Brief POD Status on Jason-3 and Sentinel-3A

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IDS AWG – May 26-27, 2016
TU Delft, The Netherlands

Two New DORIS Missions

- Jason-3 (launched on January 17, 2016)
  - DORIS-only MOE since January 19, 2016

- Sentinel-3A (launched on February 16, 2016)
  - DORIS-only MOE since February 21, 2016

- For both missions, MOEs (DORIS-only) and POEs (DORIS+GPS) are GDR-E reduced-dynamic solutions

- POEs are routinely delivered to the IDS community

Jason-3

Jason-3 Satellite

- Same as Jason-2 except for the DORIS antenna position

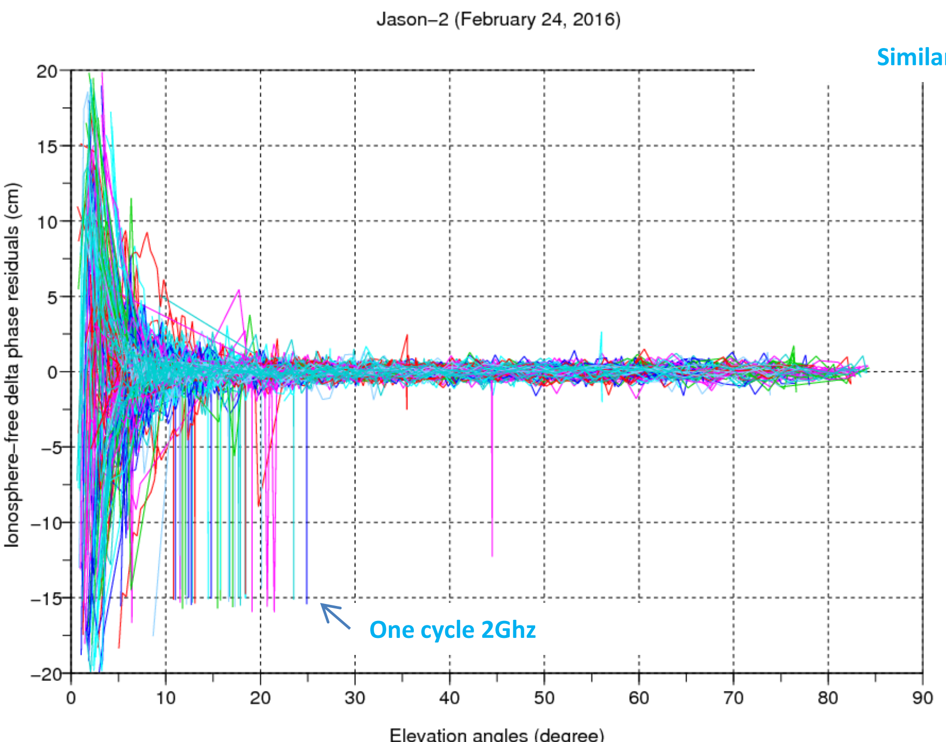
- Macromodel
  - Based on project team inputs (spacecraft body part), also used on Jason-2 (good performances)
  - GDR-E in-flight calibrated (Jason-2) solar array SRP model
  - Available atftp://ftp.ids-doris.org/pub/ids/satellites/DORISSatelliteModels.pdf

DORIS Receiver Performance

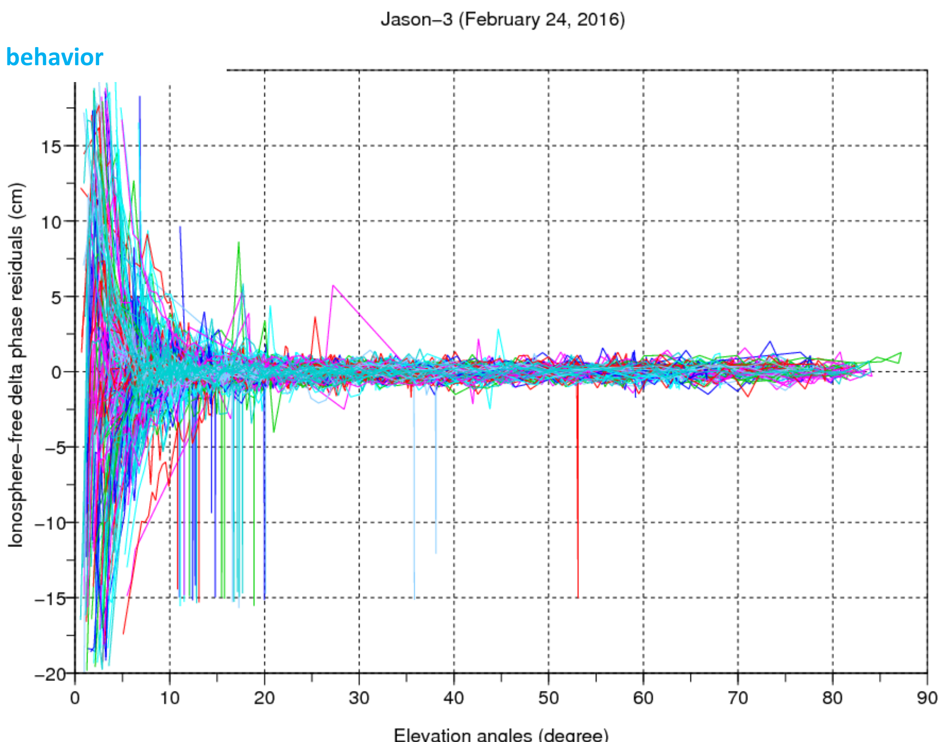
Ionosphere-free Doppler residuals

Jason-2:
Final RMS residuals: ~0.42 mm/s

Jason-3:
Final RMS residuals: ~0.45-0.46 mm/s

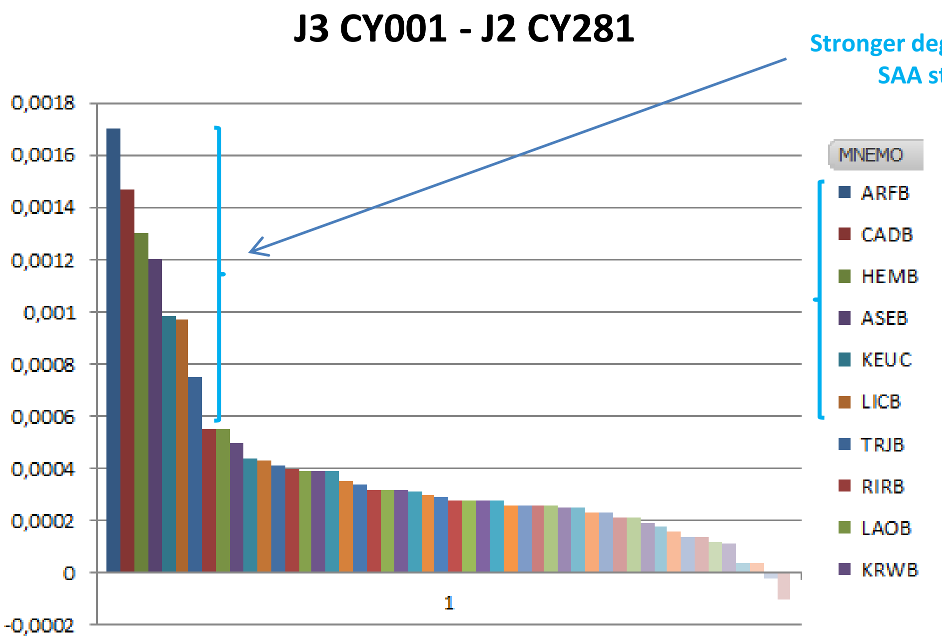


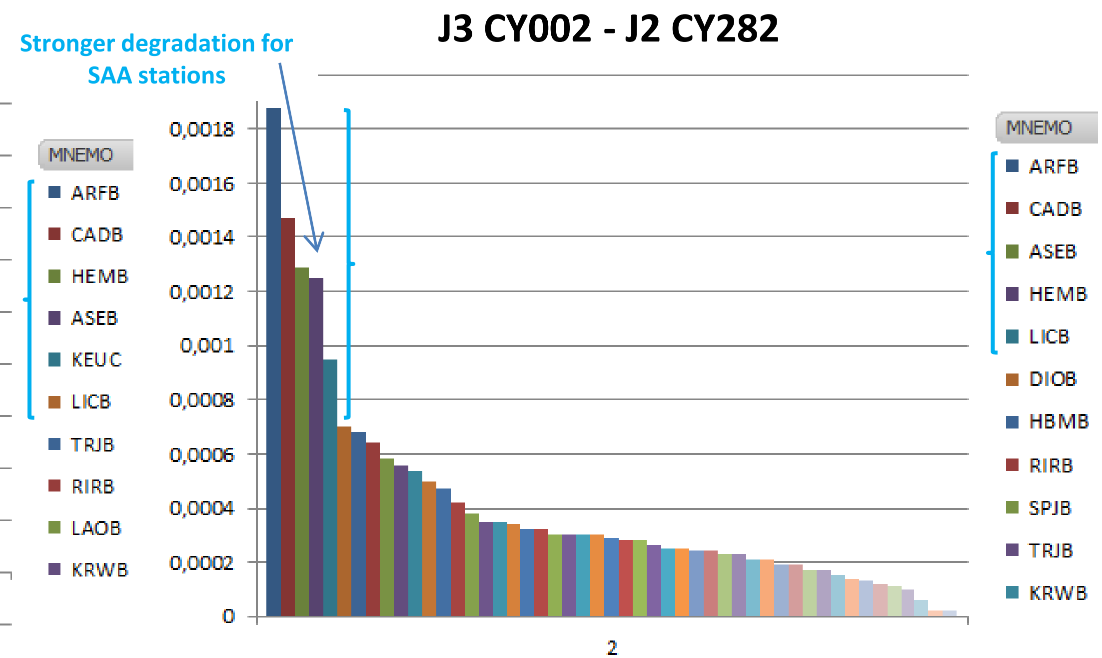
Similar behavior



DORIS Receiver Performance

RMS residual differences per station between Jason-3 and Jason-2

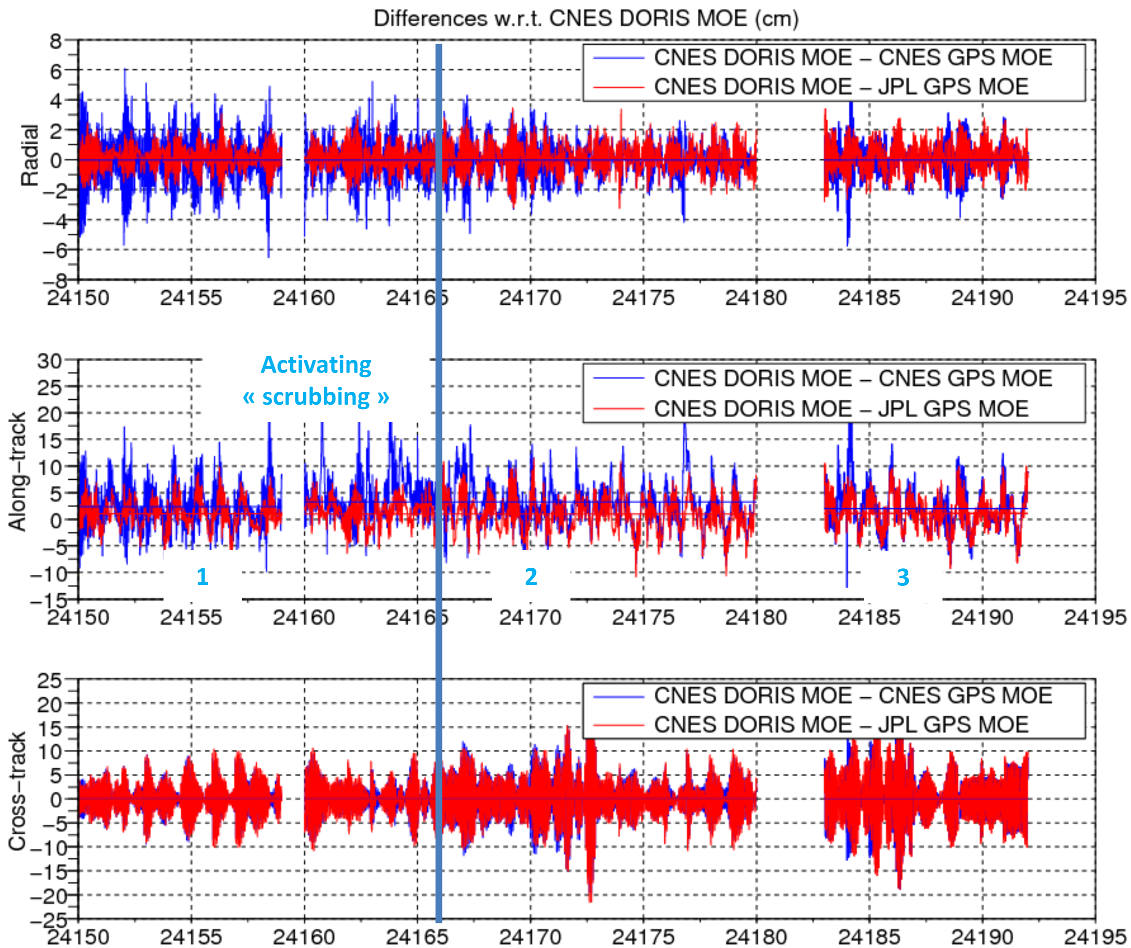




RMS differences with positive sign indicate higher RMS values for Jason-3

MOE Orbits

Comparisons between CNES and JPL GPS-based MOEs w.r.t. CNES DORIS-only MOE



Radial RMS differences:
1: 1.8cm/0.8cm,
2: 1.3cm/0.9cm,
3: 1.1cm/1.0cm

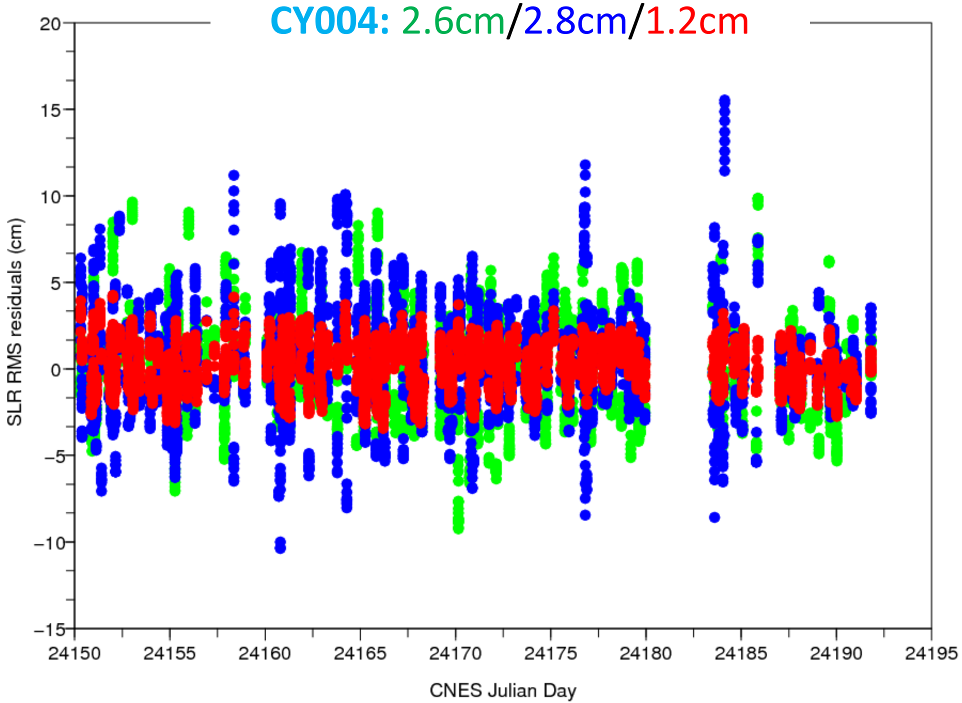
Along-track mean differences:
1: 2.4cm/1.0cm,
2: 3.2cm/1.0cm,
3: 2.0cm/1.2cm

MOE Orbits

Independent SLR RMS residuals for daily MOE arcs (DORIS-only, GPS-based, JPL orbits)

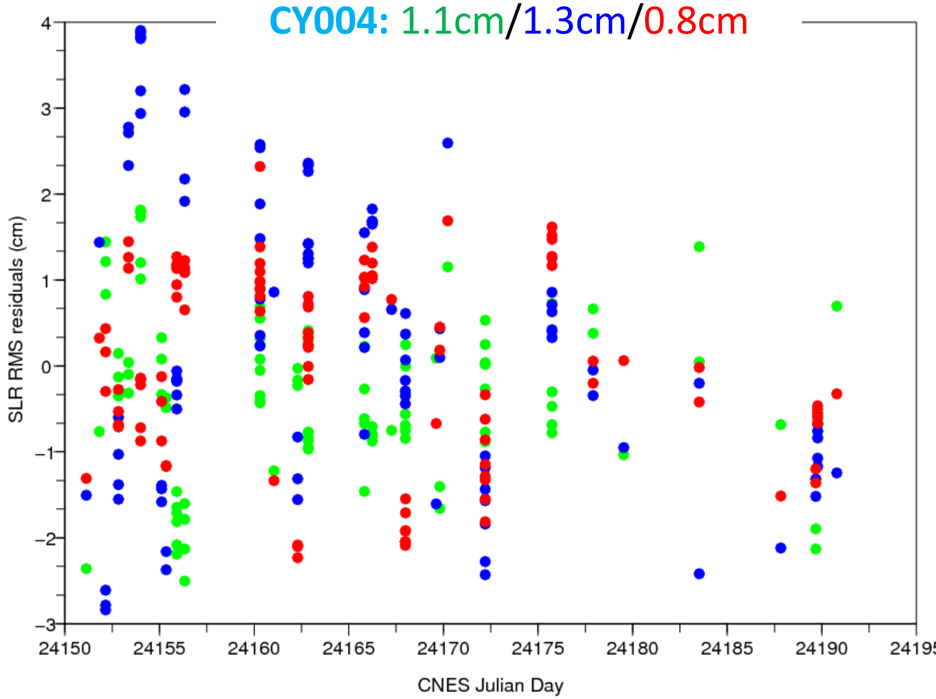
All elevations:

CY000: 2.7cm/2.9cm/1.6cm,
CY001: 2.6cm/3.3cm/1.5cm,
CY002: 2.9cm/3.1cm/1.4cm
CY003: 2.4cm/2.4cm/1.1cm,
CY004: 2.6cm/2.8cm/1.2cm



High elevations:

CY000: 0.9cm/2.1cm/0.8cm,
CY001: 1.2cm/2.0cm/1.1cm,
CY002: 0.7cm/1.3cm/1.3cm,
CY003: 0.6cm/0.6cm/1.2cm,
CY004: 1.1cm/1.3cm/0.8cm

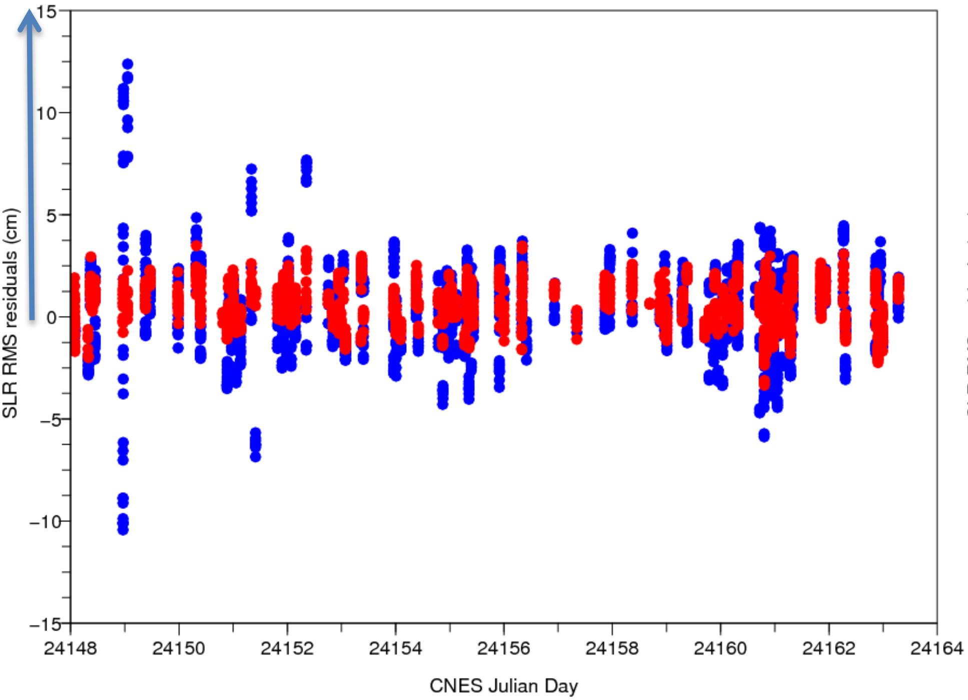


POE Orbits

Independent SLR RMS residuals for POE arcs (DORIS+GPS orbits)

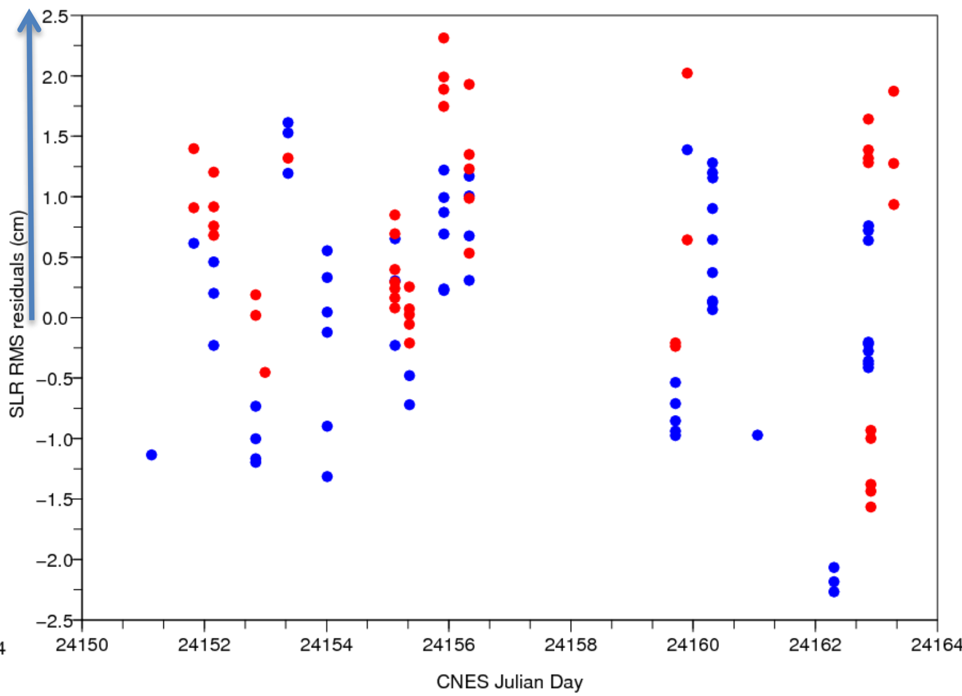
All elevations:
CY000: 2.9cm/1.2cm
CY001: 1.9cm/1.2cm

15 cm



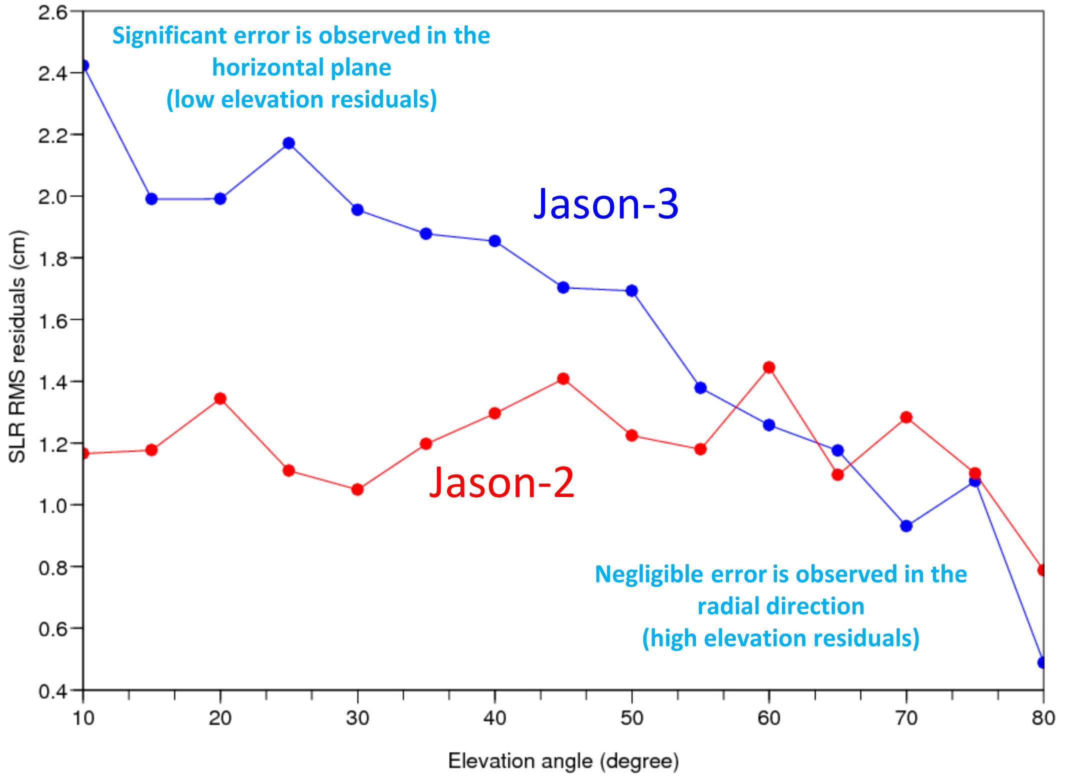
High elevations:
CY000: 1.0cm/0.9cm
CY001: 0.9cm/1.2cm

2.5 cm



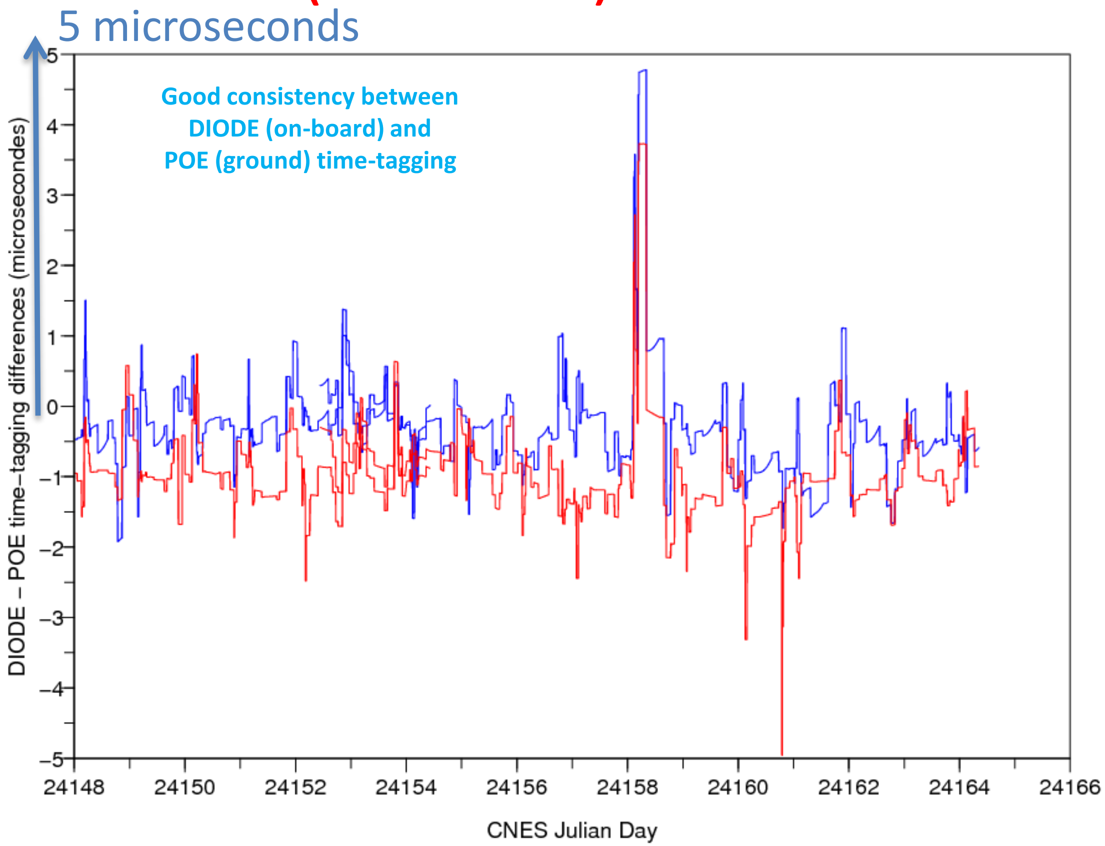
POE Orbits

Independent SLR RMS residuals for POE arcs (DORIS+GPS orbits) over 5°elevation bin, *similar performances with GSFC DORIS+SLR orbits (high elevations)*



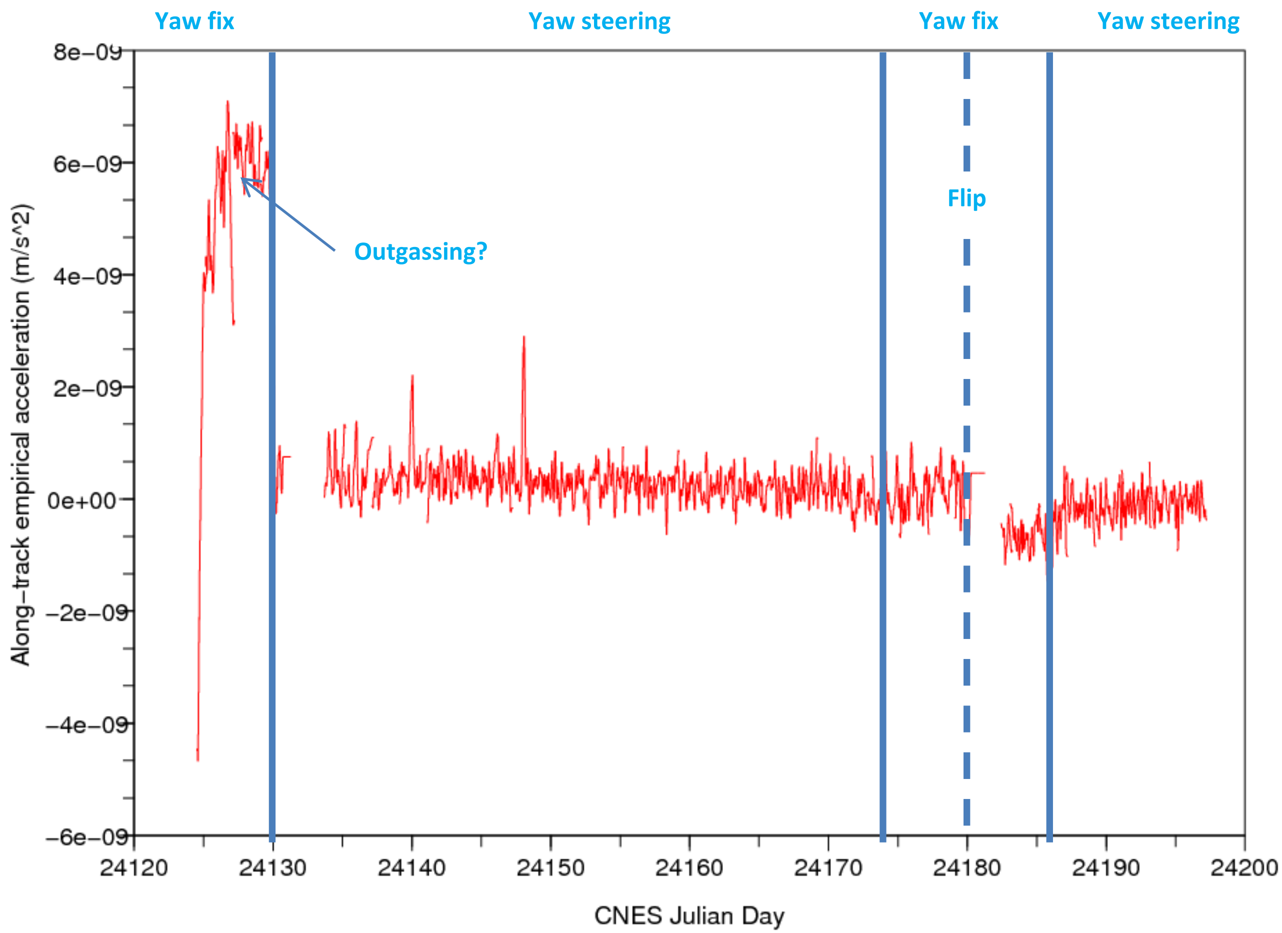
Time-Tagging Performance

DIODE–POE time-tagging differences for J3 CY000 (J2 CY280) and J3 CY001 (J2 CY281)



Empirical Accelerations

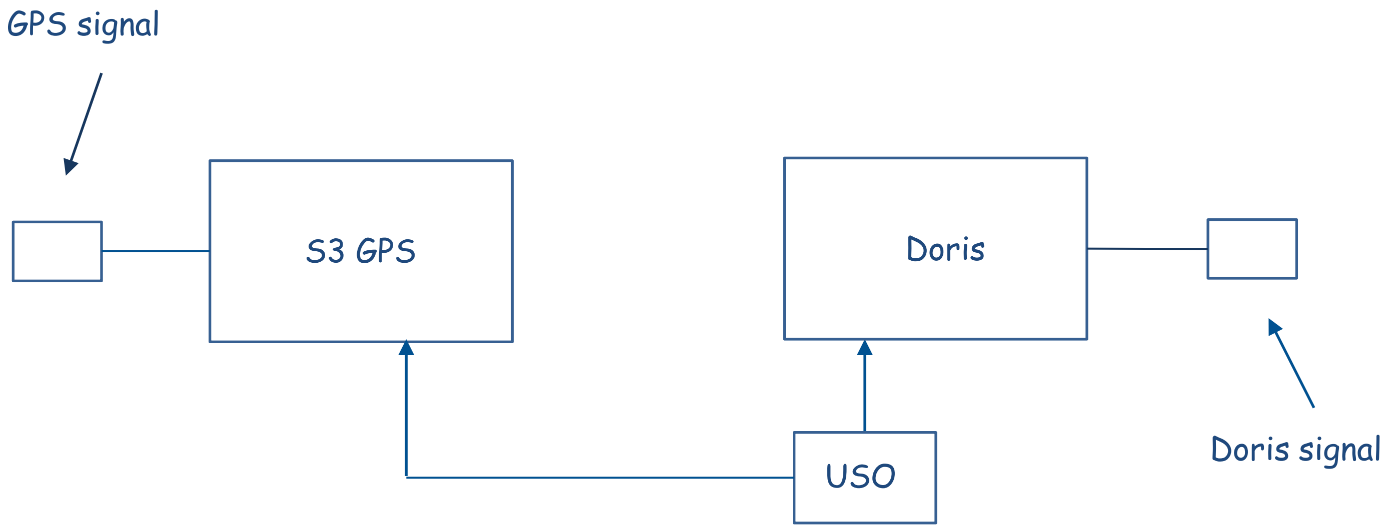
Amplitude of 30-minute along-track accelerations



Sentinel-3A

Configuration

The frequency reference for the GNSS receiver is externally provided by the Doris USO



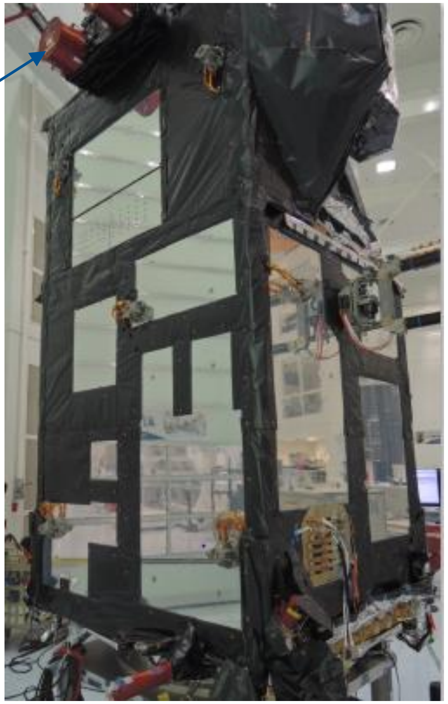
Allows USO monitoring by GNSS for the altimetry

SRP model

Construction of a pre-launch model using the documentation
- 6 elements box and solar array wing
- (black MLI, some radiator surfaces on +Y,-Y,-Z)

Photos are available to verify the surfaces and configurations

GNSS antennas



-Zs and Ys surfaces

flight direction -Xs

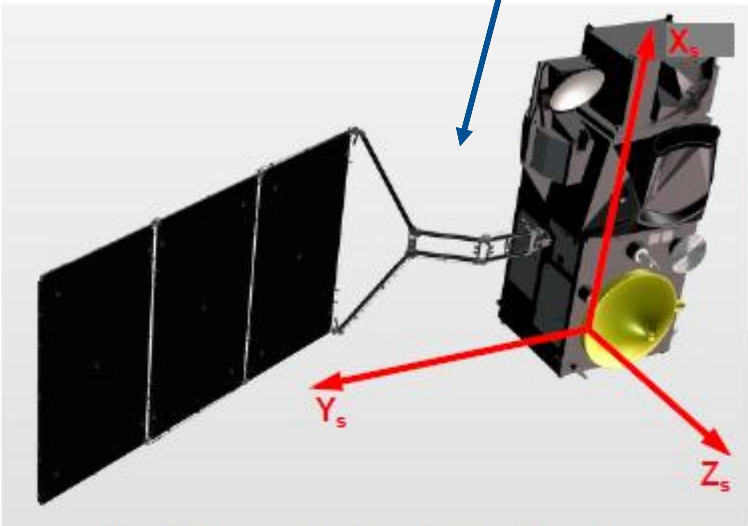


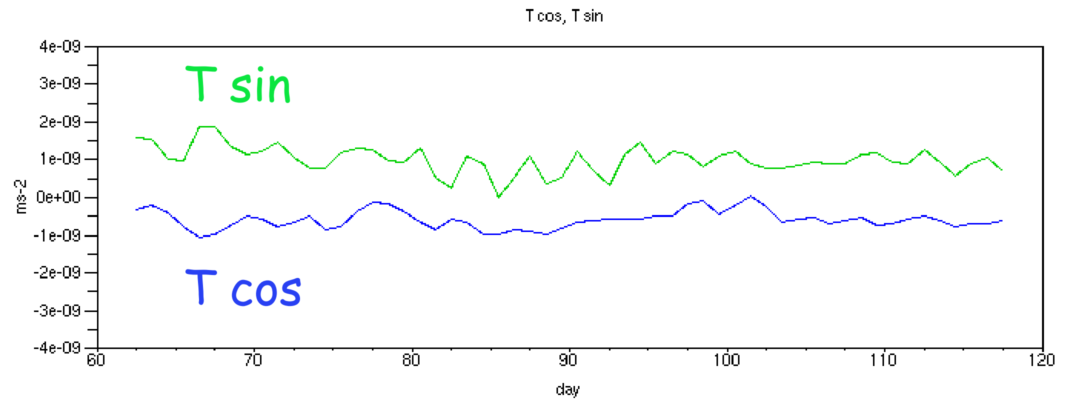
Figure 3-3 : Sentinel-3 in flight configuration and satellite reference axes

Empirical 1/rev analysis (NTC red. dyn.)

T sin : maybe due to the SRP model
10-9 ms-2 is a few %
of the total force

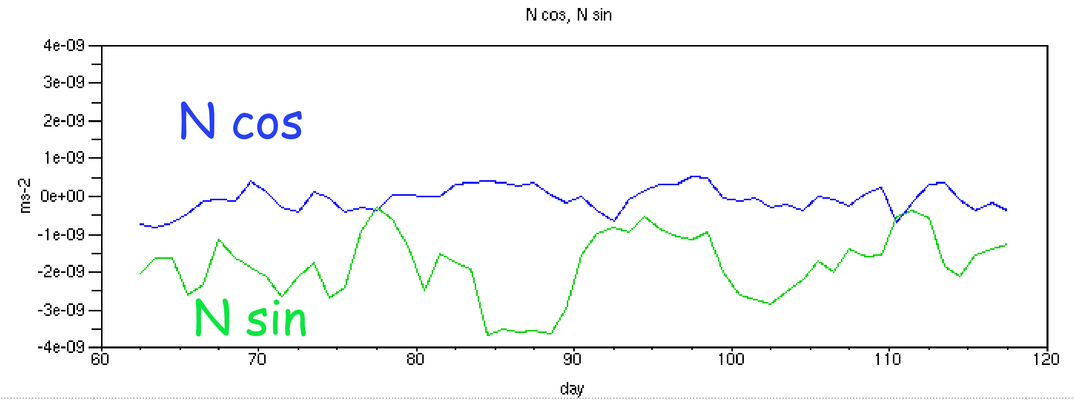
T cos : dissymmetry, difficult to
produce with a SRP model

contribution of the Drag ?



N sin : not explained, very variable
rapid sub daily variations

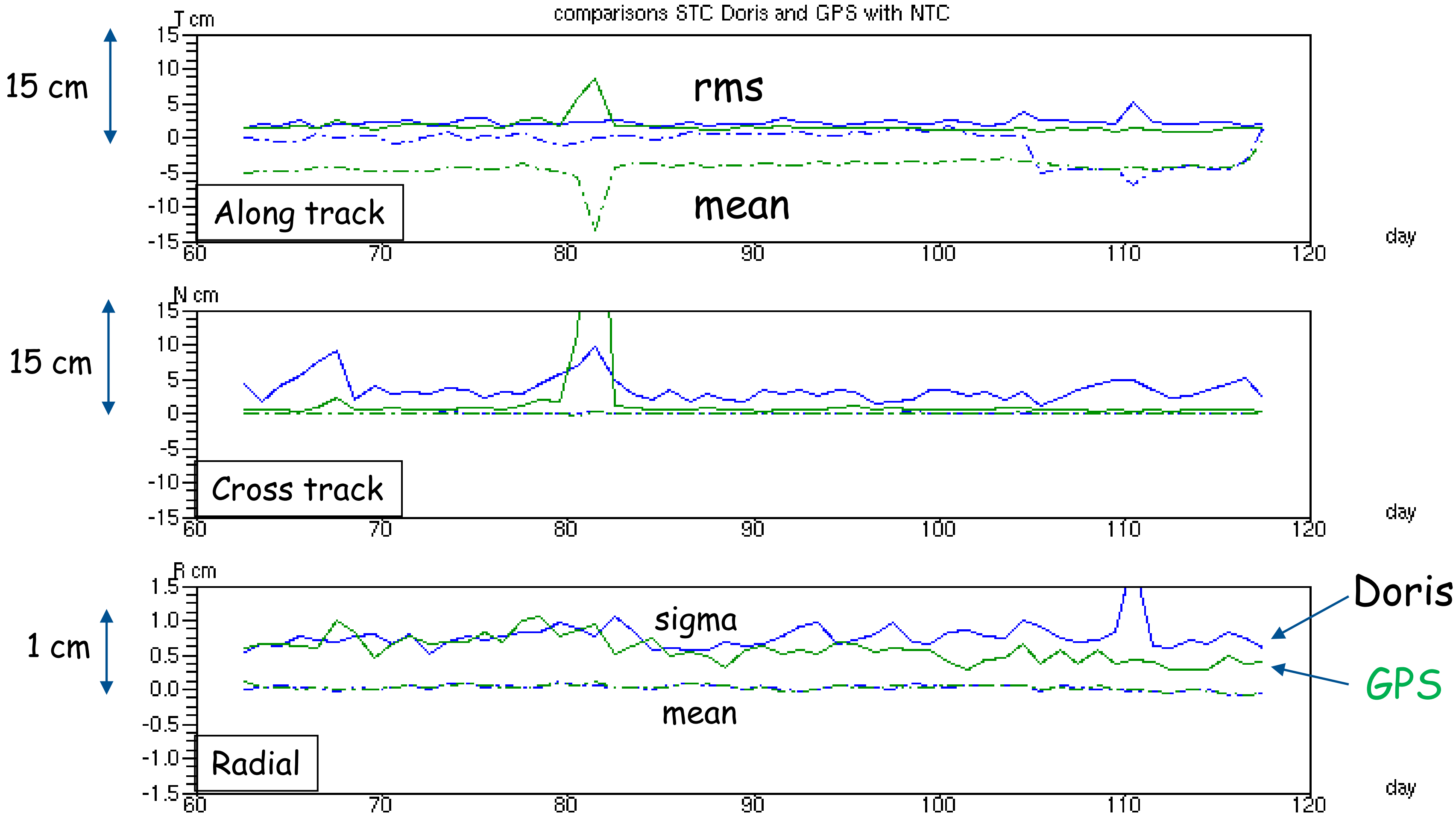
N cos : close to 0, SRP model is
correct (eclipse modulation)
very small amplitude



Also there is an important adjusted bias in the normal direction for the GNS center of phase
~2.5 cm -- > 2.5 10-8 ms-2, ten times the observed 1/rev periodic terms …

The SRP model is OK (available at IDS), normalization coefficient 1.0

Comparisons STC - NTC

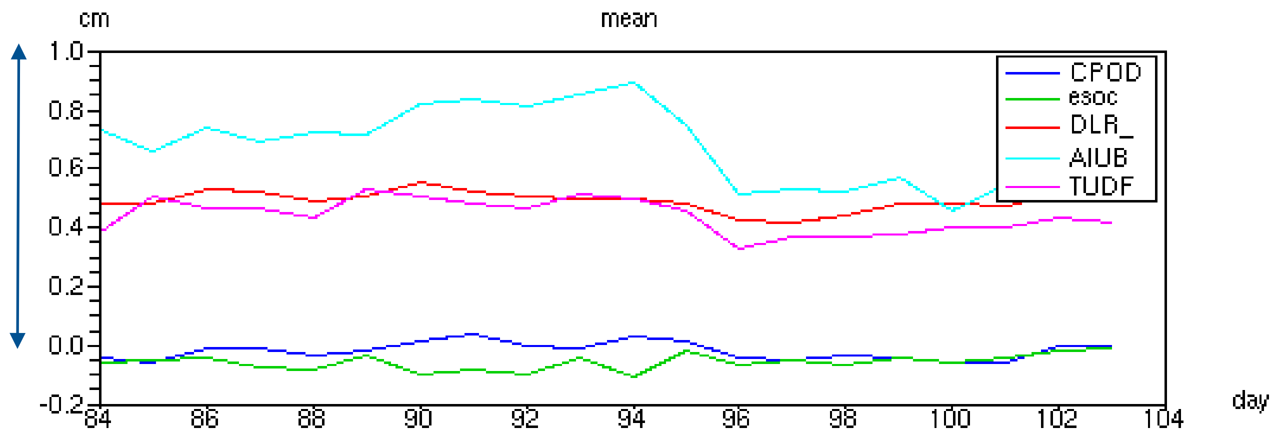


Daily mean and sigma values
Both STC orbits are close to the NTC in radial (Doris ~8 mm, GPS ~6 mm)

Other orbits, radial comparison with NTC CNES

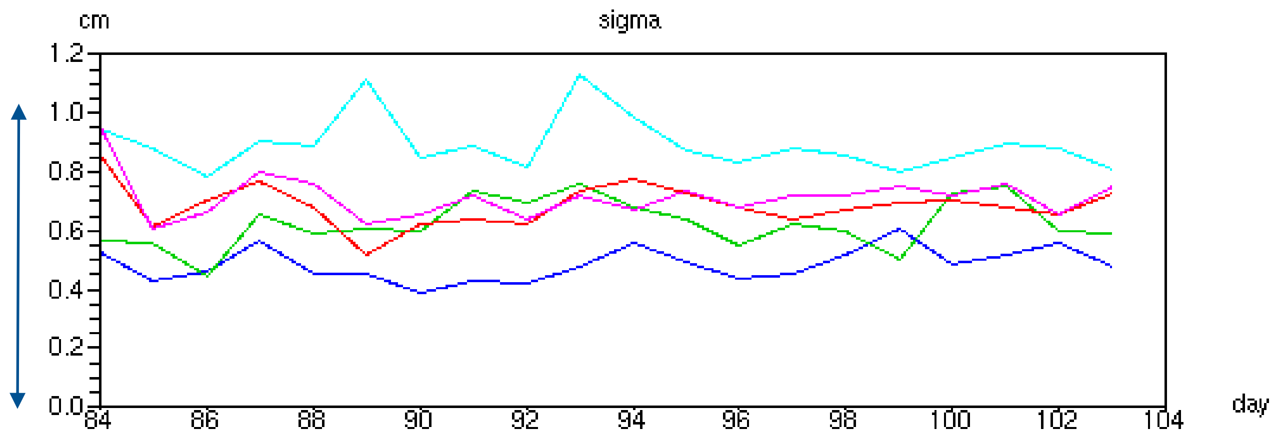
1 cm

Radial
daily mean



1 cm

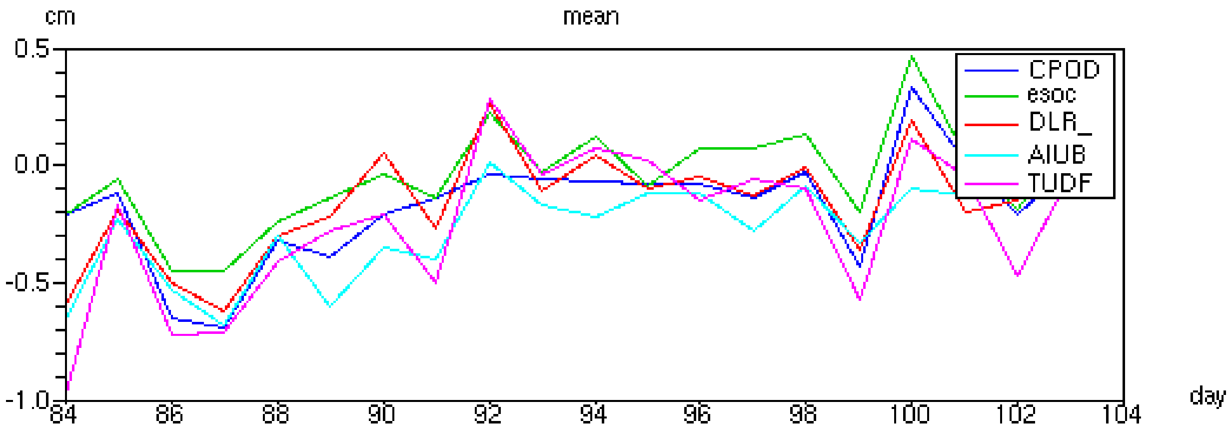
Radial
daily sigma



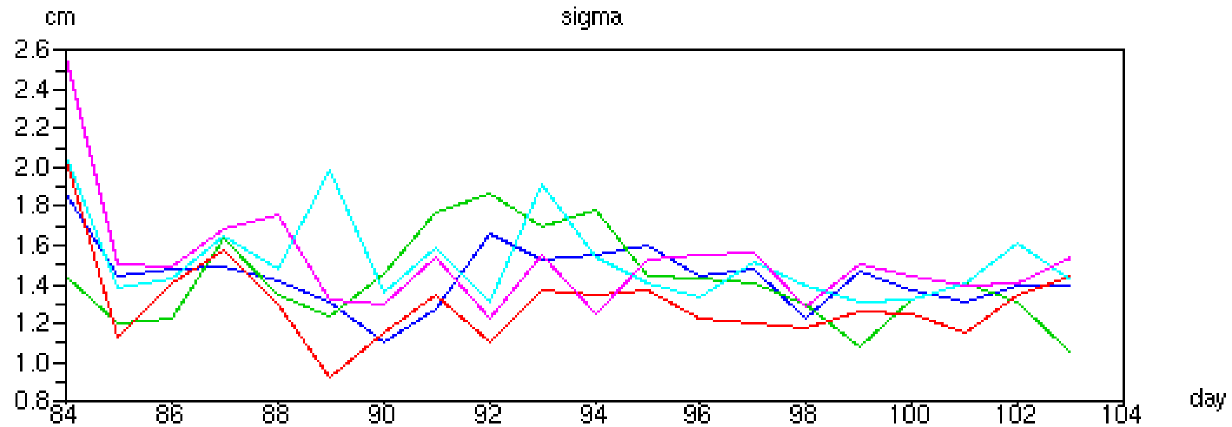
Same bias solutions : ESOC, CPOD difference 5-6 mm rms
Biased solutions (radial empirical accelerations ?) : DLR,AIUB,TUDF 4-6 mm
sigma 6-8 mm (means ~9-11 mm rms)

Other orbits, tangential comparison with NTC CNES

Tangential daily mean



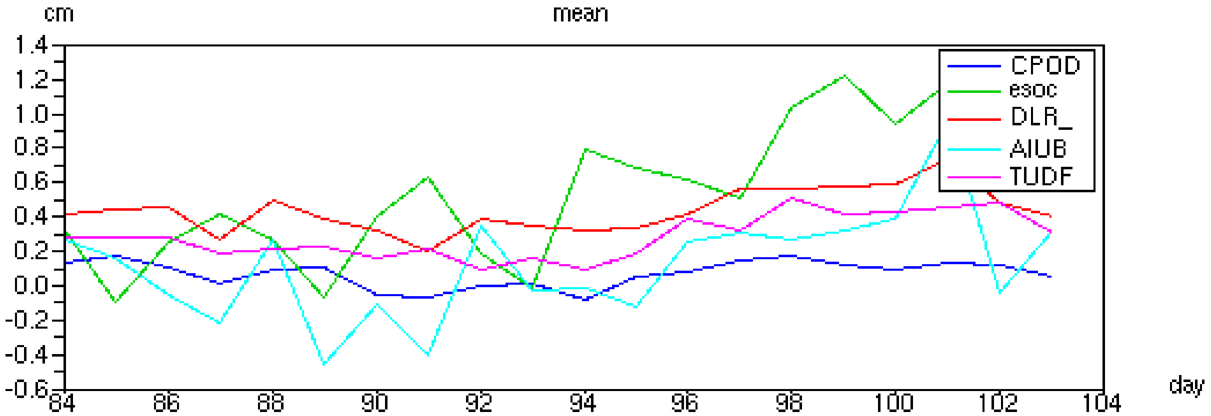
Tangential daily sigma



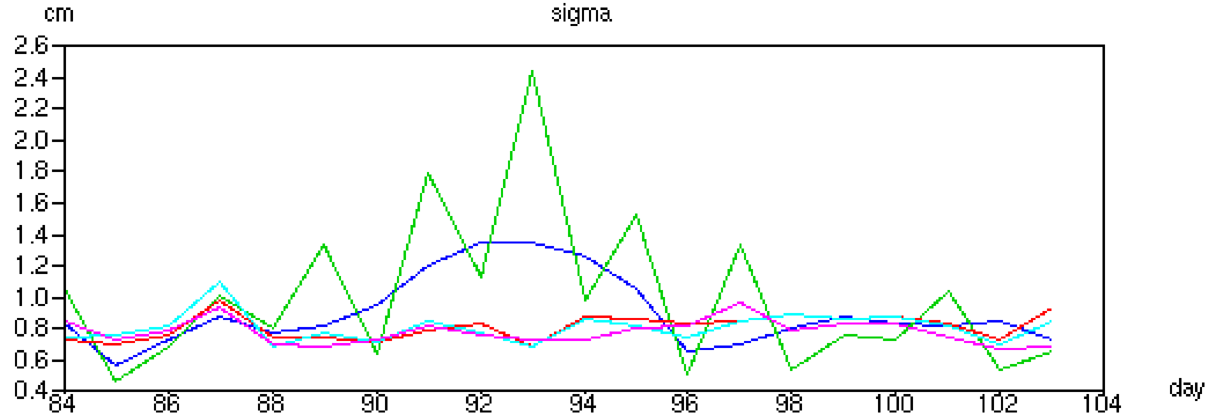
Systematic mean effect between CNES and all other solutions (5 mm)
(phase map, Doris measurements contribution ?)

Other orbits, normal comparison with NTC CNES

Normal daily mean



Normal daily sigma

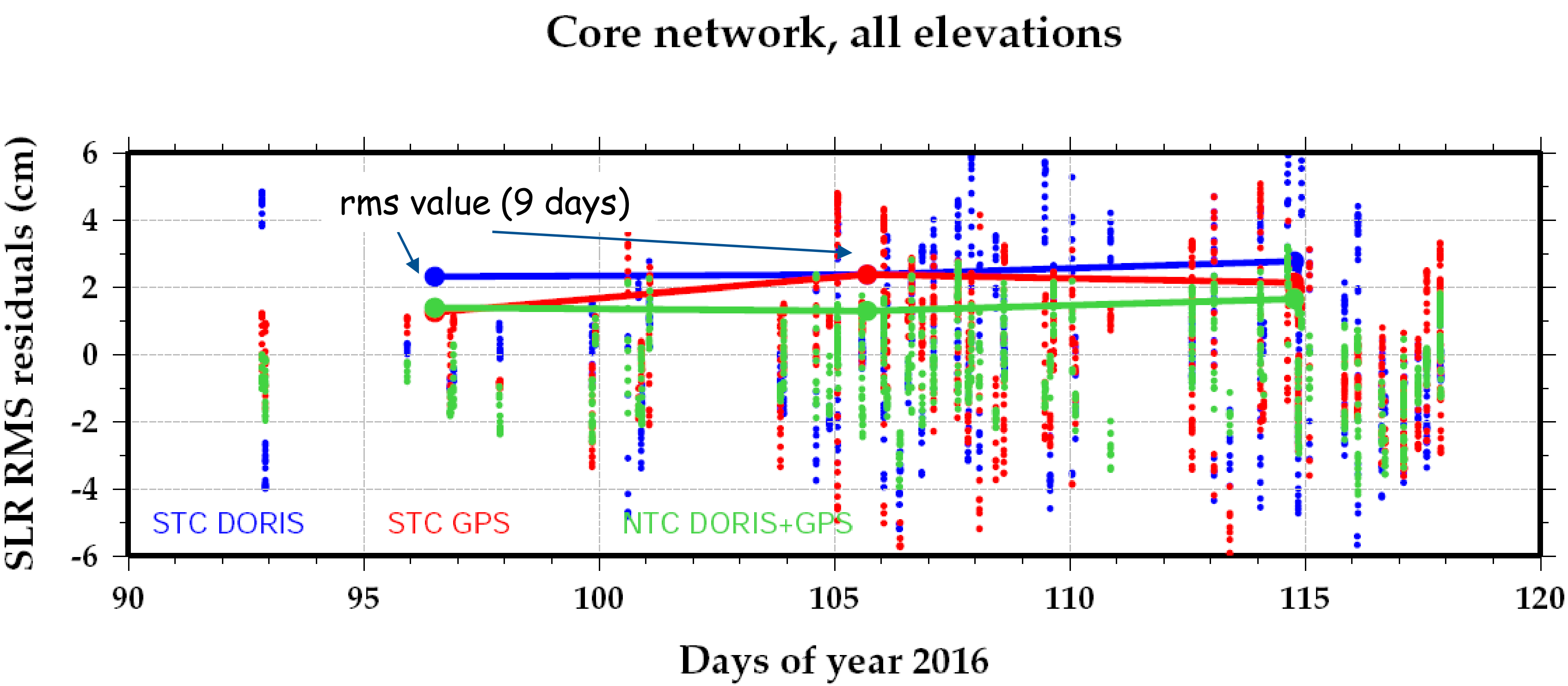


Different positive biases between CNES, CPOD and the other solutions

transverse position of PCO ?

Important sigma variations for esoc and CPOD

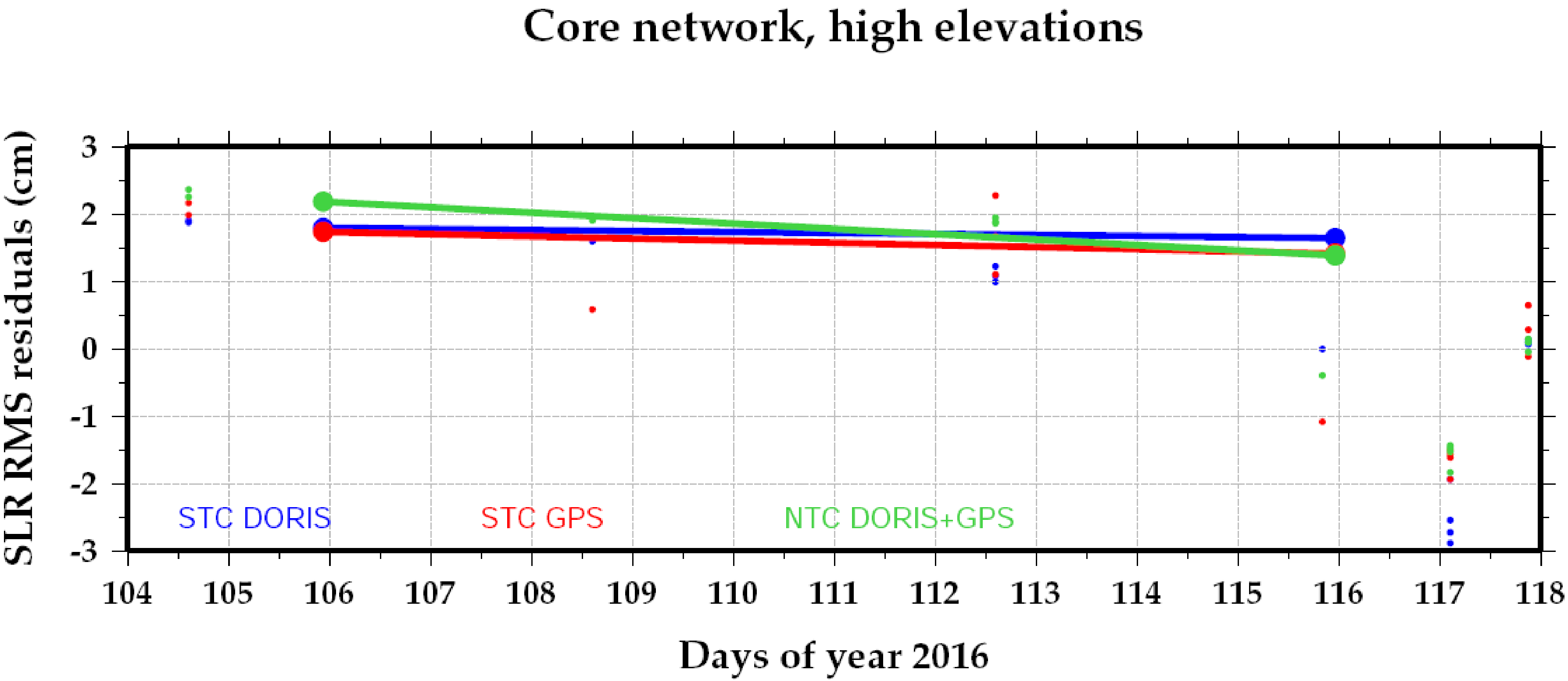
SLR residuals, Core Network, all elevations



Stations used : L7090 L7105 L7810 L7839 L7840 L7941

Yarragadee, Greenbelt, Zimmerwald, Graz, Herstmonceux, Matera

SLR residuals, Core Network, high elevations

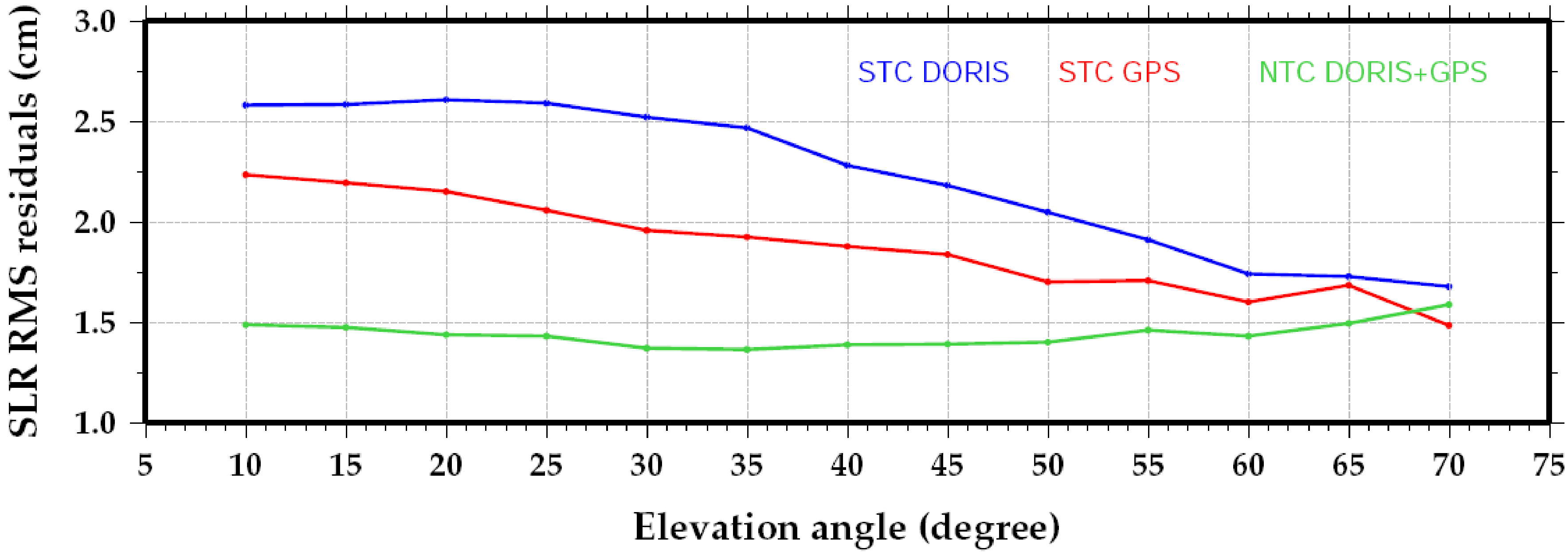


Core network, elevation > 70 degrees ----> estimation of the radial performance

very few data : the estimation is not very reliable
rms ~ 1.5 cm for NTC

SLR RMS as function of elevation (18 days)

SLR core network residuals rms, function of minimal elevation



All solutions have a radial performance around 1.5 cm, NTC is slightly better

Horizontal results (cm)

NTC :	very stable	1.5	(the SLR location in X_sat is consistent with GPS and Doris)
STC GPS :		2.2	(why is it so different from NTC ? to be investigated)
STC Doris :		2.7	(low cross track observability with Doris)

Conclusions

- Very good performances for the two DORIS receivers
- For SAA effects, the USO pre-irradiation works correctly for orbit determination needs. However, there are visible effects on Jason 3 and Sentinel 3, which may degrade some positioning performances.
- The monitoring of S3 USO by the GNSS will help to understand the on board frequency variations at intermediate time scales (100s – 1000 s).

Back-up

Standards for Precise orbits models (1)

	From proposed GDR-E Jason 2
Gravity model	**EIGEN-GRGS_RL03_MEAN-FIELD (or its updated version)** Non-tidal TVG : annual, semi-annual, **one bias and one drift for each year up to deg/ord 80; C21/S21 modelled according to IERS2010 conventions;** Solid Earth Tides: from IERS2003 conventions **Ocean tides FES2012 (FES2014 if available)** Atmospheric gravity : 6hr NCEP pressure fields + tides from Biancale-Bode model Pole Tide: solid Earth and ocean from IERS2010 conventions Third bodies: Sun, Moon, Venus, Mars and Jupiter
Surface forces	Radiation Pressure model: thermo-optical coefficient from pre-launch box and wing model Earth Radiation : Knocke-Ries albedo and IR satellite model Atmospheric density model : **MSIS-86**
Estimated dynamical parameters	Drag coefficient every 2 revolutions Along-track and Cross-track 1/rev per day or every 12 hours (GPS solutions) **Stochastic solutions**
Satellite reference	Mass and Center of gravity: Post-Launch values + variations Attitude Model : Quaternions and Solar Panel orientation.

Standards for Precise orbits models (2)

Displacement of reference points	Earth tides: IERS2003 conventions Ocean Loading: **FES2012 (FES2014 if available)** Pole tide : solid earth pole tides and **ocean pole tides (Desai, 2002)** **S1-S2 atmospheric pressure loading (Ray & Ponte, 2003)** **Geocenter variations:** **Tidal : ocean loading and S1-S2 atmospheric pressure loading** **Non-tidal : Seasonal model from J. Ries** Reference GPS constellation: JPL solution at IGS (orbits and clocks)
Terrestrial Reference Frame	Extended ITRF2008 (SLRF/ITRF2008, DPOD2008, IGS08)
Earth orientation	Consistent with IERS2010 conventions and ITRF2008
Propagations delays	SLR Troposphere correction: Mendes-Pavlis DORIS Troposphere correction : GPT/GMF model **DORIS antenna phase center correction** GPS PCO/PCV consistent with constellation orbits and clocks (IGS08 Antex)
Estimated measurement parameters	DORIS: 1 Frequency bias per pass, 1 troposphere zenith bias per pass SLR : bias per arc solved for a few stations, bias per pass for a few stations GPS: Floating ambiguity per pass, receiver clock adjusted per epoch