COMBINATION OF DORIS BEACON MEASUREMENT PARAMETERS IN CNES POE-F ORBIT SOLUTION

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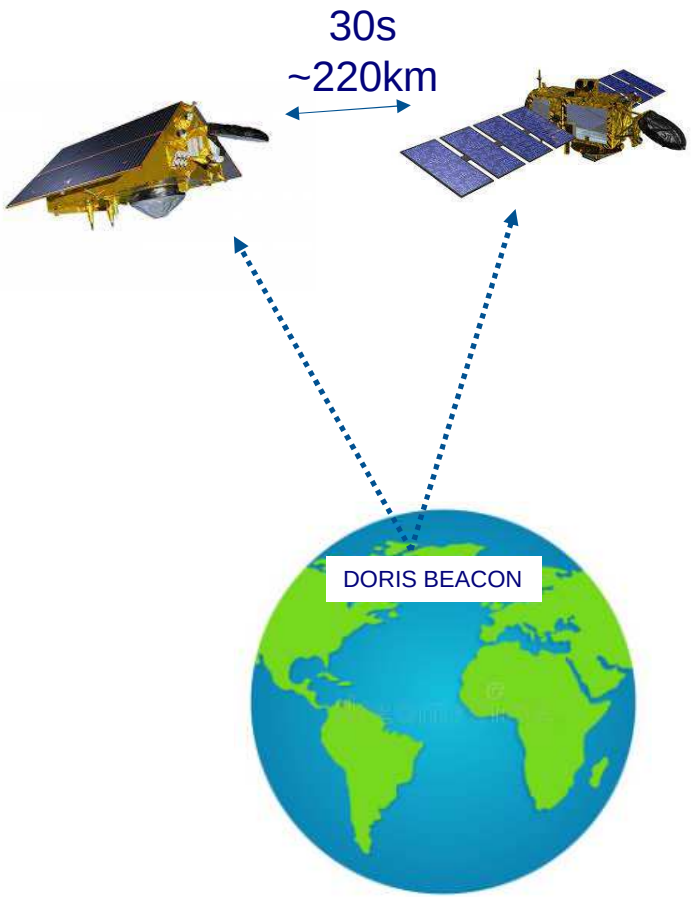
CNES POE-F STANDARDS

For both types of orbits, dynamic and reduced dynamic, a set of parameters associated to a DORIS beacon is adjusted:

	Beacon parameter	Comments
Per arc	Tropospheric gradients (North and East)	unit m, geometric propagation
	Vertical station position	unit m, coordinate correction
Per pass	ZTD : Zenith Tropospheric Delay	unit m, propagation
	Beacon USO frequency bias	unit m/s, this could also absorb onboard OUS adjusted model errors
	Beacon USO frequency drift	unit m/s^2, SAA stations only to mitigate local onboard OUS model remaining error

TANDEM PHASE



Jason-3 and Sentinel-6A satellites fly in tandem phase, 30s apart

If we take advantage of the quasi simultaneous observation conditions over each beacon pass, could a common adjustment be beneficial:

Vertical beacon position and/or tropospheric gradient?

(remark, this may be also common to all satellites)

ZTD parameter ?

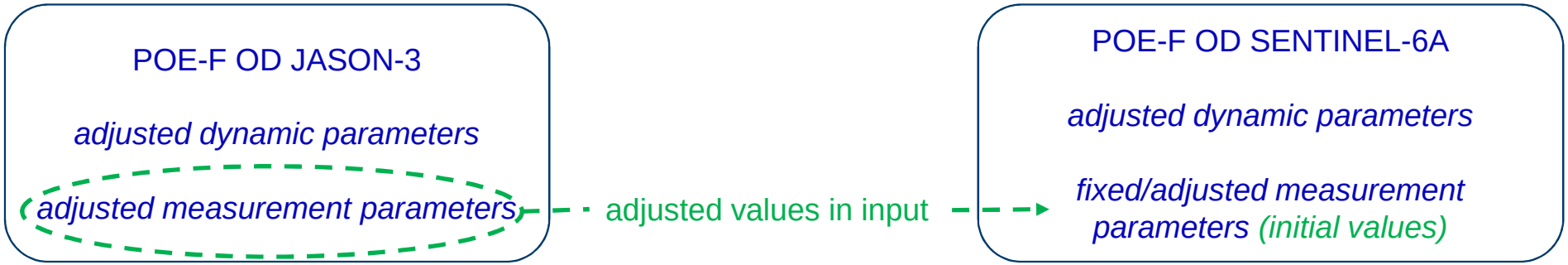
Frequency bias and frequency drift ? (Beacon USO model)

This adjustment will improve some common *parameters covariance (~1/sqrt(2) considering the same number of measurements for both satellites)*

But what about :
- the measurement parameters (USO, frequency bias) ?
- the orbit quality ?

PRELIMINARY ANALYSIS

Using DORIS reduced dynamic orbits, constrain some measurements parameters for S6A to the values observed on Jason 3



The new Sentinel-6A orbit is compared to the reference orbit (DORIS dyn. red.) to see the impact of the following configurations :

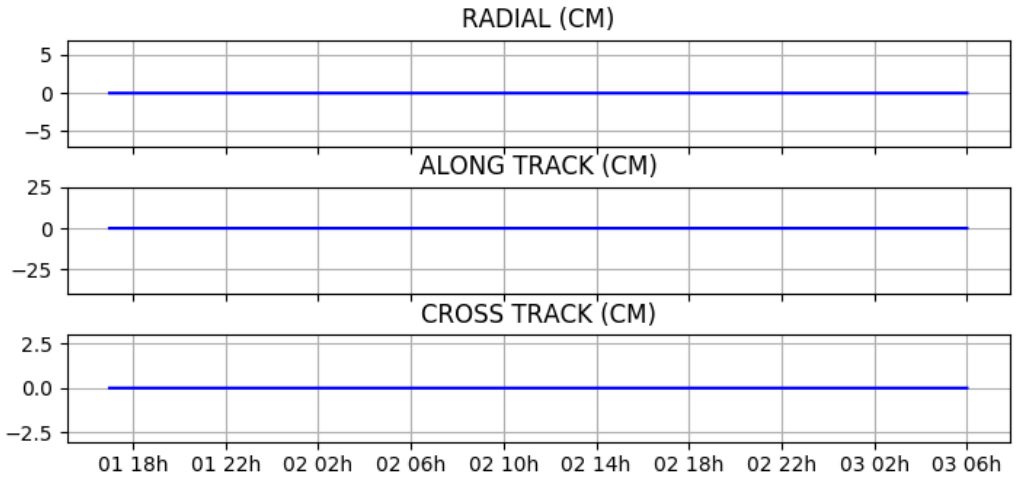
	Case 1	Case 2	Case 3	Case 4
Fixed meas. parameters	none	all	All except for ZTD	All except for frequency bias
Adjusted meas. parameters	all	none	ZTD	frequency bias
Comments	Orbit close to the reference?	Highest orbit differences?	ZTD will absorb residual errors?	Frequency bias will absorb residual errors?

PRELIMINARY ANALYSIS

Test on day 02/02/2022 (cycle 045 for Sentinel-6A / cycle 220 for Jason-3)

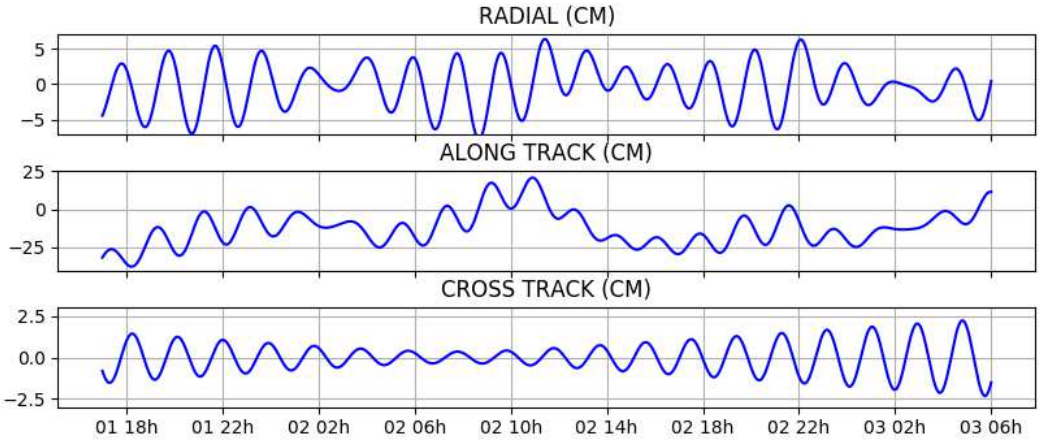
Case 1

→ Orbit differences are very small, as expected, changing the initial values of the measurement parameters does not change the solution



Case 2 (ZTD and frequency constrained)

→ The maximum of the orbit differences are around 5 cm in the radial, 30 cm in the along-track and 2 cm in the cross-track direction : could be seen as the impact of residual errors in Jason-3 measurements (on board OUS, …) on Sentinel-6A orbit.



PRELIMINARY ANALYSIS

Test on day 02/02/2022 (cycle 045 for Sentinel-6A / cycle 220 for Jason-3)

Case 3 (frequency constrained)

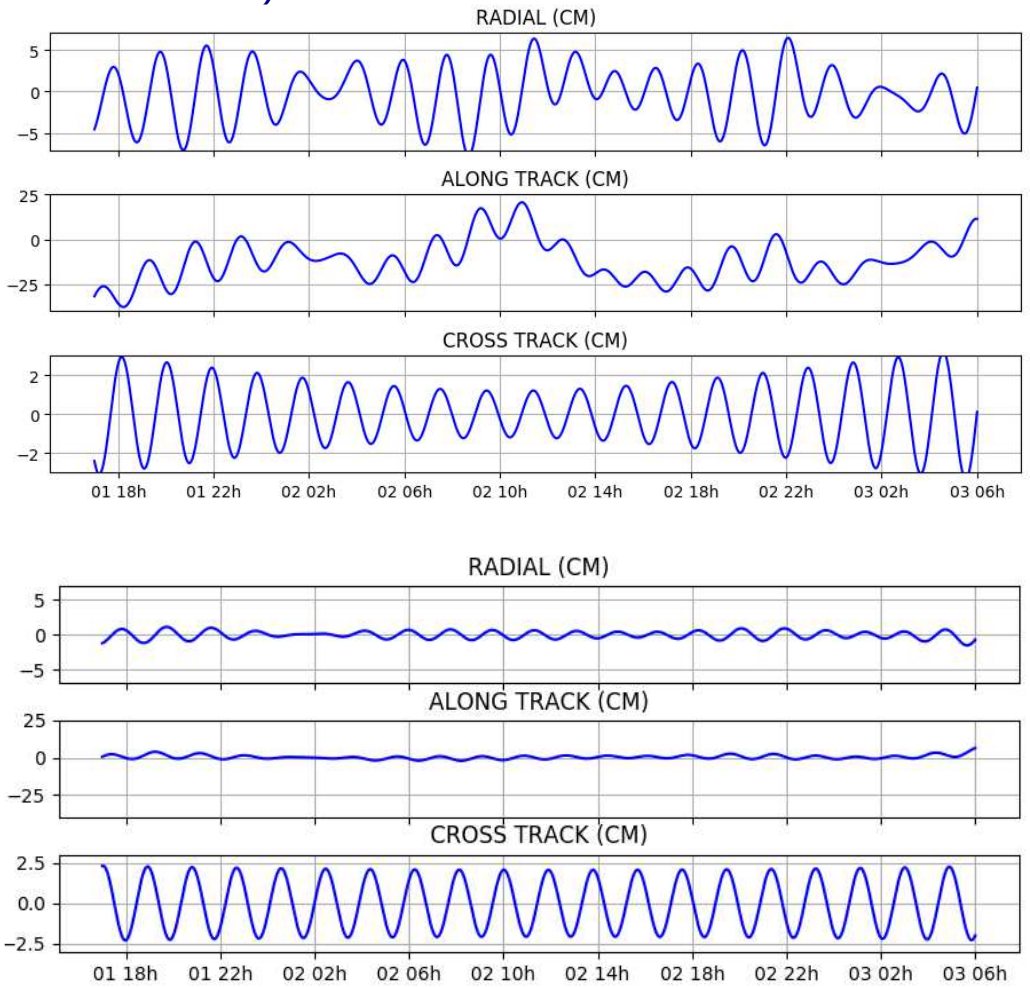
→ The orbit differences are similar to the case 2, the adjusted ZTD parameter could not absorb the Jason-3 residual measurement errors (onboard OUS,…)

→ ***ZTD could be adjusted in common***

Case 4 (ZTD constrained)

→ The maximum of the orbit differences are around 1 cm in the radial, 5 cm in the along track and 2.5 cm in the cross-track direction, the adjusted frequency bias parameter could absorb most of Jason-3 measurement errors (onboard OUS,…)

→ ***Frequency biases could not be adjusted in common***



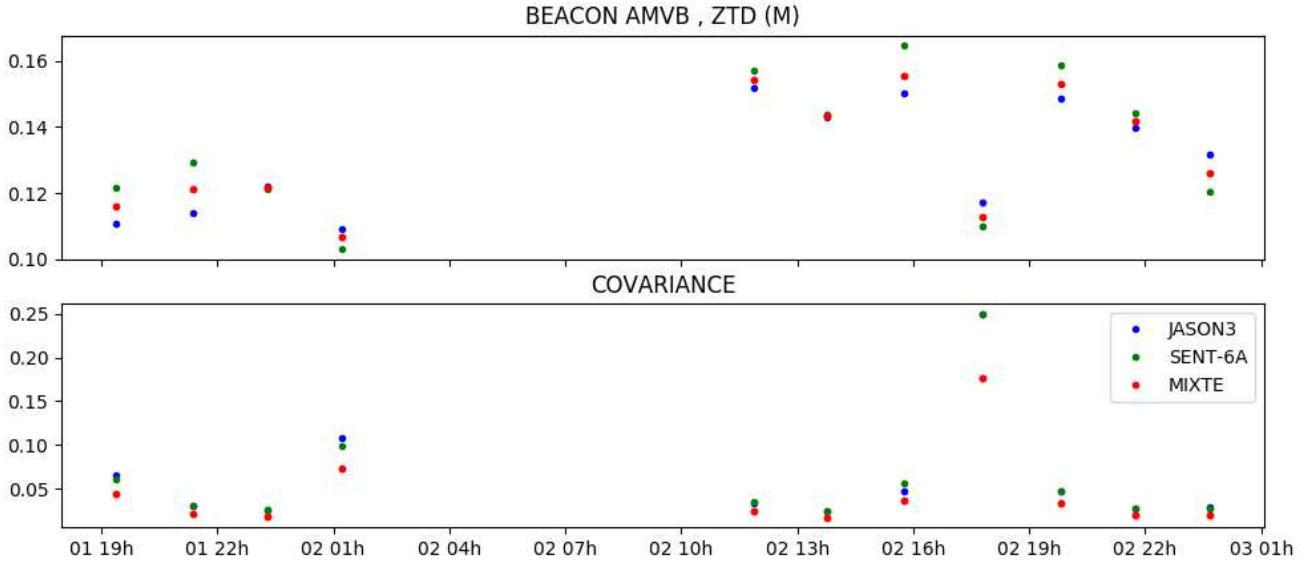
COMBINATION PARAMETERS

Combined parameters are the vertical positions and the tropospheric gradients in a first step.
The ZTD and beacon frequency parameters are independent for both satellties

3 days are processed : 29/12/2021, 07/01/2022, 02/02/2022

In general, for global combined parameters :

- The adjusted values are close to the barycenter of the individual values
- The covariance values are reduced for the combined parameters



but …

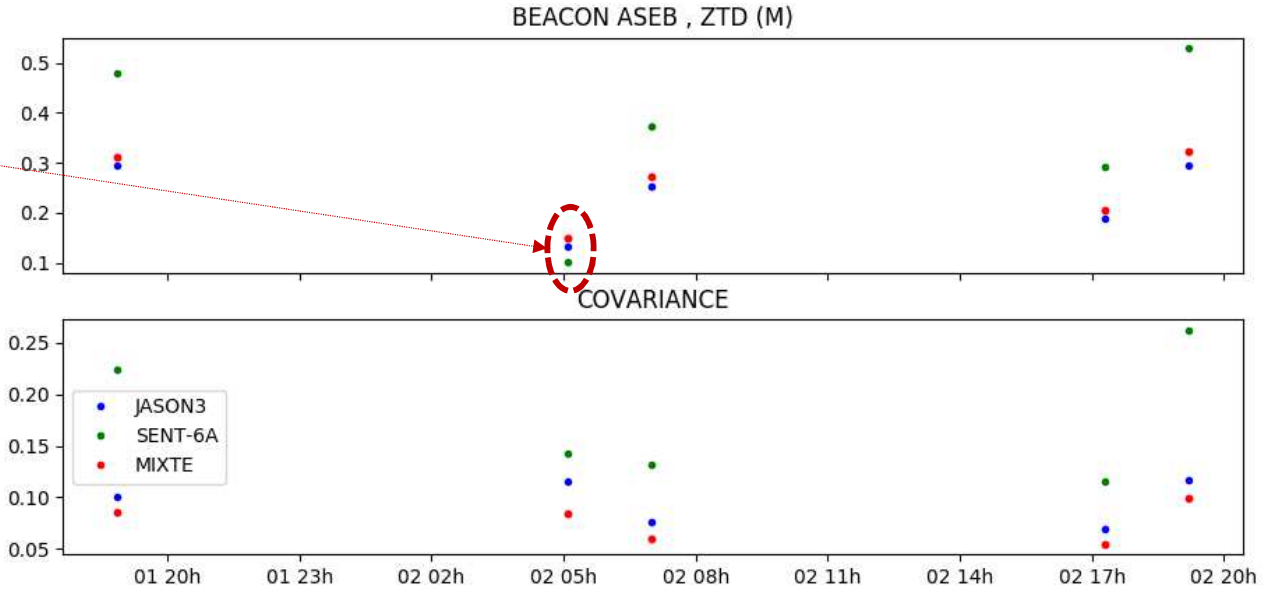
COMBINATION PARAMETERS

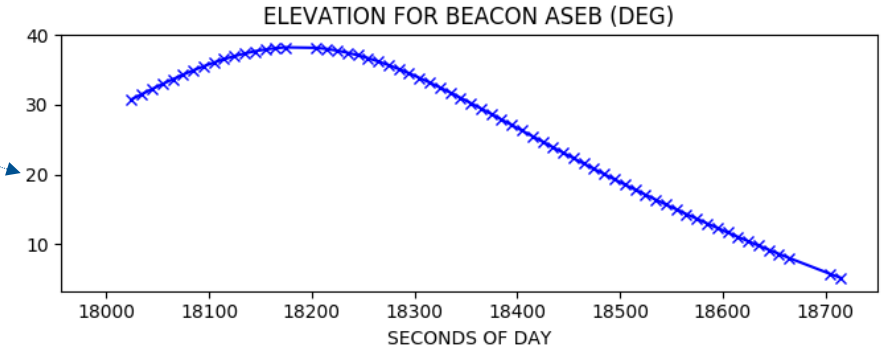
An adjusted common value could be higher than the ones adjusted separately in Jason-3/Sentinel-6A reference orbit determinations

ASEB beacon , i.e ASCENSION, is located in the South Atlantic Anomaly region.

The pass associated to this observation has :
- the same number of measurements for Jason-3 and Sentinel-6A
- a dissymmetry in elevation

Observation difficult to explain : onboard OUS SAA effect ?

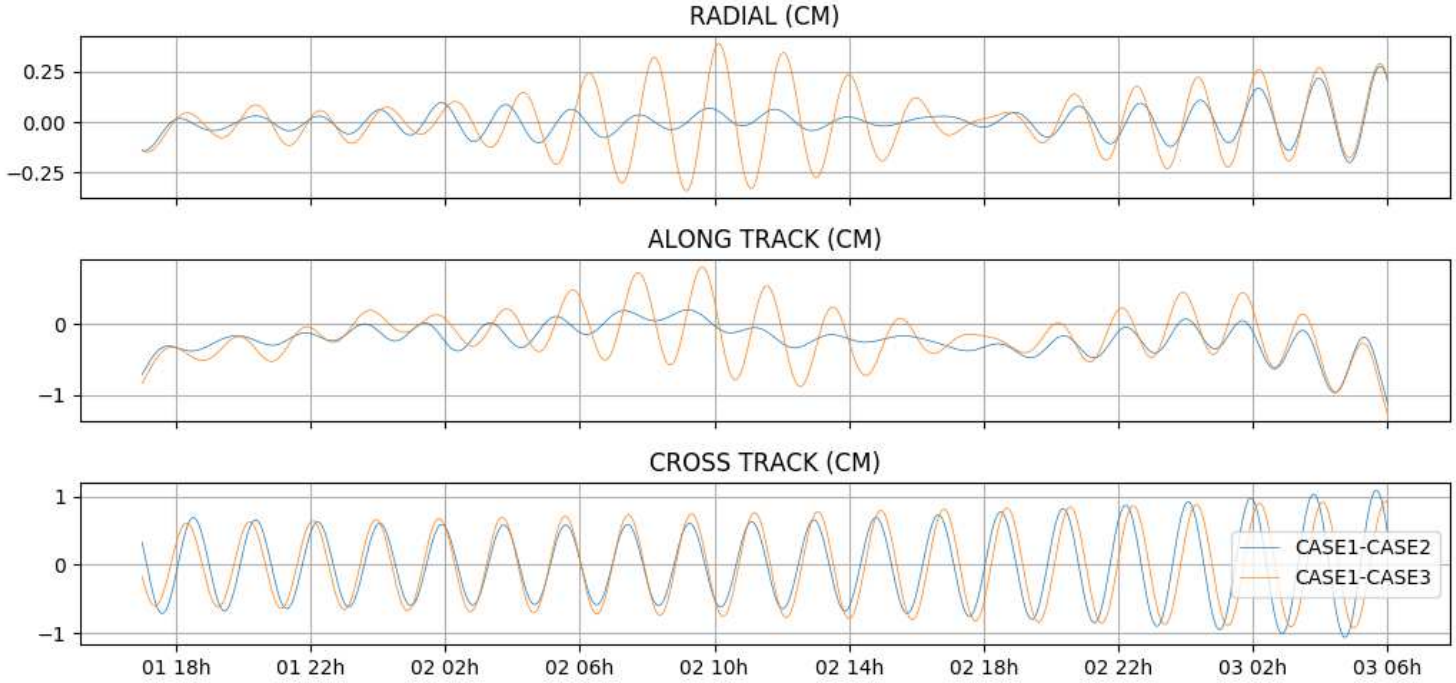




COMBINATION PARAMETERS

The following Jason-3 orbit differences take into account :

- '*CASE1*' : DORIS reduced dynamic orbit, taken as reference orbit
- '*CASE2*' : CASE1 + vertical position and tropospheric gradient adjusted in common
- '*CASE3*' : CASE2 + ZTD adjusted in common



The common adjustment of some parameters has an impact on the orbit, around few millimeters on the DORIS orbit.

COMBINATION PARAMETERS

In terms of performances, using the core network of 8 stations { *7090, 7105, 7810, 7839, 7840, 7941, 7119, 7501*}, the following SLR weighted RMS are obtained :

	Case 1	Case 2	Case 3
29/12/2021(*)	0.95cm	0.85cm	1.01cm
07/01/2022	1.22cm	1.23cm	1.21cm
02/02/2022	1.42cm	1.3cm	1.43cm

(*) WRMS based on 3 passes of 1 station

Based on this statistic, a slight improvement could be expected when the global measurement parameters { vertical position, tropospheric gradients} are adjusted in common.

To confirm these preliminary results, we should test this processing on a larger period, and with the other Doris satellites.

CONCLUSION

Adjust in common the global parameters { vertical position, tropospheric gradients} has a slight impact on the orbit performance (based on preliminary tests). This observation should be confirmed on a longer period. This can be also tested with the other DORIS satellites.

For a DORIS beacon, the adjusted parameter frequency bias absorb onboard OUS model errors. This beacon frequency bias cannot be adjusted in common in a multi-missions orbit determination process.

The observation of the DORIS USO by a GNSS receiver could help for its modelization :

[on board] CNES proposal of carrying DORIS onboard GALILEO is at a system analysis step *(already existing in Sentinel-3A/B missions)*

[beacon] for the stations of the IGS REGINA network the colocated DORIS beacons will use the same frequency reference as the GNSS receiver.

The {ZTD, frequency bias/drift} could take benefit from integrating these new modelization, by adjusting them in common. The corresponding orbit performance improvement has to be checked

THANK YOU FOR YOUR ATTENTION,
ANY QUESTIONS?