SARAL Precision Orbit Determination (MOE , POE)

L. Cerri, A. Couhert, S. Houry, F. Mercier, E. Jalabert (1)

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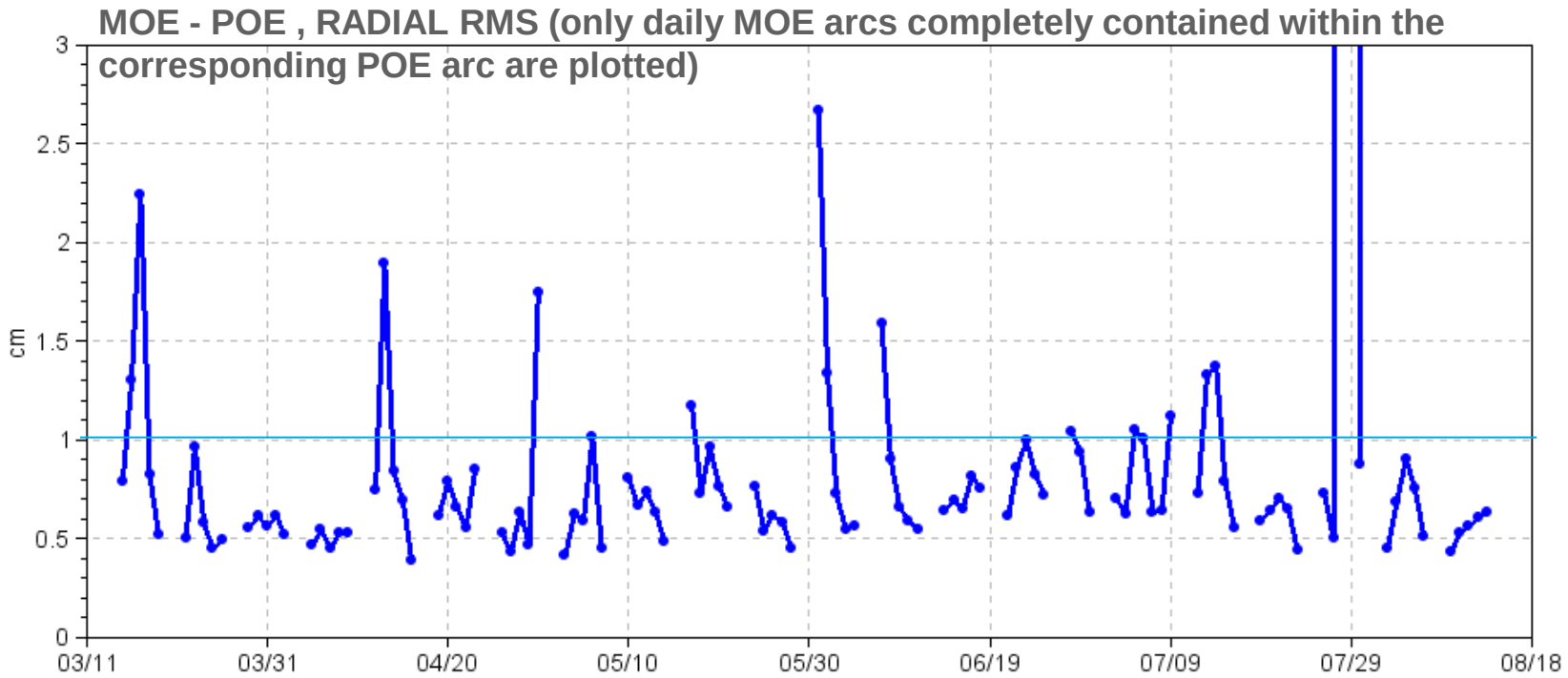
Toulouse , France

(1) CNES POD Team, Toulouse, France

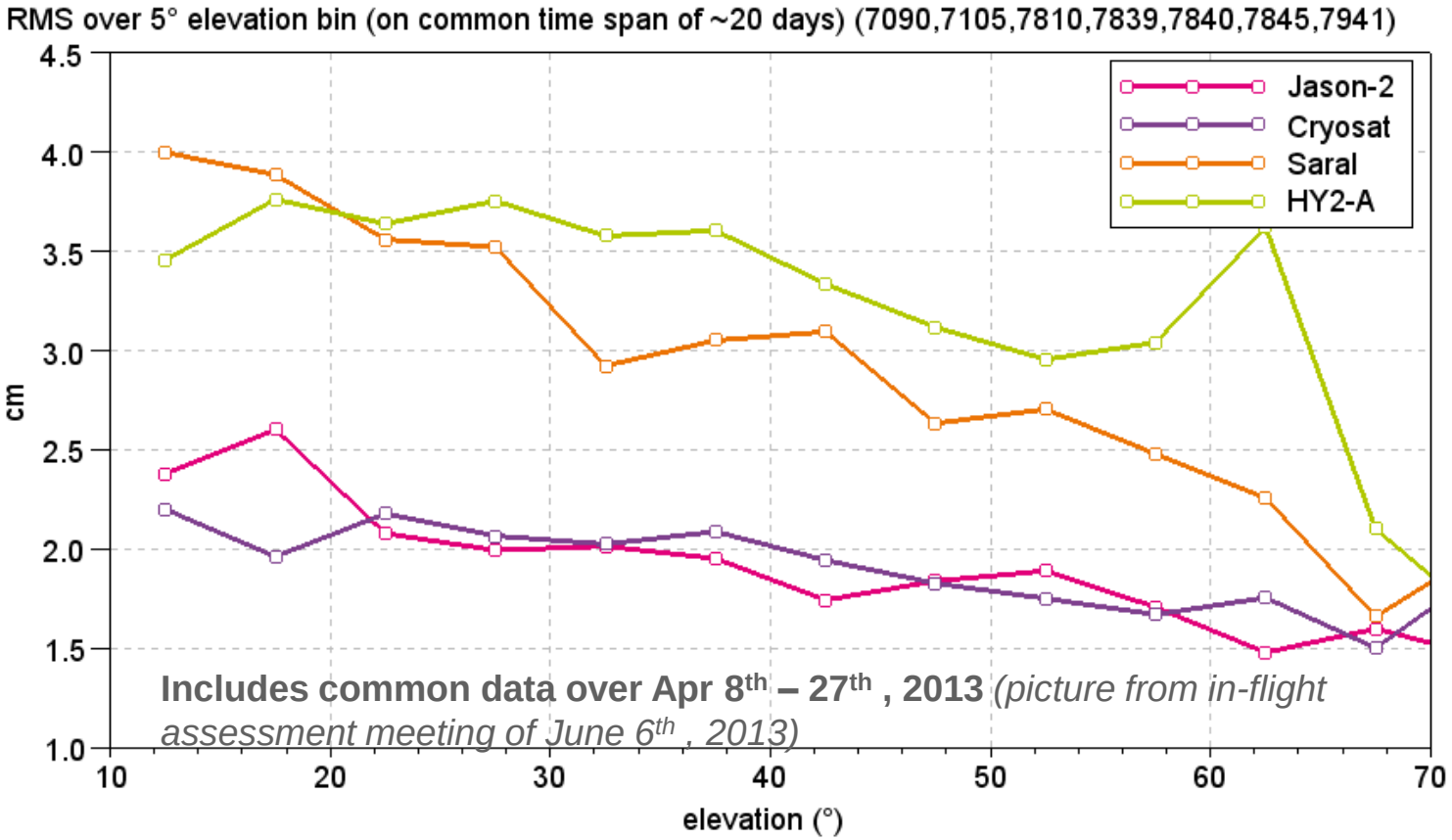
MOE

- MOE orbits routinely produced daily since Feb. 26th, 2013
- Comparison to POE is generally below 1 cm RMS
- Both solutions share essentially the same models



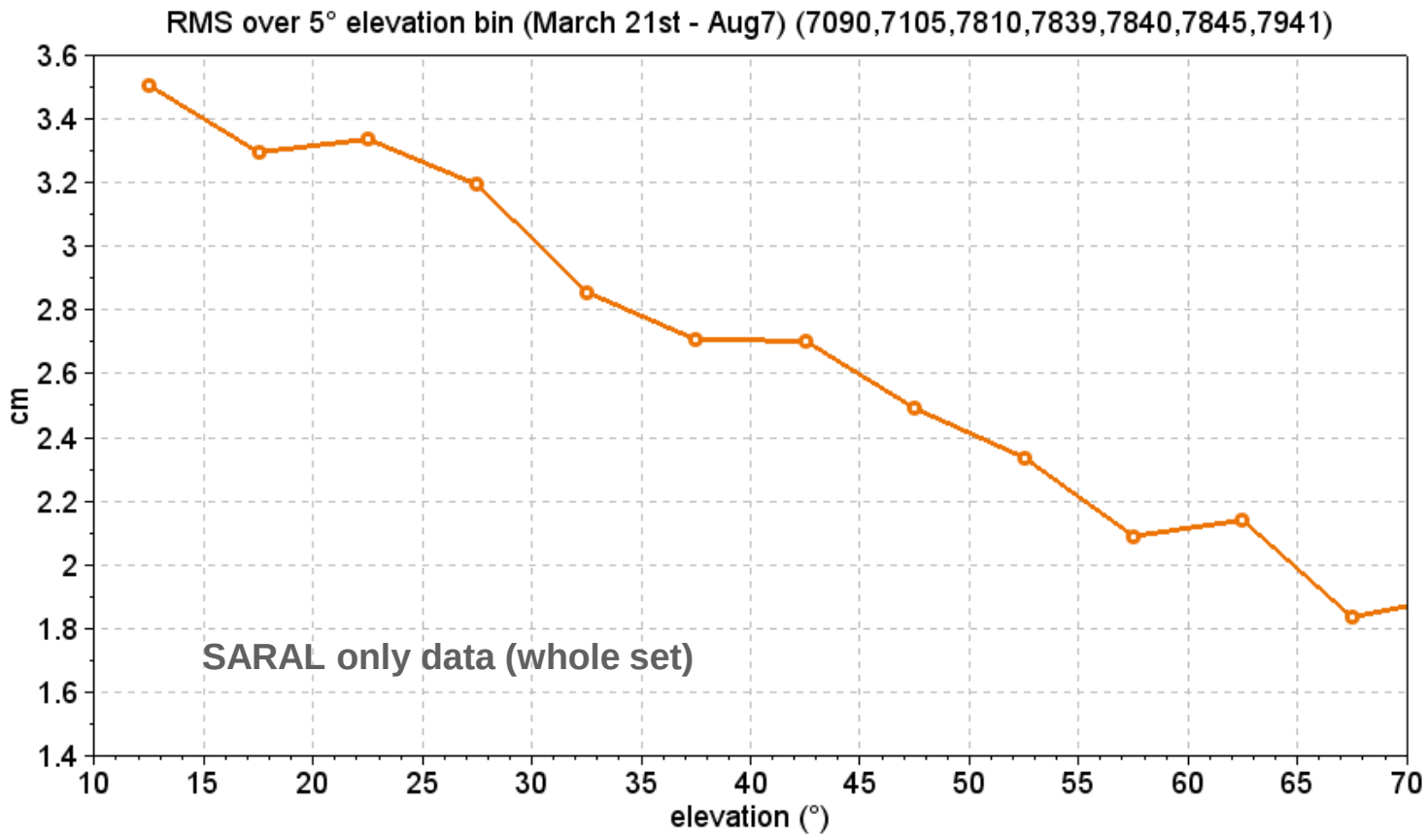
POE: SLR RESIDUALS ON DORIS-ONLY ORBITS

- **Radial accuracy** of DORIS-only orbits **better than 2 cm RMS** (SLR residuals > 70) – Similar to other DGXX-based missions
- Significant error is observed in the horizontal plane (low elevation residuals)



POE: SLR RESIDUALS ON DORIS-ONLY ORBITS

- The same level of accuracy is obtained when looking at all available SLR data over the entire data set



POE: CROSS-TRACK BIAS

- It appears that SLR residuals at low elevation are affected by a **cross-track bias of about 5 cm** of unknown origin

- Test performed : solve for optical coefficients (spec, abs) of +Z satellite surface, which results in an additional acceleration, mainly cross-track; **Estimated additional acceleration is about +5e-8 m/s2, pushing the satellite away from the sun** (5 cm / w^2)

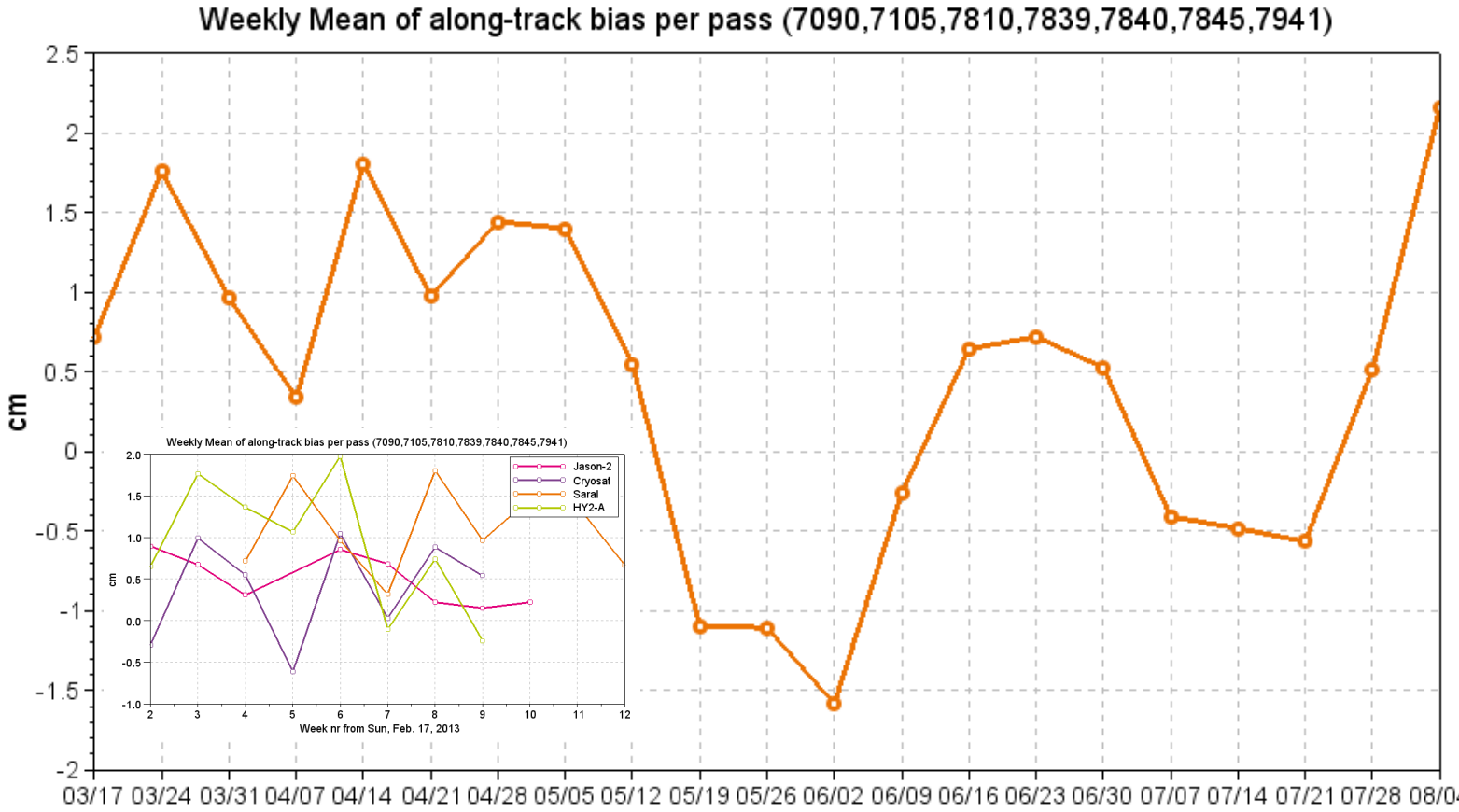
- Given the area of the +Z surface and the received power from the sun, this value is likely **too large for a surface force mismodelling error**

- The same result is obtained using either DORIS or SLR measurements → **could be partly explained by an offset in the CoM position along Z**

- POD analysis cannot distinguish between cross-track CoM offset or acceleration bias - This error is **not relevant for altimetry applications**, but **should be taken into account by IDS analysts**

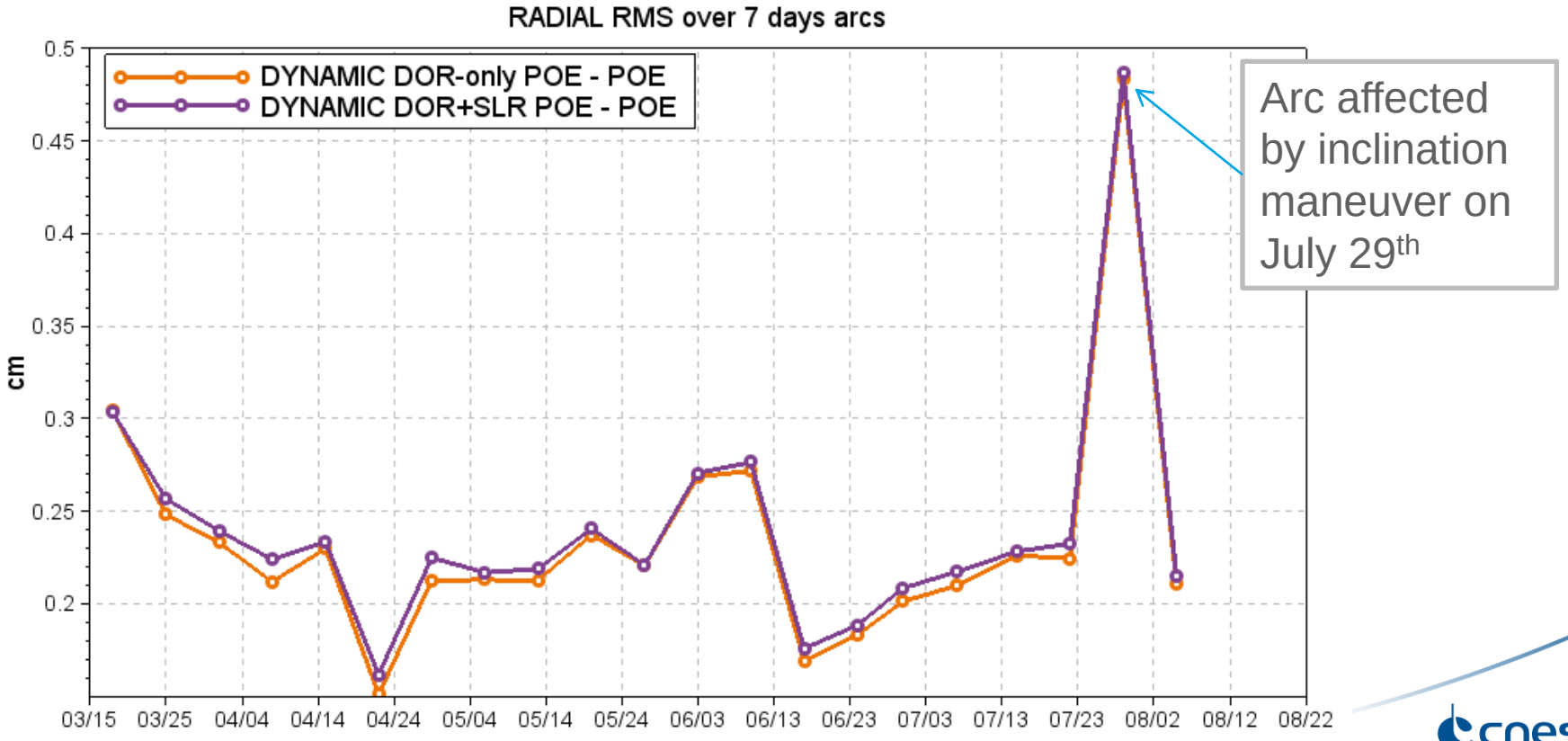
POE: SLR/DORIS ALONG TRACK BIAIS (DORIS DATATION)

- Measures the accuracy of DORIS datation as seen by SLR
- Stable, within +/- 2 cm , average close to zero
- Similar to other DGXX missions



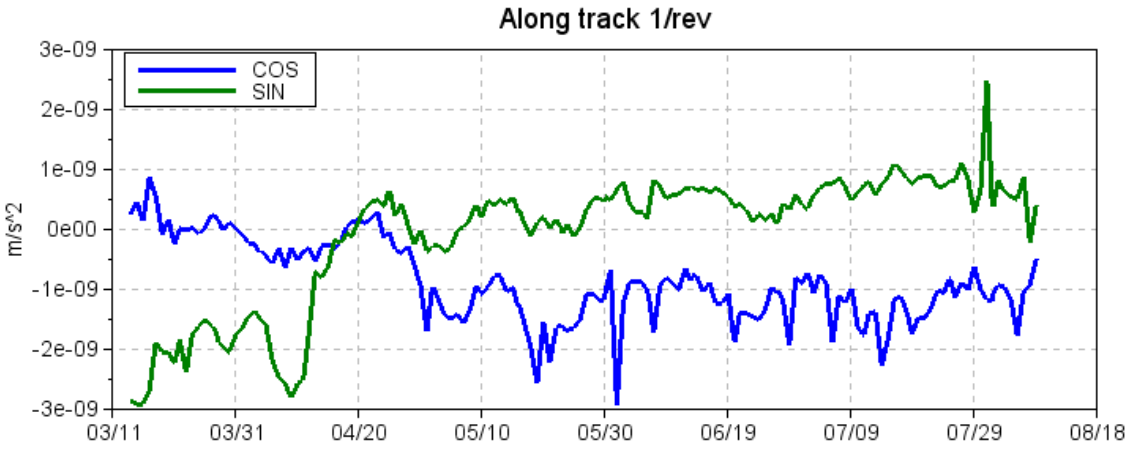
POE: INTERNAL ORBIT COMPARISON

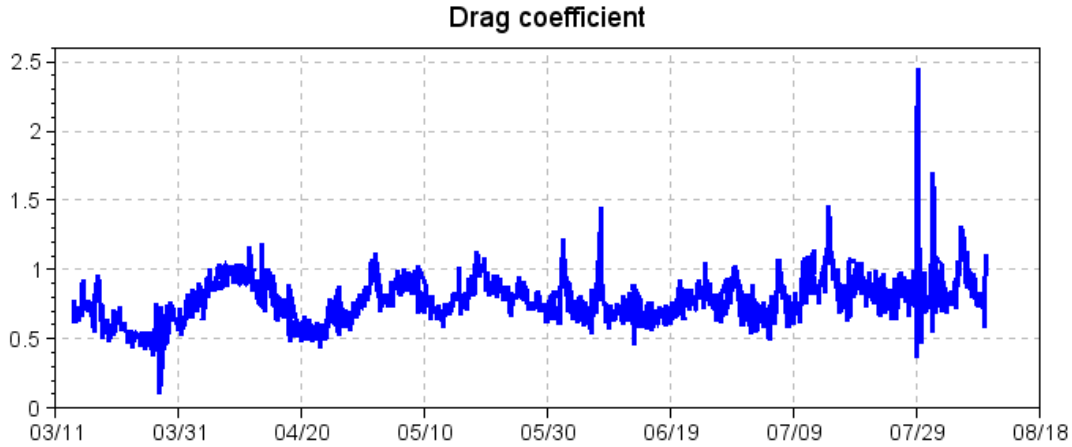
- Comparison of final POE with intermediate solutions (dynamic DORIS-only, dynamic DORIS+SLR orbit) indicates that the final orbit is essentially determined by DORIS
- The impact of stochastic process added in final POE is in the order of 2-3 mm RMS

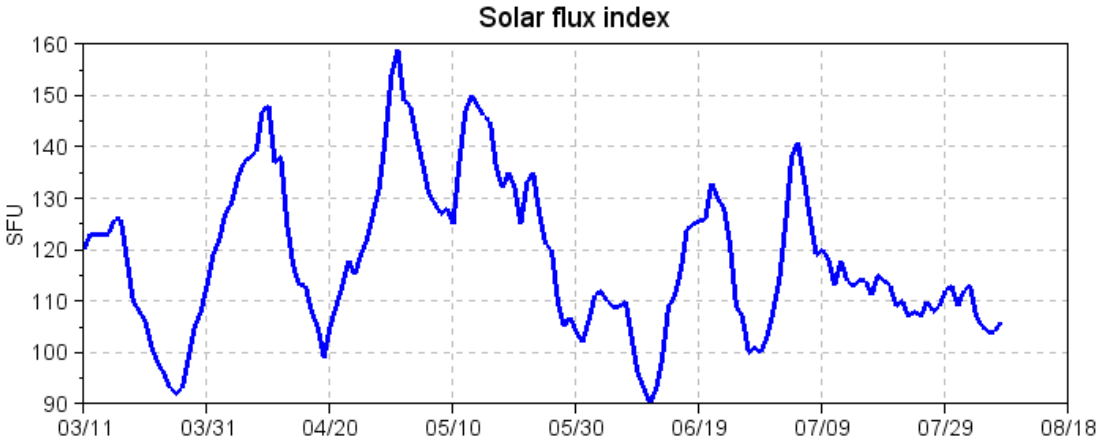


POE: estimated empirical parameters

- Solar radiation pressure acts mostly as a bias perpendicular to the orbit plane
- In this configuration, atmospheric drag mismodelling errors significantly affect the along-track 1/rev empirical (noticeable signature of the ~25-day sun-rotation cycle)
- A different behavior is observed before April 2013. Did anything change in the satellite configuration?

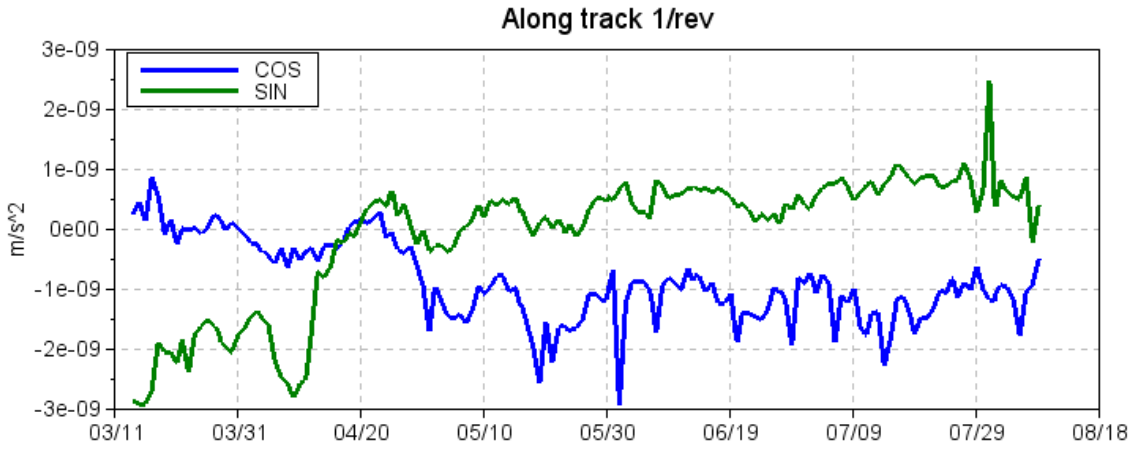


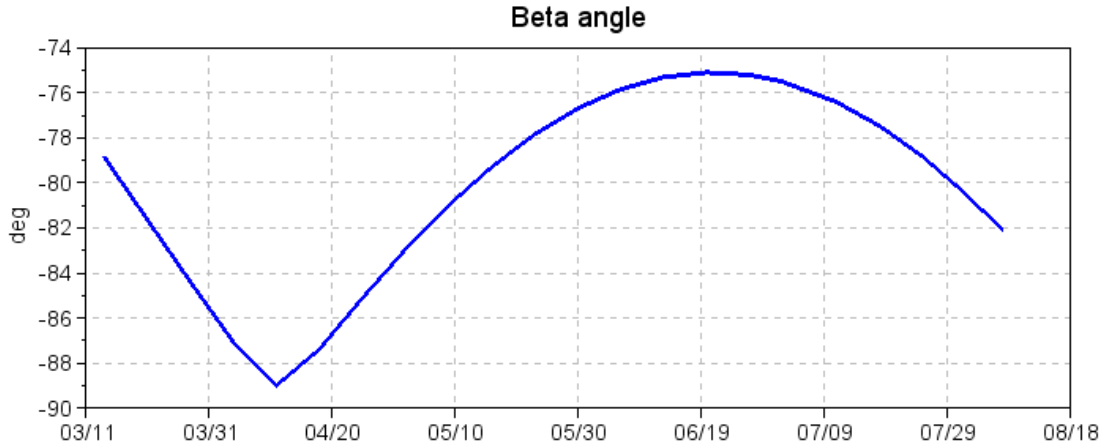


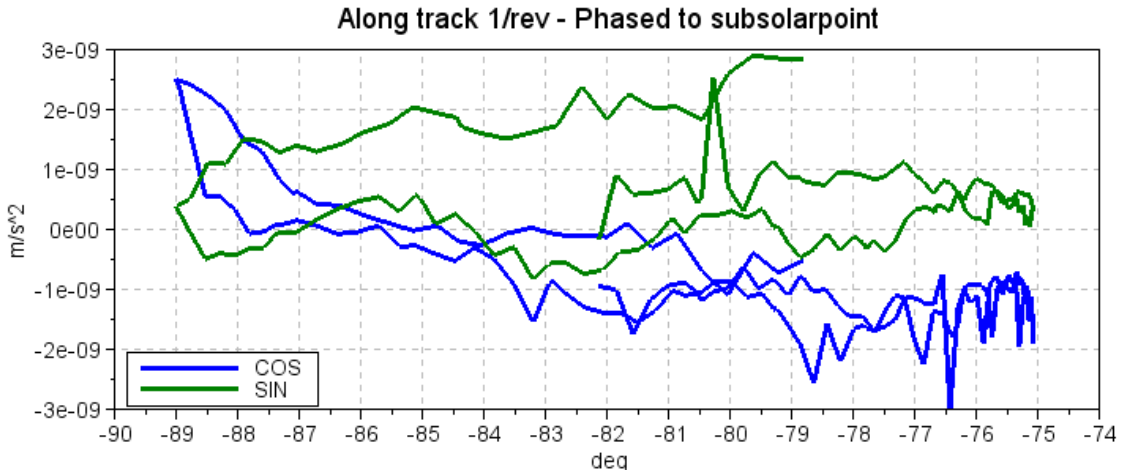


POE: estimated empirical parameters

- The systematic component in the 1/rev empiricals (constant + f(beta))– could be removed by calibration if a complete beta prime cycle (1 year) is available in stable configuration
- In conclusion, estimated empirical forces are small and comparable in amplitude to those of other missions



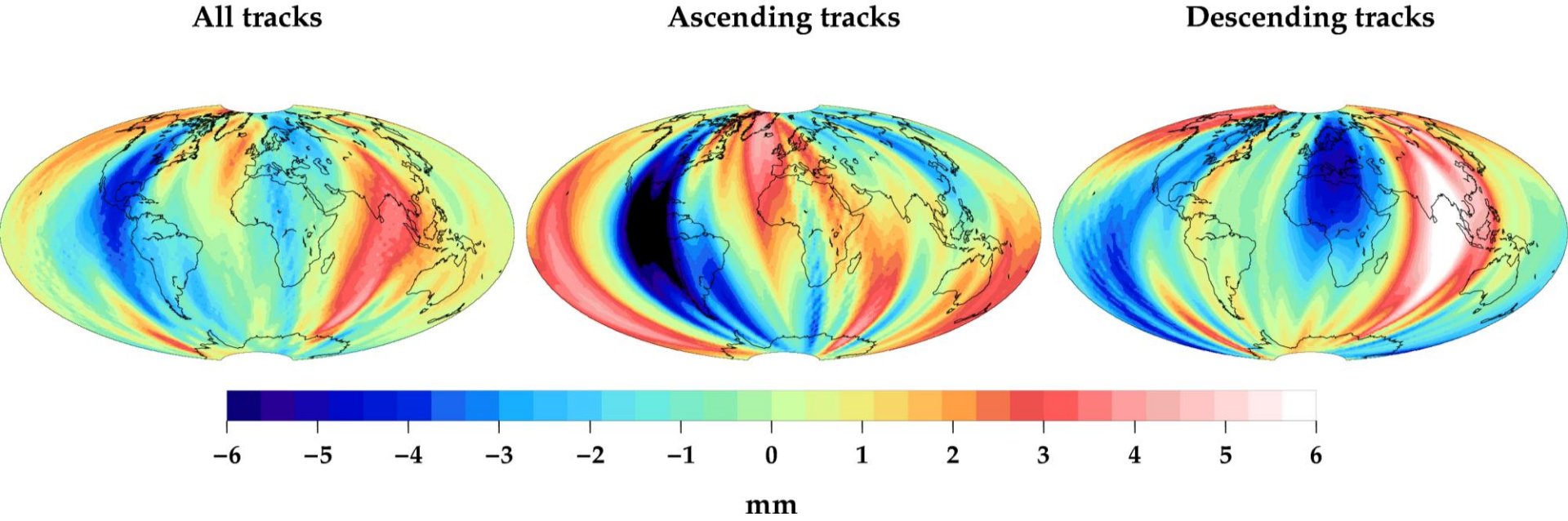




POE: SENSITIVITY TO GRAVITY FIELD ERRORS

- TVG errors are generally assessed by comparison to reference orbits obtained using a GRACE-based 10-day time series of geopotentials – which are not available after SARAL launch for the time being
- Available operational modeling options
  - **GDRD** orbit standards : EIGEN-GRGS_RL02bis_MEAN-FIELD (GRACE data < 2011 , Annual, Semi-Annual, Drifts)
  - **EIGEN-6S2** (proposed for the ITRF2013 standards) : (GRACE/GOCE data < 2012, Annual, Semi-Annual, Piecewise bias and drift per year – extrapolated with zero drift)

Doris dynamic orbits comparison : EIGEN-6S2 - GDRD



POE: SENSITIVITY TO GRAVITY FIELD ERRORS

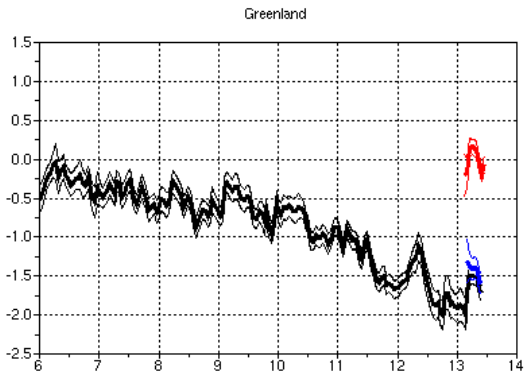
- DORIS allows to solve for local mass anomalies (mascons) to correct a given field.

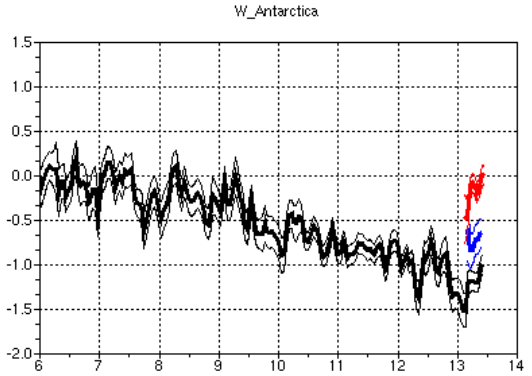
(Cerri et al. doi: 10.1016/j.asr.2013.03.023)

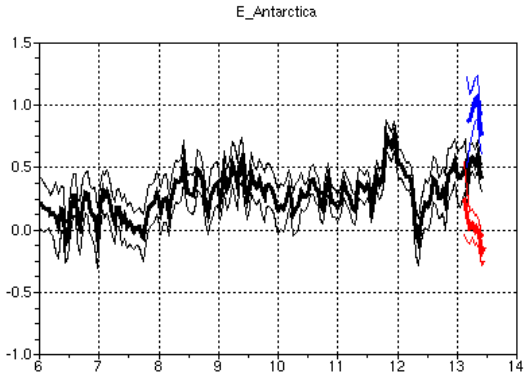
Mascons wrt to GDRD , drifts removed (Envisat, Cryosat)

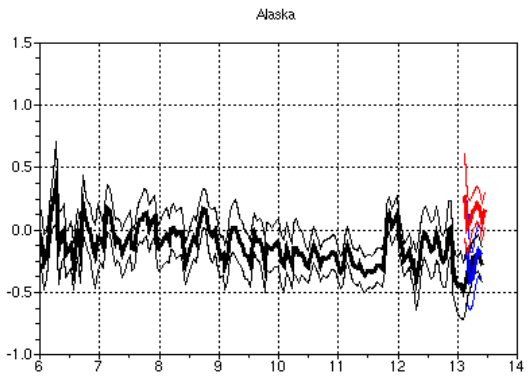
Mascons wrt to GDRD , drifts removed (Saral)

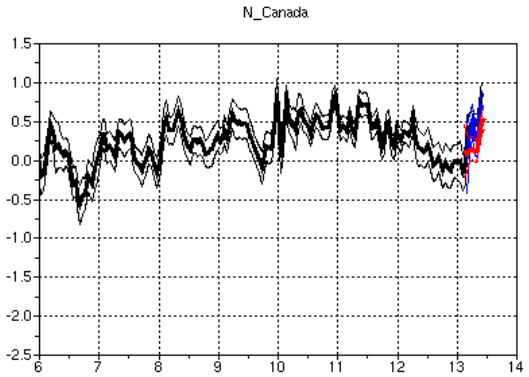
Mascons wrt to EIGEN6S2, drifts removed (Saral+Cryosat)

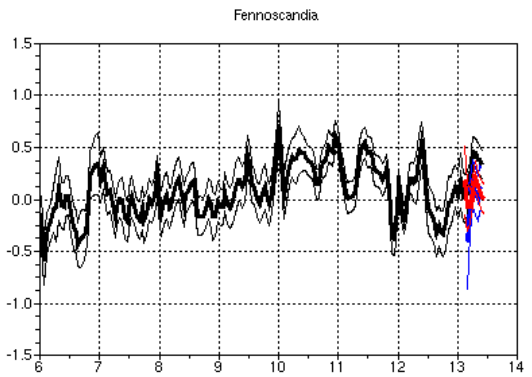








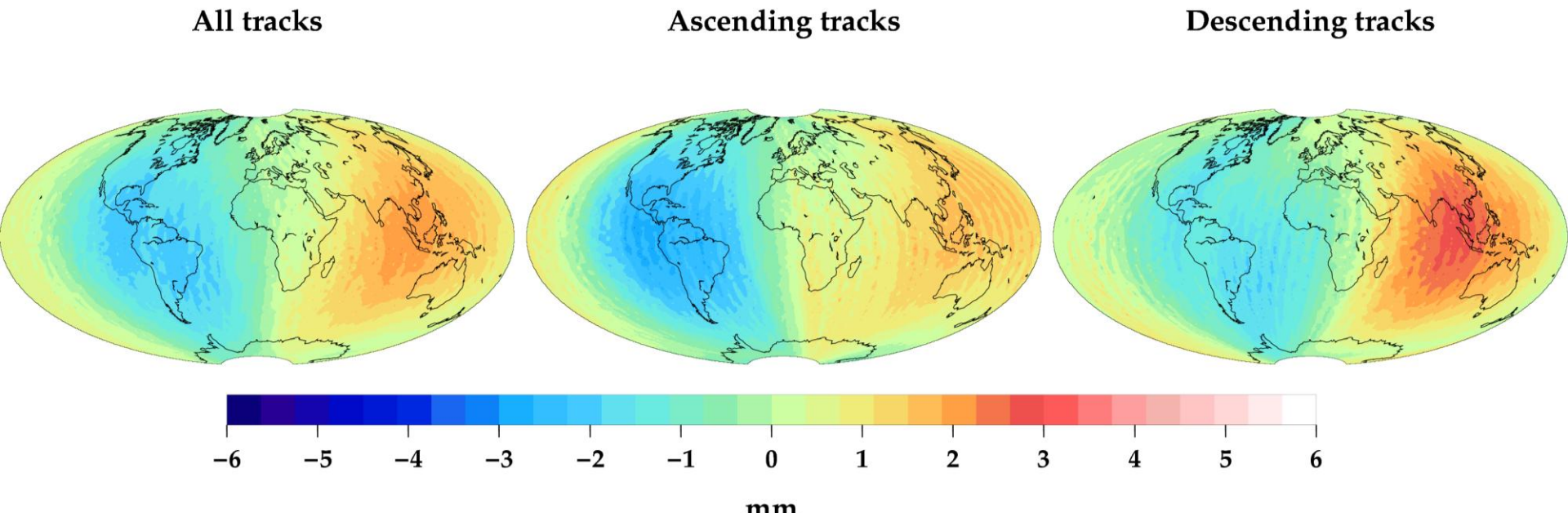




POE: SENSITIVITY TO GRAVITY FIELD ERRORS

- The mascon contribution with respect to the EIGEN-6S2 field is small (2 mm); As expected, the signature of the mascon correction is exactly the same as the one on Envisat

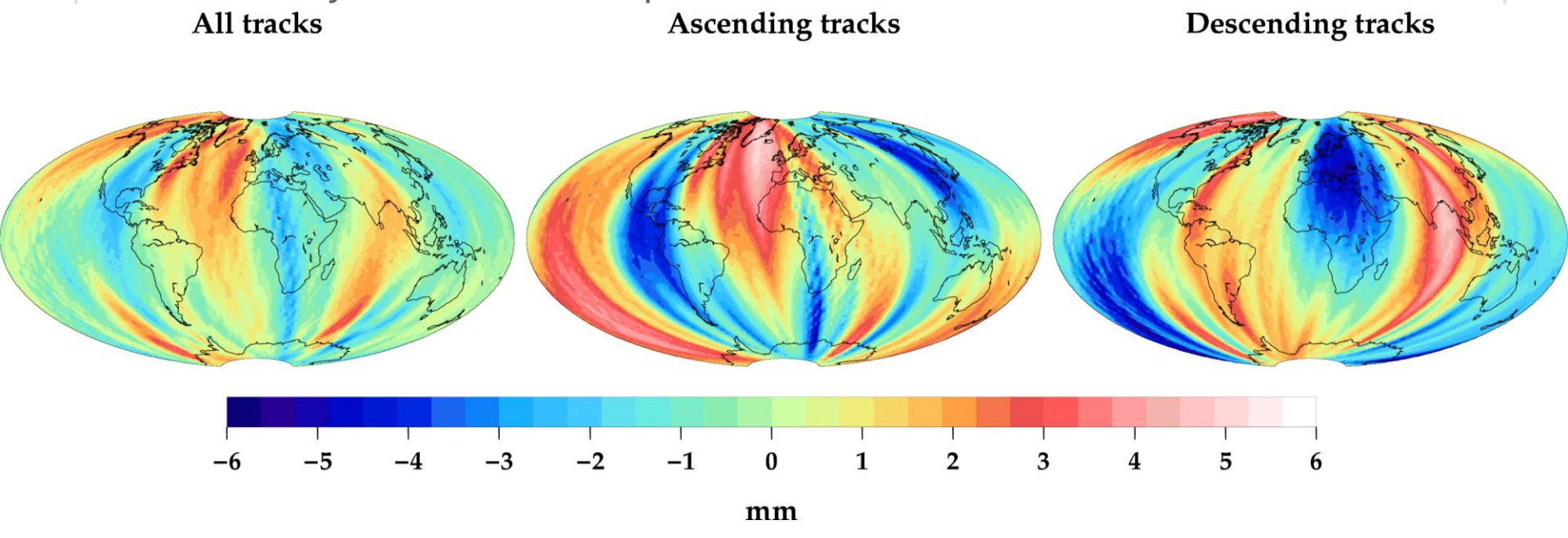
Doris dynamic orbits comparison : EIGEN-6S2 - EIGEN-6S2 + MASCON



POE: SENSITIVITY TO GRAVITY FIELD ERRORS

- Conclusion: geographically correlated orbit errors induced by gravity field mismodelling are likely in the order of 5 mm over the time interval covered by the first SARAL orbits. This estimation should be confirmed with a time series of GRACE derived fields as soon as available.

Doris dynamic orbits comparison : EIGEN-6S2 + MASCON - GDRD

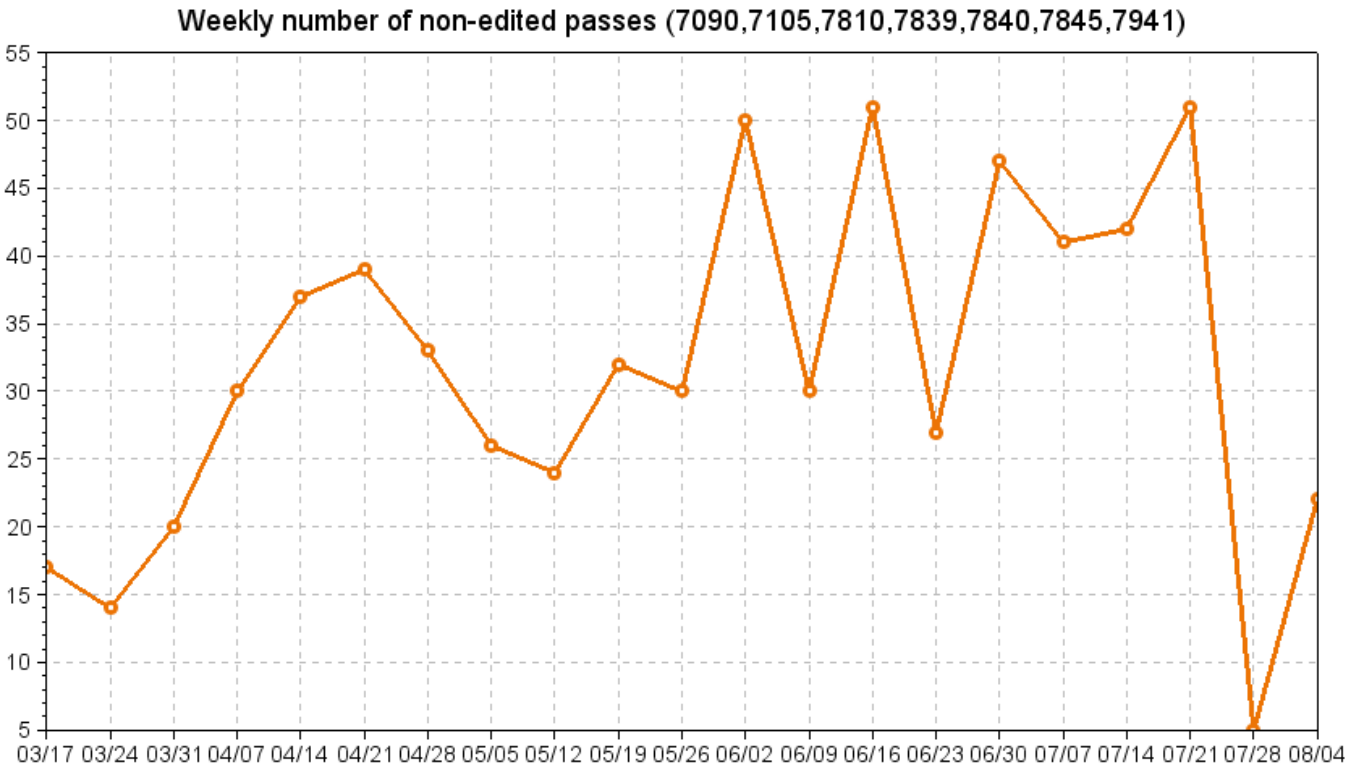


Summary and Conclusions

- The accuracy of SARAL precise orbits is comparable to that of other DORIS-based altimeter missions.
- The current estimate of the radial accuracy is better than 2 cm RMS, as measured by the core network SLR residuals at high elevations on DORIS only orbits
- The most significant contribution to the geographically correlated error component is due to the mismodeled time varying gravity field; this should not exceed 5 mm on average over the time interval covered by this analysis – TBC when GRACE time series become available
- A significant cross-track error is observed by either DORIS or SLR data. This could be due to an error along Z in a surface force model or in the center of mass Z-coordinate, or both. Given the amplitude of this error, it is unlikely that the cause is a surface force alone. No impact expected on altimeter data analysis – relevant issue for IDS

Backups

Nr of SLR passes



Nr of SLR passes