014b ocean loading and S1-S2 atmospheric pressure loading correction	**Non-tidal annual and semi-annual geocenter motion model from ITRF2020** *Unchanged*
Loading	Ocean loading: FES2014b S1-S2 atmospheric pressure loading, implementation of Ray & Ponte (2003)	*Unchanged* **Canceled (IGS20 feedback)** **Non-tidal annual and semi-annual loading deformations from ITRF2020.**
Pole tides	Pole tide: solid Earth and ocean pole tides (Desai, 2002) Linear mean pole (UAW 2017)	*Unchanged*

POE-G STANDARD PROPOSAL

	POE-F	POE-G
GNSS constellation	GRG/IGS solution with fixed ambiguity for Sentinel-6A MF Fully consistent with IGS14	GRG/IGS **CM-based (full seasonal loading corrections)** solution with fixed ambiguity for Sentinel-6 MF Fully consistent with **IGS20** **IGS satellite attitude quaternions (ORBEX)**
DORIS system		**Relativistic corrections for the on-board frequency (periodic terms only, no drift)** **Carrier phase wind-up modeling**
Others	DORIS station coordinates in DPOD 2014 SLR station coordinates in SLRF2014	DORIS station coordinates in **ITRF2020** SLR station coordinates in **SLRF2020**
Earth Orientation Parameters	EOP 14 C04 products (PARIS Observatory) Diurnal and semidiurnal tidal variations in polar motion from Desai and Sibois (IERS 2003)	EOP **20** C04 products (PARIS Observatory) Diurnal and semidiurnal tidal variations in polar motion from Desai and Sibois (2018)

POE-G STANDARD PROPOSAL

To be integrated in the final POE-G version, evolutions associated to the processing of measurements and not the standards (dynamic/measurement models) :

- DORIS station in DPOD2020 and additional SLR stations in SLRF2020
- GNSS PCV maps based on Zernike polynomials
- Improved phase data-screening for DORIS measurements (to be confirmed)
- Improved ambiguity-fixing strategy for GNSS measurements (to be confirmed)

+ Improved SRP model (satellite-dependent)

POE-G RELATED STUDIES

Additionnal information on some studies performed for this new standard are available in the POD session (oral + forum):

"*Impact of ITRF2020 on DORIS, GNSS, and SLR observations for the CNES altimeter satellite orbits*", E. Saquet

"*Enhancing satellite orbit accuracy for sea level monitoring through Earth radiation pressure modeling*", M. Nocet-Binois

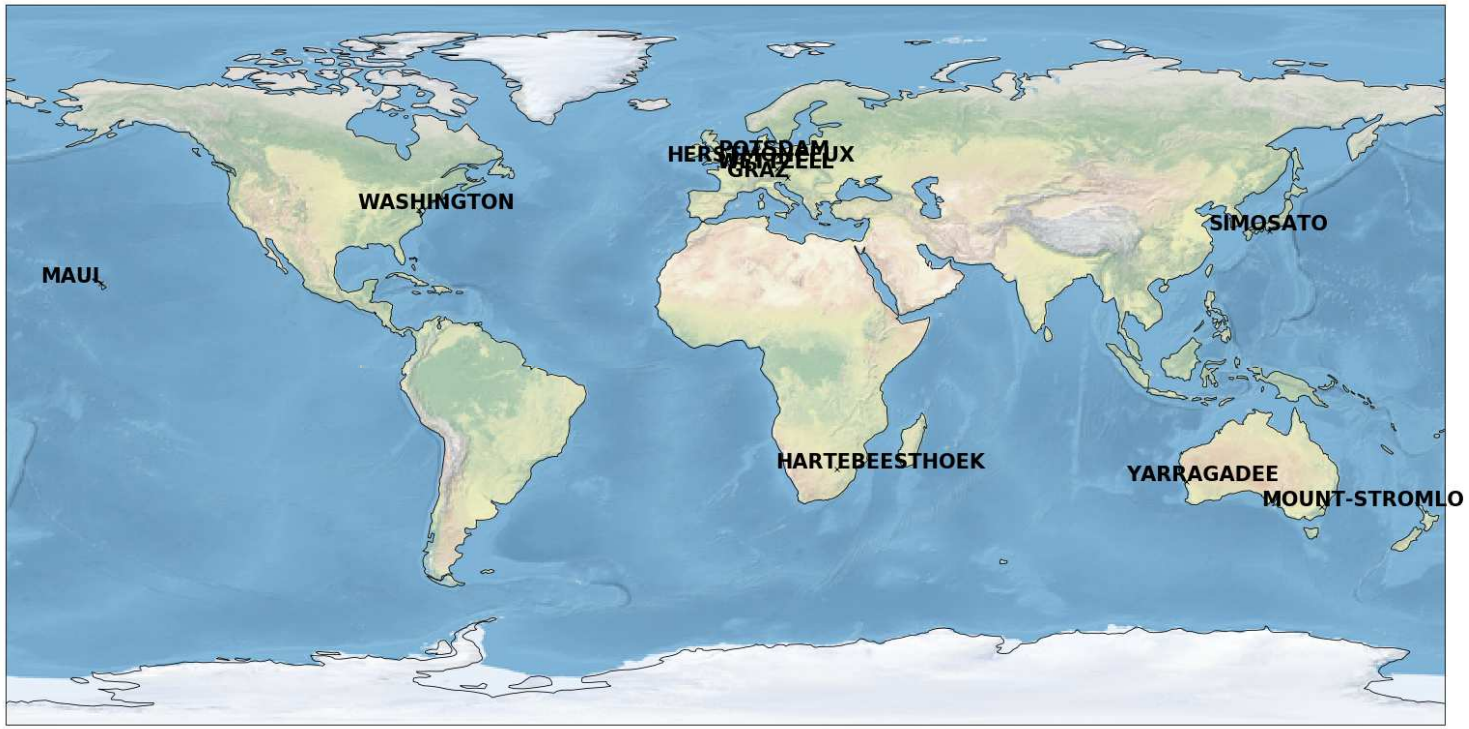
"*Introduction of 2/rev harmonics in the empirical forces model for Sentinel altimetry satellites*", G. Katsigianni

"*Assessment of Jason-3 and Sentinel-6 MF residual radiation pressure modeling errors*", M. Cherrier

"*In-flight GNSS phase map calibration modelling with Zernike polynomials*" , A. Banos Garcia

The SLR statistics of this presentation are based on a core network of 11 stations

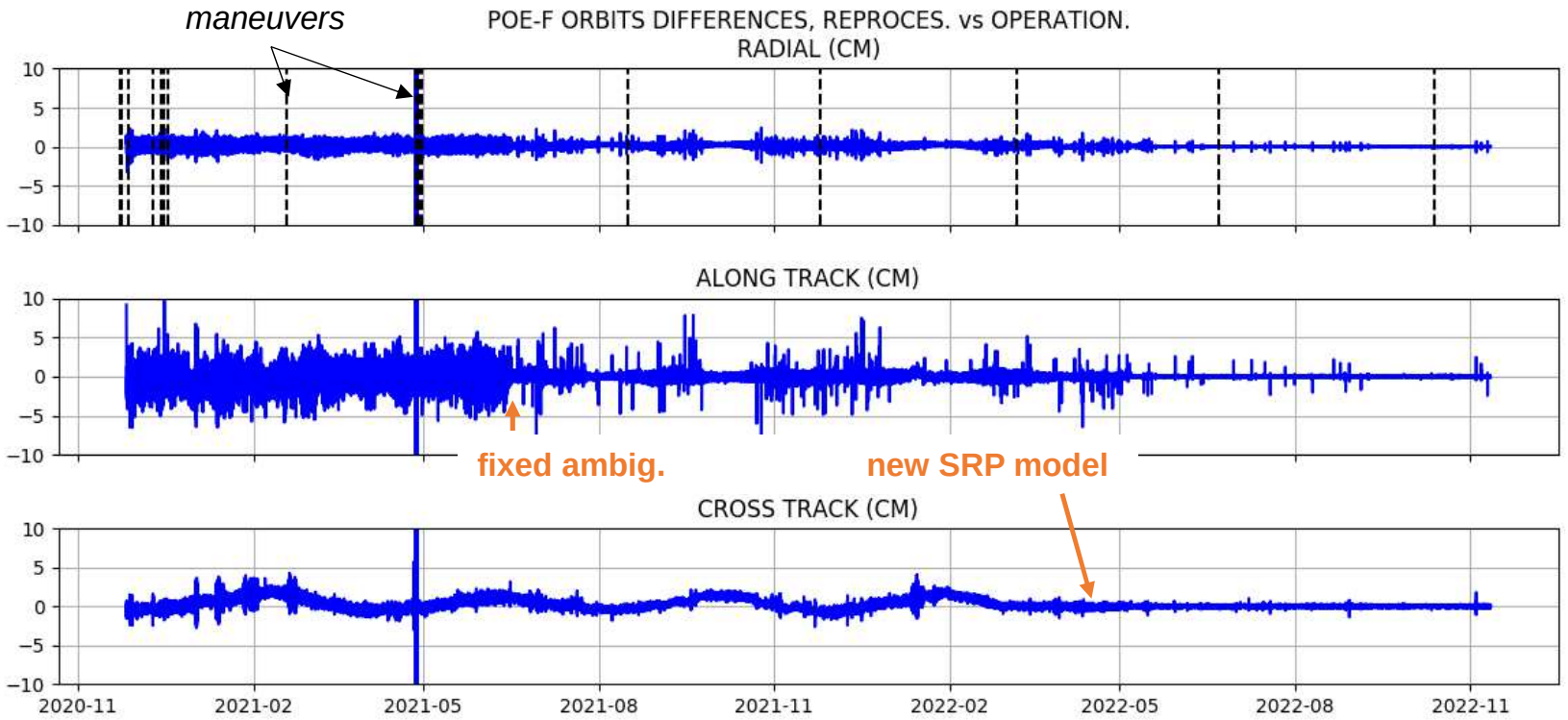
Graz Wettzell Yarragadee Washington Maui Hartebeesthoek
Mount-Stromlo Simosato Potsdam Herstmonceux



→ quite well-distributed station locations, half of them are located in Europe

SENTINEL-6 MF

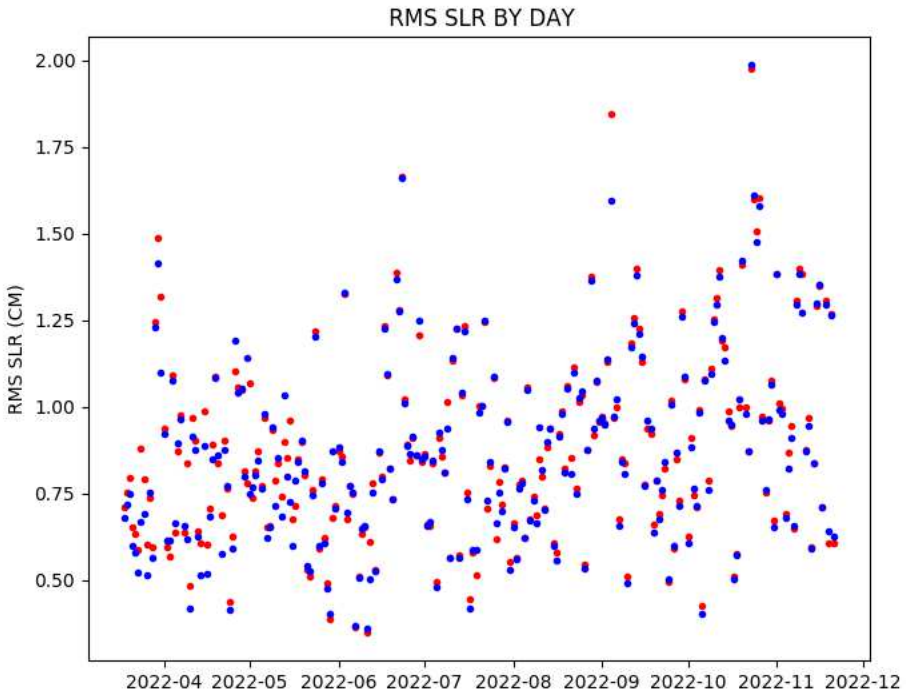
In operational context, changes have been performed since the beginning of the mission:

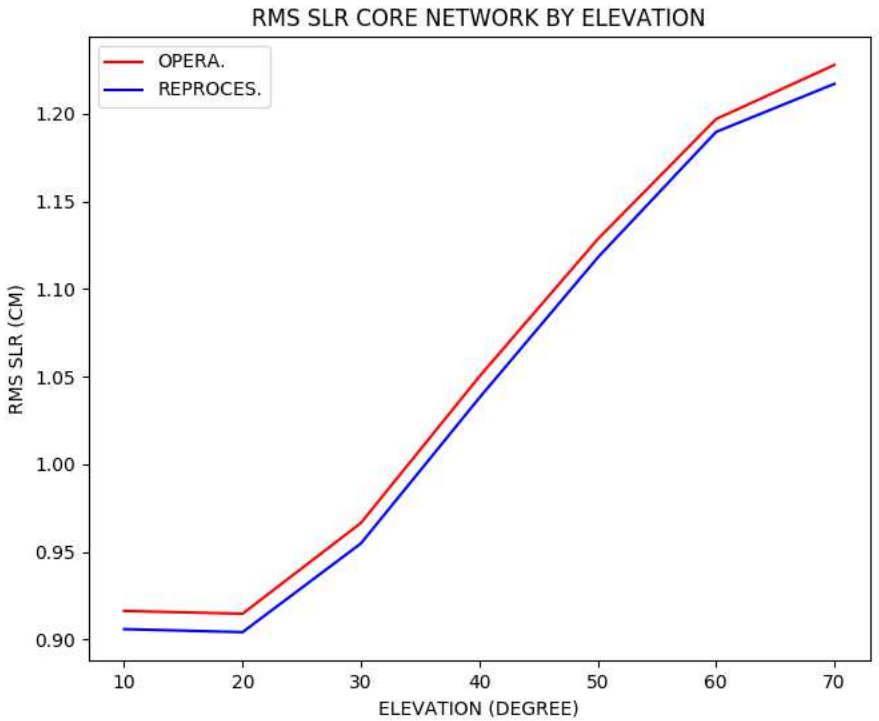


To evaluate the new POE-G standard, comparisons will be done with reprocessed POE-F orbits (and not with the operationally delivered products)

SENTINEL-6 MF

SLR statistics using the SLR core network on the final period 03/22 → 12/22 :

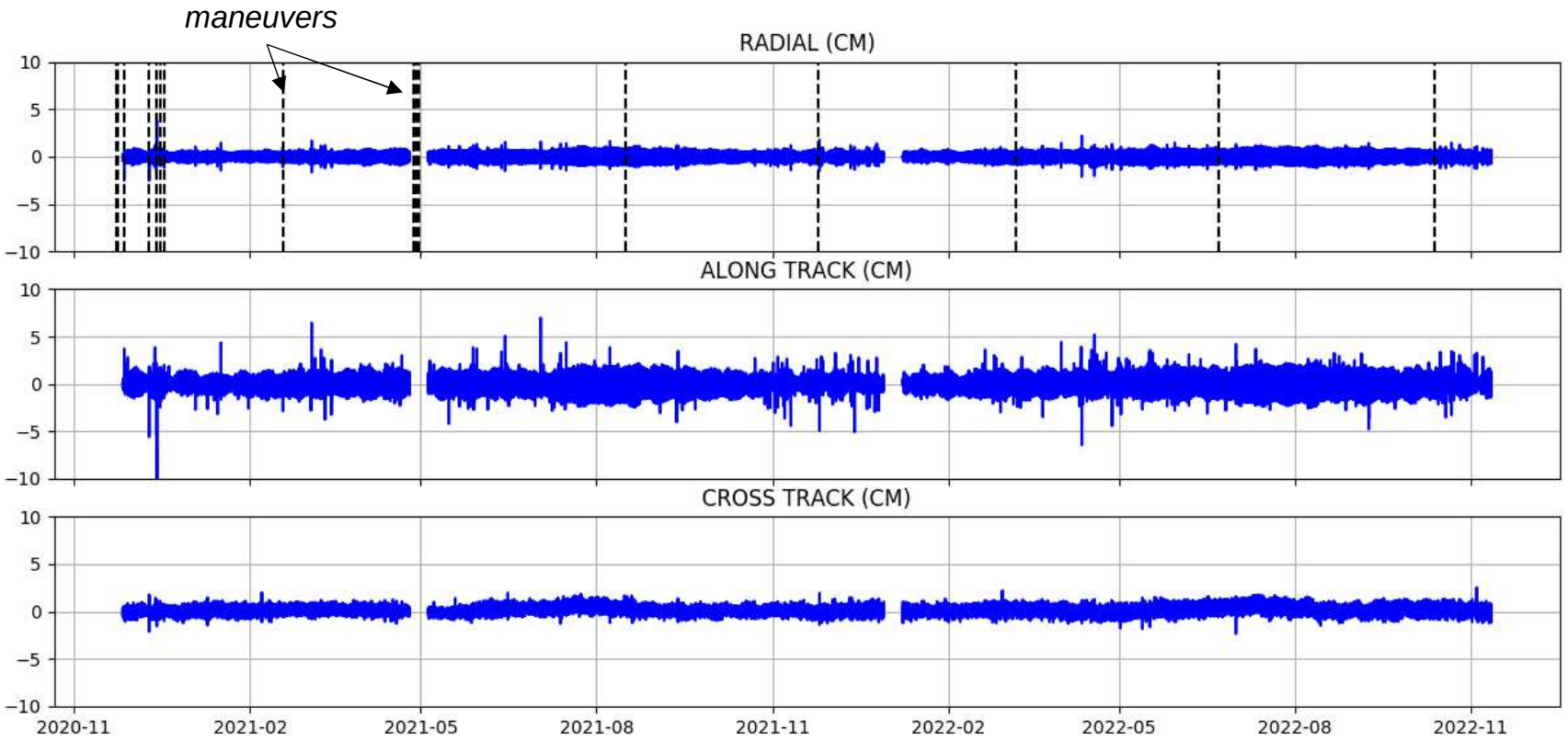




SLR performances between POE-F operational vs reprocessed are equivalent (submillimetric improvement for the reprocessed orbits)

SENTINEL-6 MF

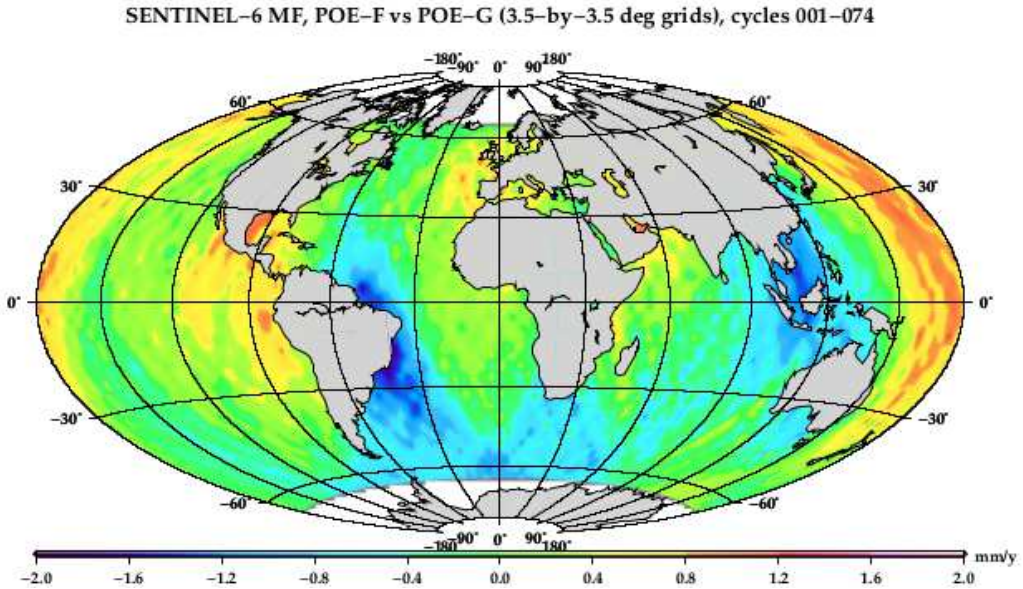
Global orbit differences POE-F vs POE-G



Less than 2 cm of maximal orbit differences in the radial direction

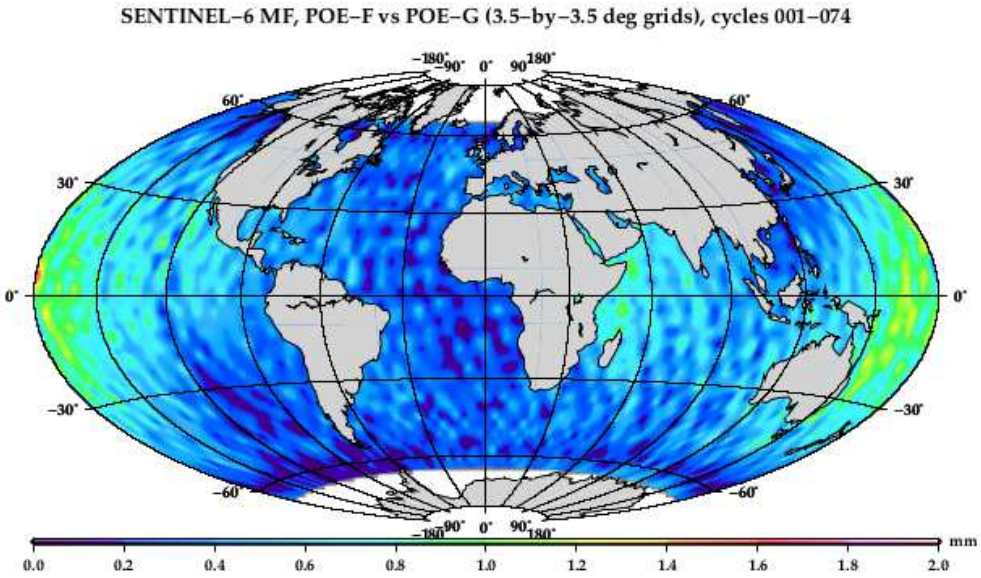
SENTINEL-6 MF

Regional orbit differences POE-F vs POE-G, geographically correlated errors



-2 ⟷ 2mm/y

drift amplitude



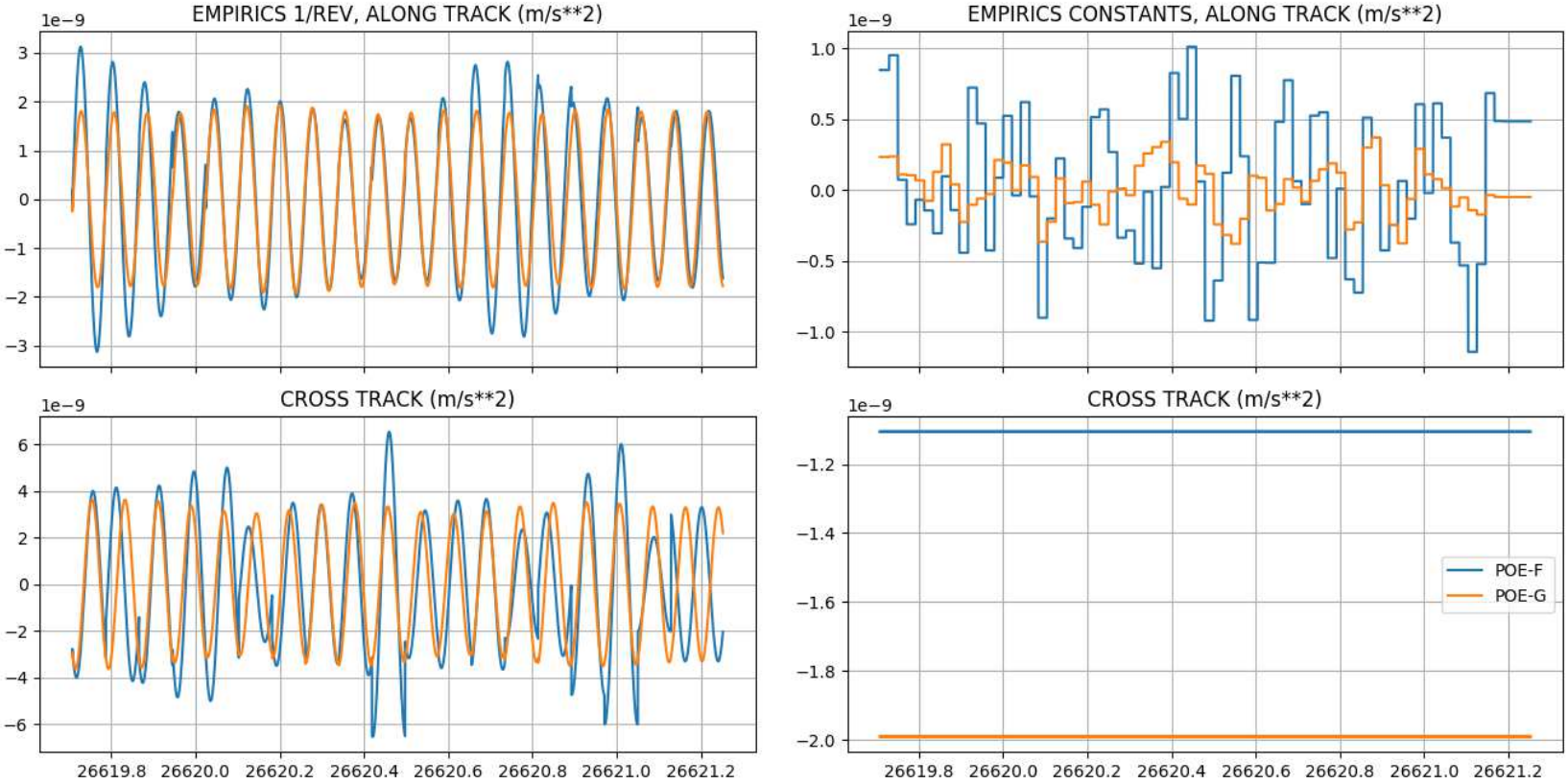
0. ⟷ 2mm

annual amplitude

Despite a quite short period to realize such comparisons, ~2 years, some patterns are observed, with a difficult interpretation (geocenter motion? gravity field ?)

SENTINEL-6 MF

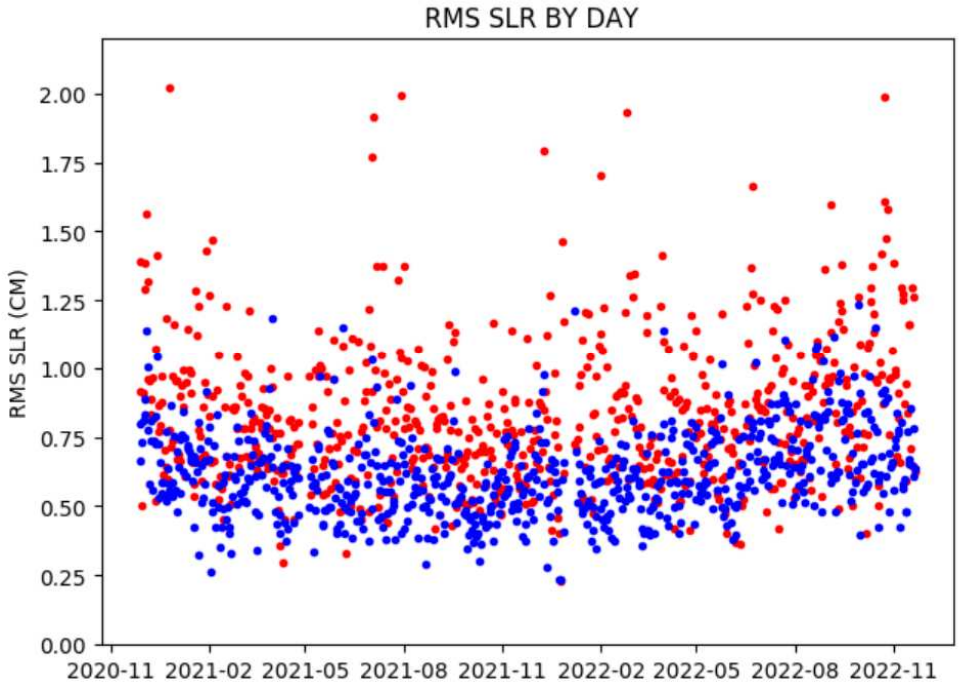
Empirical acceleration comparisons POE-F vs POE-G over one day arc :

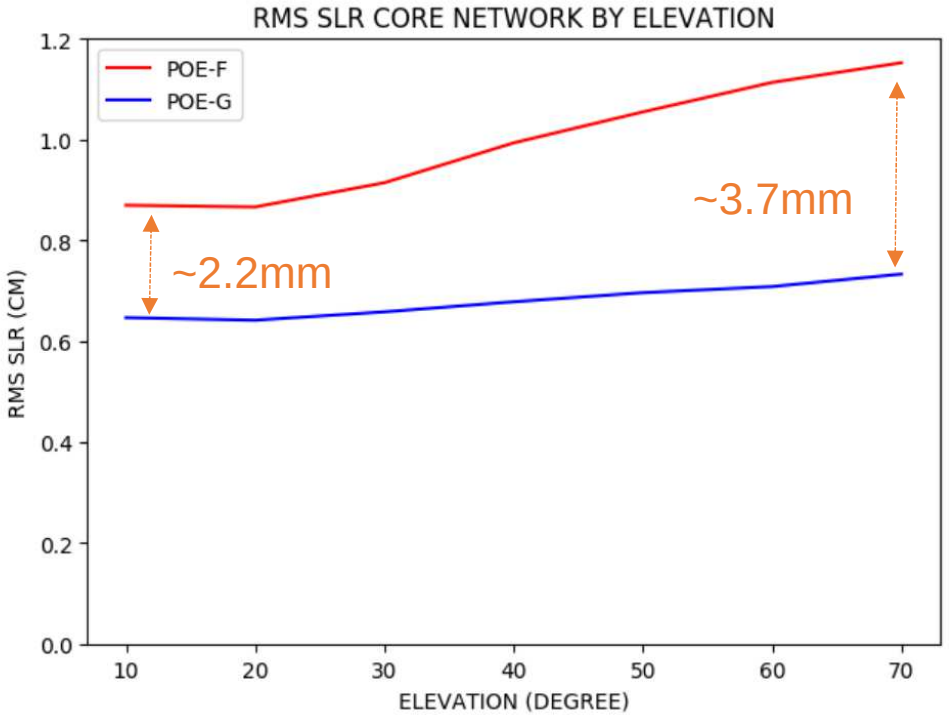


Except for the cross-track bias, an improvement is obtained for all empirical accelerations

SENTINEL-6 MF

CN SLR RMS, comparisons POE-F vs POEG

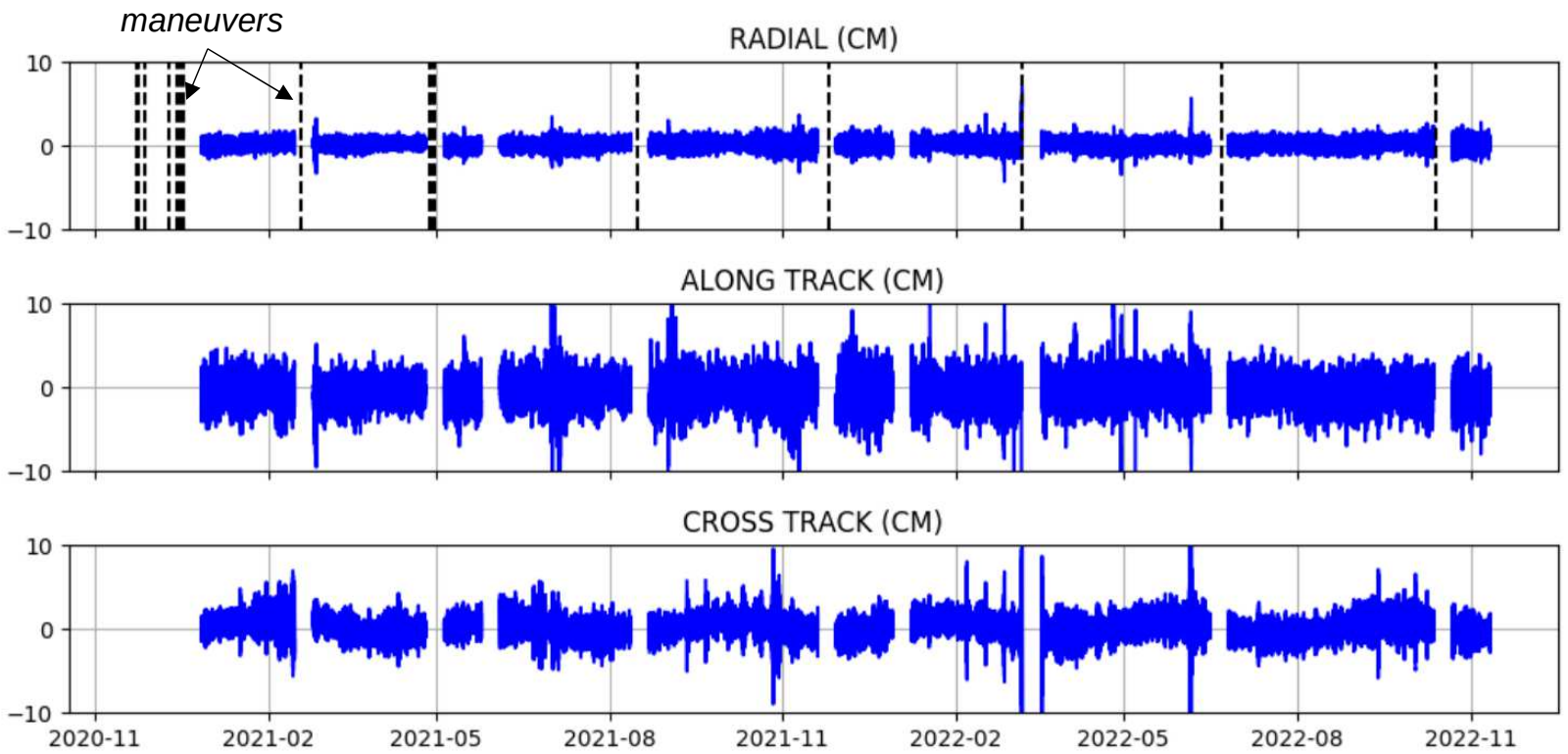




A small part of the SLR improvement could be associated to the SLR station coordinate improvements brought by ITRF2020

GSFC

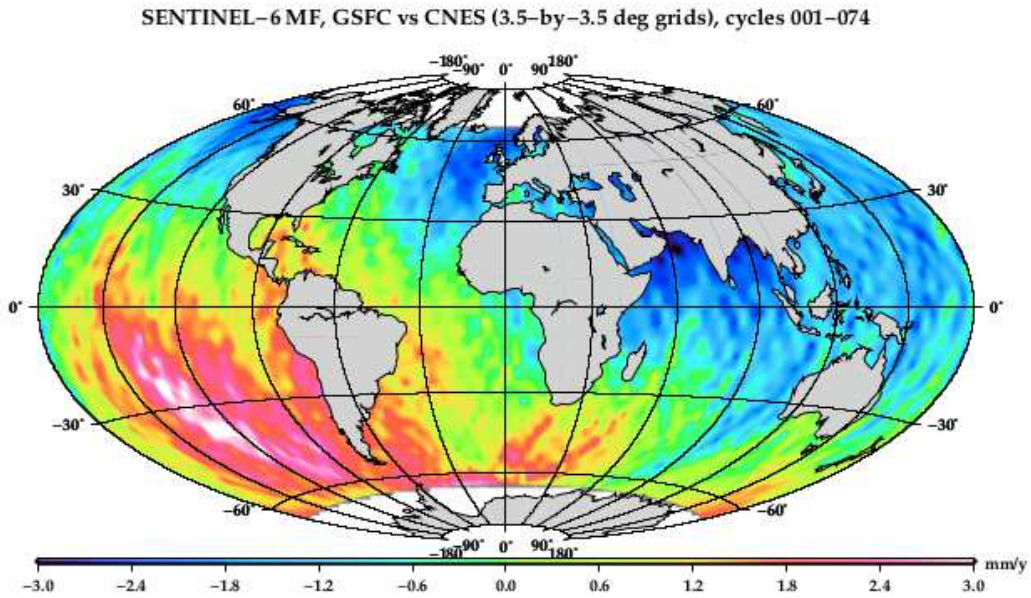
Global orbit differences between GSFC STD006 CS21 vs CNES POE-G :



Except for some spikes, the orbit differences are less than 2 cm in the radial component
The normal signature, ~118 days, could be associated to differences in SRP modeling

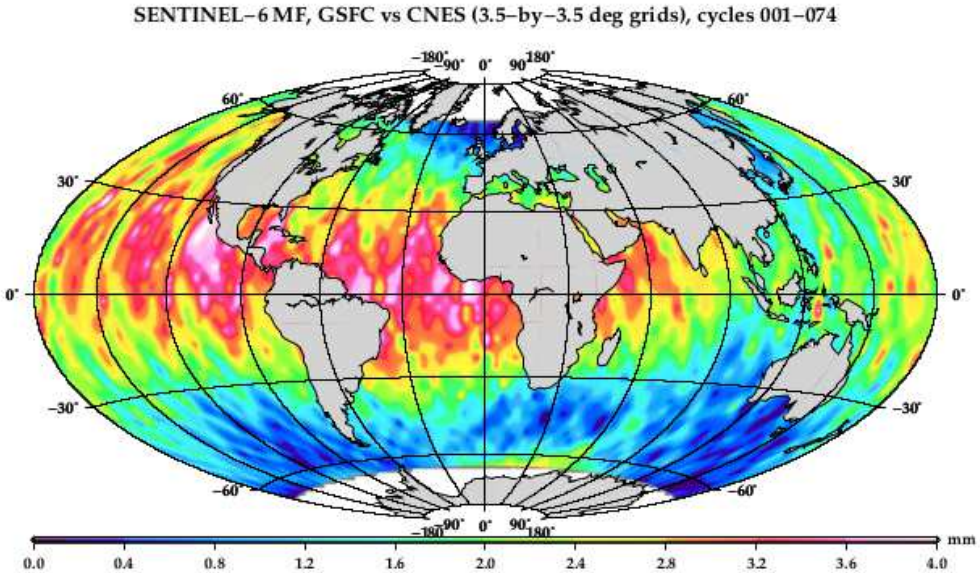
GSFC

Regional orbit differences GSFC vs CNES, geographically correlated errors



-3 ⟷ 3mm/y

drift amplitude



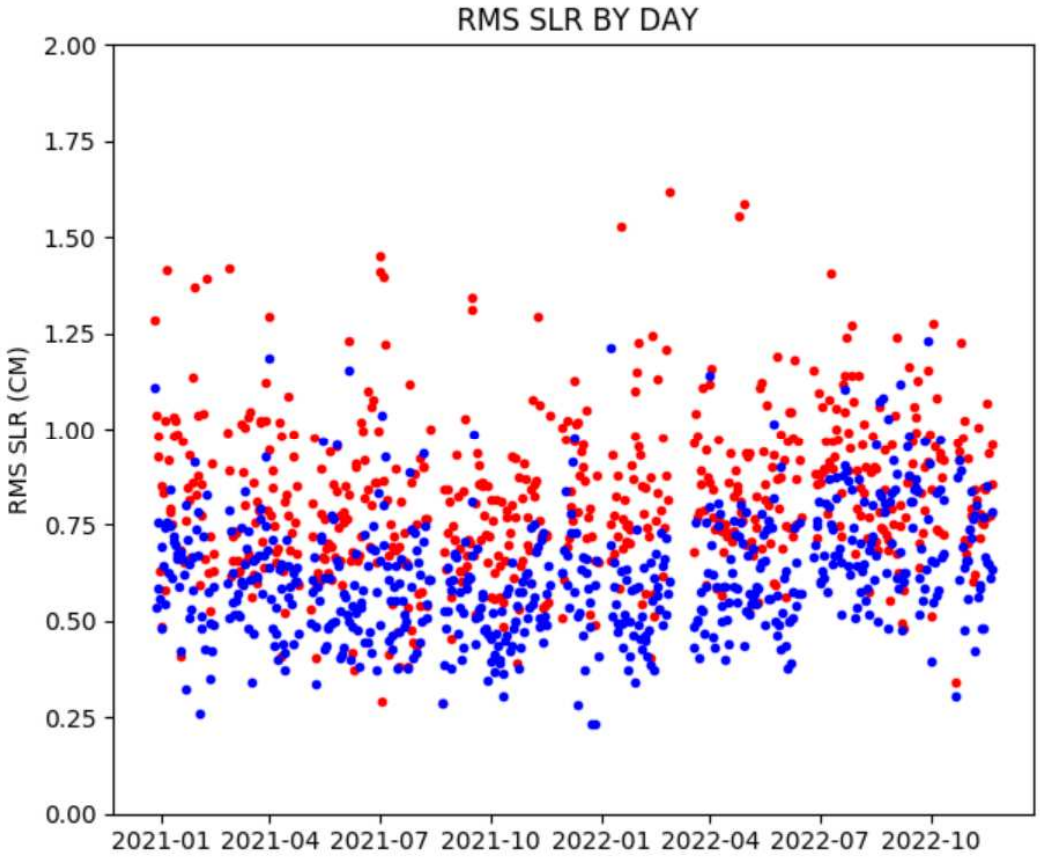
0. ⟷ 2mm

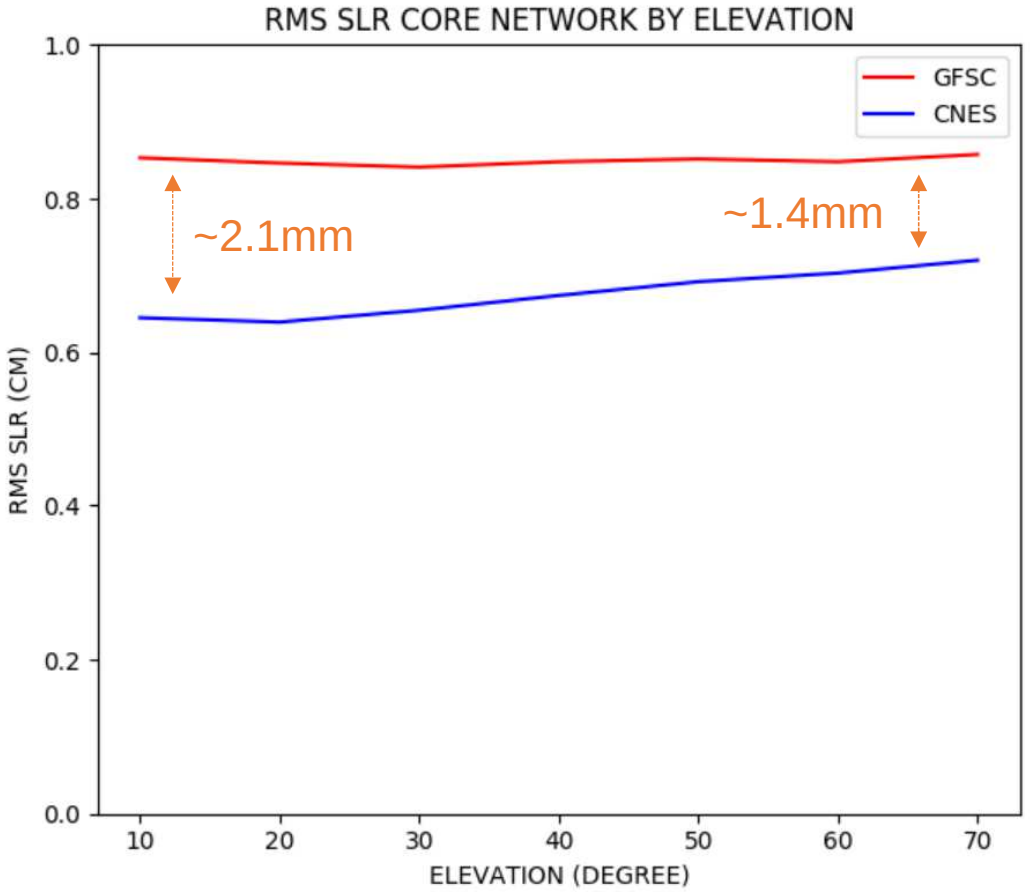
annual amplitude

Despite a quite short period to realize such comparisons, ~2 years, some patterns are observed : North-south and equatorial patterns for the drift and annual amplitude, respectively

GSFC

SLR RMS, comparisons between GSFC vs CNES





CONCLUSION

Preliminary POE-G standard shows interesting improvements for SENTINEL-6 MF

A few evolutions should complete this standard, with expected small impacts

Final validations should be performed

CNES POE-G SENTINEL-6 MF and GSFC STD006 CS21 orbits are closed in the radial direction (0.7 cm vs 0.9 cm)

… THANK YOU FOR YOUR ATTENTION , ANY QUESTIONS ? …