Systematic Differences in the Center-of-Origin Realization of Jason-1 and Envisat

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OSTST Annual Meeting, Lisbon, October 19, 2010

Outline

Multi-Mission Crossover Analysis (MMXO)

Envisat Orbit Solutions

Improvements made by reprocessing

Differences between CNES and ESA reprocessing

Differences in the realization of origin for Envisat and Jason-1

Conclusion

Multi-Mission Crossover Analysis (MMXO)

MMXO takes advantage of the high redundancy provided by a multiple surveying of the sea surface through contemporaneous altimeter missions.

The redundancy is expressed by short-term single and dual satellite crossover differences Δx_{ij} in all combinations.
Together with consecutive radial errors δx_i they are minimized by a least squares adjustment, which includes a variance component estimate to achieve an objective relative weighting between different missions.

Main steps:

1) Computation of **single and dual-satellite crossover differences** Δx_{ij} in all combinations
2) Minimizing both $\Delta x_{ij} = x_i - x_j$ and $\delta x_i = x_{i+1} - x_i$ and estimation of radial errors x_i at all crossover points within a **least squares adjustment**
3) Derivation of relative range biases, center-of-origin shifts as well as common error components of ascending and descending passes

Orbit Solutions available for ENVISAT

Originally GDR orbits

- GDR-A (009-040), GDR-B (041-067), GDR-C (068-070), GDR-C' (since 071)
- Inhomogeneous, partly based on GRIM gravity field and ITRF2000

Version	Cycle	Gravity field	Reference System	Tracking Systems
GDR-A	09-40	GRIM5	ITRF2000	DORIS/SLR
GDR-B	41-67	EIGEN-CG03C	ITRF2000	DORIS/SLR
GDR-C	68-	EIGEN-GL04S	ITRF2005	DORIS/SLR

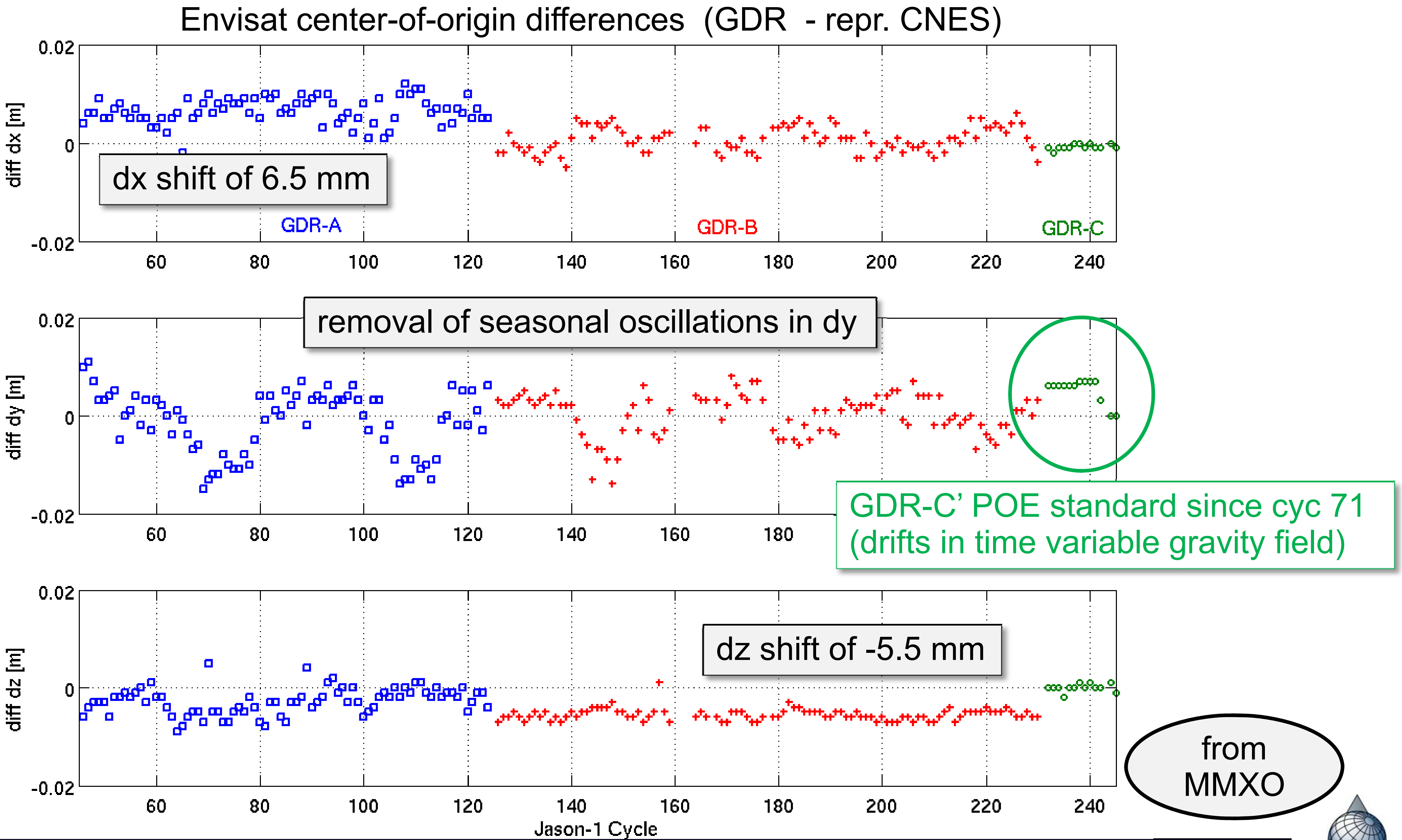
Reprocessed CNES orbits

- available for cycles 015 – 071, GDR-C' POE standard
- not available for the first part of the mission (about 0.5 years)

Reprocessed ESA orbits (sol6)

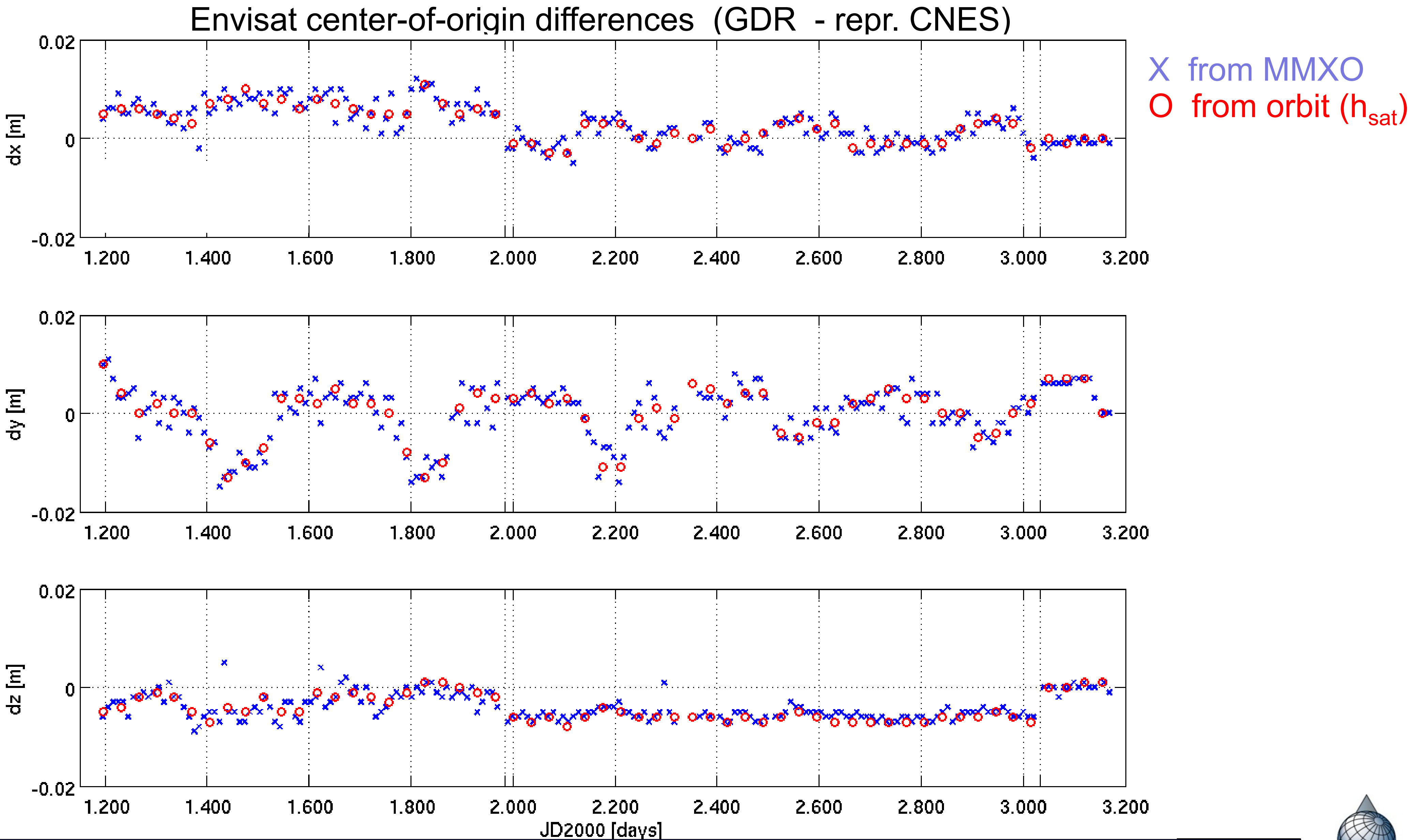
- available for whole mission lifetime (cycles 009-090)

Orbit improvements due to Reprocessing



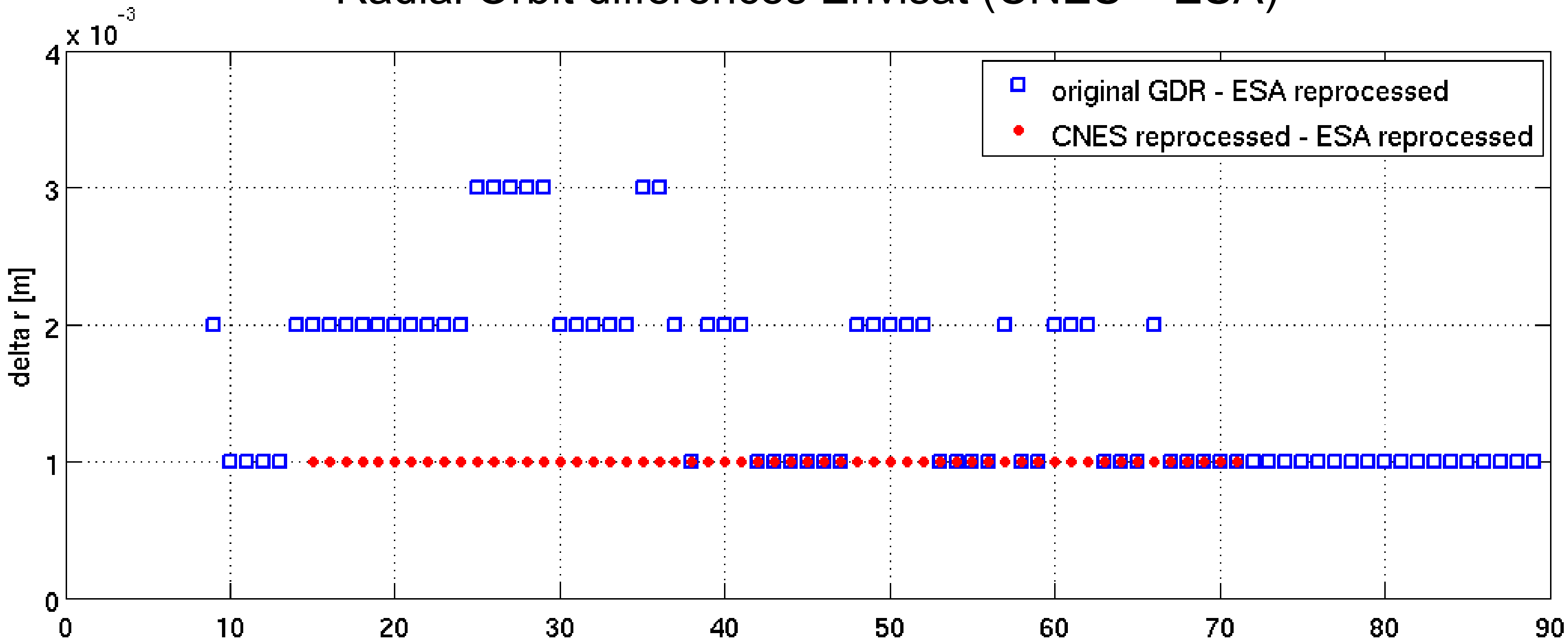
from MMXO

Orbit improvements due to Reprocessing



Differences between CNES and ESA reprocessing

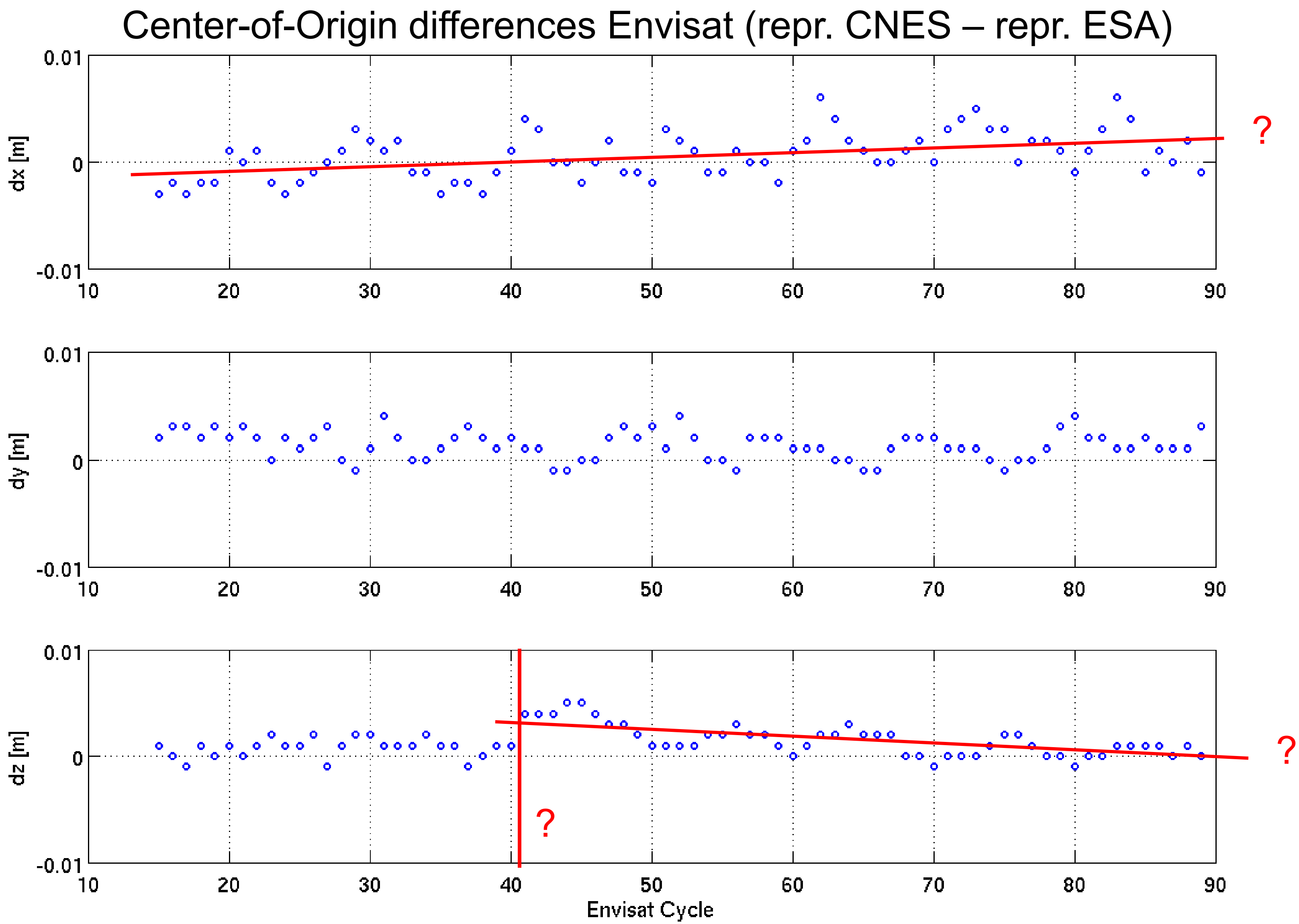
Radial Orbit differences Envisat (CNES – ESA)



- maximal difference of 3 mm
- differences in reprocessing solutions 1 mm

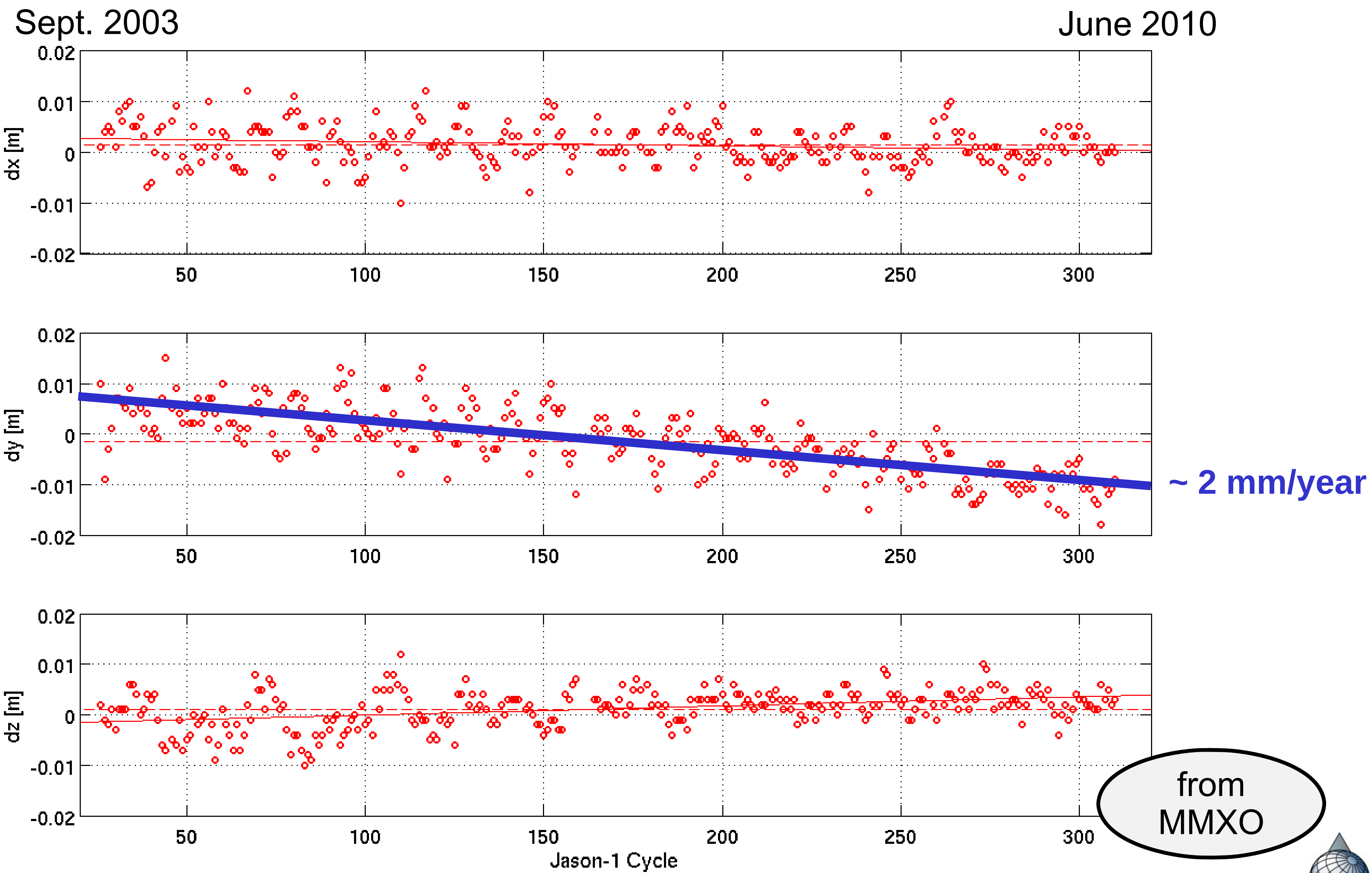
=> Orbit solution do not change the range bias of Envisat

Differences between CNES and ESA reprocessing

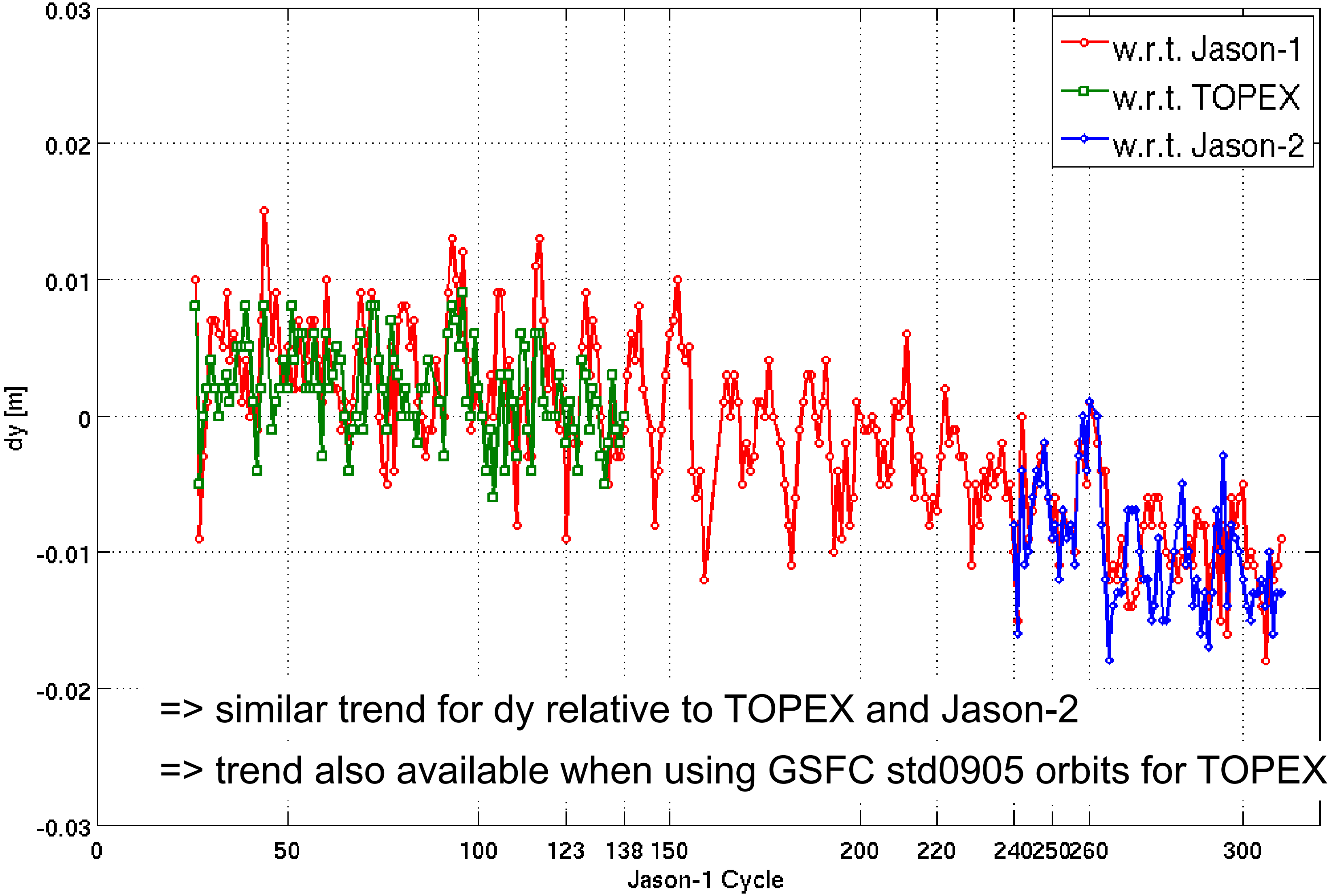


=> no significant differences in realization of origin between ESA and CNES

rel. center-of-origin shifts of Envisat w.r.t. Jason-1



rel. center-of-origin shifts of Envisat



=> similar trend for dy relative to TOPEX and Jason-2

=> trend also available when using GSFC std0905 orbits for TOPEX and Jason

rel. center-of-origin shifts of Envisat

What is the reason for this trend ???

it is visible for all orbit solutions (CNES/ESA/GSFC)
it is probably caused by Envisat
may also be a long-period oscillation
significant only in the y-component

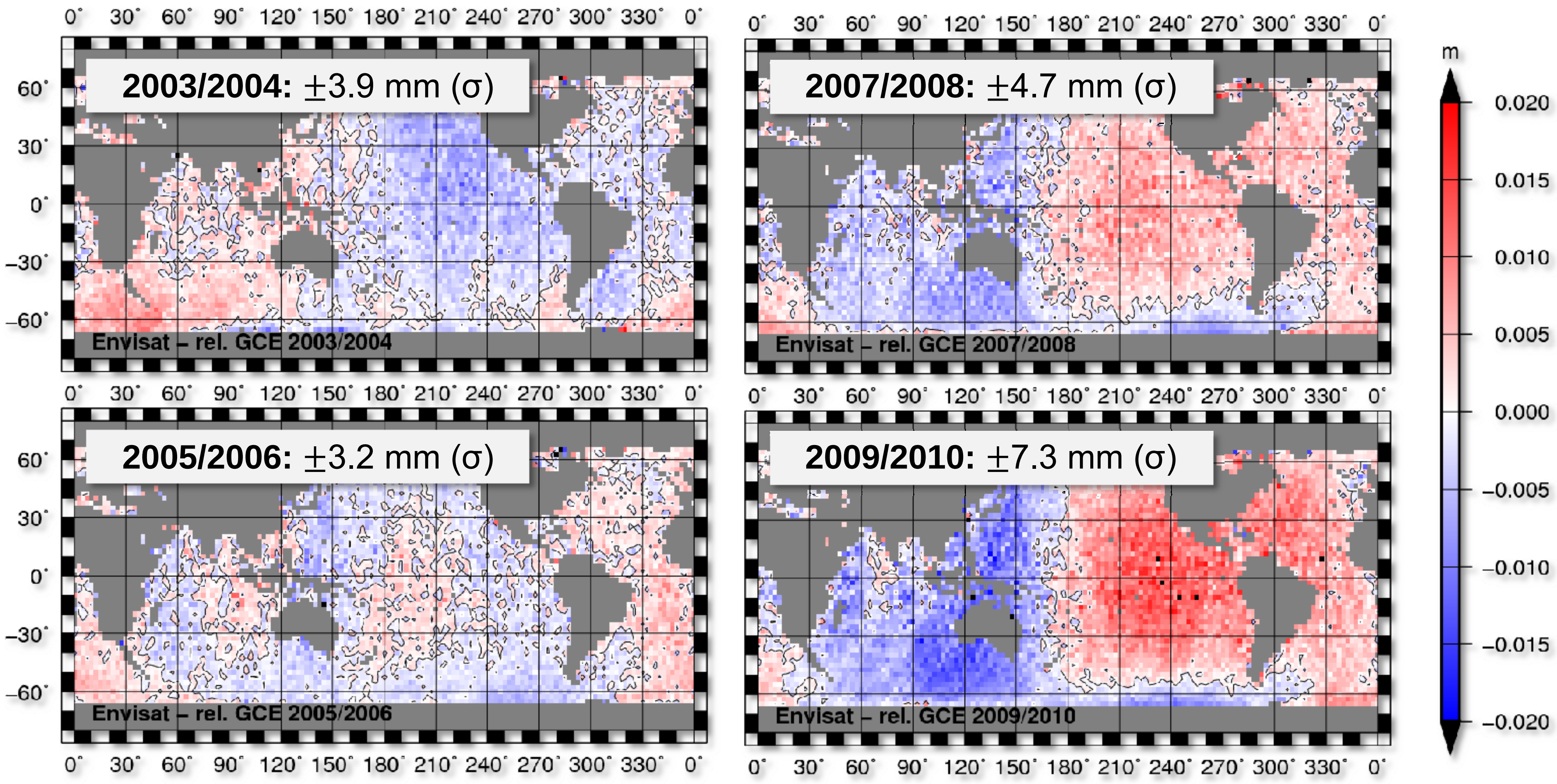
Possible explanations:

⇒ Solar Radiation pressure model
⇒ time variable gravity field (different orbit heights)
⇒ tracking system differences
⇒ reasons other than orbit
⇒ … ???

What are the consequences of this trend ???

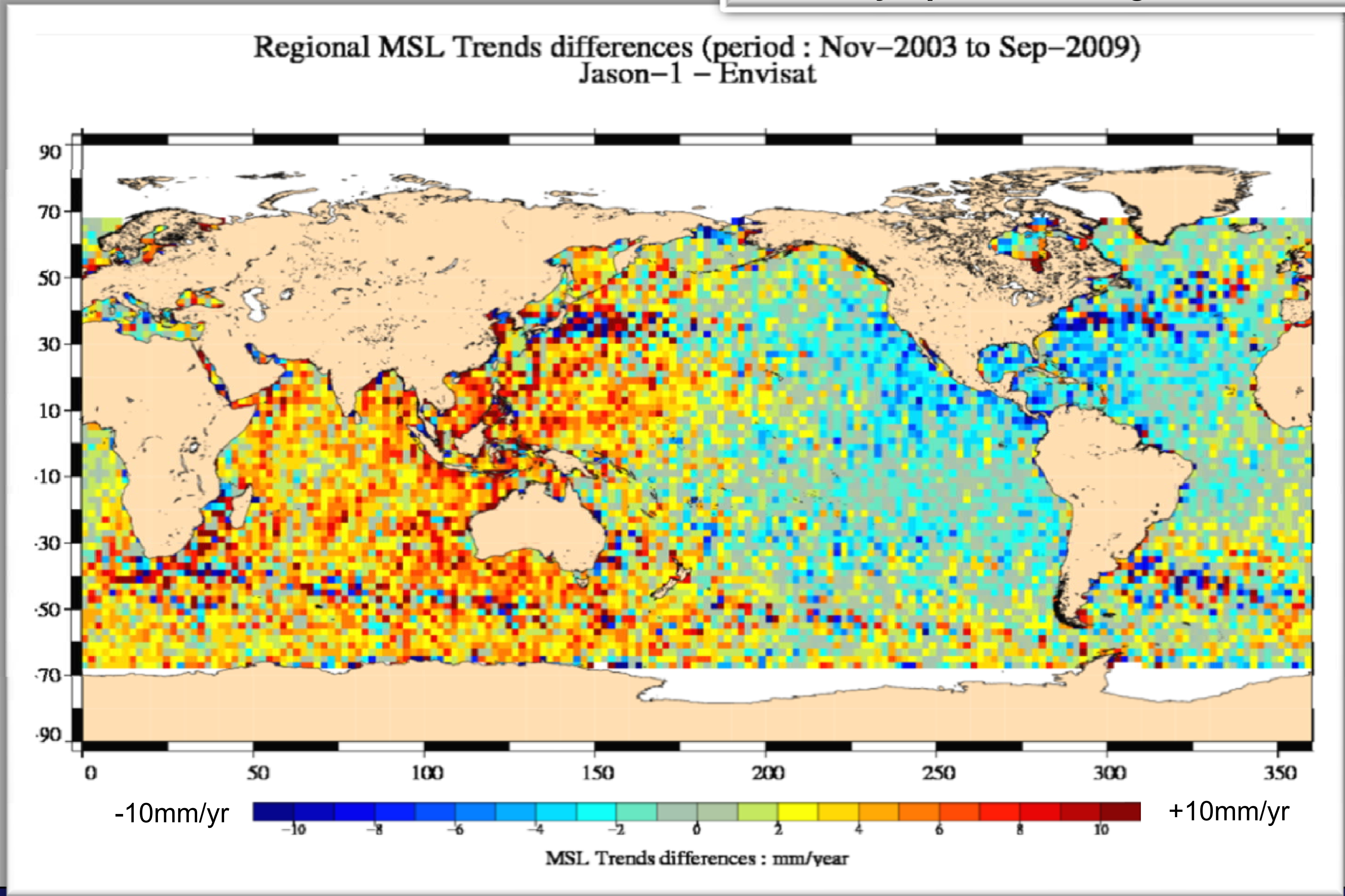
⇒ time-dependent geographically correlated errors

relative GCE of Envisat (w.r.t. Jason-1)



Mean sea level trends

taken from:
Faugere et al. (2010): *Envisat ocean altimetry performance assessment*, Living Planet Symposium, Bergen



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Conclusion

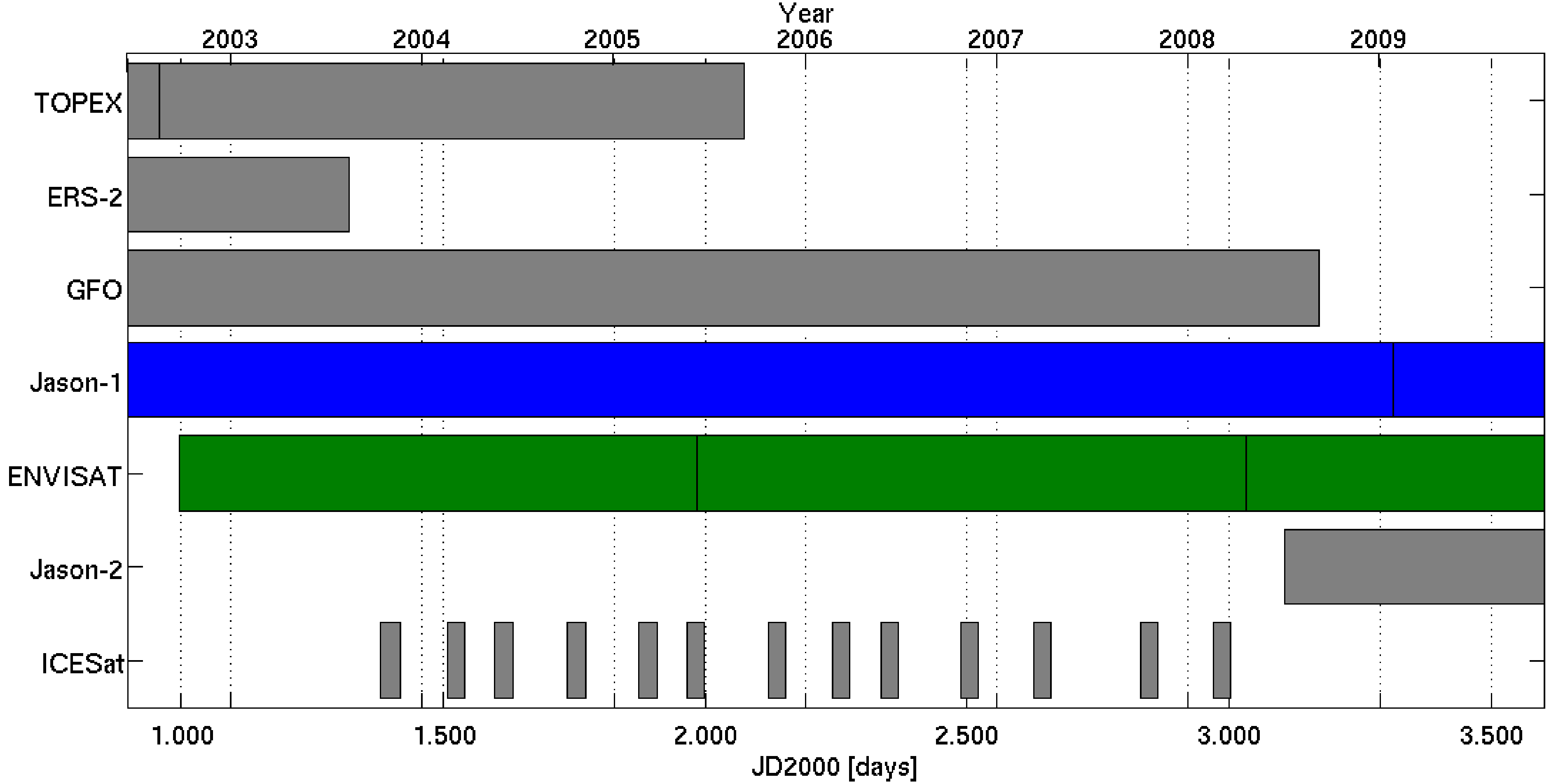
✓ MMXO can reveal range bias between different altimeter missions as well as information on the center-of-origin realization and geographically correlated errors. It is independent from orbit configuration (no repeat tracks, formation flights, etc. necessary).

✓ New, consistent Envisat orbits for the whole missions lifetime are available. There are no significant differences between reprocessing solutions from CNES and ESA.

✓ Small but significant differences in the realization of orbit origin of Envisat and Jason exist, mainly in the y-component. The reasons are still unknown.

The End

Missions included in MMXO



Center-of-Origin Shifts

Separation of radial errors into range bias and center-of-origin shifts

Least square adjustment for each 10-day cycle

$$x_i + \varepsilon_{x_i} = \Delta r + \Delta x \cos\varphi_i \cos\lambda_i + \Delta y \cos\varphi_i \sin\lambda_i + \Delta z \sin\varphi_i$$

input: radial errors x_i at location φ_i, λ_i

output: mean range bias Δr

mean center-of-origin shifts Δx, Δy, Δz

Geographically correlated errors

Radial Errors are available for ascending and descending tracks.

From the differences between ascending and descending errors (mean values per 2.5° by 2.5° region) the mean GCE can be computed:

$$\Delta\gamma = (dr^{asc} + dr^{desc})/2$$

[Rosborough, 1986]

dr^{asc}	average of the radial errors (mean reduced) of all asc. passes
dr^{desc}	average of the radial errors (mean reduced) of all desc. passes
$\Delta\gamma$	mean of ascending and descending errors, GCE per cell