Ocean Surface Topography Science Team Meeting

Precise Orbit Determination Splinter

North-South miscentering of the Jason-3 orbit observed by its yaw-flip capability

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Introduction

- **Context**
- **Previous approaches**
- **Normal offset (GPS int ambiguity)**
- **Flips approach (GPS int ambiguity)**
- **Normal offset (other measurements)**
- **Flips approach (other measurements)**
- **Conclusion**

Context

- Satellite: Jason-3
- Nominal orientation: nadir Earth-pointed
- Attitude law:
  - Yaw steering when β’>15° and β’<-15°
  - Fixed yaw when -15°<β’<15°
  - A yaw flip is performed at β’=0°

Yaw flip benefits:

- Disentangle time tagging from along-track center of phase POD instrument offsets
- Observe separately the combined effects of cross-track miscalibrated SRP models/thermal effects or POD instrument locations, and the **Z-component of geocenter motion whose amplitude is thoroughly debated**

Context

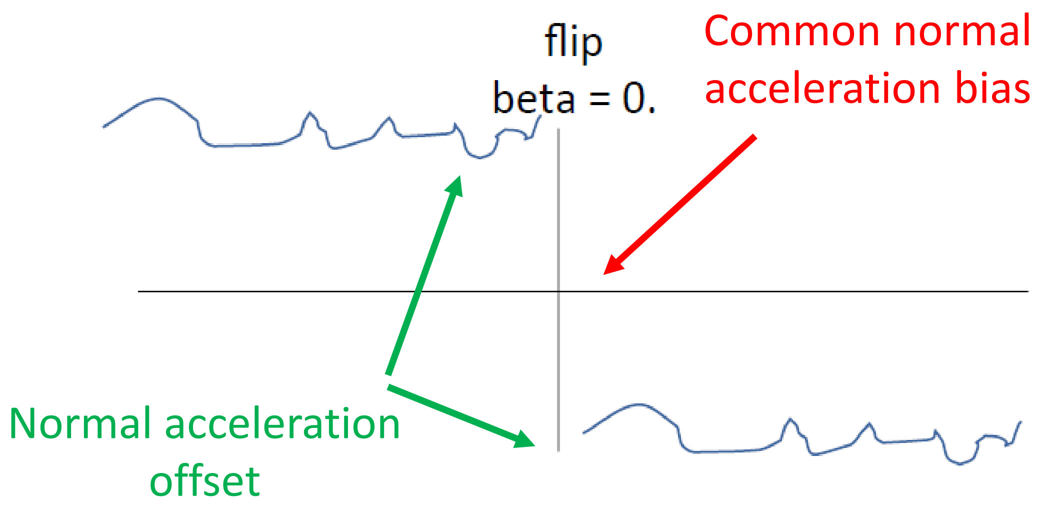
<u>Goal</u>:

- Monitoring of the residual normal perturbations
- Observation of the geocenter motion estimates in the Z (North-South) direction
    - Comparison with previous methods

<u>Approach</u>:

- Focus on orbit arcs where flip events occur
- Definition of the 8-day orbit arcs: 4 days before and after the flip events
- Estimated empirical parameters:
    - constant cross-track accelerations with 4-day intervals
    - periodic once-per-revolution accelerations in the along/cross-track directions with 1-day intervals
    - constant along-track accelerations with 2 orbital period intervals

Context



Normal acceleration offset before and after the flip caused by:

- Cross-track error in the POD center of phase location
- Residual SRP modeling error of the satellite normal surfaces
- Unmodeled satellite thermal effects

Common normal acceleration bias on both sides of the flip caused by:

- Geocenter motion in the Z direction (mainly)
- Residual solar-reflected/Earth-emitted radiation modeling errors?

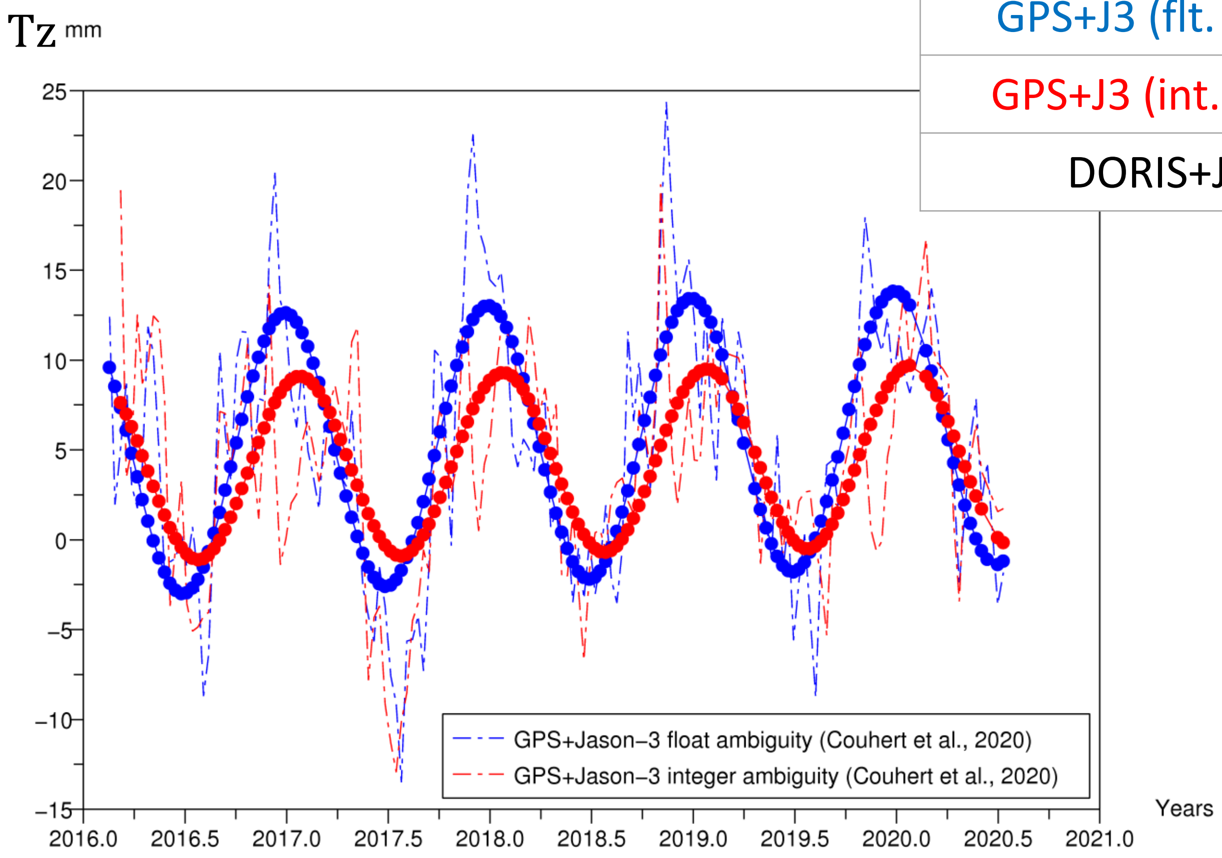
The miscentering of the orbit around the Earth's CM in the Z direction can be recovered using the equation:

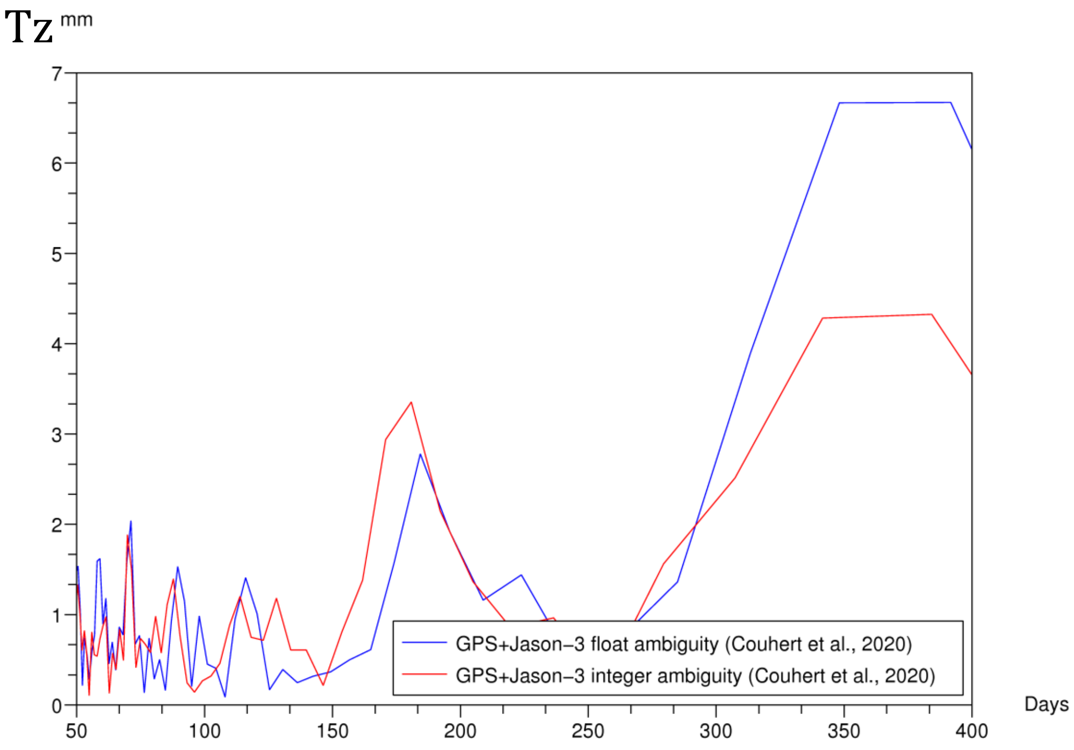
$$\mathrm{Tz} = \frac{-C_{N0}\, r^3}{GM\cos(i)}$$

where C_{N0} is the common cross-track acceleration bias

Previous approaches

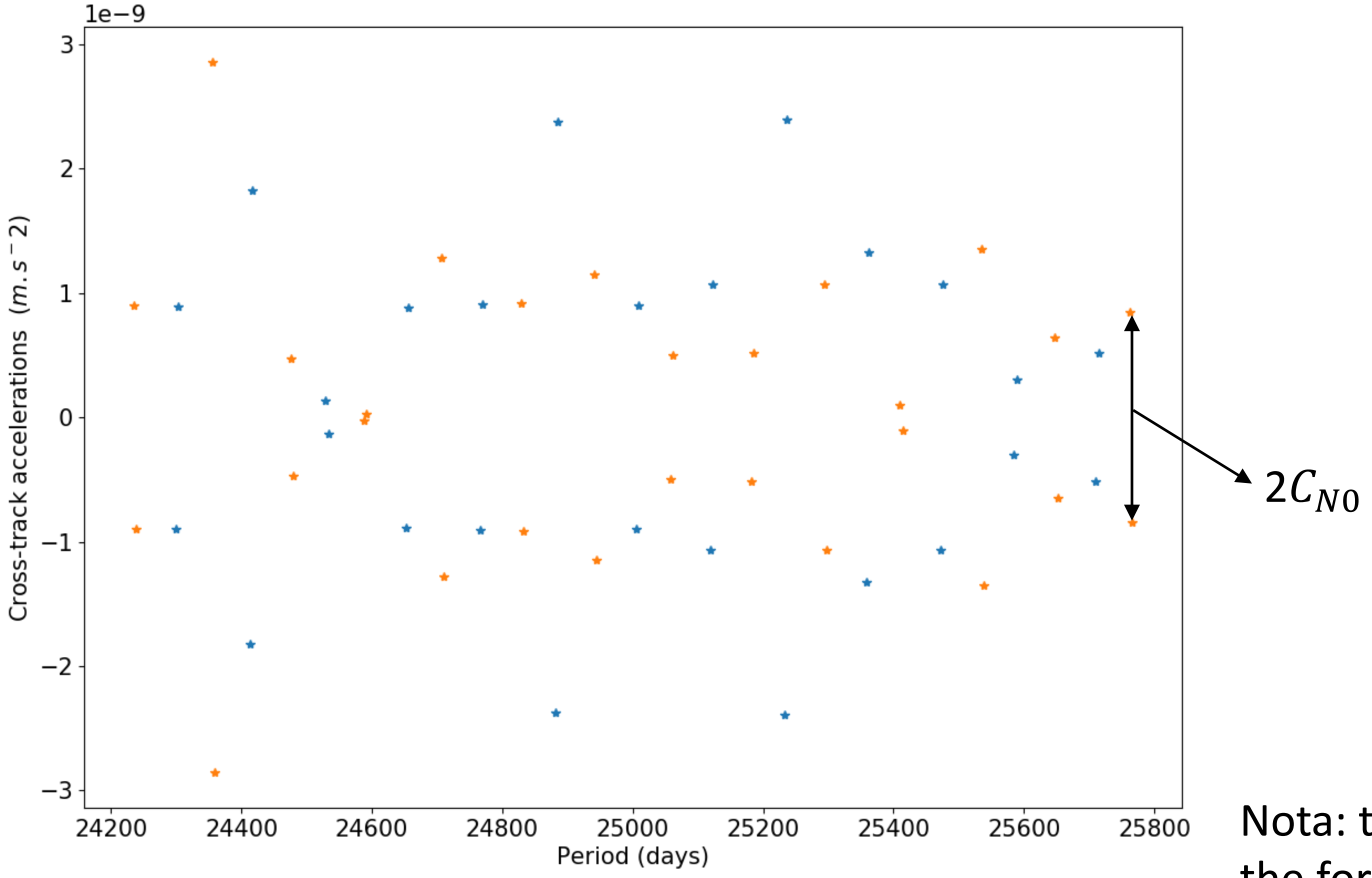
Approach	365-day Amplitude	Phase
GPS+J3 (flt. amb., Couhert et al., 2020)	7.7 mm	361 d
GPS+J3 (int. amb., Couhert et al., 2020)	5.0 mm	24 d
DORIS+J3 (Couhert et al., 2018)	4.4 mm	23 d





Normal offset (GPS int. ambiguity)

GPS measurements: integer ambiguity

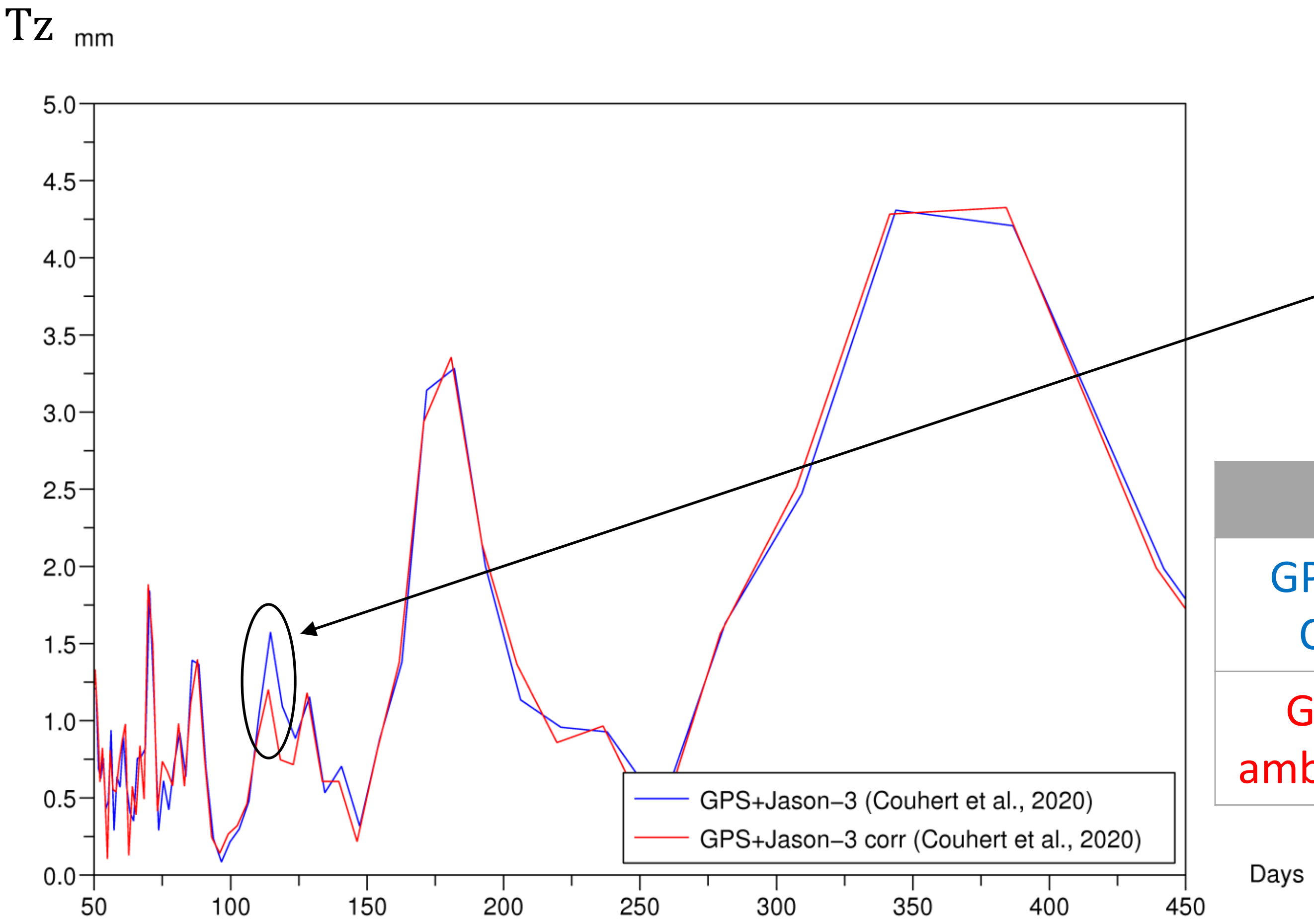


Offsets of the estimated normal accelerations before/after the flip (the common bias has been removed), which can be attributed to a wrong cross-track center of phase/mass location. The correction to be applied is given by:

$$\frac{C_{N0}}{{\omega_0}^2} = 1.15\ mm$$

Nota: the two groups of colors (blue/orange) denote the forward and backward flying attitude regimes

Normal offset (GPS int. ambiguity)

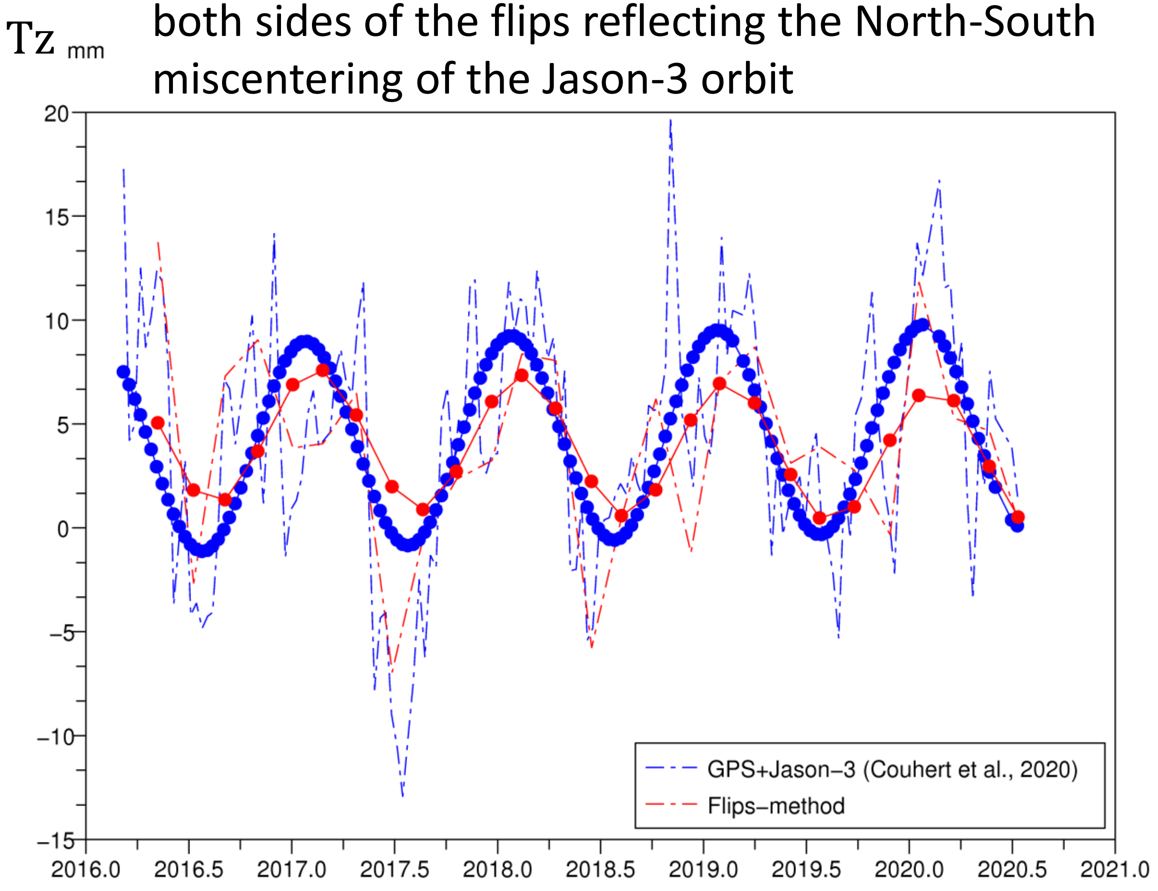


Decrease in the 118-day signal of the previous approaches, when applying the normal offset correction (via the GPS antenna phase center)

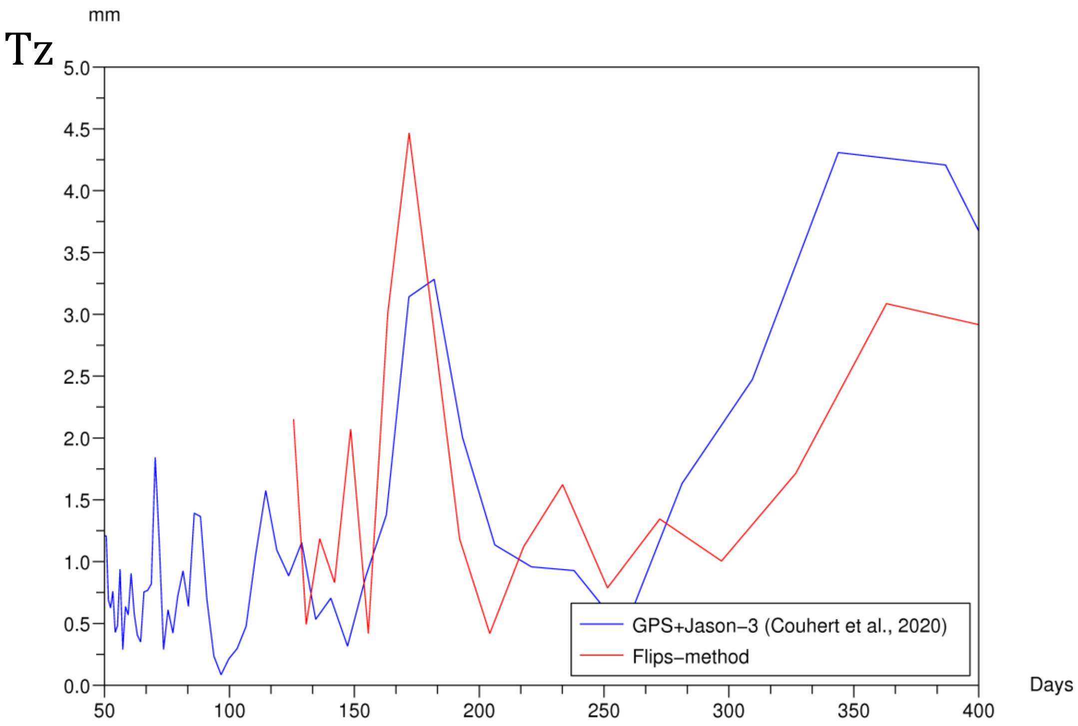
Approach	365-day Amplitude	Phase
GPS+Jason-3 (int. amb., Couhert et al., 2020)	5.0 mm	24 d
GPS+Jason-3 corr (int. amb., Couhert et al., 2020)	5.0 mm	24 d

Flips approach (GPS int. ambiguity)

Common normal acceleration biases estimated on both sides of the flips reflecting the North-South miscentering of the Jason-3 orbit

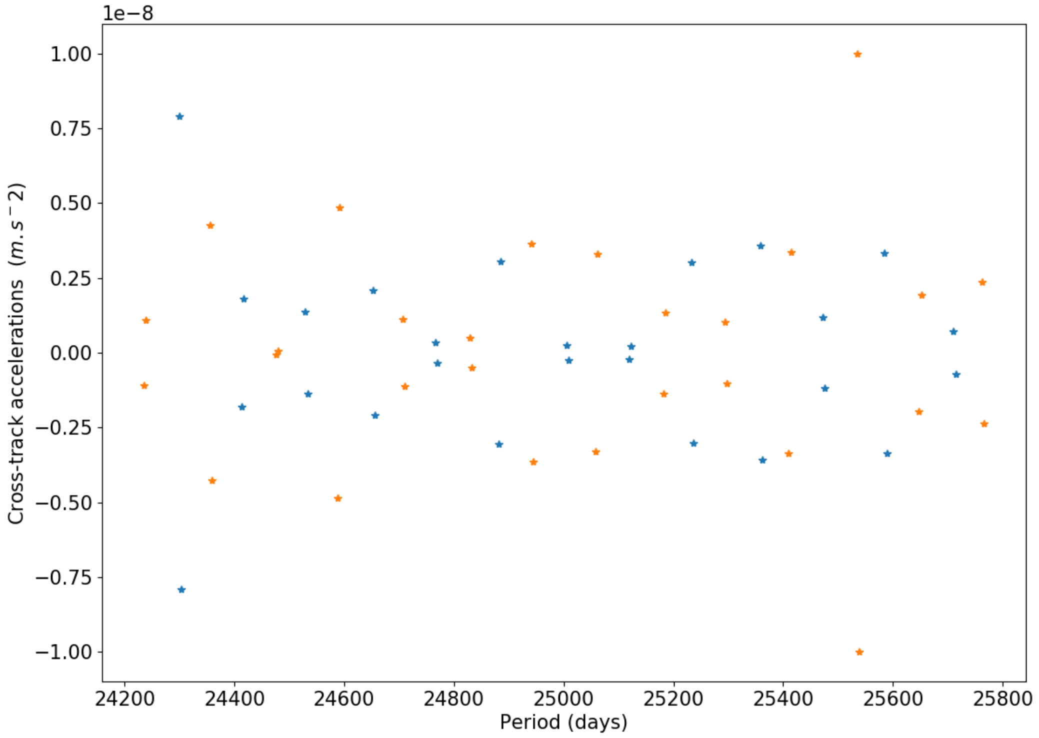


Approach	365-day Amplitude	Phase
GPS+Jason-3 (int. amb., Couhert et al., 2020)	5.0 mm	24 d
Flips (GPS int. amb.)	2.9 mm	48 d

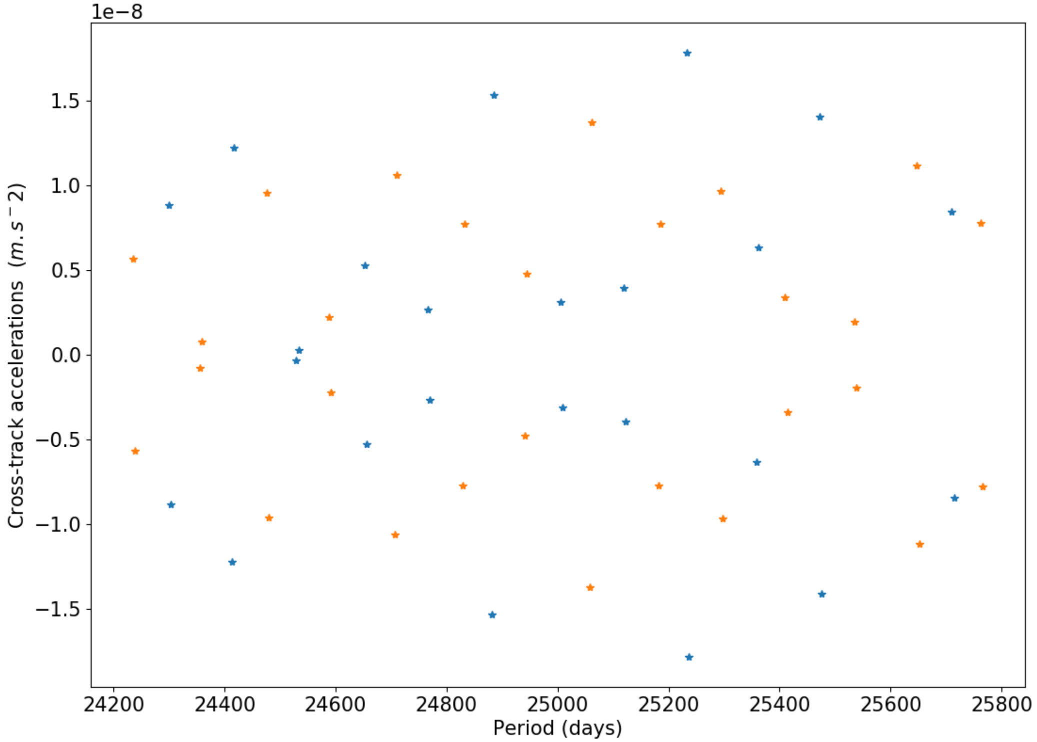


Normal offset (other measurements)

GPS measurements: float ambiguity



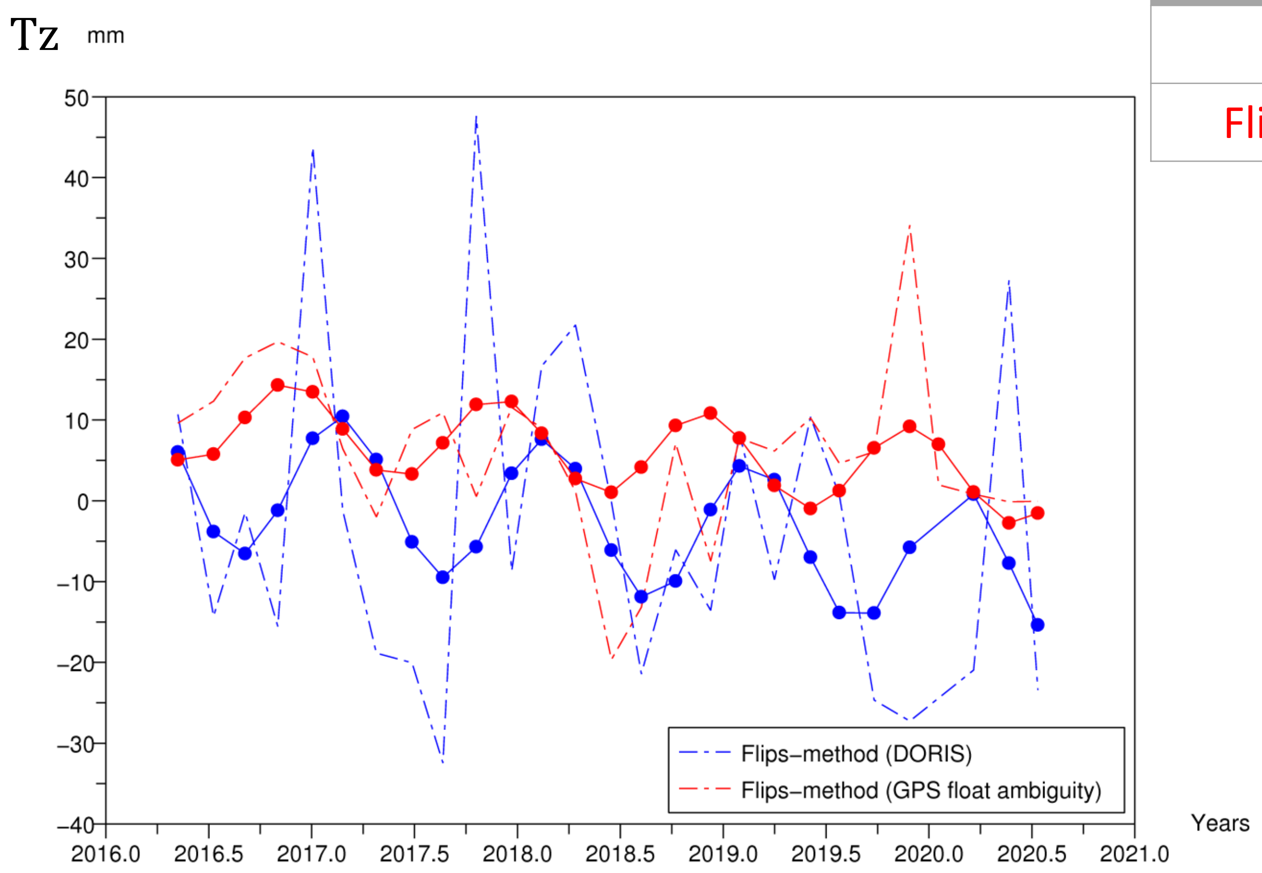
DORIS measurements

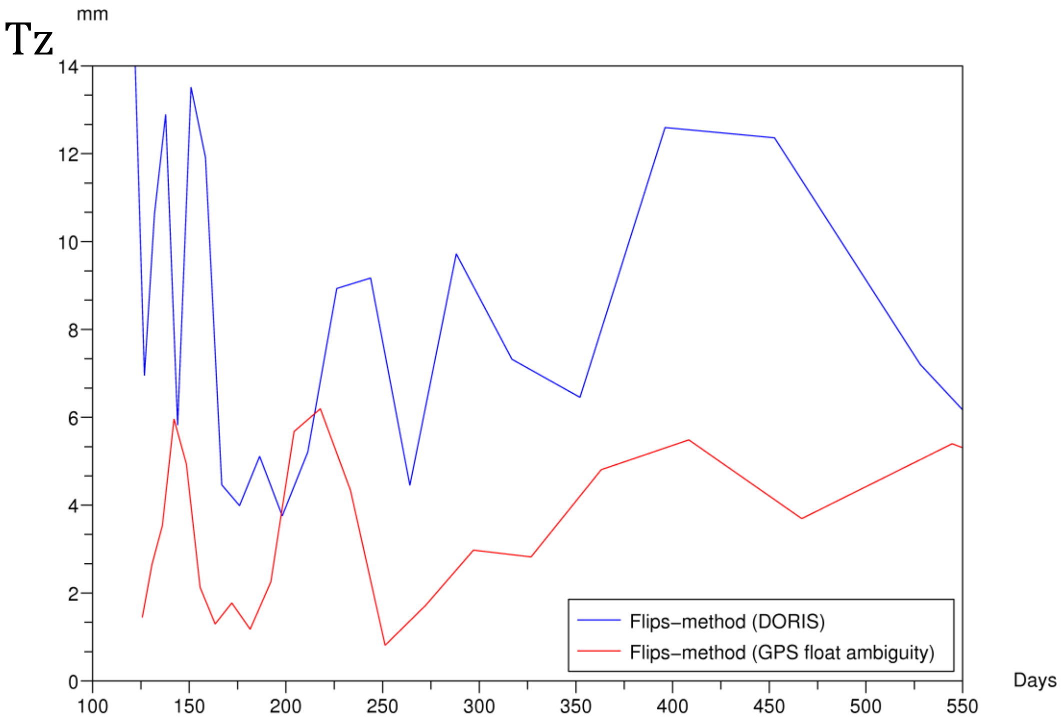


The observability of these measurements in the cross-track direction is not strong enough

Flips approach (other measurements)

Approach	365-day Amplitude	Phase
Flips (DORIS)	9.3 mm	52 d
Flips (GPS flt. amb.)	5.5 mm	331 d





Conclusion

- The flips approach allows us to observe specifically the geocenter motion along the Z (North-South) axis.

- The 60-day sampling and/or residual errors in the modelling of solar-reflected/Earth-emitted radiations could explain the differences in the annual TZ geocenter estimates between the flips and previous approaches.

- Yaw flips are specific to the T/P and Jason missions. A recommendation of the OSTST POD group is to maintain the yaw flips for the Sentinel-6/Jason-CS mission.