# CROSS-CALIBRATION between ENVISAT and JASON-1/2

**A Ollivier, Y Faugere, P Femenias (ESA), N Picot (CNES)**

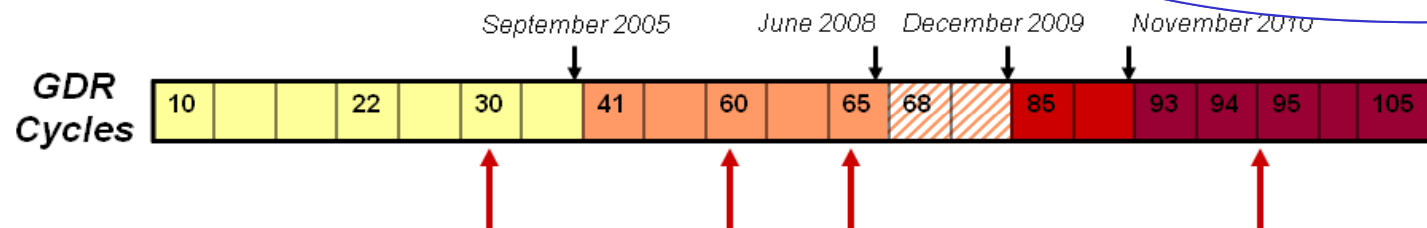A Ollivier, Y Faugere, P Femenias (ESA), N Picot (CNES)

- Data, processing, performances on Envisat mission

- Further improvements concerning geographically correlated biases: Impact of preliminary CNES GDR-D orbits

- Further improvements concerning global trend: major impact of a correction of an instrumental correction

**Envisat GDR dataset**

In this work:
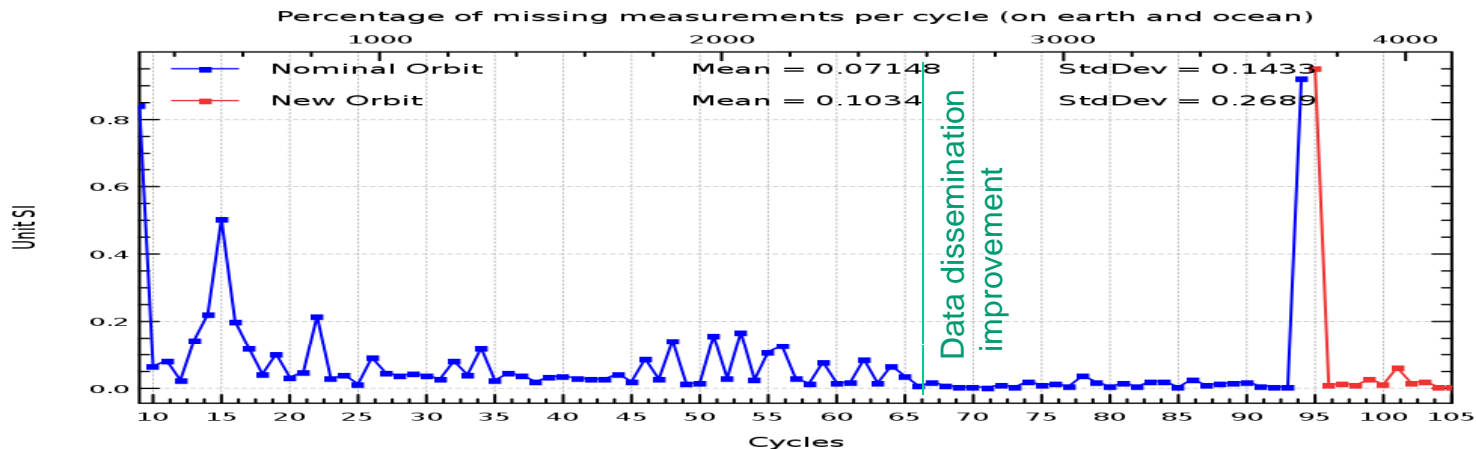All SSH Correction have been homogenized
USO auxiliary correction used

September 2005    June 2008    December 2009    November 2010

GDR Cycles: 10 | 22 | 30 | 41 | 60 | 65 | 68 | 85 | 93 | 94 | 95 | 105

✓**Excellent coverage for the last 2 years in GDR and IGDR**

✓**No impact of orbit change on coverage**

*Beginning of drifting phase:*
22-26 November 2010
➔ 30 days pseudo cycles instead of 35 days cycles

Percentage of missing measurements per cycle (on earth and ocean)

Nominal Orbit    Mean = 0.07148    StdDev = 0.1433
New Orbit    Mean = 0.1034    StdDev = 0.2689
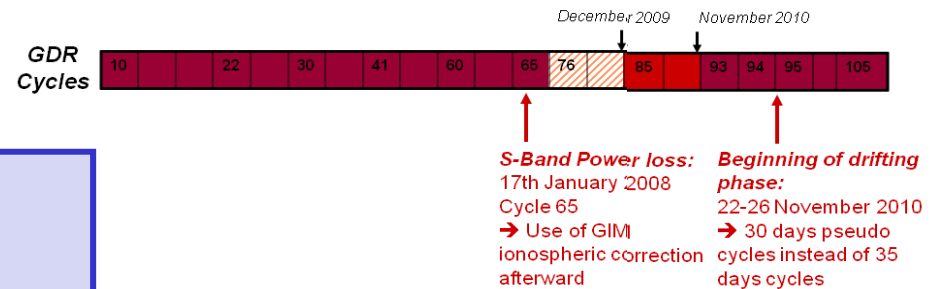
Data dissemination improvement

Unit SI

Cycles

**Reprocessing:** Early 2011, the GDR reprocessing (2.1) exercise started

✓ Essential to **homogenize** the GDR time series and to take into account the updates performed off line until now (ex Duacs products, Aviso).

✓ ~70% of the reprocessing have been performed

✓ All GDR, SGDR data + Cyclic reports available at:

   **ftp://diss-nas-fp.eo.esa.int**

   **directory : altimetry_dataset_v2.1**

*2 cycles validated per week End expected early 2012*

**Envisat GDR V2.1 reprocessed dataset**

December 2009   November 2010

| GDR Cycles | 10 | | 22 | 30 | 41 | 60 | 65 | 76 | | 85 | 93 | 94 | 95 | | 105 |

**S-Band Power loss:**
17th January 2008
Cycle 65
➔ Use of GIM ionospheric correction afterward

**Beginning of drifting phase:**
22-26 November 2010
➔ 30 days pseudo cycles instead of 35 days cycles

**Preliminary results:**

• Data quality and coverage improved for the beginning of the mission

• GDRC Orbit strongly improve the Geographically correlated biases

• Instrumental correction impacts range and SWH
   • Range: Long term drift modified
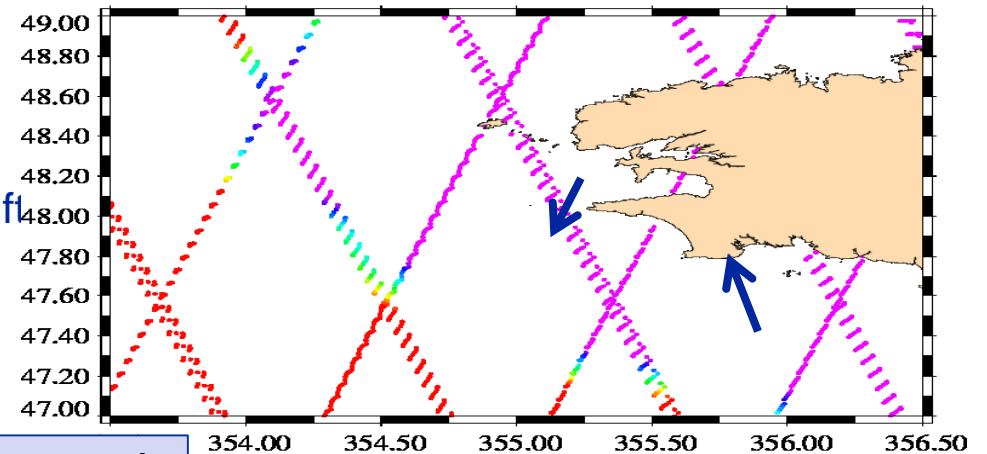   • SWH: Bias reduced with models/Jasons with slight inconsistency observed on small SWH

Stdev SSH difference at crossovers

St. dev. of X_SSH per cycle - |Latitude|<50 deg. - Bathy<-1000m, Var<20cm

2004        2006        2008        2010

Envisat before Reproc
Envisat Reproc
Jason-1

0.05
0.04
0.03

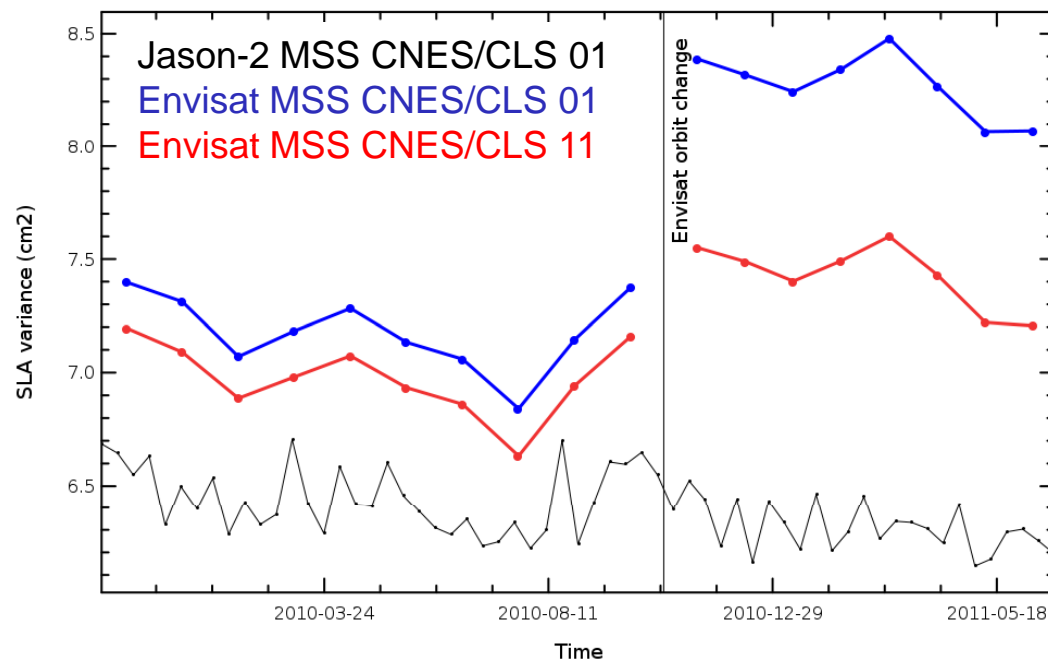10  15  20  25  30  35  40  45  50  55  60  65  70  75  80  85  90  95  100 105
Envisat Cycles
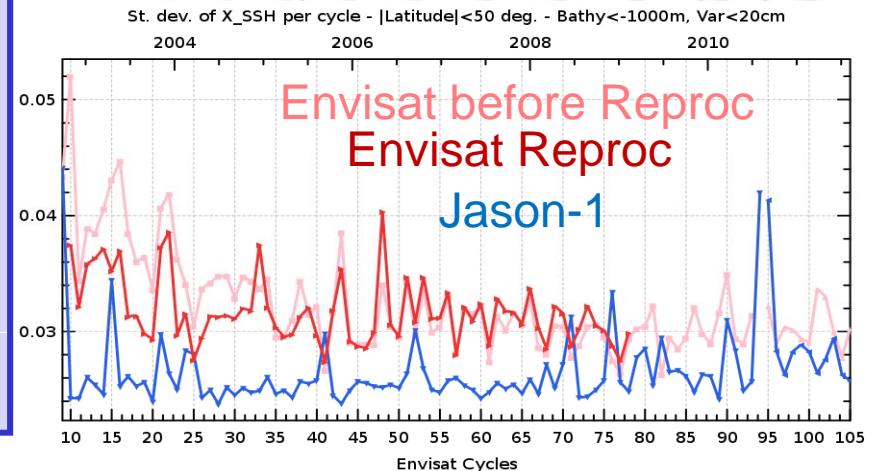
## New drifting Orbit

✓ Pseudo repetitivity 30 days instead of 35

✓ the observed drift is slightly higher: Min/Max drift estimated = 0km/yr at 38° / 20km/yr at 50°

✓ Envisat data quality are still very good

**Variance of SLA filtered: wavelength <50km and >500km are removed**

Jason-2 MSS CNES/CLS 01
Envisat MSS CNES/CLS 01
Envisat MSS CNES/CLS 11

SLA variance (cm2)

Envisat orbit change

Time

✓ The slight degradation expected is observed. It is due to the shift of passes compared to the theoretical passes (MSS is now used instead of the mean profile).

➔ More information , See Envisat related web sites:
http://earth.eo.esa.int/pcs/envisat/ra2/

# Plan

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# Remaining Est/West bias explained

- In 2010, several authors showed an East/West signature drifting in time on the Jasons and Envisat data (using GDR-C orbit standard)

- This discrepancy highlighted a **strong sensibility to the gravity field model** used as an input of orbit solutions

Mean SSH difference at crossovers (2010)
EN GDR-C / J1 GDR-C (cm)



- New CNES orbit with **GDR-D standards** (as well as the **V7 ESOC** solution) have been tested
    - EIGEN_GRACE_RELEASE2Bis Gravity field estimated over 2002-2010 instead of 2003-2005
    - Additional drift component
    - ITRF2008 instead of ITRF 2005

2003
2004
2005
2006

2007
2008
2009
2010 (half)
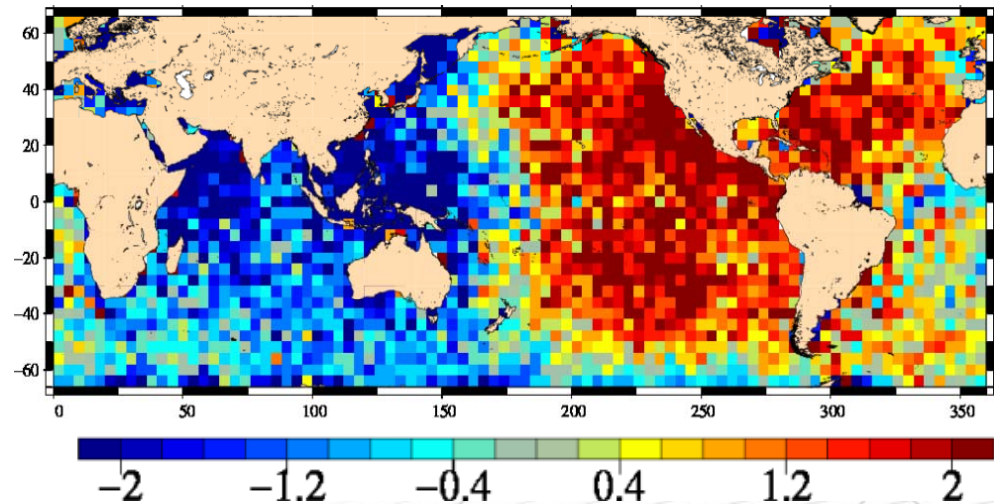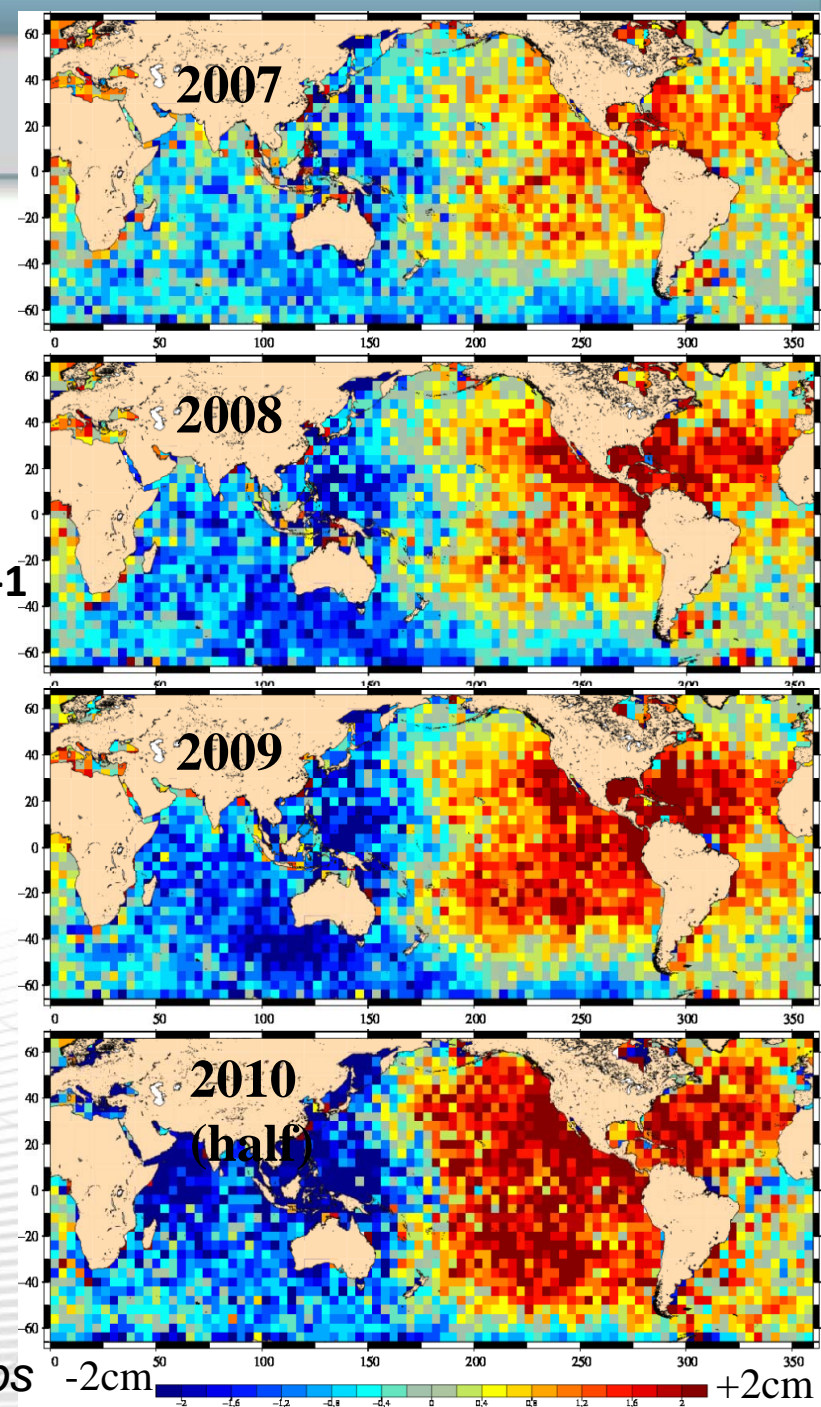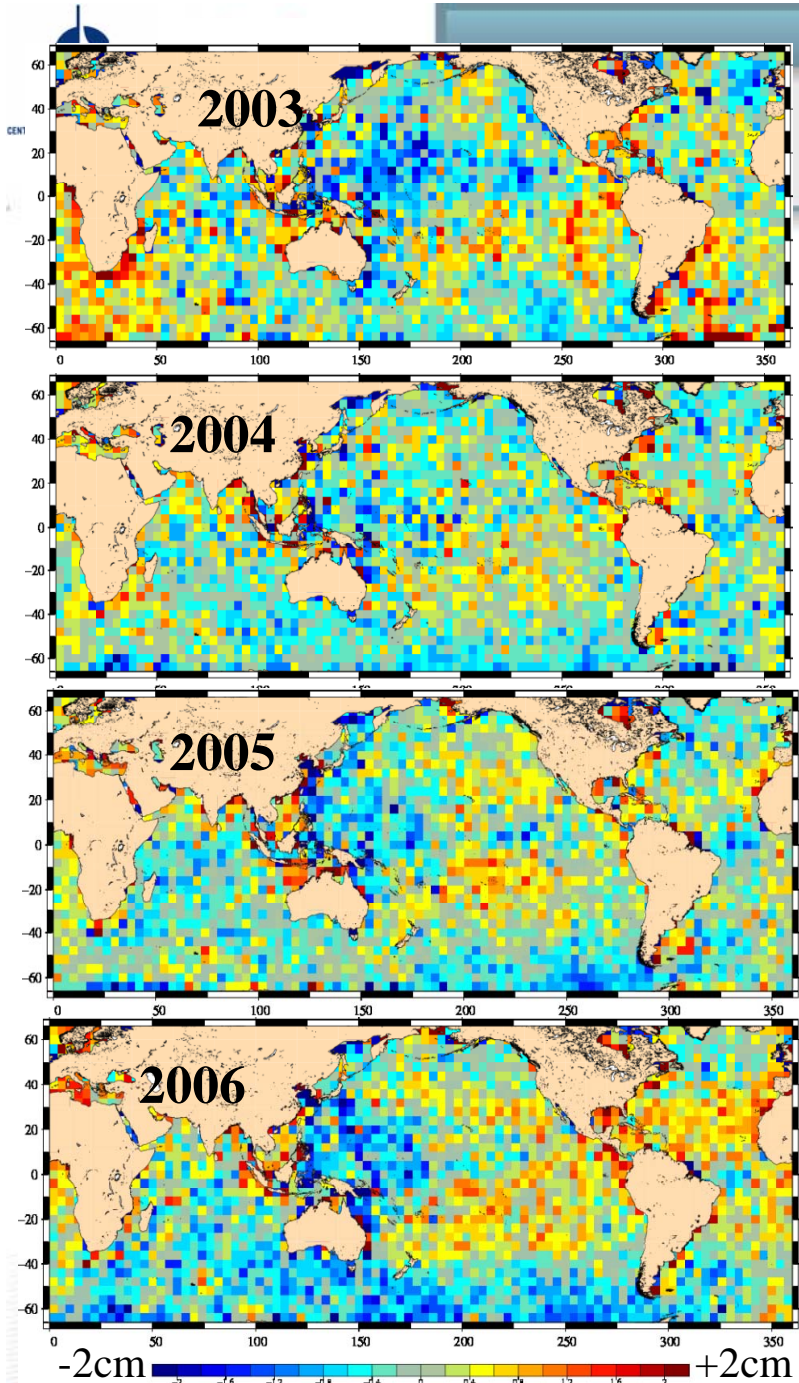
Envisat –Jason-1 at crossovers

Using GDR-C orbits

-2cm +2cm

Centered Maps

-2cm +2cm

2003

2004

2005

2006

2007

2008

2009
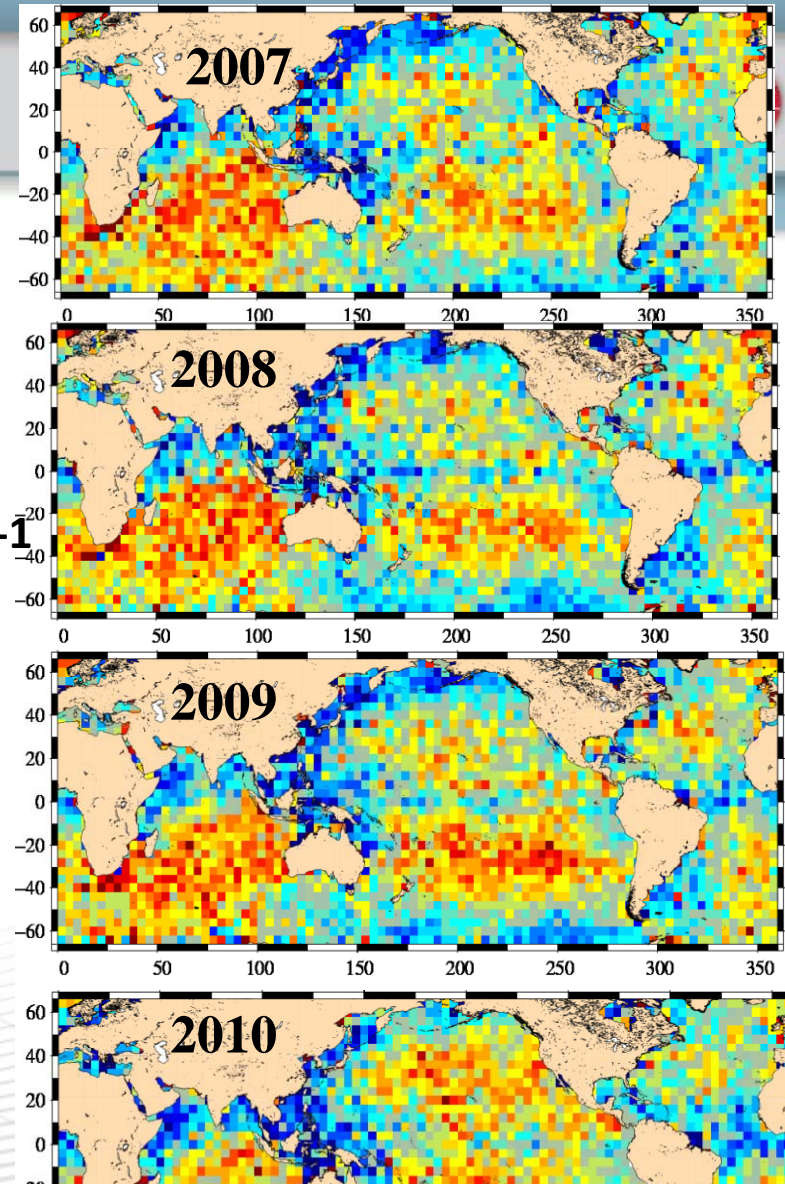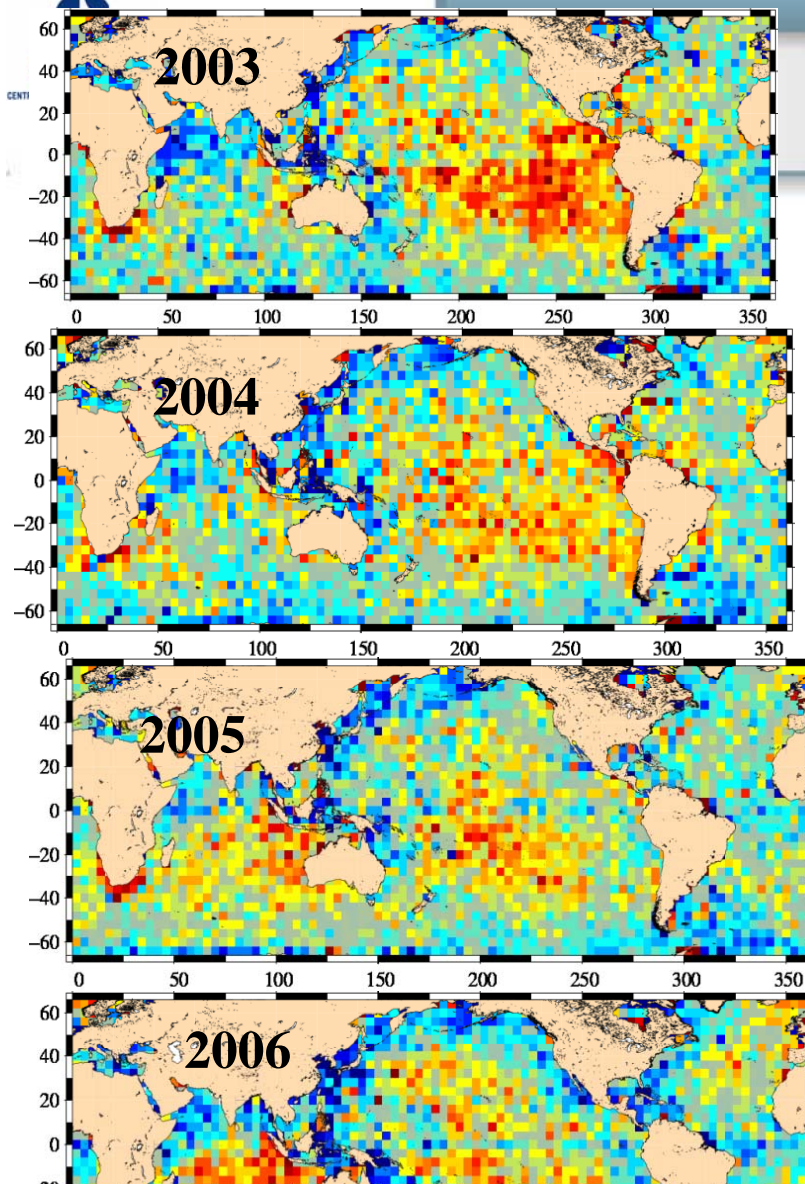
2010

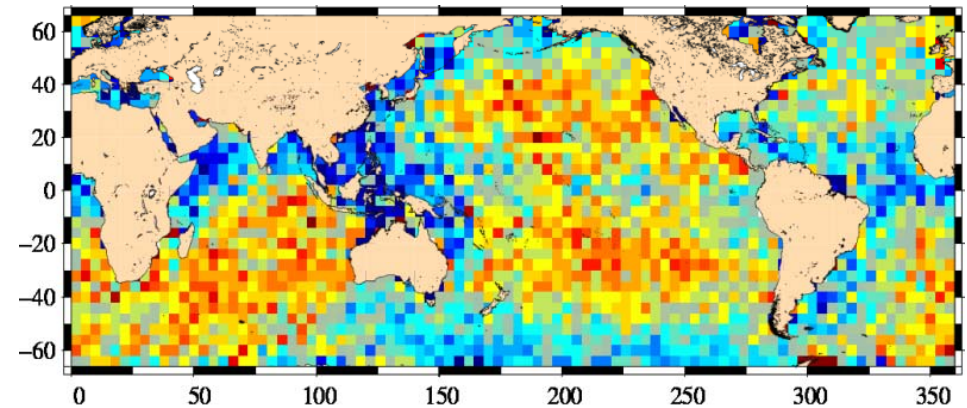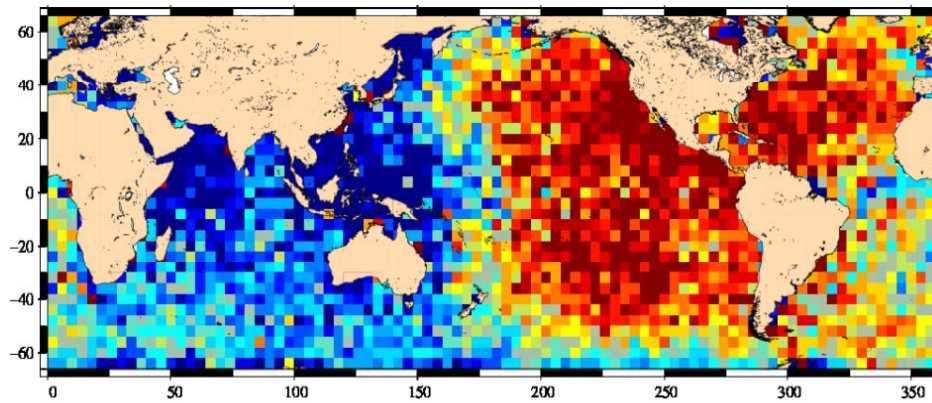Envisat –Jason-1 at crossovers (cm)

**Using GDR-D orbits**

Great improvement of GDR-D standards: removes the East-West discrepancy and its temporal variation! Remaining errors are likely to be due to a mix of errors on both missions

## 2010

EN GDR-C / J1 GDR-C

EN GDR-D / J1 GDR-D



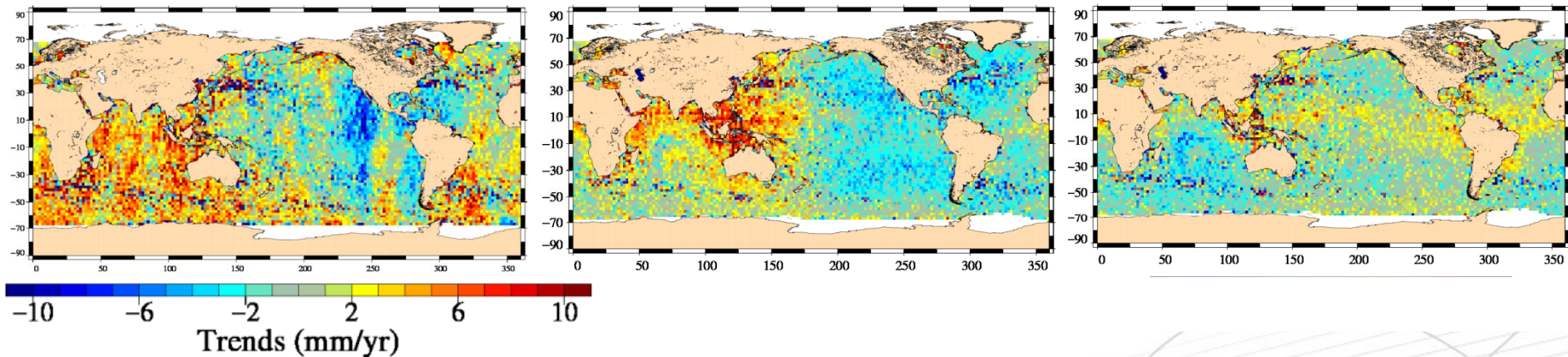Using GDR-D orbit for Envisat and Jason-1 removes the East/West Bias.

# Regional Mean Sea Level trend differences Jason-1-Envisat and orbit standard impact

EN-J1 MSL differences using GDR-A-B Orbits

EN-J1 MSL differences using GDR-C Orbits

EN-J1 MSL differences using GDR-D Orbits



Trends (mm/yr)

- Thanks to multimision analysis, Geographically correlated bais were observed on Envisat and Jasons missions.

- Notably, the gravity field used in the orbit solution was shown to have a great impact on the long term drift for all missions. With the latest standard (futur GDR-D), regional consistency between mission is largely improved.

- See also talk from M. Ablain (Regional MSL), S. Philipps (Orbit) and Poster from JF Legeais (In situ)
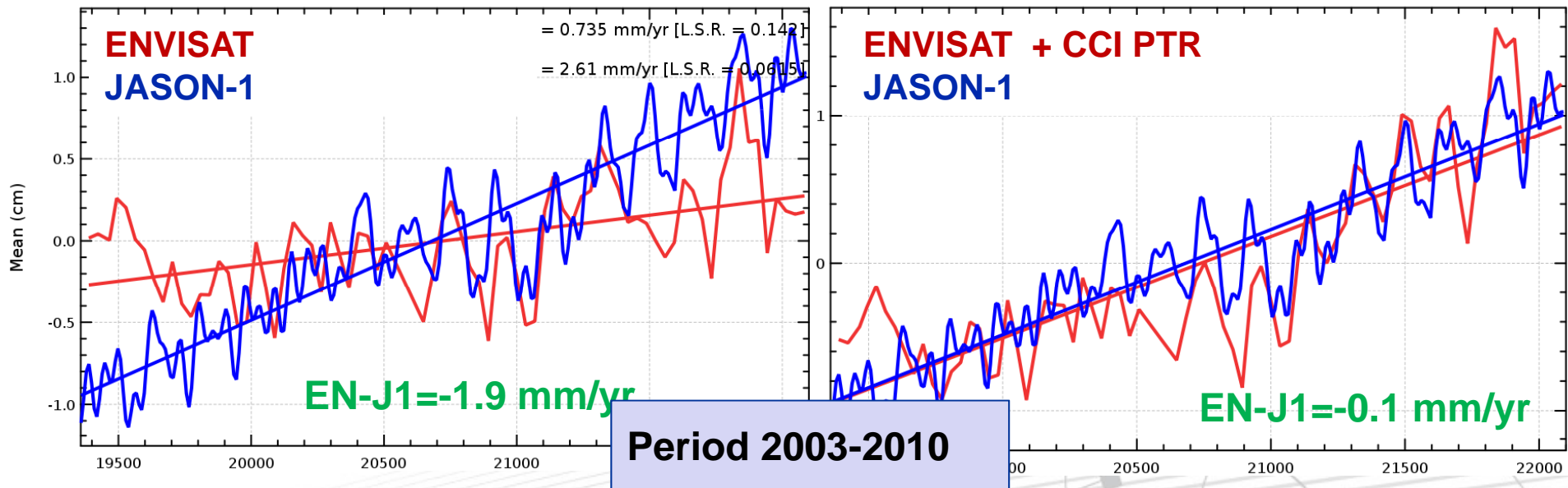
# Plan

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# Envisat Mean Seal Level Evolution

- The difference with Jason-1 is **about 2mm/year over 2003-2011** using the GDR 1 data set + Aviso updates
- An error in one of the **RA-2 instrumental correction (PTR) has been demonstrated** (P Thibaut and M Roca) this year.
- A new PTR correction has been tested within the ESA CCI project



**ENVISAT**
**JASON-1**

= 0.735 mm/yr [L.S.R. = 0.142]
= 2.61 mm/yr [L.S.R. = 0.0615]

EN-J1=-1.9 mm/yr

**ENVISAT + CCI PTR**
**JASON-1**

EN-J1=-0.1 mm/yr

**Period 2003-2010**

- The new PTR correction increases the Mean Sea Level trend by 1.8mm/year reducing drastically the differences with Jason-1. **This is a major progress in the understanding of Envisat / Jason-1 discrepancies**
- **The reprocessed GDR 2 data will not contain this correction**

# Envisat Mean Seal Level Evolution

- Differences still remain: differences at interannual scales are clearly visible:
  - ➤ The reprocessed data may correct a part of these discrepancies – TBC
  - ➤The erroneous behavior of the first year is not corrected, still unexplained and will remain after reprocessing

| | Slope (mm/yr) over 2003/2010 | Slope (mm/yr) over 2004/2010 |
|---|---|---|
| Envisat GDR1 + Updates | 0.7 | 1.1 |
| Envisat + CCI PTR | 2.5 | 3.1 |
| Jason-1 | 2.6 | 2.6 |

**EN-J1=-0.1 mm/yr**          **EN-J1=+0.5 mm/yr**

- Removing year 2003 strongly increases the EN/J1 differences
- These are **preliminary results** and further analyses have to be performed on the PTR correction impact
- Fine Calval and Cross-calibration studies including the tests of new standard have to continue in order to understand the remaining differences

# Conclusion

- **Ra-2 altimetry system has good performances, even on its new orbit**
  - ✓ A very good availability
  - ✓ Good metrics at crossovers, at the same level as Jason series
  - ✓ Improved with the reprocessing in terms of coverage and performance

- **Reprocessing of the GDR in version 2.1 will be completed very soon**
  - ✓ improved with the reprocessing in terms of coverage and performance
  - ✓ Crucial to have an homogeneous dataset for climate studies

- **Global and regional MSL trend discrepancies between EN and the Jason's are getting understood/reduced**
  - ✓ Envisat /Jason-1 East West differences are removed using GDR-D orbit
  - ✓ The CCI PTR correction increases the Mean Sea Level trend by 1.8mm/year reducing drastically the differences with Jason-1. This is a major progress in the understanding of Envisat / Jason-1 discrepancies

- **Once more multi-mission analyses enabled to highlight fine errors on all altimetry datasets.**