Preliminary GDR-D Orbit Quality Assessment through SSH calculation

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Introduction

- Quality of Precise Orbit Ephemeris is crucial for quality of altimeter data products and the studies based upon these data.

- Inversely, studies using Sea Surface Height (SSH) calculation from altimeter or in-situ data enable to
  - ✓ give insight in orbit quality for the different missions.
  - ✓ to compare different orbit solutions for one mission,
  - ✓ to give hints which mission is impacted by suspicious behavior, when comparing several missions.

- <u>Method:</u>
  - ✓ Mono- or dual satellite crossovers (improvement of small (<10 days) time-scale coherence)
  - ✓ Along-track Sea Level Anomaly (SLA) analysis
  - ✓ Comparison to in-situ data

Data used

- Preliminary GDR-D orbit standard from CNES tested for
  - Jason-1 cycles 1 – 331 (~9 years)
  - Envisat cycles 10 – 93 (~8 years)
  - Jason-2 cycles 1 – 107 (~3 years)

- Compared to GDR-C orbit standard (currently used for Jason-1 GDR-C, Jason-2 GDR-T, Envisat GDR V2.1)

	GDR-C	Preliminary GDR-D orbit
Gravity field	EIGEN-GL04S Drift:Annual+Semiannual 50x50 from EIGEN-GL04SANNUAL	EIGEN-GRGS_RL02bis_MEAN-FIELD
Itrf	2005	2008

Analyses of orbit differences

- Objective: characterize the spatial and temporal differences between 2 orbit solutions :

⇒ Temporal evolution of mean and variance

⇒ Geographical differences of mean

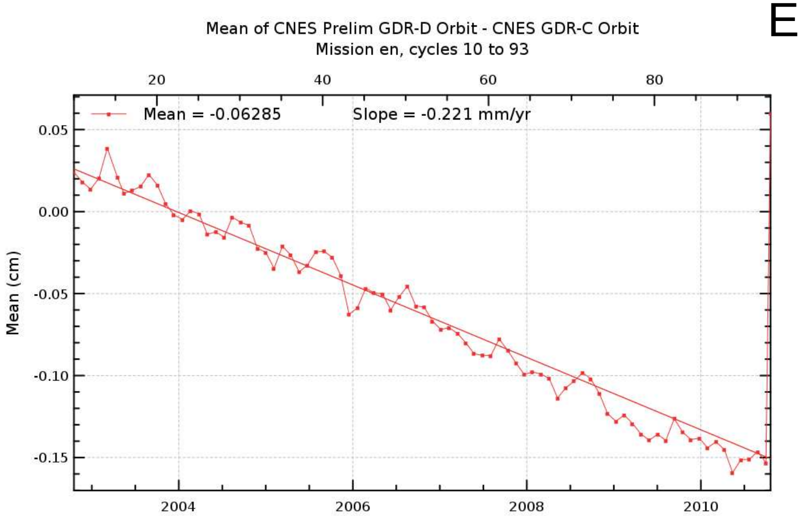
Analyses of orbit differences

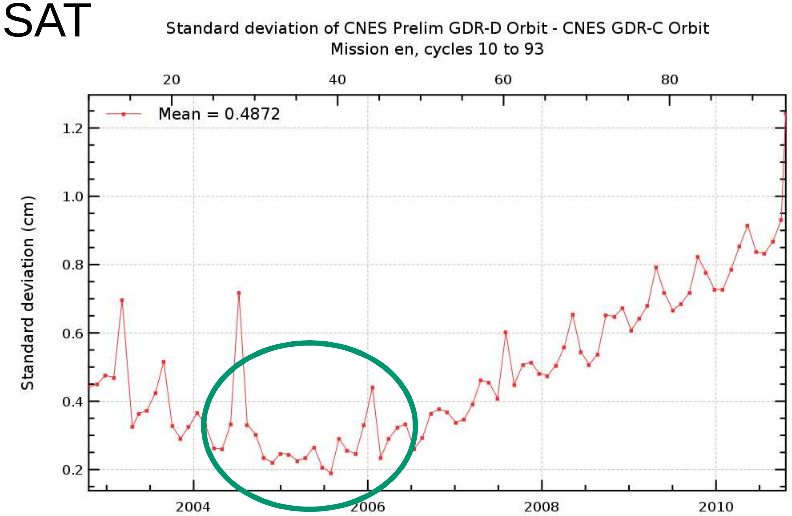
Temporal evolution

- Effect of the **long term drift of gravity field** used for preliminary GDR-D orbit : Difference between POE GDR-C and preliminary GDR-D orbit standard increases over time (in absolute value)

- Effect of the gravity field model **centered around 2005** : Standard deviation of orbit differences is minimal in 2005, before and afterwards it increases

ENVISAT

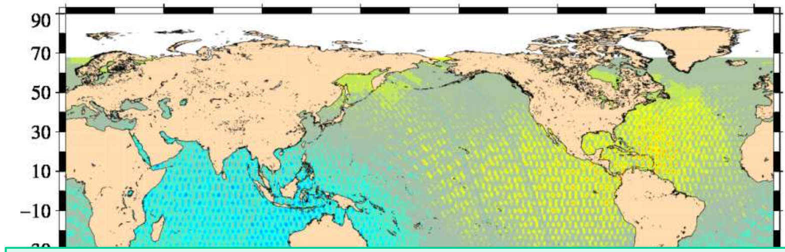




Analyses of orbit differences

Geographical differences

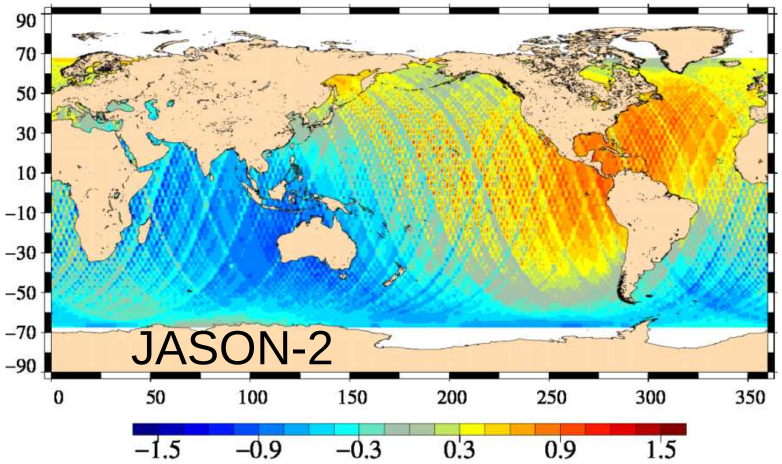
Mean of CNES Prelim GDR–D Orbit – CNES GDR–C Orbit
Mission j1, cycles 1 to 331



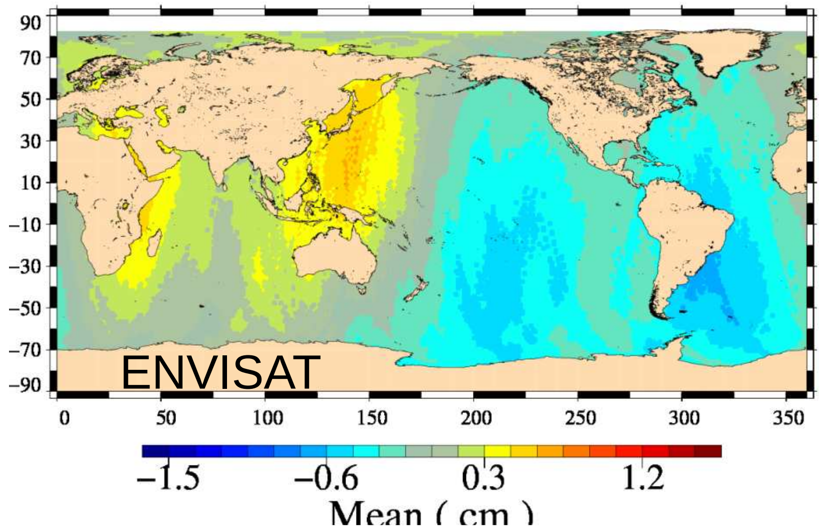
- Similar structures appear for Jason satellites -> related to different gravity fields
- Differences are stronger for Jason-2 (shorter and more recent time period)

- Are these temporal and spatial orbit differences an improvement to calculate the sea-level calculation ?

Mean of POE GdrD – POE GdrC
Mission j2, cycles 1 to 107



Mean of CNES Prelim GDR–D Orbit – CNES GDR–C Orbit
Mission en, cycles 10 to 93



Impact on Mean Sea Level Trend

- Objective: analyze impact of preliminary GDR-D orbit on sea level trend

⇒ Temporal evolution of global sea level trend

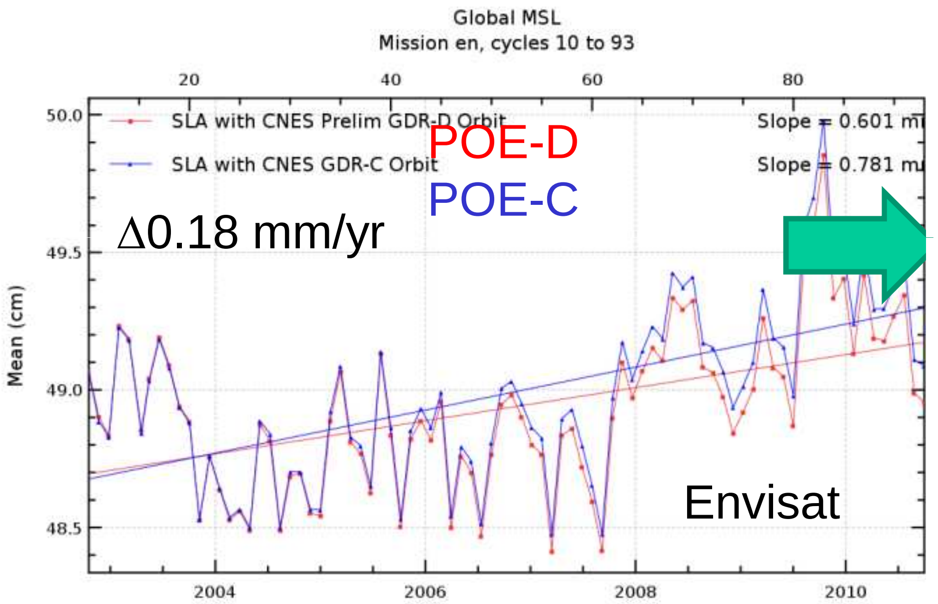
⇒ Separation of ascending and descending trends

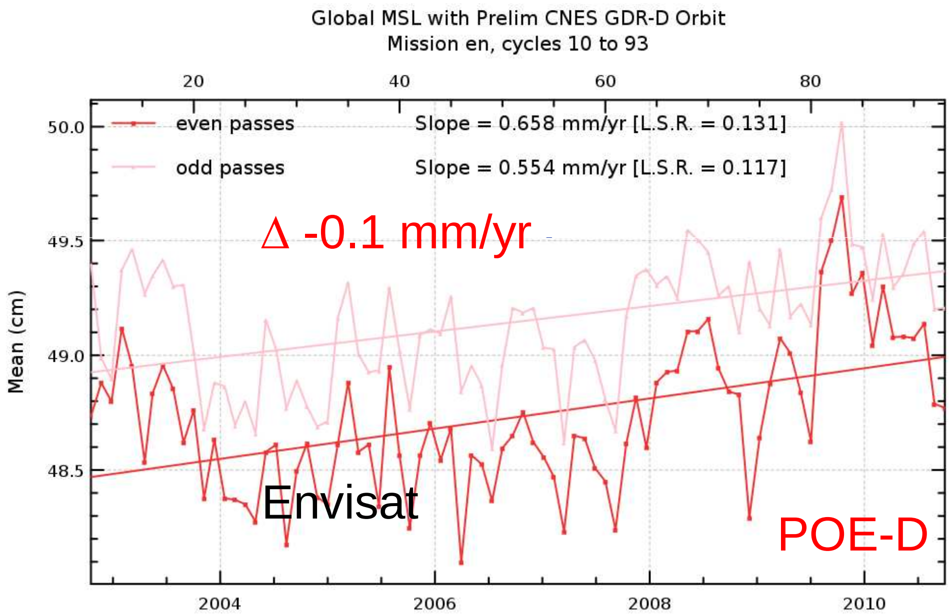
Sea level anomaly = orbit – range – corrections - MSS

Impact on global Sea Level trend

Using preliminary GDR-D POE instead of GDR-C POE has negligible impact on Jason-1 and Jason-2 global sea level trends

- Impact on Envisat is significant (Δ0.18 mm/yr)

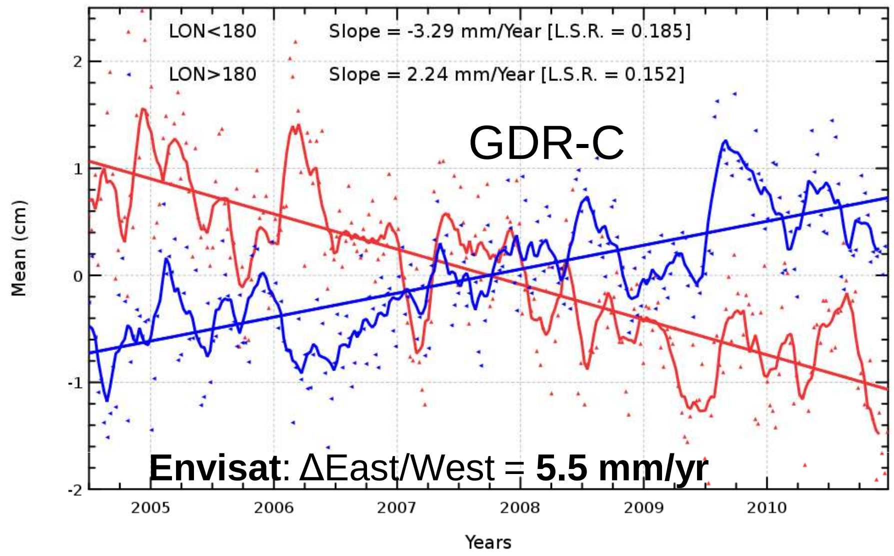


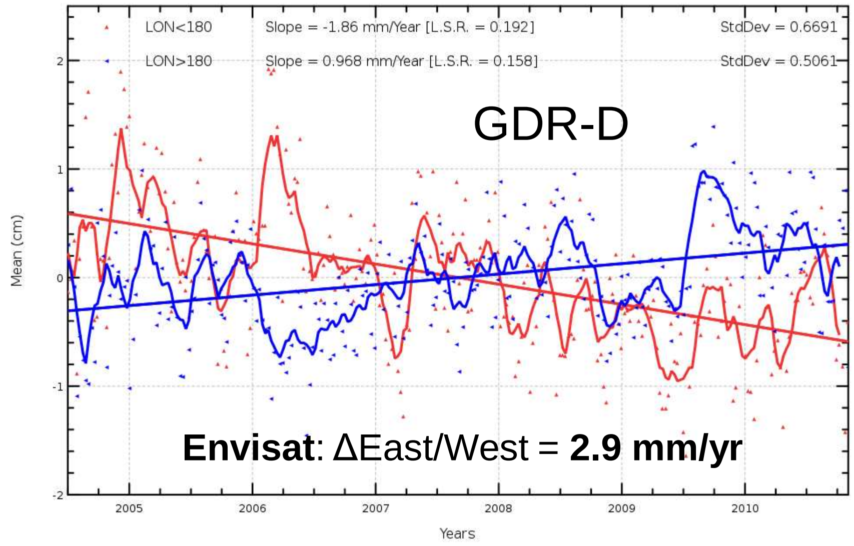


- Envisat SLA trend differences between ascending and descending passes are reduced using preliminary GDR-D orbit
- Passes are homogenized

Impact on global Sea Level trend

- Altimeter data are compared to an external data source (in-situ data) -> see also poster G. Valladeau "Cross-comparisons of Sea Surface Height derived from In-Situ and Altimeter measurements"
- Drifts of **altimeter-T/S** (temperature/salinity profils) differences are estimated separating East (0°/180°) and West (180°/360°) parts
- Reveals a drift between East and West for Envisat using GDR-C orbit standard.
- Drift reduced when using preliminary GDR-D orbit standards (computed with EIGEN-GRGS_RL02bis_MEAN-FIELD gravity field)





Analyses at crossovers

- Objective: analyze the SSH consistency between ascending and descending passes within a 10-day window

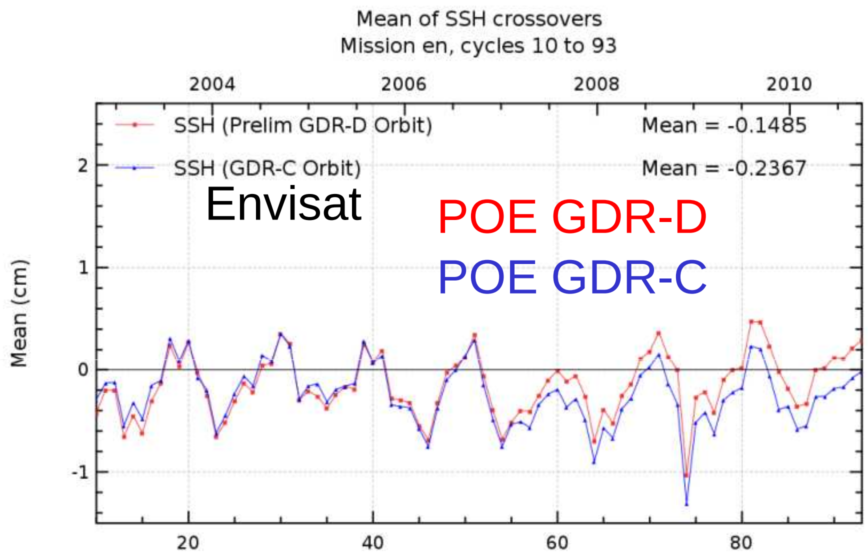
⇒ Temporal evolution of mean and variance of SSH

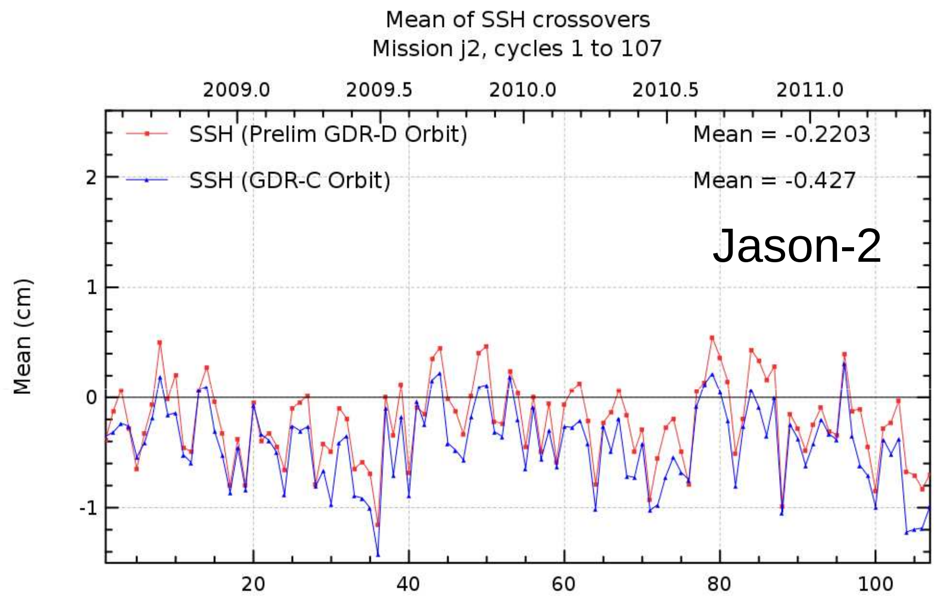
⇒ Geographical differences of mean

Sea Surface Height = orbit – range – corrections

Analyses at crossovers

Temporal evolution of mean differences



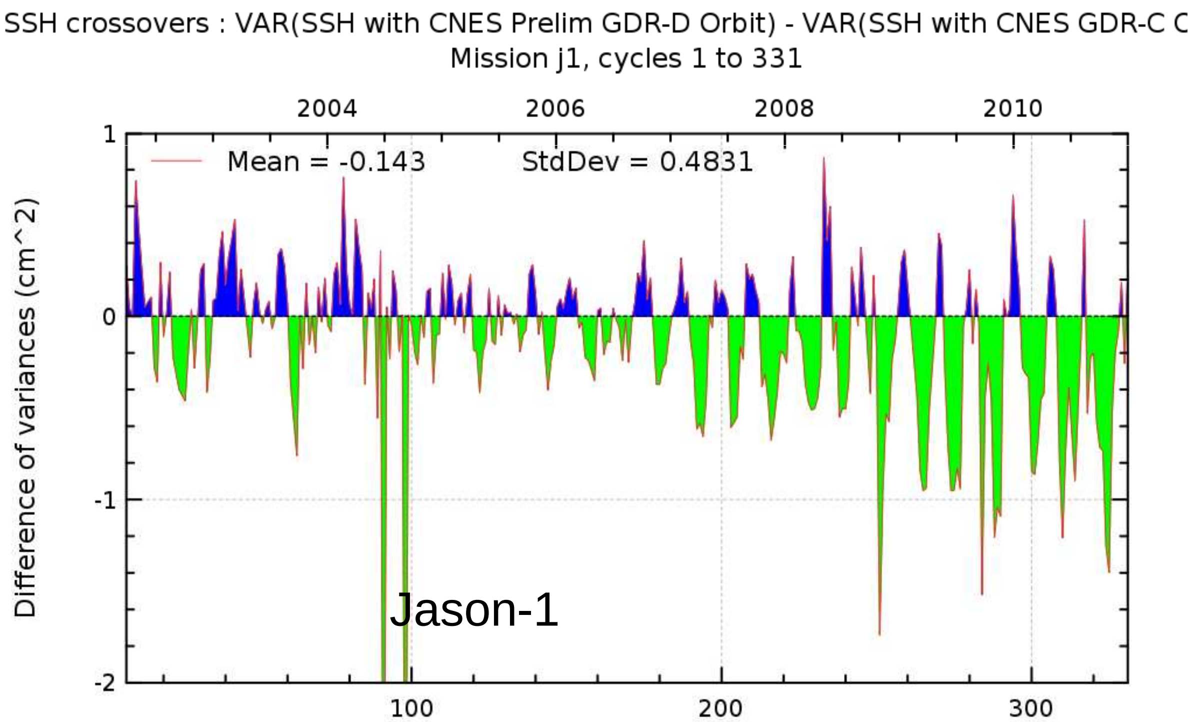


- Ascending/descending differences are generally slightly negative for Envisat and Jason-2 using GDR-C orbit showing systematic ascending/descending differences
- Using preliminary GDR-D orbit standard better centers the curves -> reduces systematic ascending/descending differences

Analyses at crossovers

Temporal evolution of variance differences

- Variance is reduced when using preliminary GDR-D orbit standard for all the altimetry missions
- For instance, for Jason-1, the SSH variance reduction increases over time

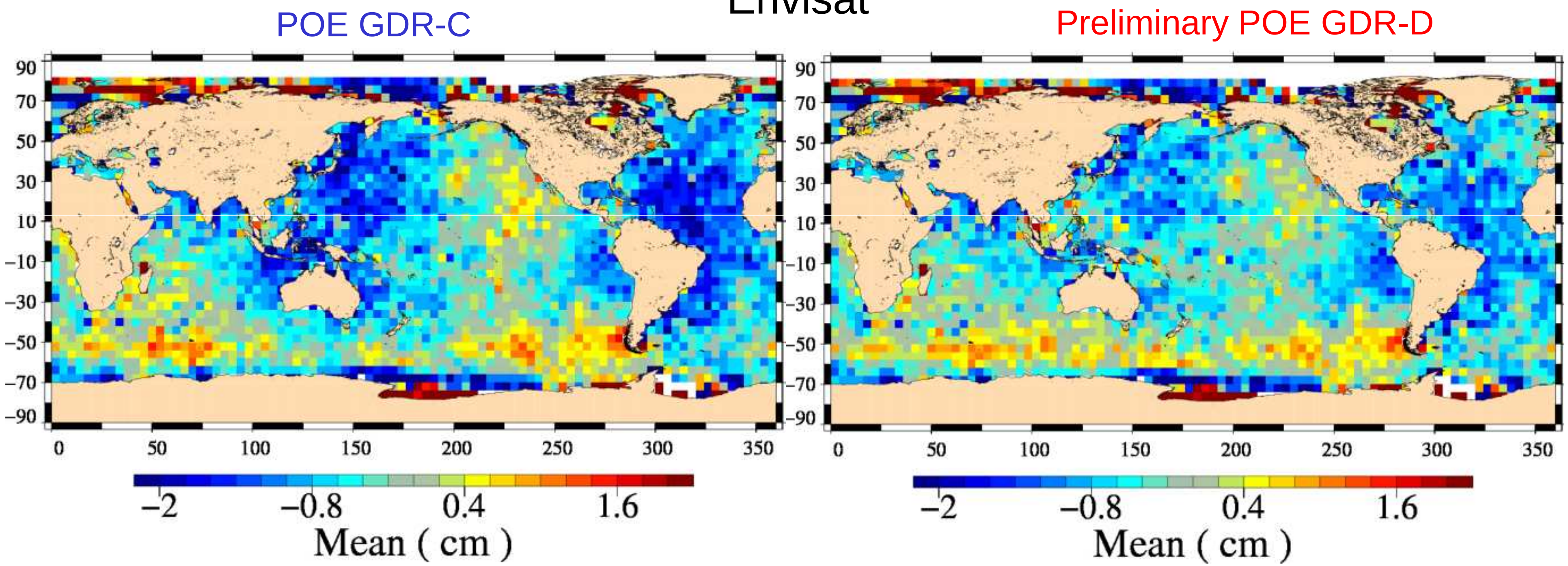


Analyses at crossovers

Spatial distribution of mean differences

- Method:
  - Ascending/descending SSH cross-over differences over an entire mission

Envisat



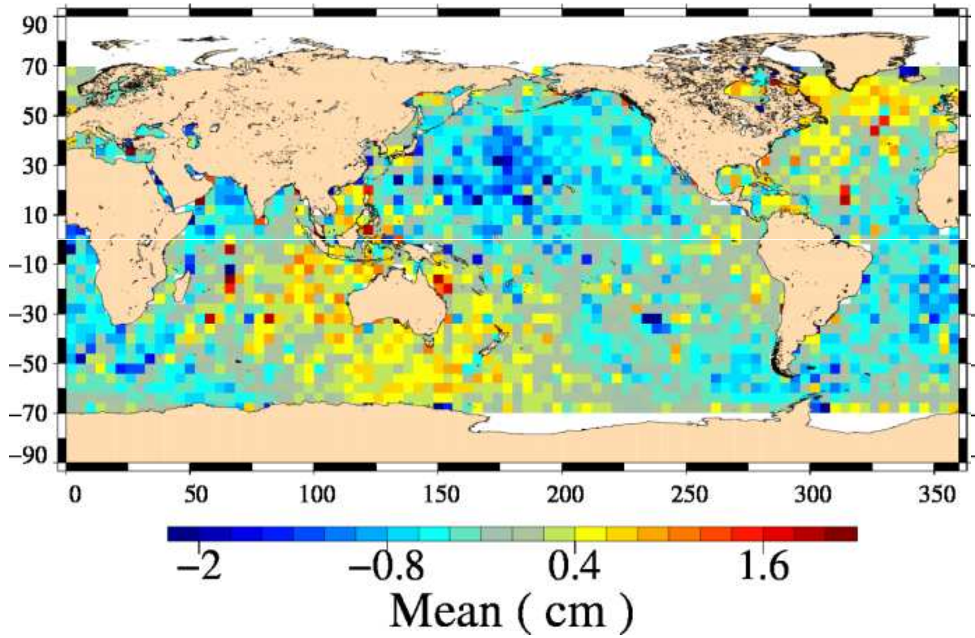
- Using POE GDR-C:
  - Large geographical correlated patterns visible (-2 cm amlitude)
- Using preliminary POE GDR-D:
  - Amplitude of geographical correlated patterns are reduced

Analyses at crossovers

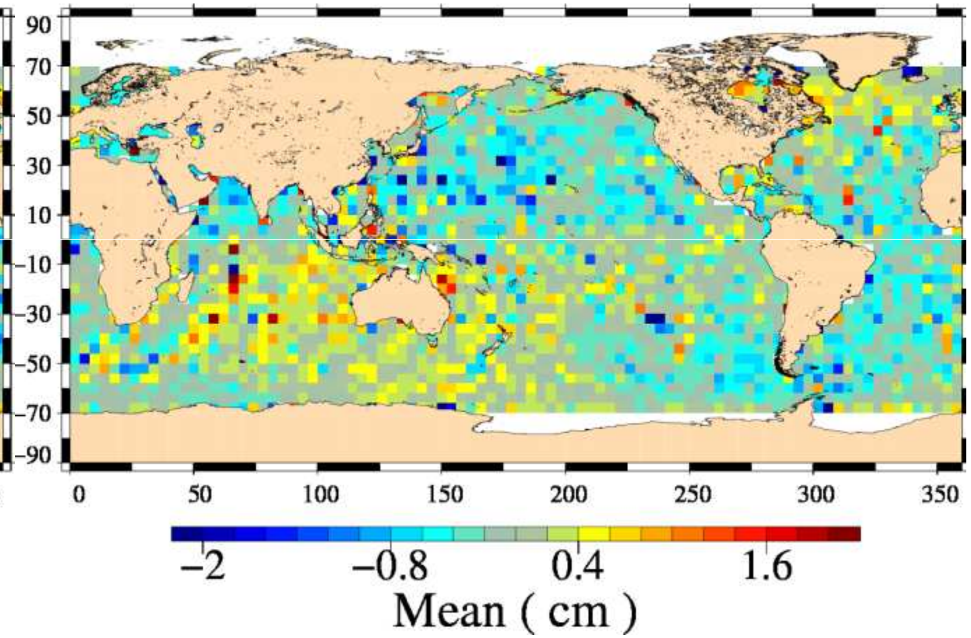
Spatial distribution of mean differences

Jason-1

GDR-C POE



Preliminary GDR-D POE



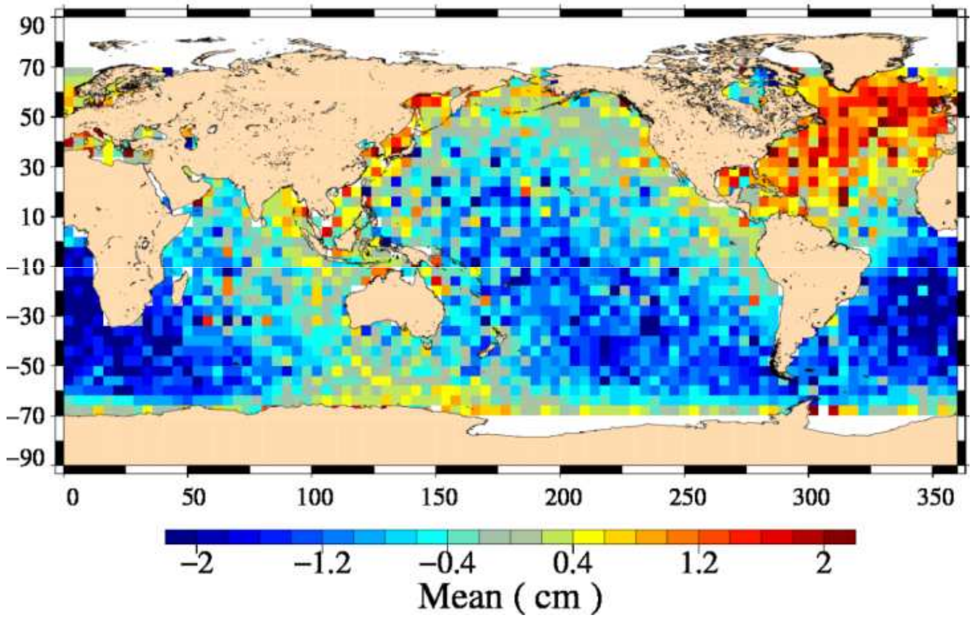
- Jason-1: geographically correlated patterns are already small using GDR-C POE
- Using preliminary GDR-D POE, geographically correlated patterns are slightly reduced

Analyses at crossovers

Spatial distribution of mean differences

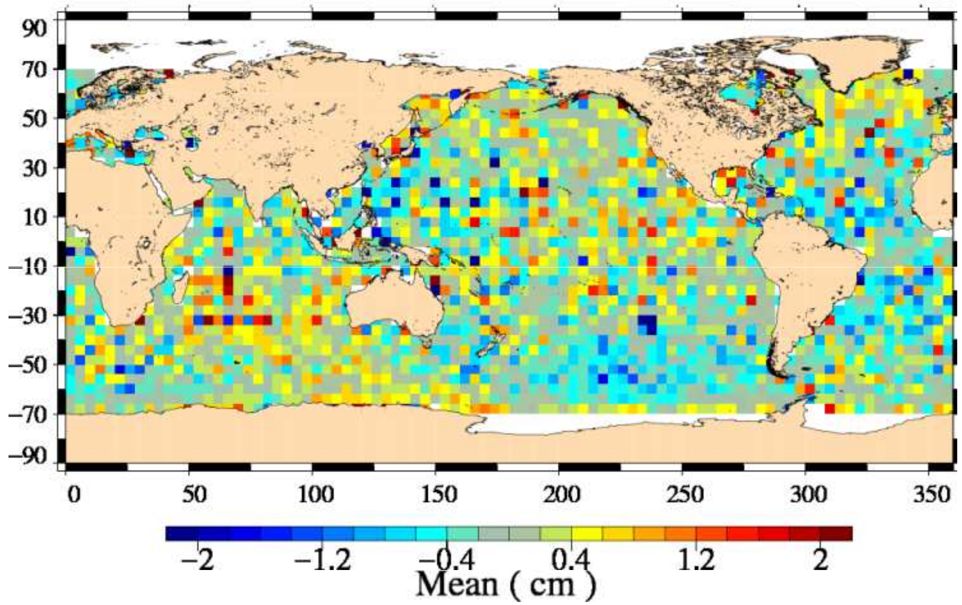
Jason-2

GDR-C POE



preliminary GDR-D POE

preliminary GDR-D POE+BIAS_DAT



- For GDR-C POE standard, geographical pattern of +/- 2 cm amplitude
- For preliminary GDR-D POE standard, a hemispheric N/S bias (~+/- 1.2 cm) appears
- Using preliminary GDR-D POE + Correcting for datation bias (similar to the one available for Jason-1: ~0.3 milli-seconds) removes the N/S structure

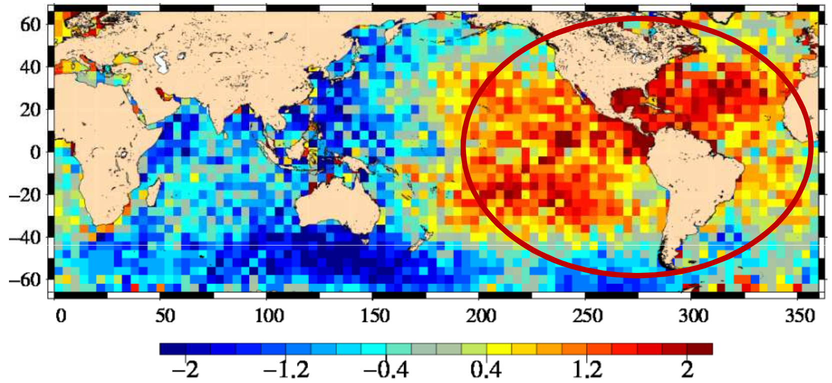
Analyses at crossovers

Spatial distribution of mean differences at multi-mission cross-overs

- In 2010, several authors showed an east/west drift between Jason-1 and Envisat data (using orbit standard GDR-C for Jason-1 and Envisat), also visible on Envisat/Jason-1 SSH cross-over differences

EN GDR-C / J1 GDR-C

2008



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EN GDR-C / J1 GDR-C

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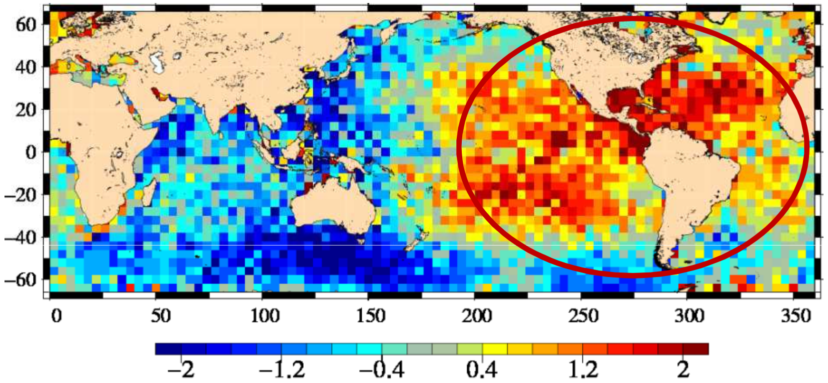
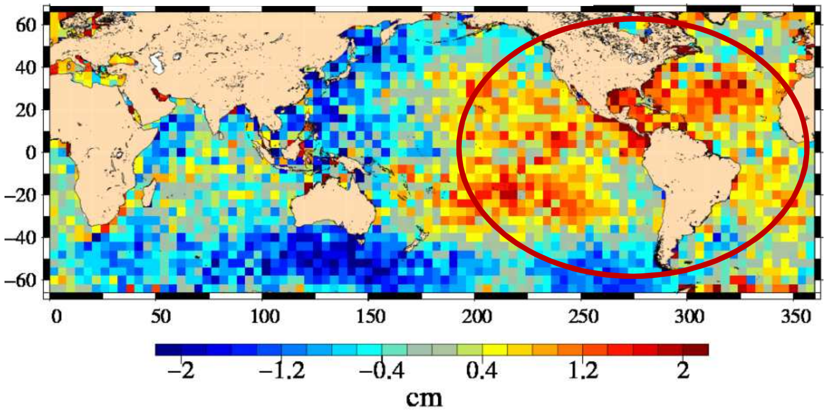


EN GDR-C / J1 GDR-D



- Using preliminary GDR-D orbit only for Jason-1, reduces slightly east/west differences

Analyses at crossovers

Spatial distribution of mean differences at multi-mission cross-overs

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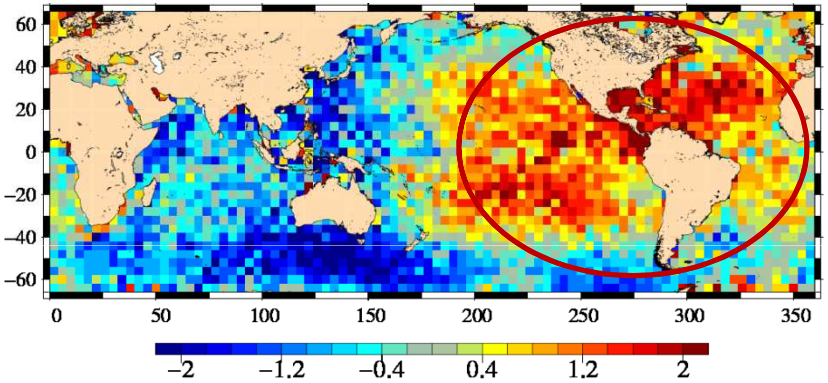
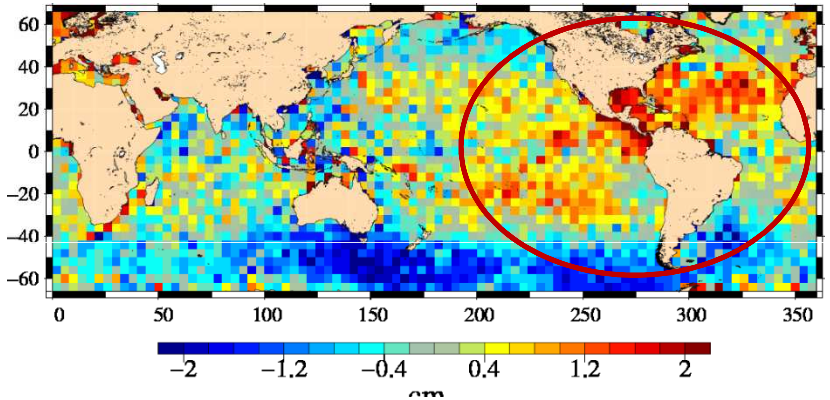
2008

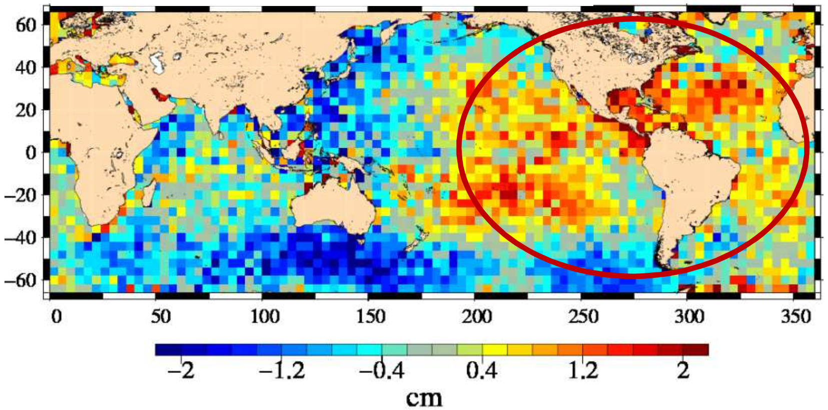
EN GDR-C / J1 GDR-C



EN GDR-D/ J1 GDR-C



EN GDR-C / J1 GDR-D

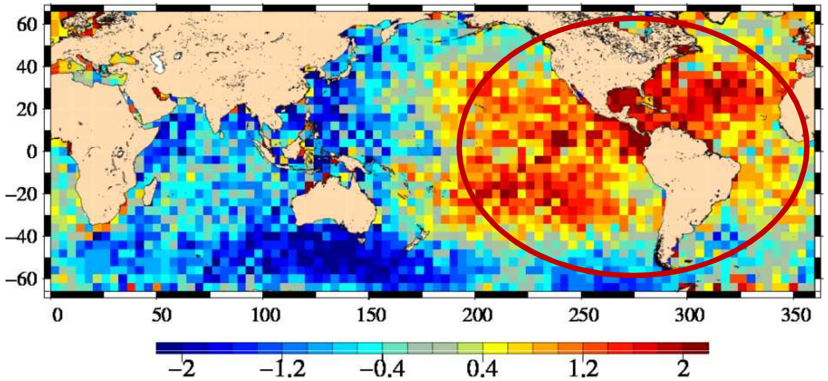


- Using preliminary GDR-D orbit only for Envisat, reduces strongly east/west differences

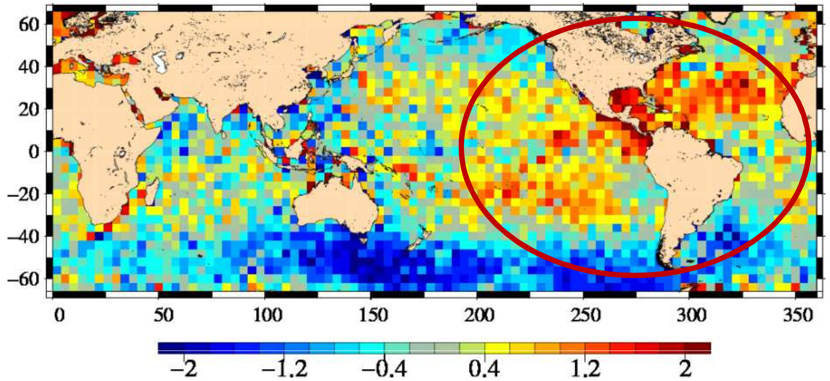
Analyses at crossovers

Spatial distribution of mean differences at multi-mission cross-overs

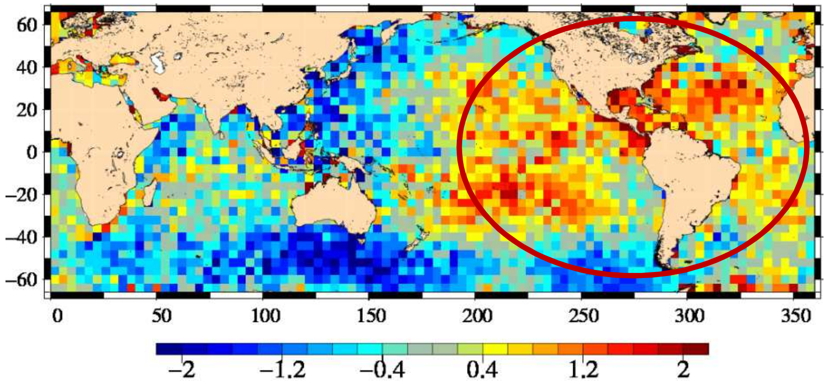
EN GDR-C / J1 GDR-C



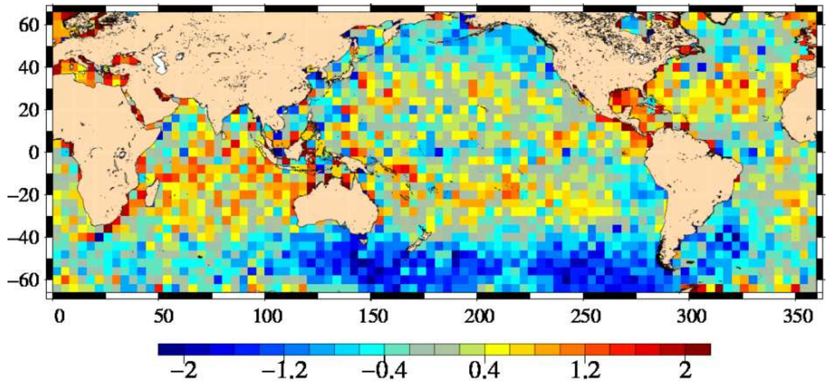
EN GDR-D/ J1 GDR-C



EN GDR-C / J1 GDR-D



EN GDR-D/ J1 GDR-D



Stronger impact observed on Envisat than on J1: cumulate effect removes the East/West Bias.

- Similar results using preliminary ESOC V7 orbit

Summary

- Use of preliminary GDR-D orbit standard increases homogeneity of ascending/descending passes
  - Systematic geographical patches are slightly reduced for Jason-1, strongly reduced for Envisat, disappear for Jason-2 (especially when correcting for datation bias)
  - Spatial coherence is increased
  - reduces strongly East/West differences between Envisat and Jason-1 satellite. ➔ Data are now more homogeneous
- Increases homogenity of Sea level trend for Envisat
  - Makes Envisat ascending/descending sea level trends more homogeneous
  - Comparison to T/S shows that use of new orbits reduces East/West slope differences between Envisat and T/S profiles
- As for preliminary GDR-D orbits, a drift of the gravity field model is used outside of 2002-2010 period, verification should be done, in order to assure that the applied drift will not depart too much from reality. Test orbits produced with 10 day grace gravity field would be very useful for this verification.