# Geographically correlated errors for latest Jason-1/2 and TOPEX orbits

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# Outline

**Input Data**

**Multi-Mission Crossover Analysis (MMXO)**

**Differences in the realization of origin**

**Consistency between Jason-1 and Jason-2 origin**

**Geographically correlated mean errors (GCE)**

**Conclusion**

# Input Data

About 15 years of data from 8 different missions are used for the MMXO:

ERS-1, ERS-2, Envisat, GFO, ICESat (with original orbits)
TOPEX, Jason-1, Jason-2 (with two different types of orbits)

| | TOPEX | Jason-1 | Jason-2 |
|---|---|---|---|
| original orbit | MGDR-B | GDR-C | GDR-T |
| reprocessed orbit | GSFC std0905 *[Lemoine et al. (2010)]* | | |
| cycle | 001-446 | 001-259 | 001-056 |

In advance to the MMXO analysis the altimeter data of all missions are as far as possible harmonized by applying the same geographical correction models for all missions (e.g. DAC and tides). This widely excludes that the identified GCE pattern reveal other than orbit errors.

# Multi-Mission Crossover Analysis (MMXO)

## 1) Computation of Crossovers Differences

Computation of crossover differences in all combinations (single-satellite as well as dual-satellite crossovers)

## 2) Least Square Adjustment

Determination of radial errors per mission in 3D (time, latitude, longitude)
Method: Minimization of crossover differences as well as of consecutive errors

## 3) Error Decomposition

Separation of range bias from differences in center-of-origin realization
Computation of geographically correlated errors

# 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 $\varphi_i$, $\lambda_i$

output: mean range bias $\Delta r$

mean center-of-origin shifts $\Delta x$, $\Delta y$, $\Delta z$



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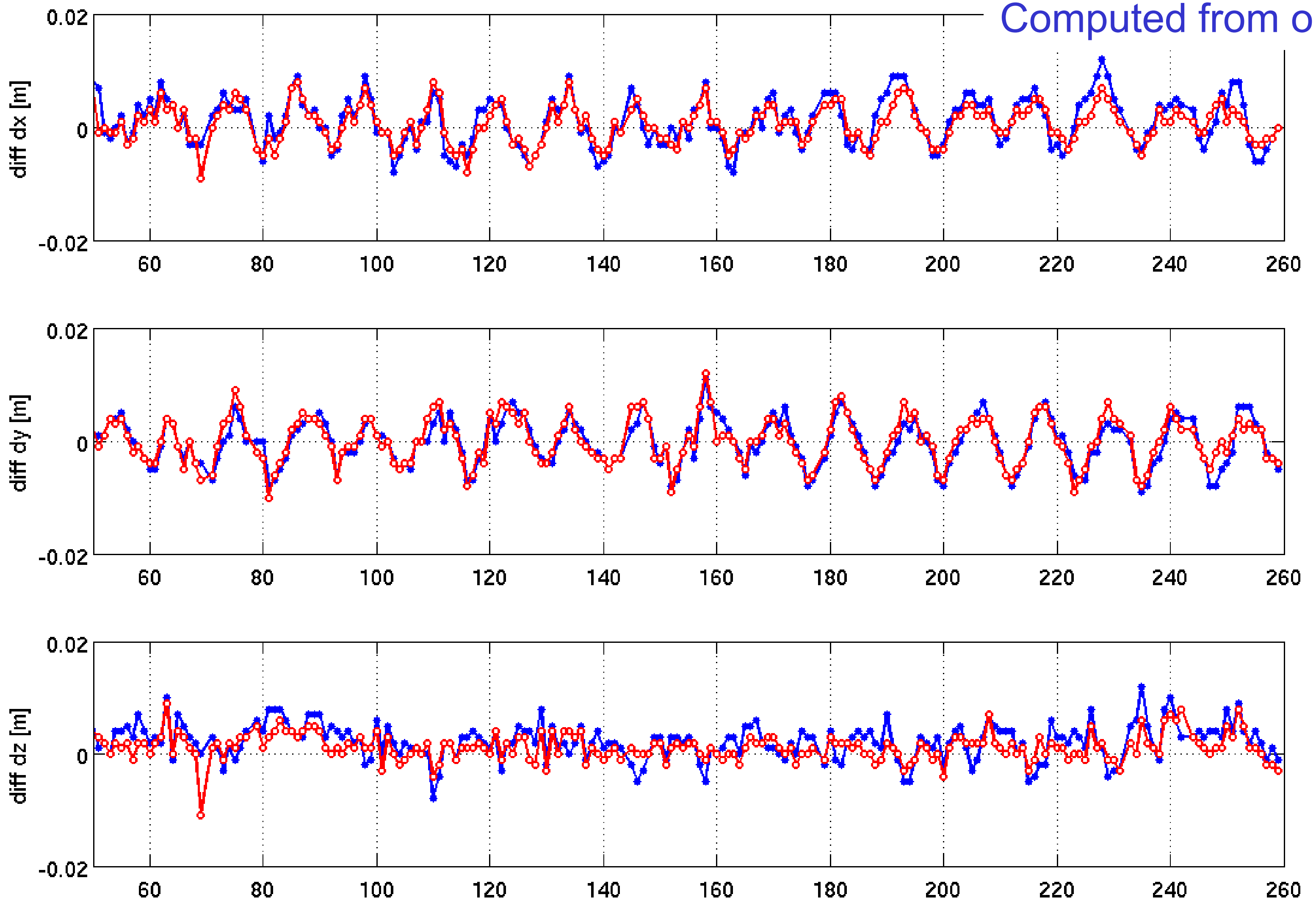
# Differences in the realization of Jason-1 origin

GSFC – GDR orbit

Computed from MMXO

Computed from orbit ($h_{sat}$) differences




high correlation:

ρ=0.9

ρ=0.9

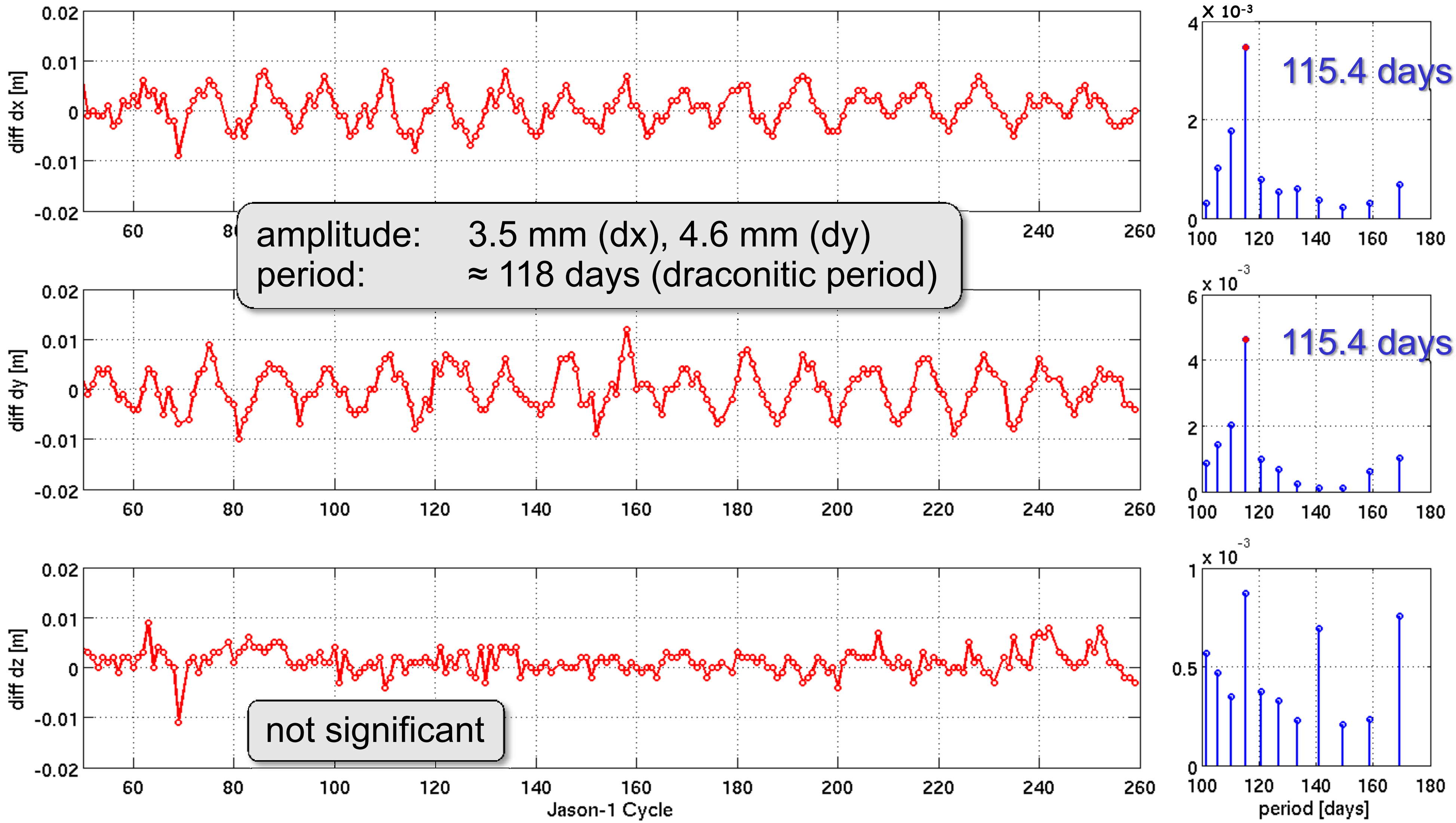
ρ=0.7

=> MMXO is able to detect differences in the origin realization

# Differences in the realization of Jason-1 origin

GSFC – GDR orbit

power spectrum

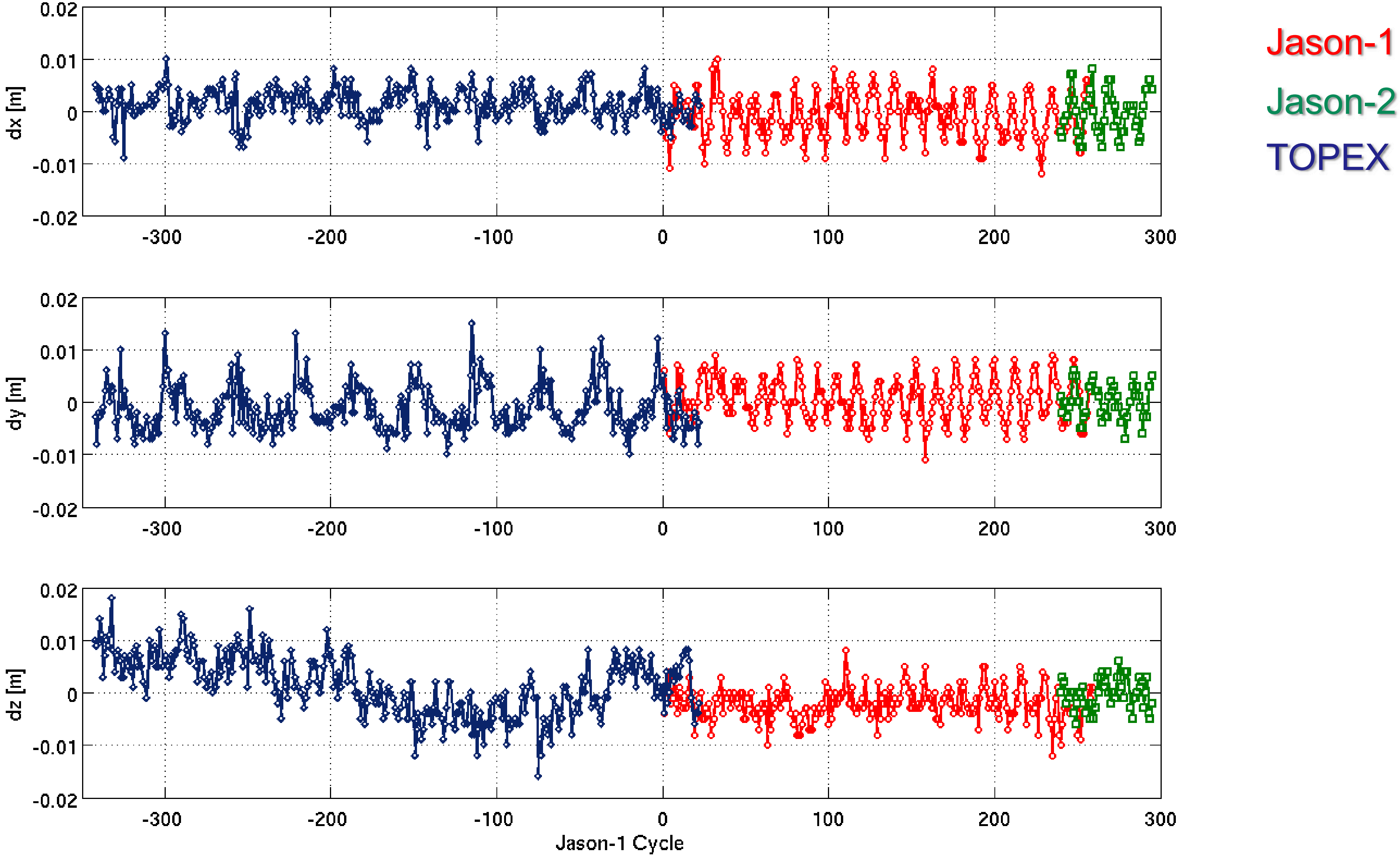



amplitude: 3.5 mm (dx), 4.6 mm (dy)
period: ≈ 118 days (draconitic period)

not significant

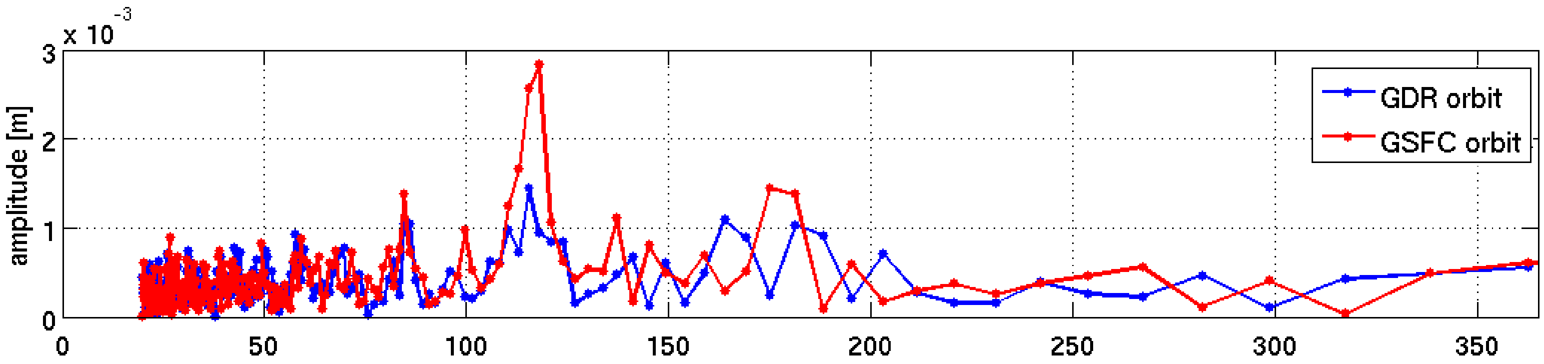
# Differences in the realization of origin (GSFC – GDR)

GSFC – GDR orbit



# Differences in the realization of origin (GSFC – GDR)

•oscillation mainly in GSFC solution

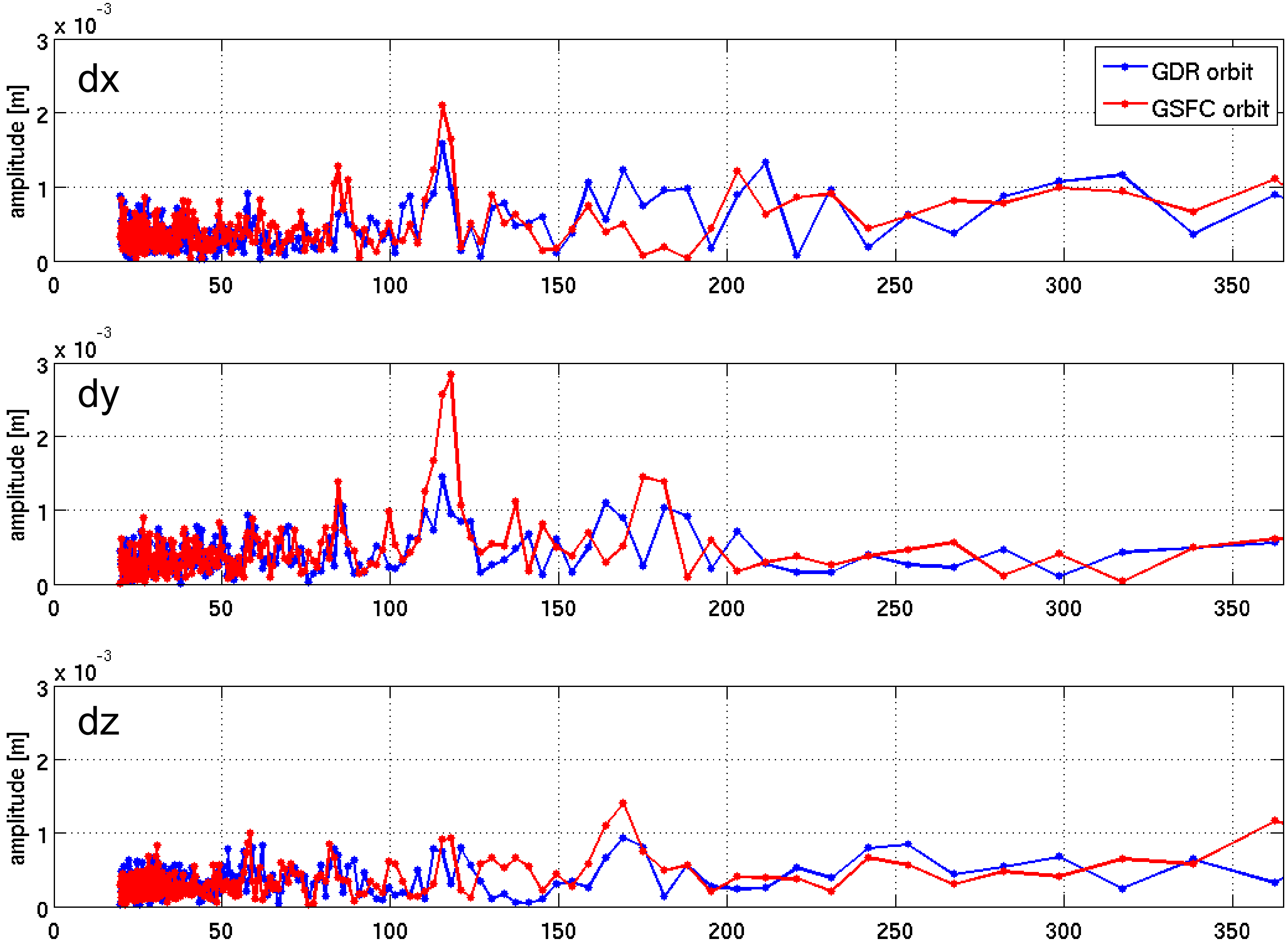



• same for Jason-2 differences

<u>Reason ?</u>

✓ Correlation to solar illumination (beta angle)
✓ Probably caused by new radiation pressure model (UCL)
? only in x,y and not in z component

# Differences in the realization of origin (GSFC – GDR)




Reason ?

✓ Correlation to solar illumination (beta angle)

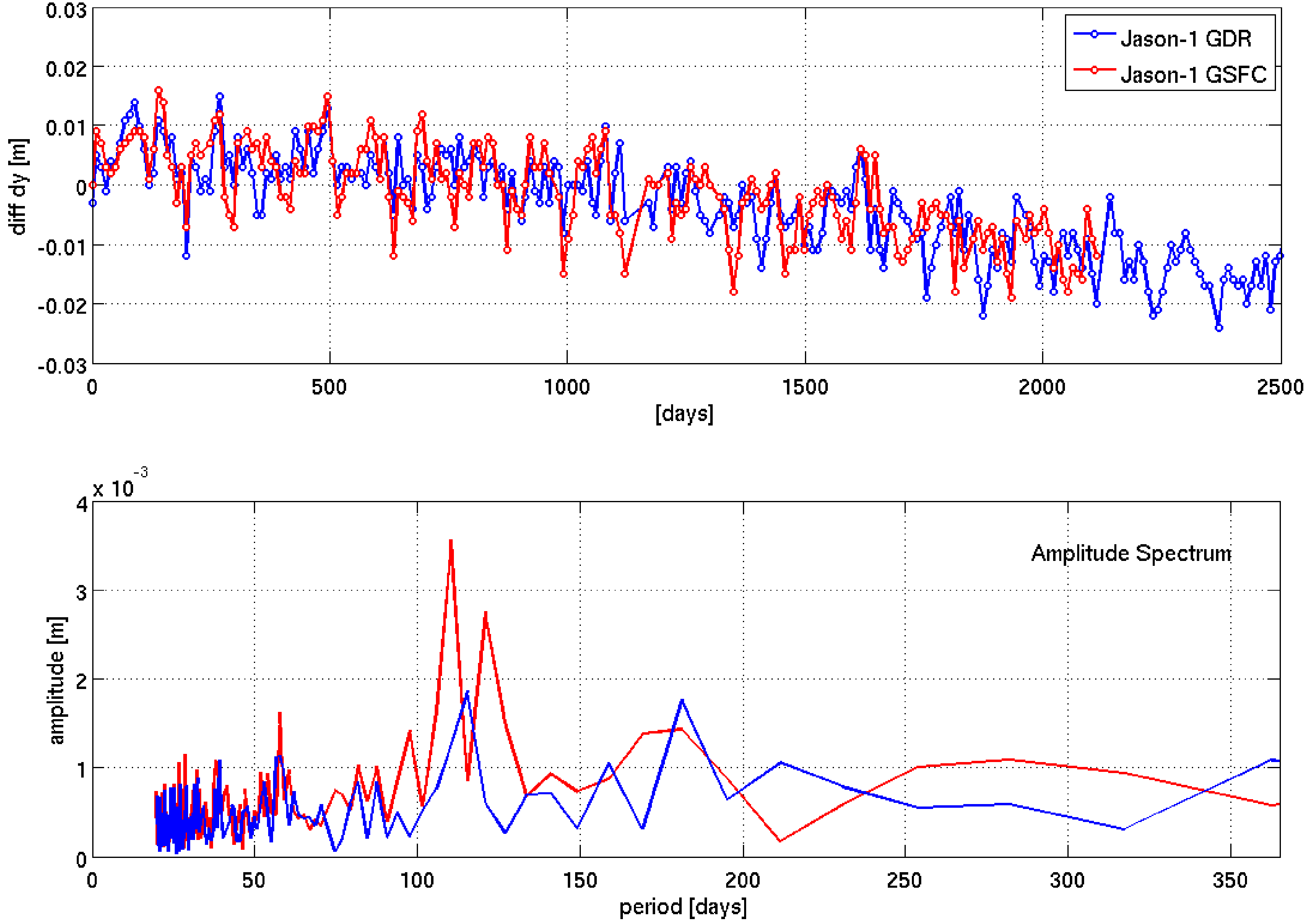
✓Probably caused by new radiation pressure model (UCL)

? why in x,y and not in z component?

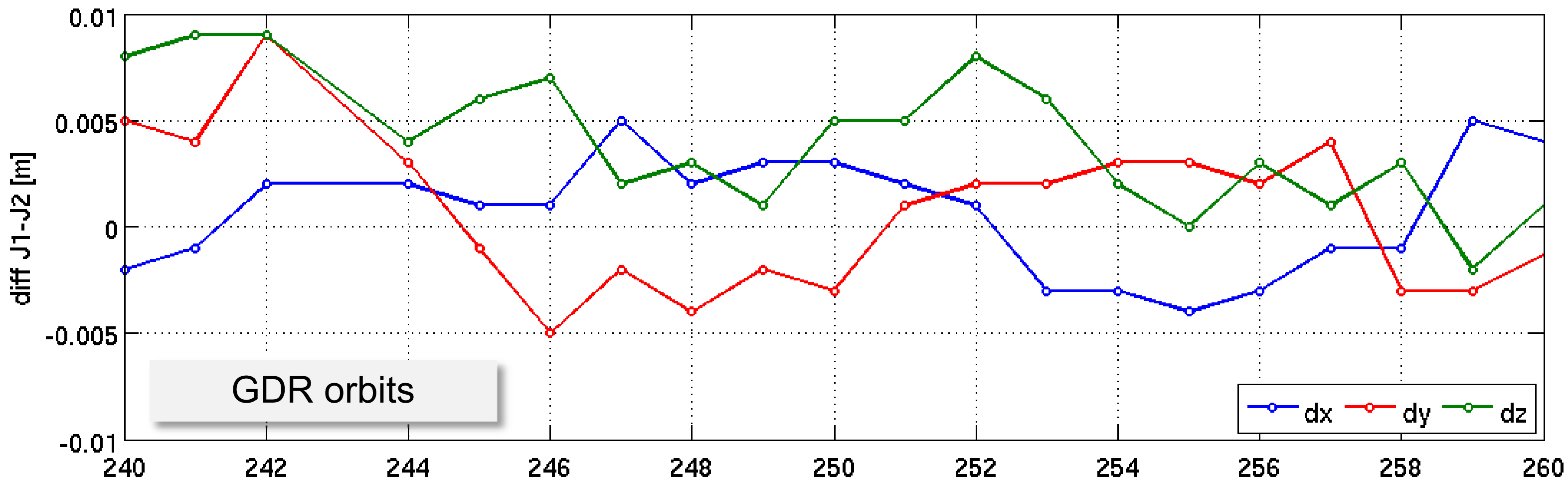
=> 118 days period is included in GSFC orbit

# Differences in the realization of origin (GSFC – GDR)

relative dy shift of Envisat w.r.t. Jason-1



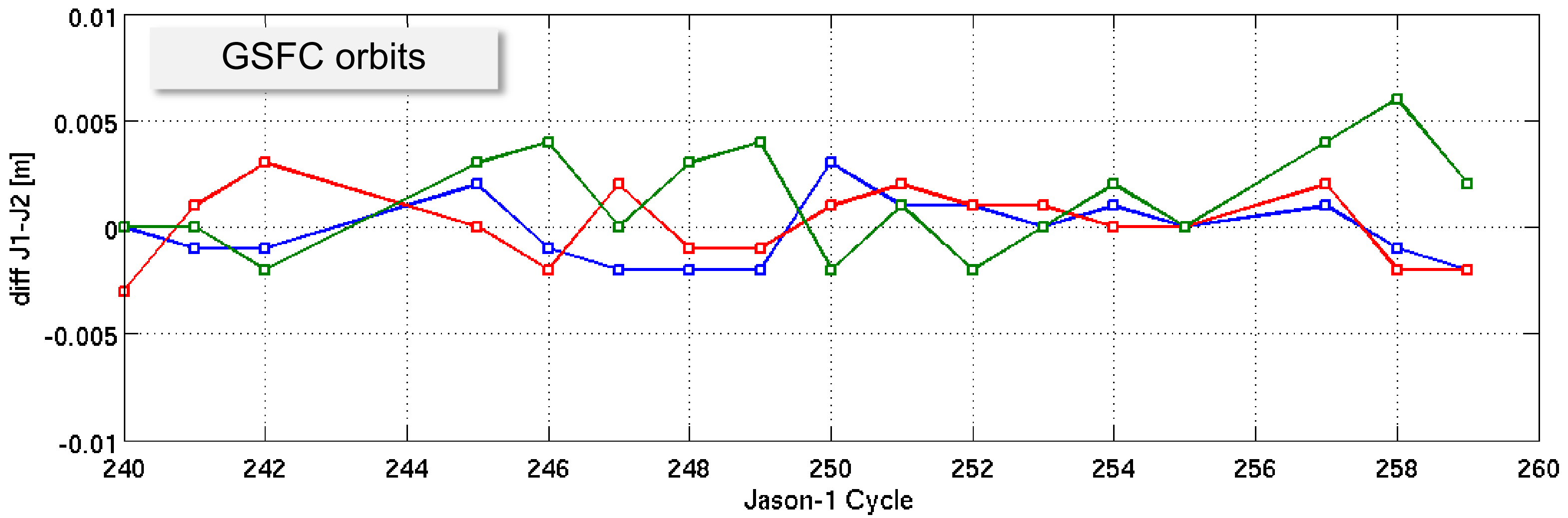
# Consistency between Jason-1 / 2 origin




0.8 ± 2.7 mm

0.6 ± 3.8 mm

4.3 ± 3.3 mm




-0.2 ± 1.5 mm

0.1 ± 1.7 mm

1.4 ± 2.4 mm

=> Jason-1/2 origin is more consistent with GSFC orbits

# Geographically correlated mean errors (GCE)

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:

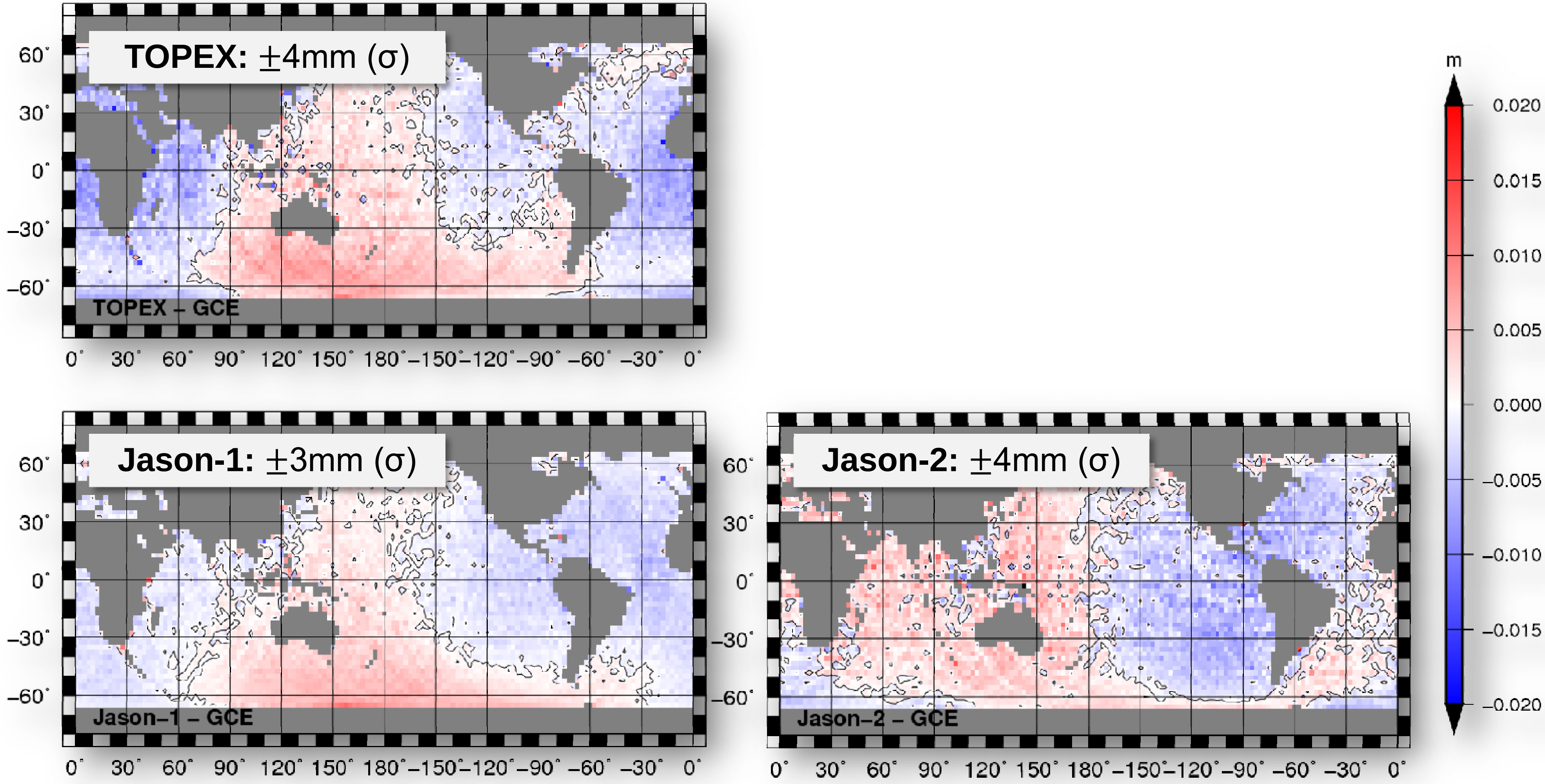
$$\Delta\gamma = (dr^{asc} + dr^{desc}) / 2$$

$dr^{asc}$ average of the radial errors (mean reduced) of all asc. passes
$dr^{desc}$ average of the radial errors (mean reduced) of all desc. passes

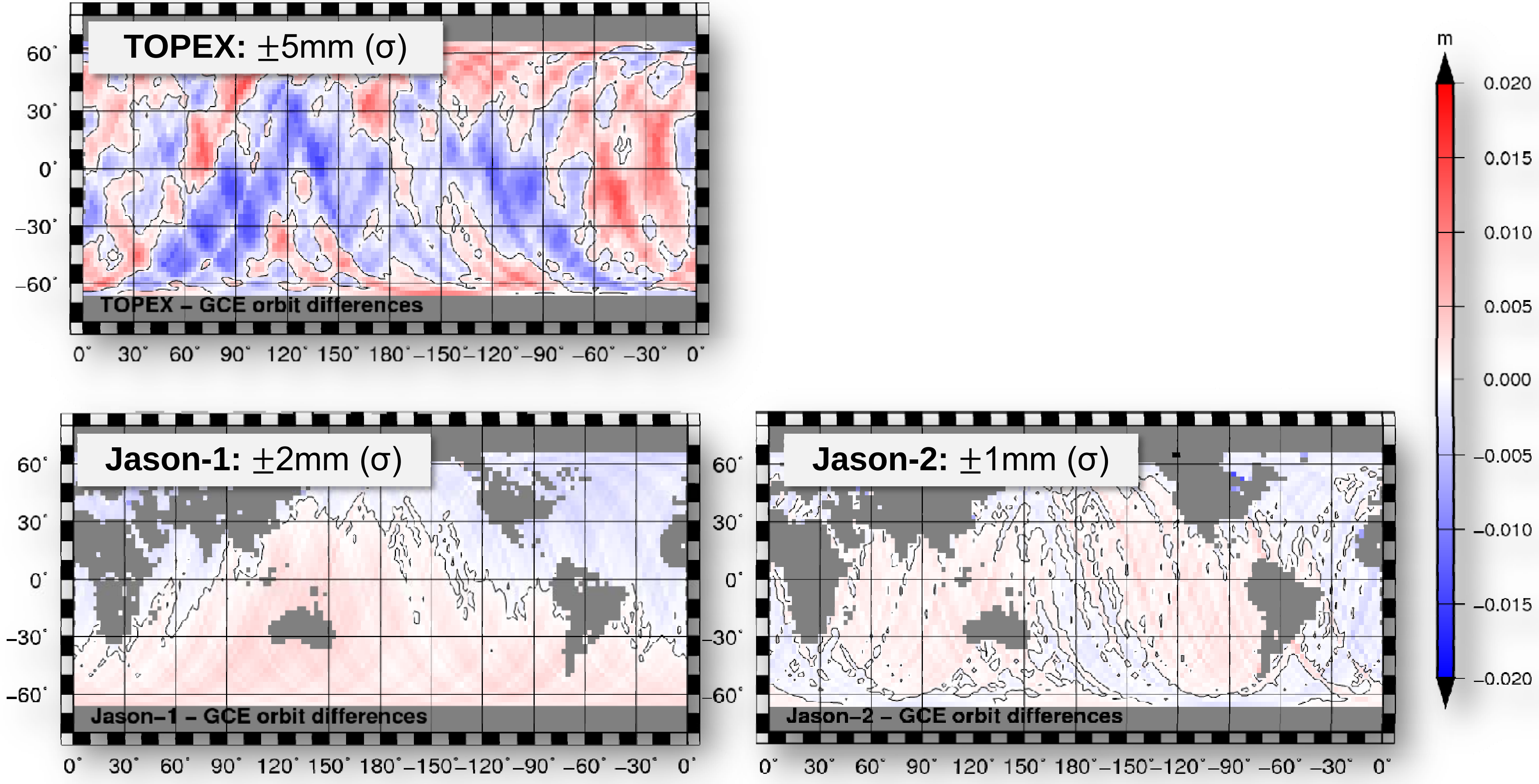
$\Delta\gamma$ mean of ascending and descending errors, GCE per cell

mean errors => used time period: all mission lifetime
=> short-time temporal variations will cancel out

# absolute GCE (GSFC orbits)



# relative GCE (GDR-GSFC)



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# Conclusion

✓ MMXO is able to provide information on range bias, origin realization, and GCE of actual orbit solutions

✓ GSFC std0905 orbit solution show pronounced oscillations in origin realization (dx,dy) – due to radiation pressure model

✓ GCE remain smaller than 1 cm in all parts of the globe and are quite similar for TOPEX, Jason-1 and Jason-2