SERVICE
ALTIMETRIE
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PRECISE

# Jason-2 cross-calibration with Jason-1 and Envisat

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# Introduction

- Since Envisat was launched, Cross Calibration studies with the Jason-1 mission are performed to assess the data quality and performances of both missions.

- A precise altimetric mission as Envisat can help to understand the observed differences between Jason-1 and Jason-2 by giving a third reference

- This presentation aims at showing the cross-calibration between Jason-2 and Envisat, compared to Jason-2 / Jason-1 and Jason-1 / Envisat results.

# Overview

In this presentation, we will focus on :

1. Short overview of Envisat mission : *A precise and complementary altimetric mission.*
   - ➔ Systems comparison
   - ➔ Comparison method: small precautions needed

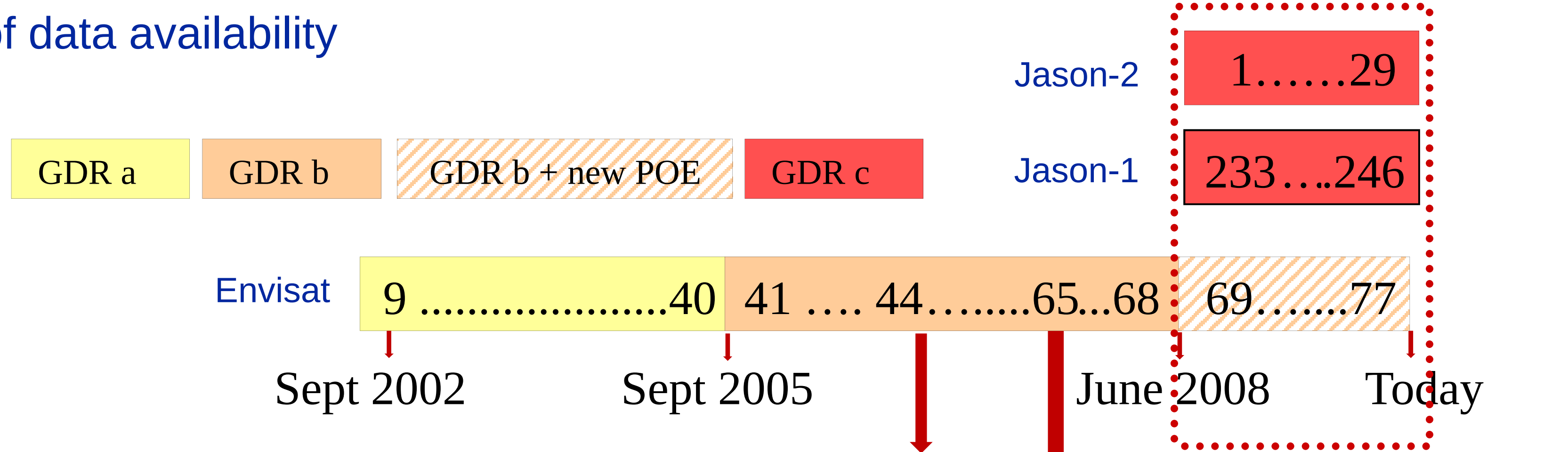
2. Envisat / Jason-1 / Jason-2 : *Performance and correlation estimations*
   - ➔ Dual and Monomission statistics monitoring

3. Envisat / Jason-1 / Jason-2 : *Three very similar missions*
   - ➔ New results using GDR compared to IGDR time series
   - ➔ Geographically correlated biases and variability

# 1. Envisat mission :
# *A precise and complementary altimetric mission.*

# Envisat GDR status

- 7 years of data availability




- Good general quality :
  - Very good availability of data.
  - **USO anomaly**: In February 2006, the RA-2 Ultra Stable Oscillator (USO) clock frequency underwent, for an unknown reason, a strong change of behavior.
    ➔ Altimeter range can be corrected from this anomaly by users, thanks to **auxiliary files** distributed by ESA since mid 2006
  - **Loss of the S-Band**: On the 17 January 2008, a drop of the RA2 S-band transmission power occurred. There is thus no more dual frequency altimeter both in A and B-Sides.
    ➔ GIM ionospheric correction is available in the IGDR and GDR products
  - **Reprocessing** of the whole Ra-2 Envisat GDR in version C will start in 2009

# Method used for SSH at crossovers comparison

- Statistics are computed on a J2 cyclic basis (10 days)

- An average per boxes is performed, prior to the statistics in order to allow us to have homogeneous sampling of the ocean for the 3 satellites (statistics slightly different from the J1/J2 presentation).

- Sea Surface Heigh formula used:

**SSH_Common = Orbit –Range – ECMWF Dry Tropo (Gaussian grids) – MOG2D High Frequency – GOT00 tide – Solid tide – Polar tide-SSB**

**SSH_J2** = SSH_Common – AMR Wet Tropo - Filtered Bifrequency Ionospheric correction
**SSH_J1** = SSH_Common – JMR Wet Tropo- Filtered Bifrequency Ionospheric correction
**SSH_EN** =SSH_Common – USO correction - MWR Wet Tropo- GIM Ionospheric correction

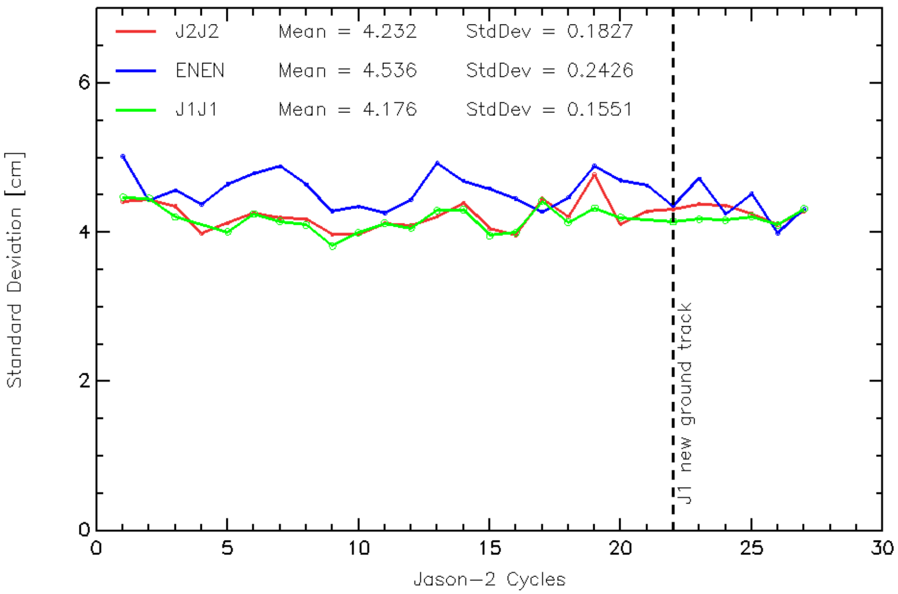
- Selections are applied on the crossovers to consider only those for:

- Lat < 50° (N/S) to avoid ice zones
- Mean ocean variability < 20cm
- Bathymetry > 1000m to avoid known errors near coasts

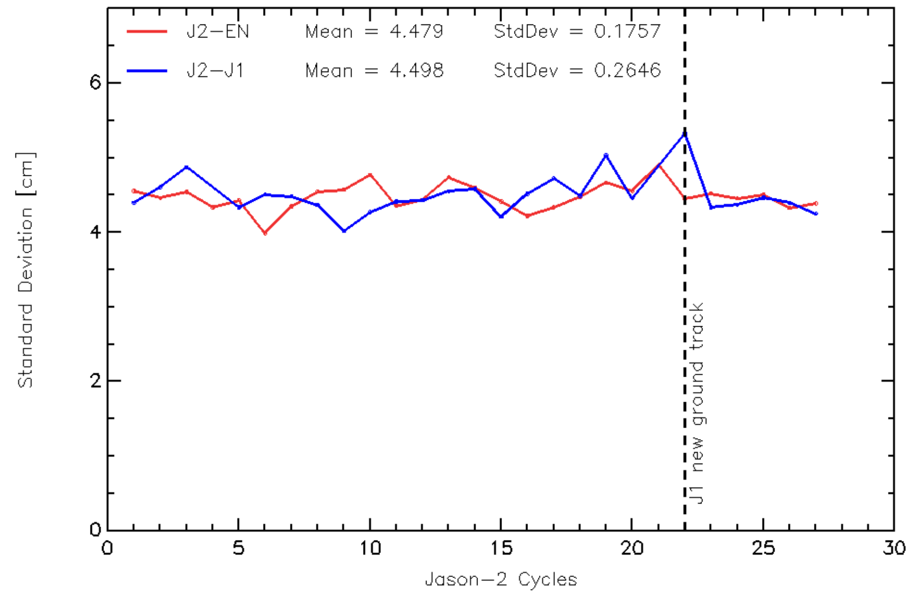
# 2. Envisat / Jason-1 / Jason-2 :
# *Performance and correlation estimations using GDR*

# Standard deviation of the SSH differences at cross-overs

## GDR Monomission cross-overs



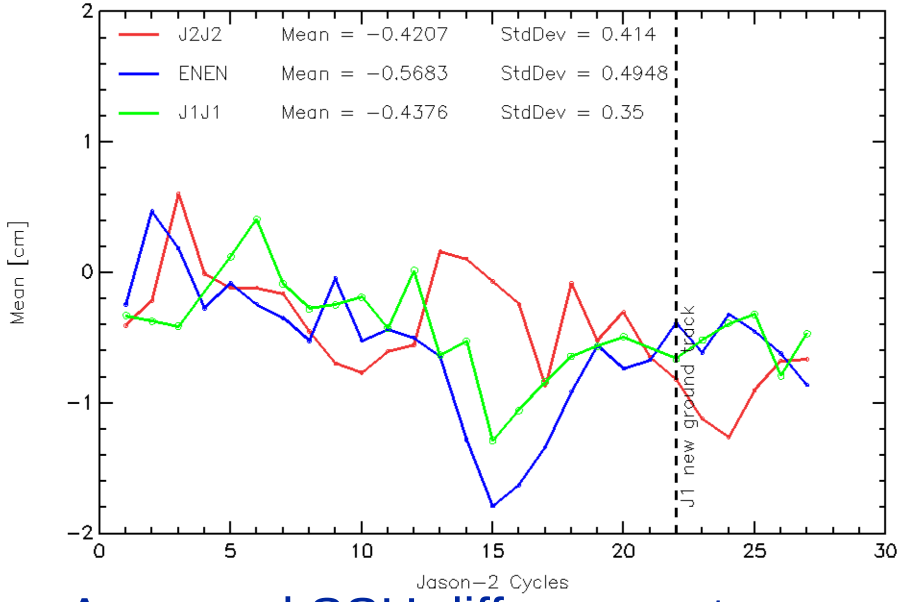

## GDR Dual cross-overs



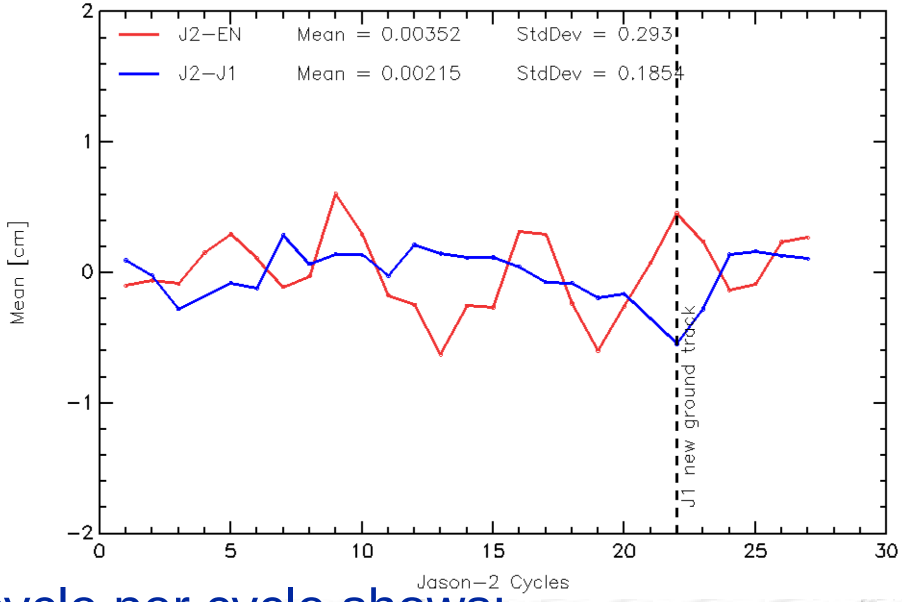

- Standard deviation of SSH crossover difference cycle per cycle shows:
  - ➔Good consistency for the three missions for the whole period
  - ➔ Slightly better performances for Jason-1 and -2 (4 cm) than for Envisat (4.5cm).
  - ➔ The covariance of Jason-2 with Envisat and with Jason-1 is similar, even though the missions are different!

# Average bias of SSH differences at crossovers

## GDR Monomission cross-overs




## GDR Dual cross-overs




- Averaged SSH difference at crossover cycle per cycle shows:

➔ Good agreement between Ascending and Descending tracks for the 3 missions in GDR.
➔ Known annual signal on EN appearing.
➔ Good stability.

➔ Very good agreement/ stability between the 3 missions in GDR.

➔ **Geographic behavior detailed in the Orbit session presentation and poster**

➔ **Geographic behavior detailed hereafter…**

# 2. Envisat / Jason-1 / Jason-2 :

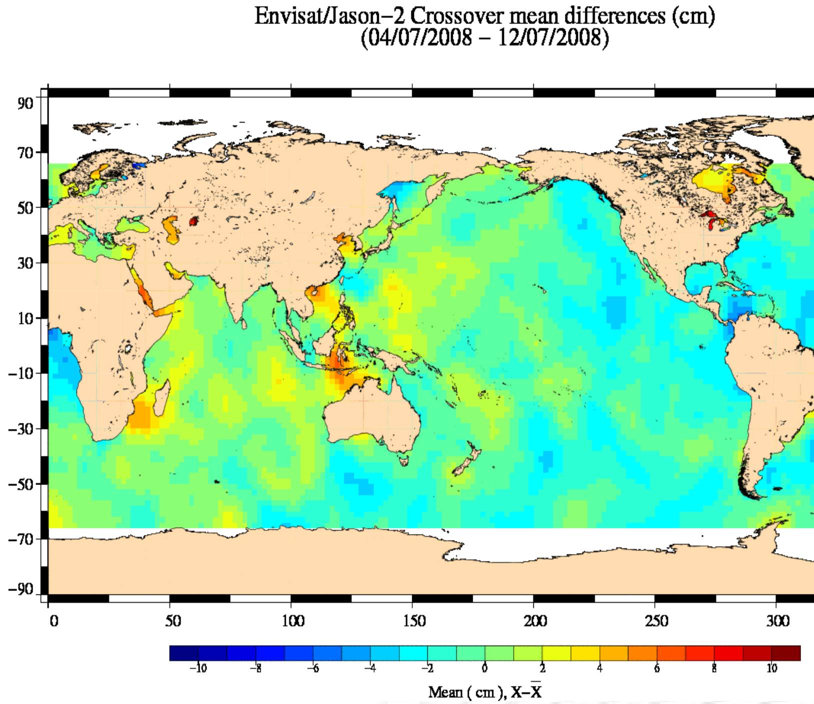
## *Three very similar missions*

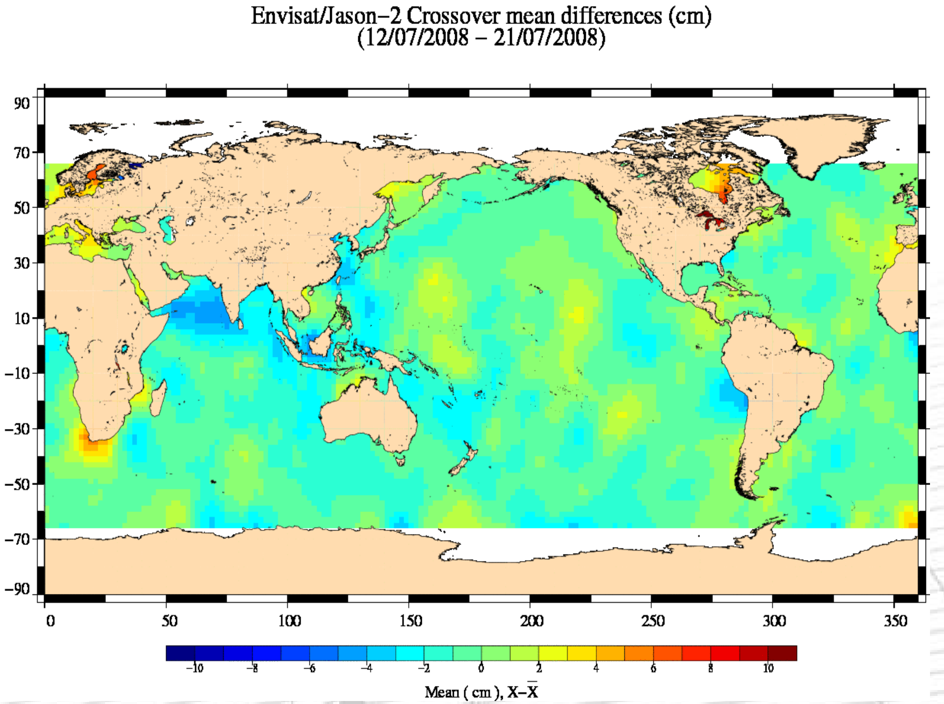
*IGDR improving GDR*

# Cyclic evolution of J2/EN average Crossovers

**Near Real Time, IGDR**

**Delayed Time, GDR**



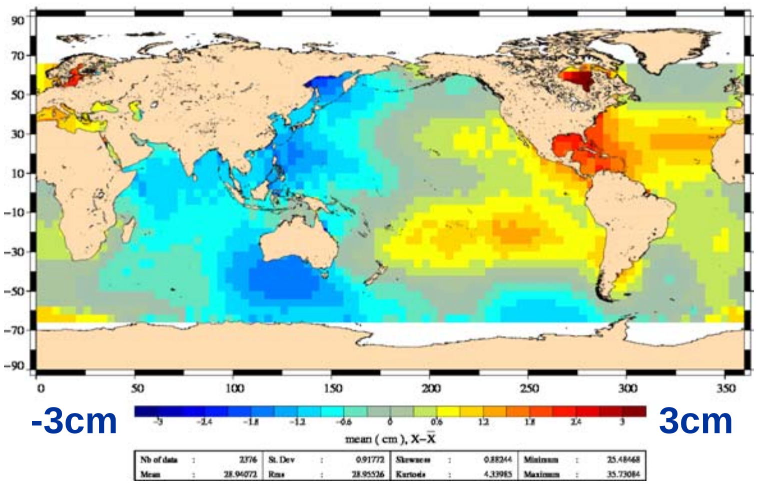

**Cycles 1 to 25:**

Consistency between both missions improved in GDR compared to IGDR.

# J2/EN dual crossovers

**Near Real Time, IGDR**

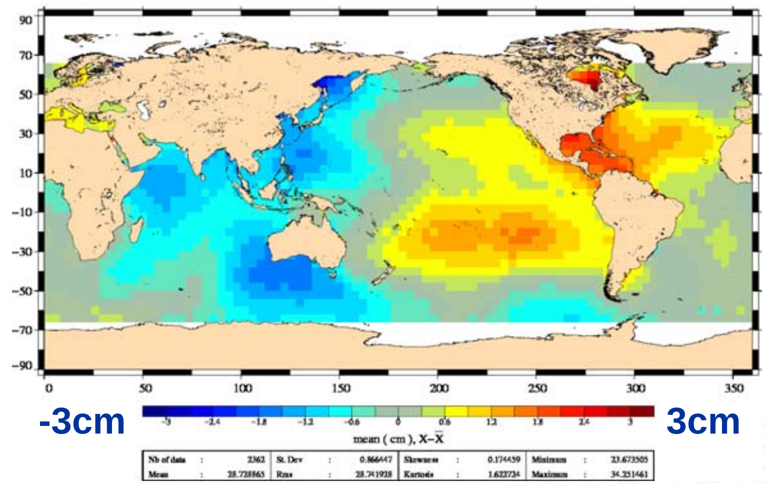
Average Crossovers ENJ2 IGDR




-3cm 3cm

**Delayed TimeGDR**

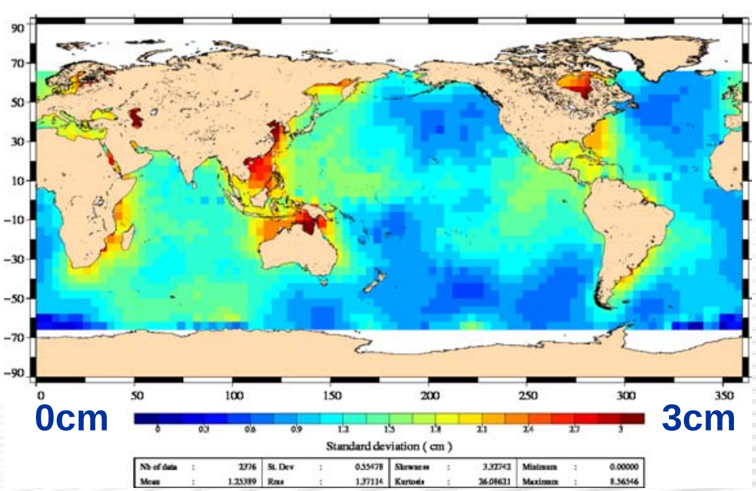
Average Crossovers ENJ2 GDR




-3cm 3cm

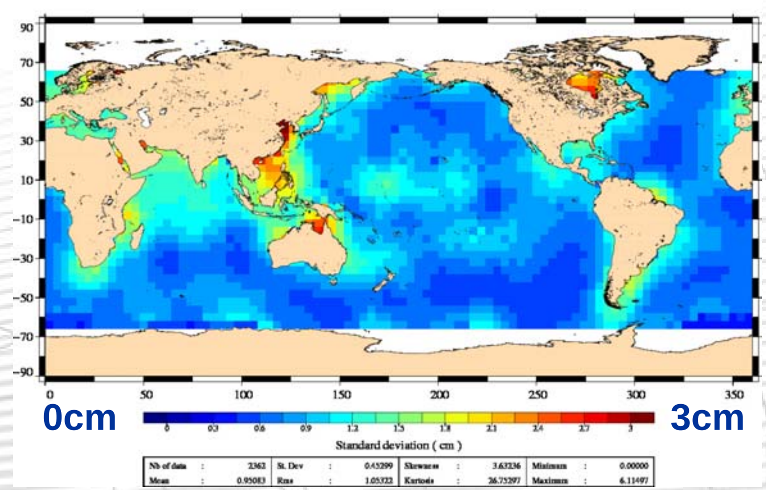
**Mean:**
Apart from the **bias** (due to the AMR radiometer shift between IGDR and GDR), no major differences are noticed on the geographical patterns

Crossovers Standard deviation ENJ2 IGDR




0cm 3cm

Crossovers Standard deviation ENJ2 GDR




0cm 3cm

**Standard deviation of the Smoothed average per cycle:**
- Variability well decreased in GDR
- Mean Std:

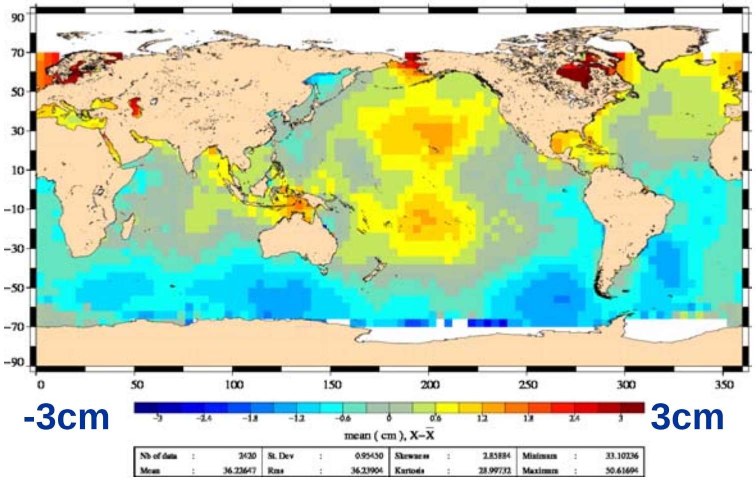
**←1.2 cm / 0.9 cm→**

# J1/EN multimission crossovers

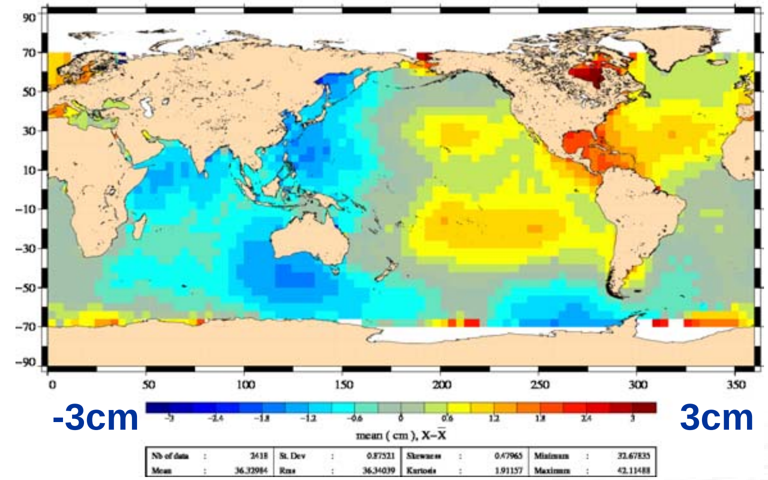
**Near Real Time, IGDR**

**Delayed TimeGDR**

Average Crossovers J1EN IGDR

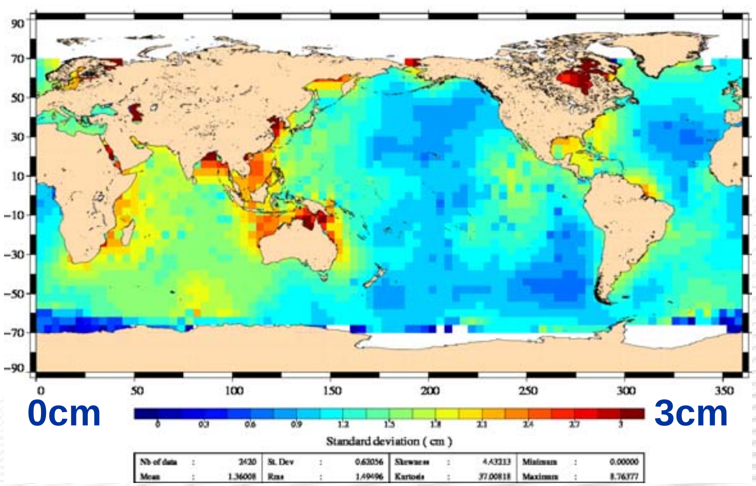



Average Crossovers J1EN GDR

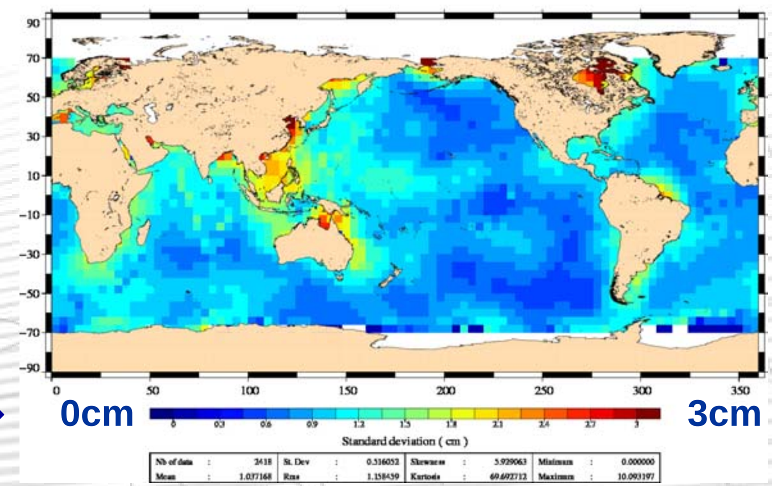



**Mean:**
the geographical paterns in IGDR are moved and reduced on the GDR map: induced by J1 POE improvement / MOE

Crossovers Standard deviation J1EN IGDR




Crossovers Standard deviation J1EN GDR




**Standard deviation of the Smoothed average per cycle:**
-Variability well decreased in GDR
- Mean Std:
**←1.4 cm / 1.1 cm→**

# Conclusion

- **Geographic / temporal coverage difference**
  - ➔ The performances of the 3 missions can be compared after averaging by boxes
  - ➔ Can also be completed by crossing results from 10 days cyclic observation (based on J2 cycles) to 35 days observations (based on EN cycles). Further results using this formalism are developed in Y.Faugere et al. Poster.

- **Envisat /Jason-2/Jason-1 are very precise missions**
  - ➔ Standard deviation of monomission cross-over differences around 4 cm (GDR), which enables a precise cross calibration

- **Jason-1 and -2 comparisons with Envisat GDR are very consistent**
  - ➔ The geographical biases observed on IGDR products disappears in the GDR thanks to the POE improvement compared to MOE.

- **In GDR, Jason-2 / Envisat has the same level of consistency as Jason-2/Jason-1**
  - ➔ This consistency is even more relevnt considering that its orbit configuration is different from the Jason-1 and 2
  - ➔ making Envisat a very precious input to quantify Jason-2 altimetric performances

*Further results showing orbit orientated results are developed in A.Ollivier et al. Poster and presentation.*

# Backup slides

# Variance and covariance of the SSH differences at crossovers

The SSH difference at cross-over gives information on the error of a system.
2 different measurements over the same points contains:
➔ Variability due to the system error/noise
➔ Variability of the ocean during the period between the two measurements

Selections are applied on the crossovers to consider only those for:
- Lat < 50° (N/S) to avoid ice zones
- Mean ocean variability < 20cm
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Monomission / Dual missions statistics are complementary on these aspects:

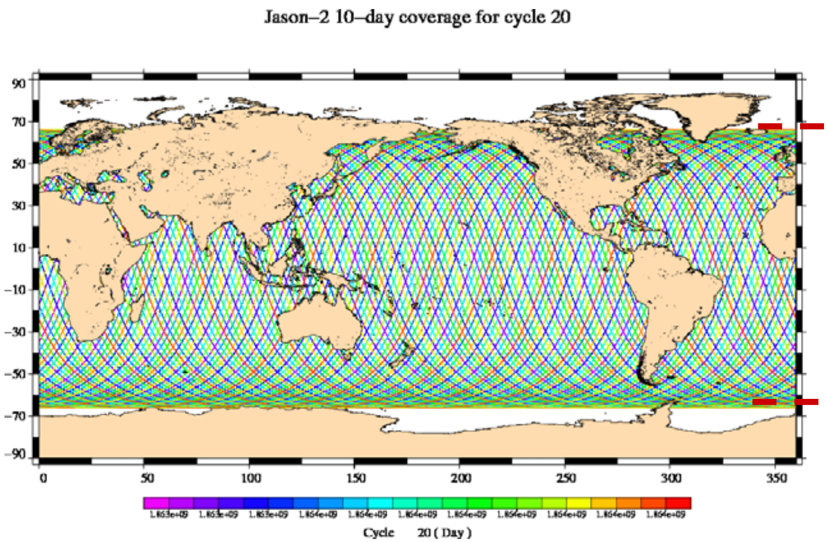
**Monomossion**

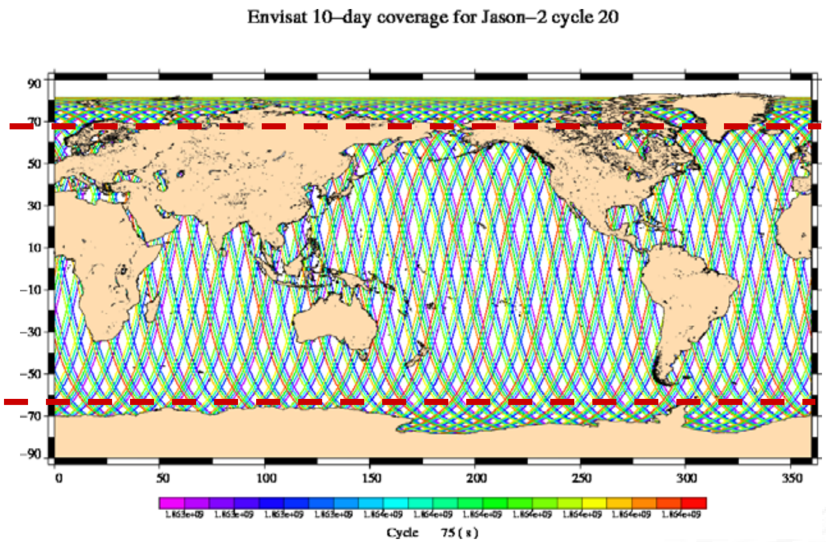
$$Var^2(S_{J2}) = Var^2(Oce(<10days)) + Var^2(Noise_{J2})$$

**Dual mission (J2 and M (J1 or EN))**

$$Var^2(S_{J2} - S_M) = Var^2(S_{J2}) + Var^2(S_M) - 2\,CoVar(S_{J2}S_M)$$

# Method used for Jason-2 / Envisat comparison

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