IMPACT OF THE NEXT FORESEEN IERS MEAN POLE MODEL (LINEAR) ON ALTIMETER SATELLITE PRECISE ORBITS, AND VALIDATION OF UPDATED MEASUREMENT MODELS

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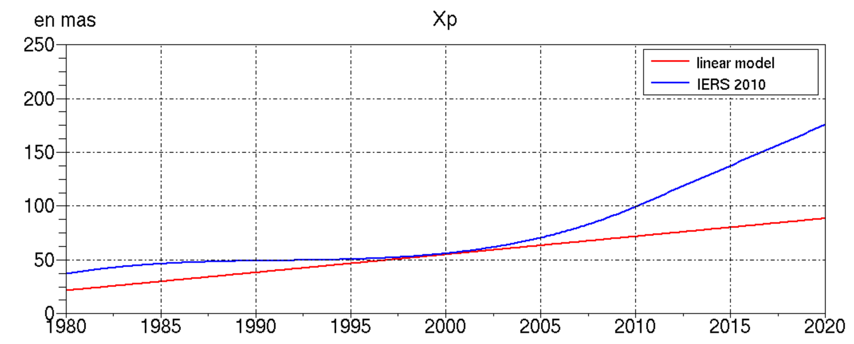
Introduction

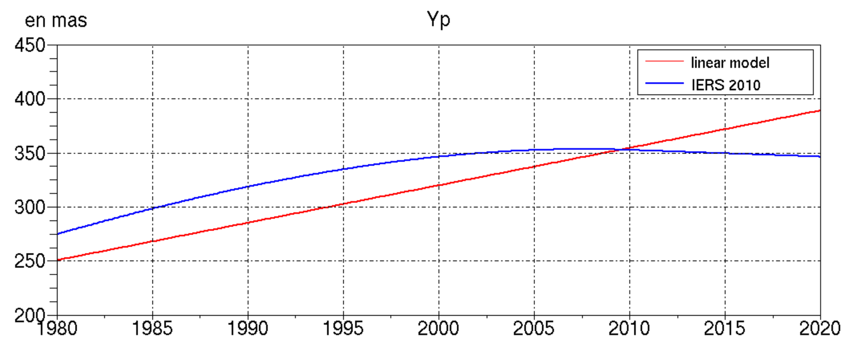
To improve the radial orbit accuracy of the altimeter missions, the dynamic and measurement models used for precise orbit determination are regularly updated. This year, a **linear mean pole model** was proposed to replace the current IERS model, and improve station positioning. To update the measurement modelling, a **new phase map** was suggested for the Alcatel DORIS ground antennas, and we estimated the POD instrument offsets for the currently flying altimeter missions, in particular the **DORIS phase center offsets**.

Mean pole models

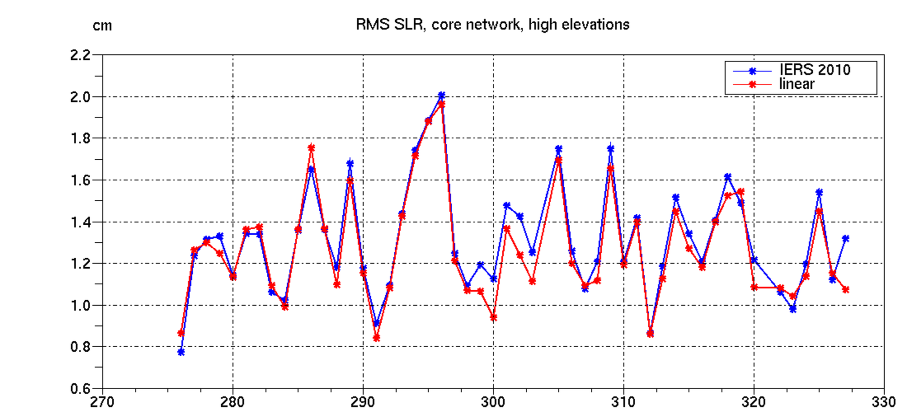
The rotational displacement due to the pole tide must be taken into account to derive accurate station positions. The IERS Conventions 2010 provides a cubic+linear mean pole model used to compute the correction of the station vertical and horizontal location [1]. Owing to the linear extrapolation after 2010 that tends to diverge from the observed polar motion, a filtered mean pole is currently used, which includes inter-annual signals such as those resulting from the current ice melting, implying that their contributions are missing in the computed correction.

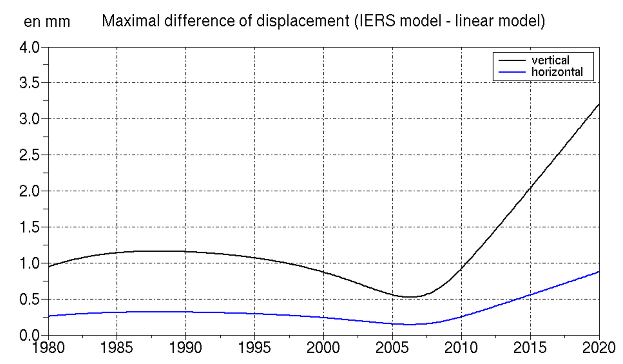
For this reason, a linear mean pole that only handles the GIA effect is recommended for the next convention. The figures below show the polar coordinates described by the two models tested in this study: the linear model suggested by J. C. Ries at UAG 2017 [2] and the model of the IERS Conventions 2010.



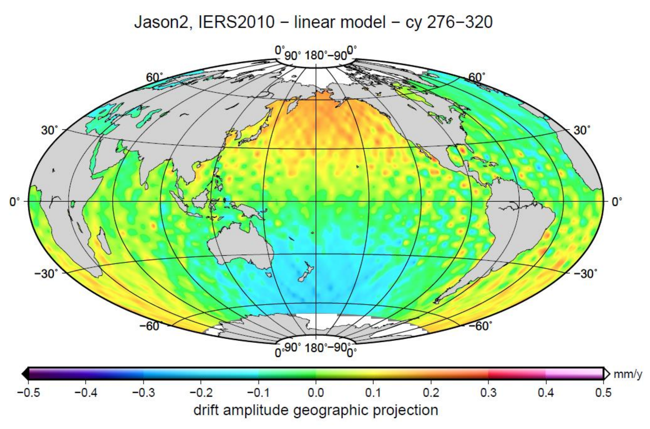


The analysis was carried out on the OSTM/Jason-2 CNES GDRE DORIS-only dynamic orbits from 01/01/2016 to 23/05/2017.
The high-elevation SLR residuals from a core network show that the radial orbit performance tends to be improved by 1 mm when the linear mean pole is used, which is consistent with the order of magnitude of the difference of displacement.





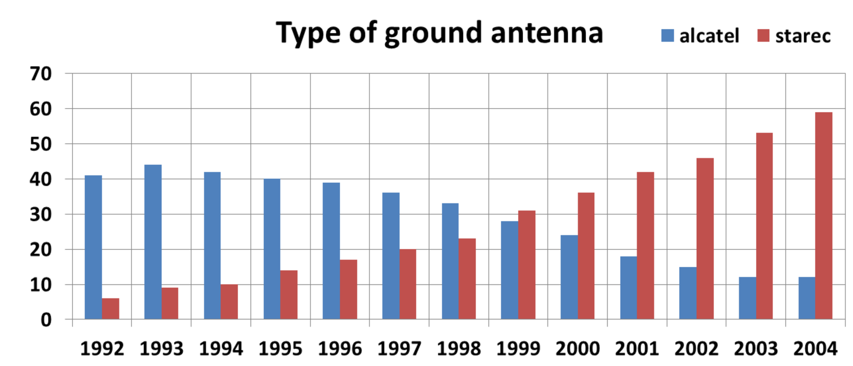
On the geographically correlated errors, **the drift amplitude show a degree-2 order-1 signal of 0.25 mm/y is** as to be expected from the linear part in the maximal difference of displacement after 2010.

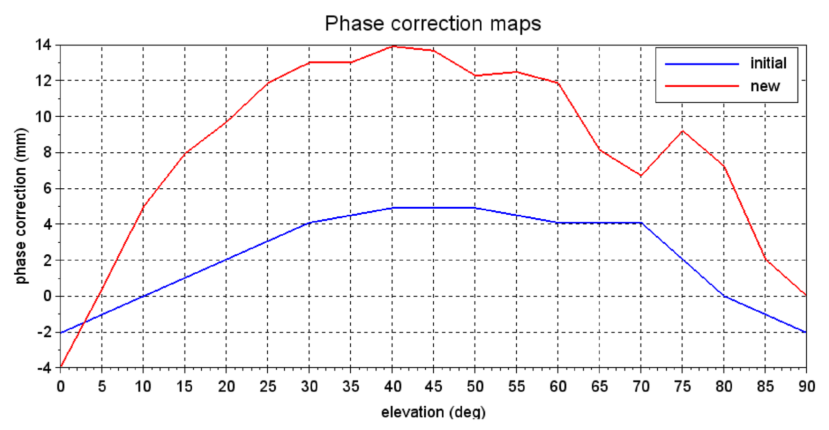


Measurements modelling

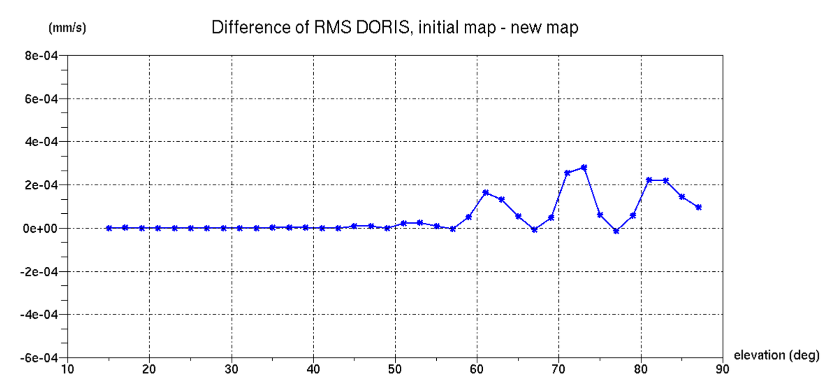
DORIS ground antennas phase map

In 2017, a new characterization of the Alcatel DORIS ground antennas, predominant in the 1990s, was performed by CNES, leading to a new phase map (red curve on the figure on the right).

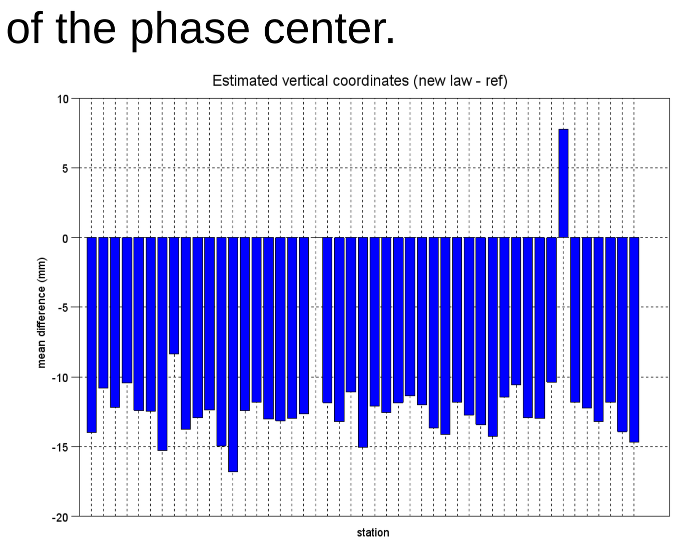


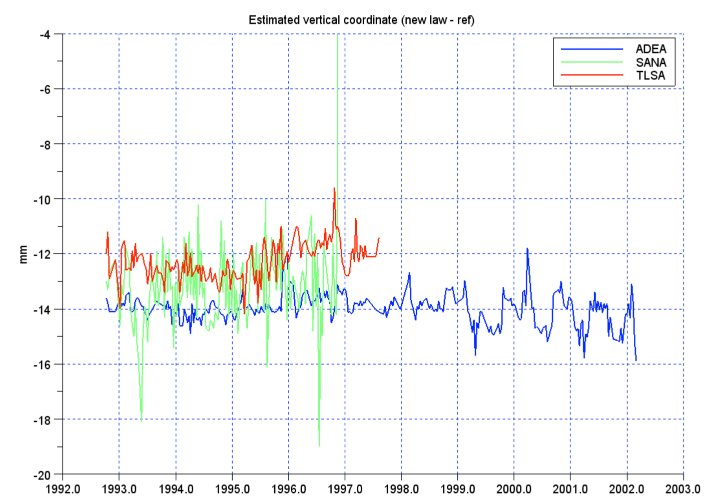


There is no noticeable difference either in the overall DORIS RMS, or in the high-elevation SLR RMS over a core network.
The DORIS residuals are however improved in the high elevation range, where the shape of the two maps differs the most.



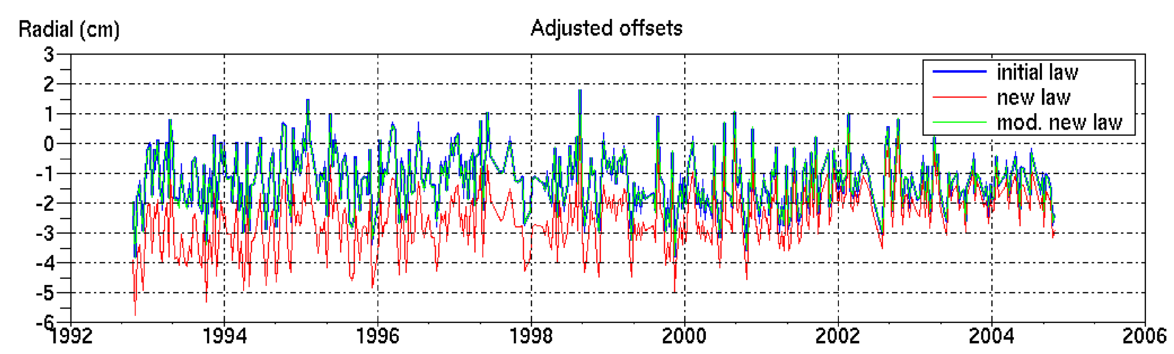
The estimation of the vertical station coordinates over a cycle performed with the 2 phase maps **shows a difference of 13 mm**, except for 2 stations: HVOA (few passes over 3 cycles) and SPIA, assumed to be from a lack of observability. Spitzberg is indeed located in a latitude of 78°, higher than the inclination of the TOPEX/Poseidon orbit (66°). This bias does not vary in time (figure on the right) and can be interpreted as a shift of the phase center.





Finally, we looked at the estimation of DORIS receiver phase center radial offset. Compared to the initial map (Test A), the new phase map (Test B) leads to a degradation from 5 to 20 mm, varying in time with the number of active Alcatel antennas. If the Alcatel antenna phase center is translated by 13 mm upwards (Modified test B), we retrieve a consistent behavior over the TOPEX/Poseidon lifespan, independent of the predominant type of ground stations.
However, there still is a radial offset of -12 mm, probably related to the DORIS scale factor.

Mean offsets (cm) over 1992.7-2004.8		
Test	R	N
A	- 1.2	0.7
B	- 2.5	0.2
Mod. B	- 1.2	0.3

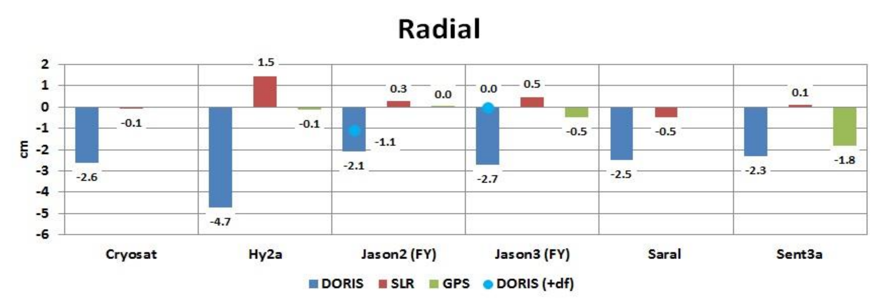


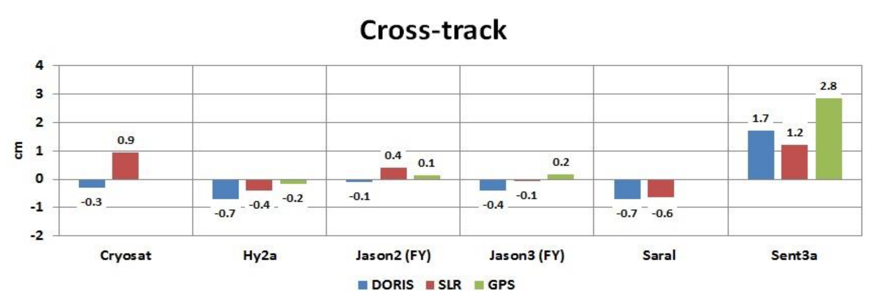
POD instrument offsets

A study was carried out to estimate the DORIS receiver phase center offsets and the consistency between the DORIS receiver and the other POD systems (GPS, SLR) for the 6 current altimeter missions.

In the radial and cross-track direction, the offsets were independently estimated for the 3 techniques. As for the along-track direction, the relative offsets between 2 instruments were estimated.

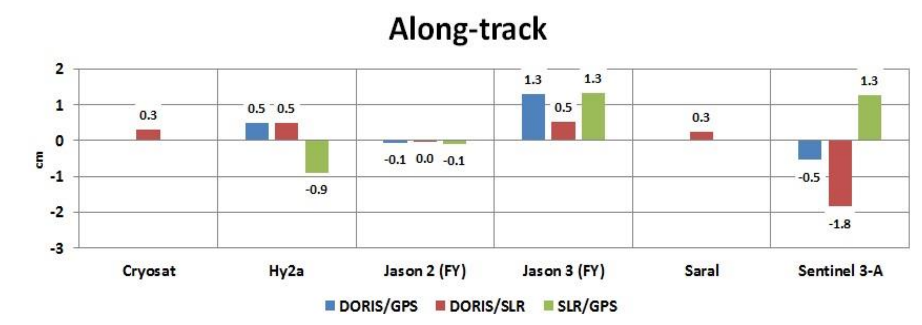
In the radial direction, a systematic -2.5 cm offset was found for all missions (,and a -4.7 cm offset for HY-2A). This common radial offset may affect the scale factor or the station positioning of the DORIS network.





In the cross-track direction, no significant offset was estimated except for Sentinel-3A. Indeed, biases from 1.2 cm to 2.8 cm were observed by the 3 tracking systems. These biases cannot be caused by errors in the model of solar radiation pressure. Indeed, a variation of the coefficient CR by 10 % slightly changes these biases. There is therefore a bias in the location of the center of mass. Indeed, by translating it by - 2 cm in the cross-track direction, all offsets are within the -1/1cm interval.

Mean radial offset (cm)			
CR	DORIS	GPS	SLR
1.0	1.7	2.8	1.2
0.9	1.4	2.6	1.0



In the along-track direction, DORIS is consistent with the other tracking systems for almost all missions. For Sentinel-3A, DORIS and GPS are consistent but the LRA optical center seems to be biased.

Jason-3 GPS receiver seems also biased with respect to the DORIS receiver and the LRA. This bias can be explained by the GPS data screening and fixing the ambiguities enables to remove this along-track offset.

- **For the future Sentinel-3A GDR-F precise orbits we propose to translate the GPS receiver reference point by -1.8 cm in the radial direction, all instruments were translated by 2 cm in the cross-track direction (to keep the location of the center of mass for the altimeter products, all instruments are then translated), and the LRA reference point by 1.5 cm in the along-track direction.**

References

[1] Petit, G., & Luzum, B. IERS Conventions 2010, IERS Technical Note, No. 36 (Ch 7), 2010

[2] Ries, J. C. "Conventional Model Update for Rotational Deformation", GGOS UAW, *Paris, 2017*

[2] Ferrage, P. "DORIS missions and system news", *IDS AWG, London, 2017*