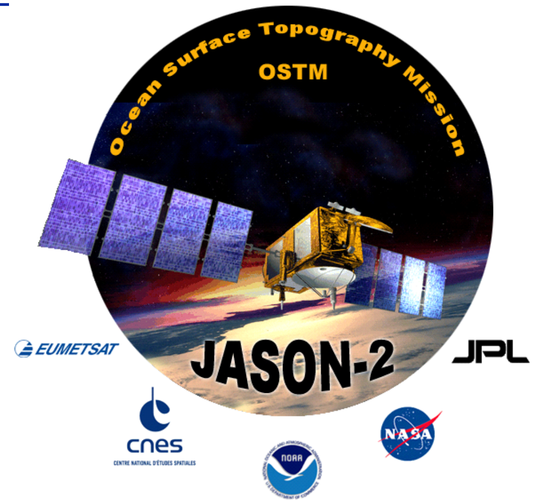


Which duration for the Jason-2 / Jason-1 repeat-track phase?

- Verification and Cal/Val purposes
- Applications and operational needs

J. Dorandeu - CLS

Introduction (1/4)

- Objectives of the verification phase:
  - To ascertain that the overall **altimeter System** (including all components: sensors, platform, orbit calculation, ground processing…) complies with its **specifications**, and fulfils the mission requirements. Thus the primary objective is to **compare the actual error budget to the specified one**.
  - To fulfill users' needs (this objective stretches over the whole mission lifetime) :
    - The main users' needs have been translated into system requirements (specified error budget)
    - **1 mm/yr** error in the MSL estimation at global scale is only a **goal, not a specification** and, as shown in the recent years, the MSL problem is now more on local estimates (few mm/yr at local scale)
    - It is the **strength of the OSTST** for many years **to enlarge mission objectives**, to **refine the needs** and consequently to require **more and more accuracy**: climate change studies are the more demanding in terms of stability , even at local scale.

Introduction (2/4)

OSTM/JASON-2 Science and Operational Requirements (Menard, Fu, Lambin, Bonnekamp, Lillibridge, ref: TP3-J0-SP-188-CNES)

- Scientific Objectives and Requirements:
  - Mean Dynamic Topography
  - Intra-seasonal to inter-annual variability
  - Mesoscale and coastal oceanography
  - Mean Sea Level trend
  - Marine meteorology
  - Inland studies
  - Geophysics and geodesy
- Operational Applications and Requirements
  - Short and mid-term applications: mesoscale, coastal applications, climate applications
  - Near Real Time applications: marine meteorology and other NRT applications
  - CalVal activities and oceanographic campaign

Introduction (3/4)

Both Science and operational requirements have been translated into the overall error budget (OSTM/Jason-2 system, TP3-J0-STB-44-CNES by Perbos, Parisot, Vaze, Bannoura):

C	OGDR 3 hours	IGDR 1 to 1.5 days	GDR 40 days	GOALS
Altimeter noise	2.5 *(a)(c)(d)*	1.7 *(b)(c)(d)*	1.7 *(b)(c)(d)*	1.5 *(b)(c)(d)*
Ionosphere	1 *(e)(d)*	0.5 *(e)(d)*	0.5 *(e)(d)*	0.5 *(e)(d)*
Sea State Bias	3.5	2	2	1
Dry troposphere	1	0.7	0.7	0.7
Wet Troposphere	1.2	1.2	1.2	1
Altimeter range RSS	**5**	**3**	**3**	**2.25**
RMS Orbit (Radial component)	10 *(h)*	2.5	1.5	1
Total RSS sea surface height	**11.2**	**3.9**	**3.4**	**2.5**
Significant wave height	10% or 0.5 m *(i)*	10% or 0.4 m *(i)*	10% or 0.4 m *(i)*	5% or 0.25 m *(i)*
Wind speed	1.6 m/s	1.5 m/s	1.5 m/s	1.5 m/s
Sigma naught (absolute)	0.7 dB	0.7 dB	0.7 dB	0.5 dB
System drift				1mm/year *(j)*

- *(a)* Combined Ku + C measurement
- *(b)* Ku band after ground retracking
- *(c)* Averaged over 1 sec
- *(d)* Assuming 320 MHz C bandwidth
- *(e)* Filtered over 100 Km
- *(f)* Can also be expressed as 1% of H1/3
- *(g)* After ground retracking
- *(h)* Real time DORIS onboard ephemeris
- *(i)* Which ever is greater
- *(j)* On global mean sea level, after calibration

Introduction (4/4)

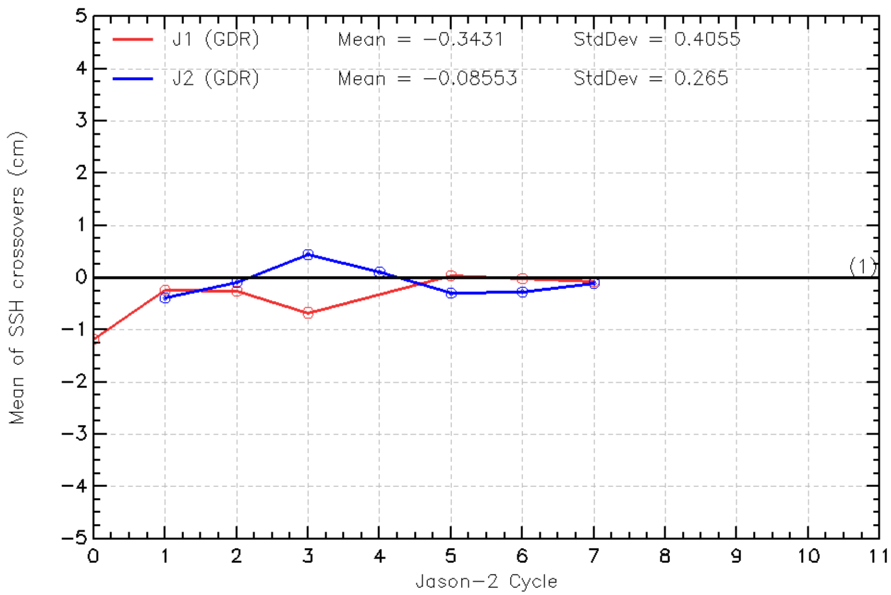
- A proposed trade-off objective for the verification phase in repeat-track configuration:
  - Ensure **compliance with error budget specifications** (minimum required)
  - Ensure that **further improvements** in J2 quality will be **possible** (ground processing, orbit calculation) and even using the repeat-track data
  - Establish **other efficient CalVal methods after** the exact repeat phase
  - Show that further **consistency** improvements between J1 and J2 would not necessarily improve **J2 quality** (intrinsic J1 errors, consistency of errors…)

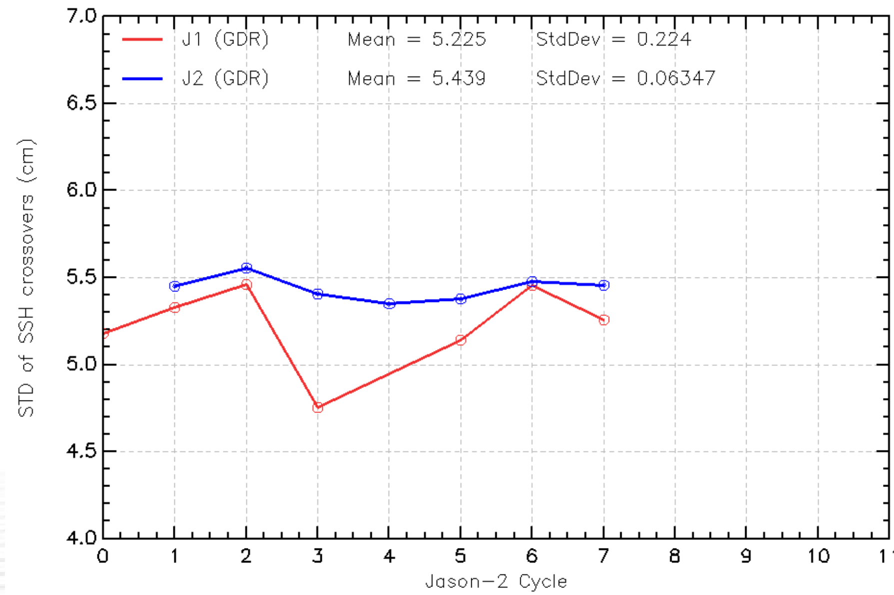
  - Then **move as soon as possible to a new ground track** to improve time/space sampling by altimeter data for applications' needs (like operational oceanography)

- This outlines the following slides

1. J2 SSH overall performances

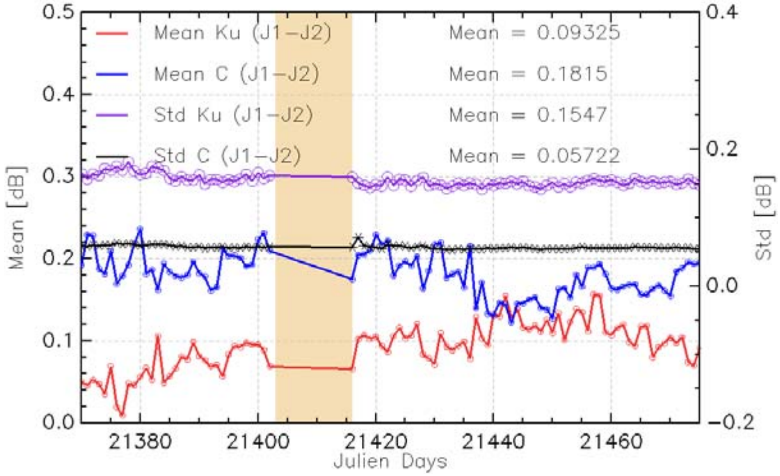
- Very good SSH performances from crossover analysis
  - Though the Precise Orbit calculation is not yet completely tuned



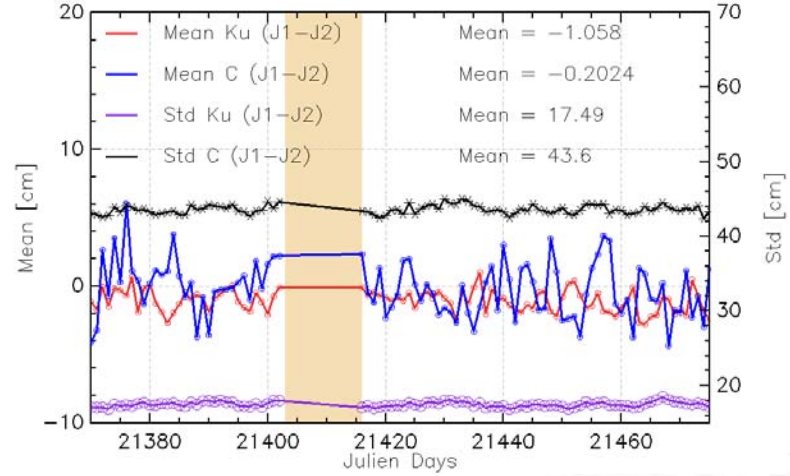


1. J2 overall performance

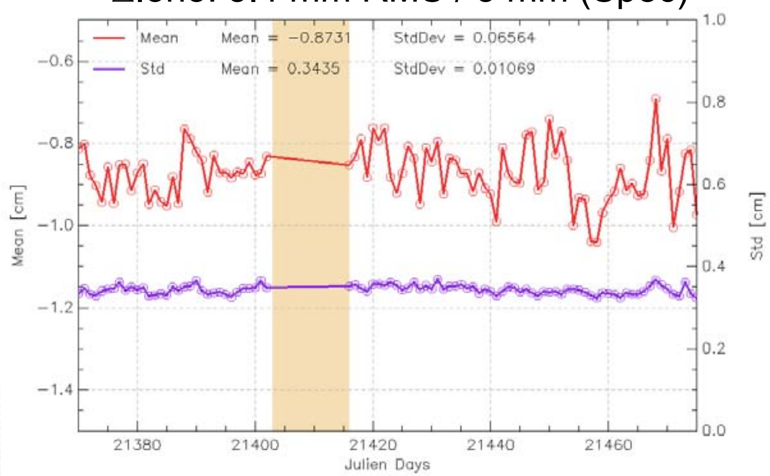
ΔSigma0: 0.15 dB RMS / 0.7 dB (Spec)



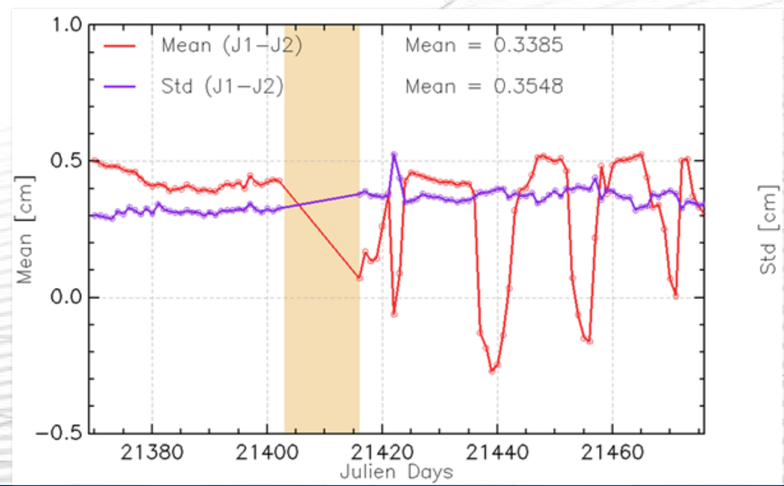
ΔSWH: 15.5 cm RMS / 40 cm (Spec)



ΔIono: 3.4 mm RMS / 5 mm (Spec)

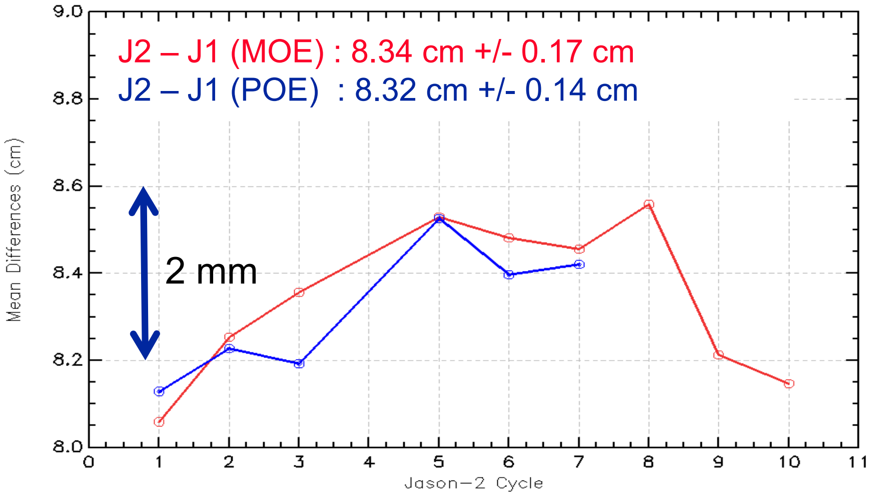


Δtropo ~ 5 mm due to Jason-1

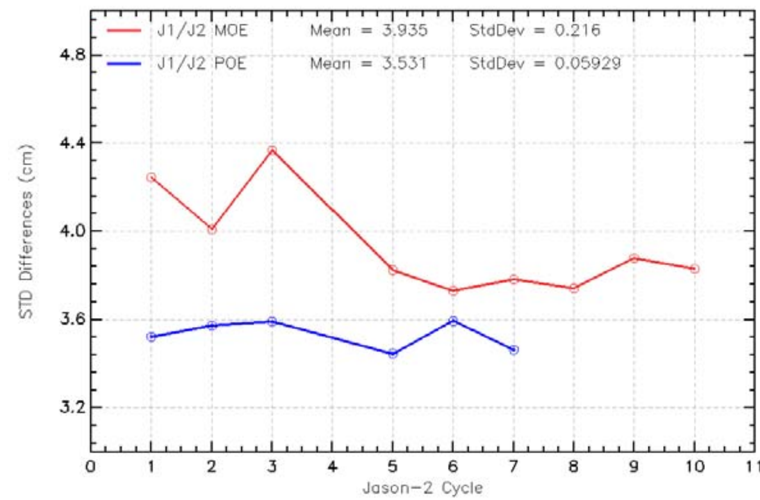


J2 SSH performance and Consistency relative to J1

J2 – J1 mean differences



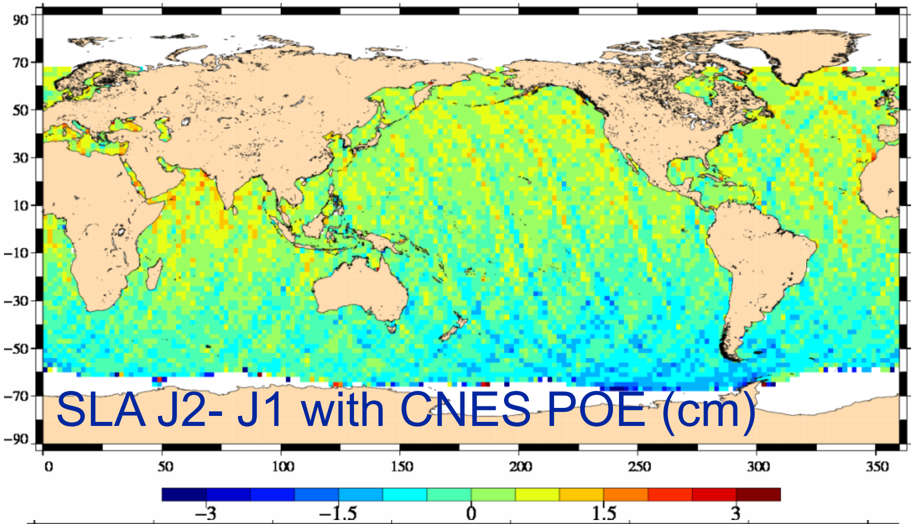
(J2 – J1) Std

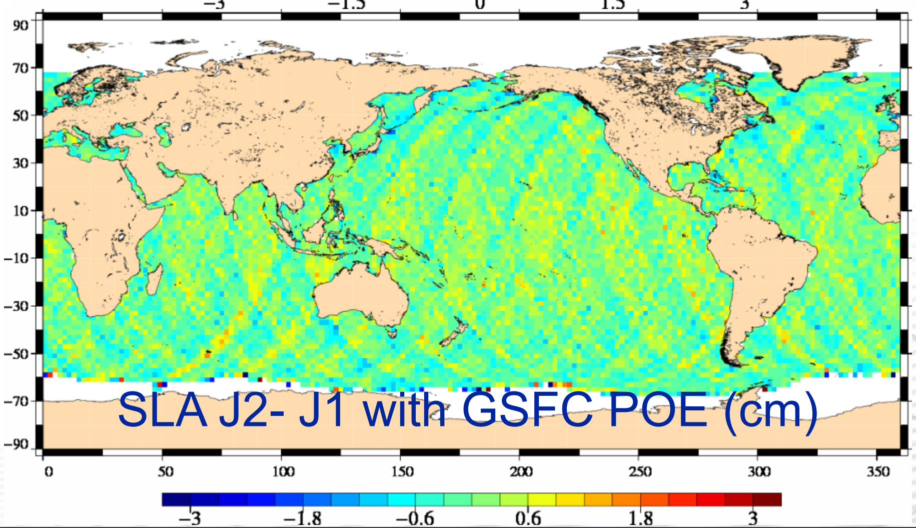


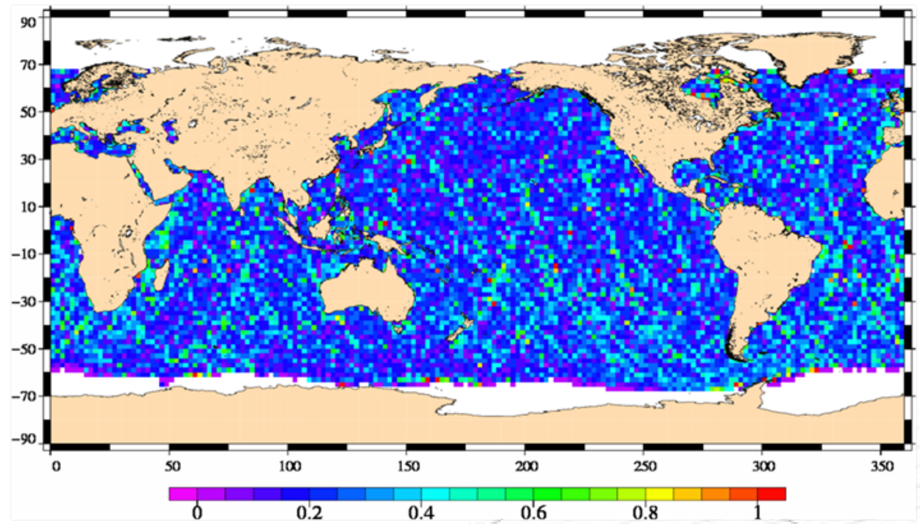
3.5 cm RMS to be compared to 3.4 x√2 (spec)

J2 / J1 geographically correlated errors

(main issue between J1 and T/P during J1 verification phase)

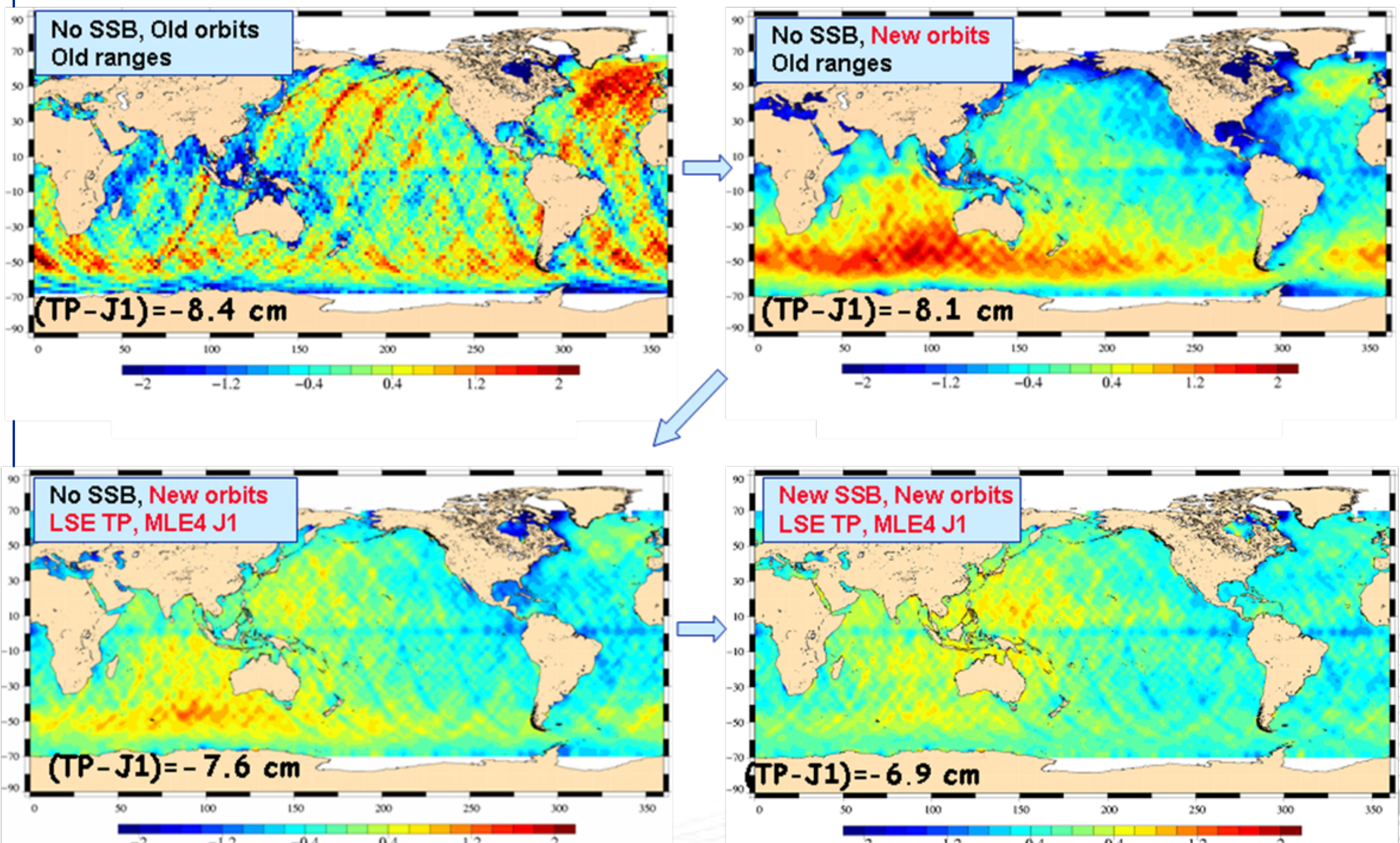


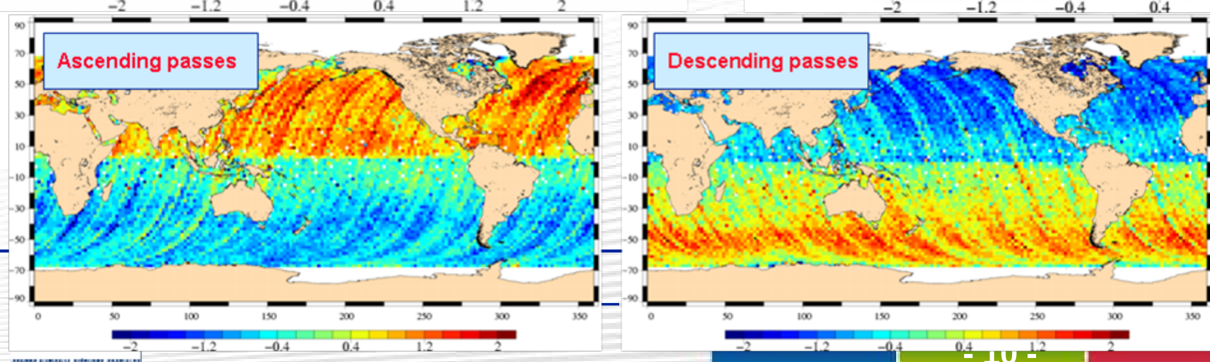




- Local differences accumulated over 6 cycles (POE orbit)
- Mean differences locally reduced to less than 5 mm (left figure)
- Local differences are constant: Std. Dev ~ 2 mm RMS

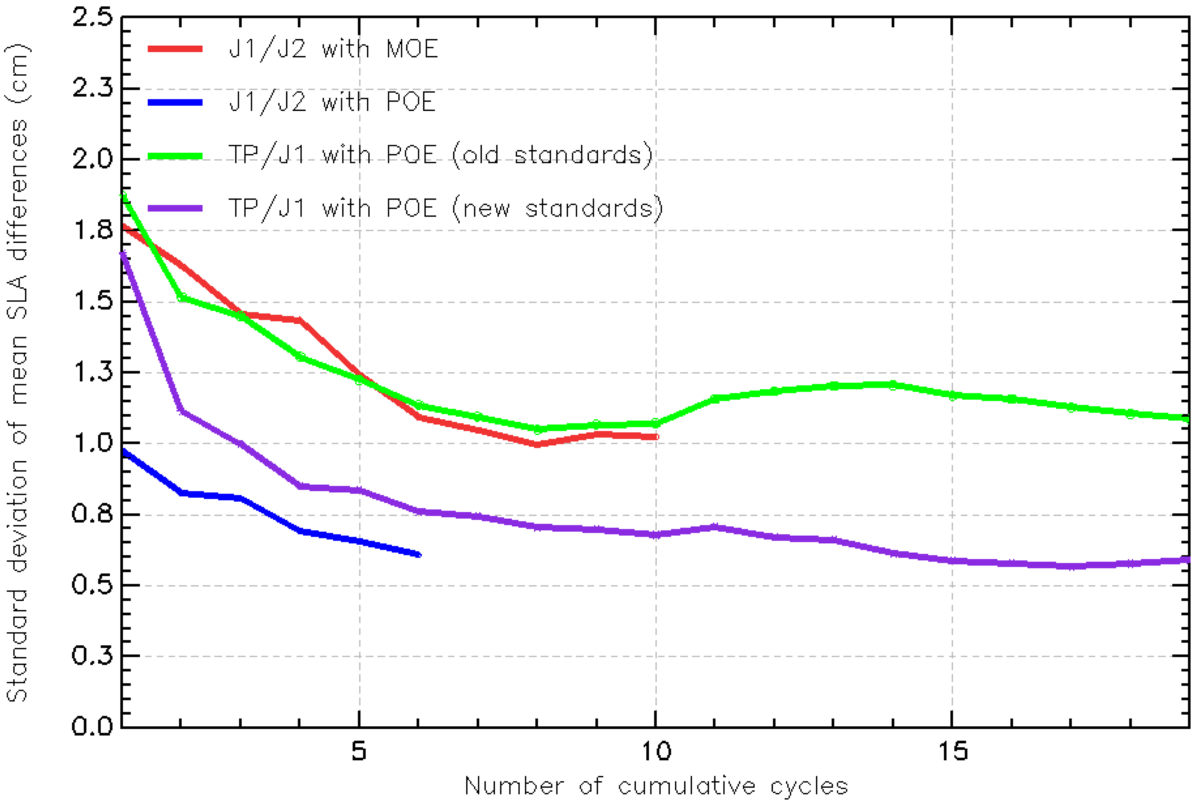
Comparison with the former J1/ T/P differences





- Local differences accumulated over 21 cycles
- Improvements carried out after the shifting the T/P track
- Orbit calculation impact: Grace gravity fields
- Retracking impact (T/P)
- SSB impact
- Retracking of the whole TOPEX dataset will improve the continuous precise altimeter series

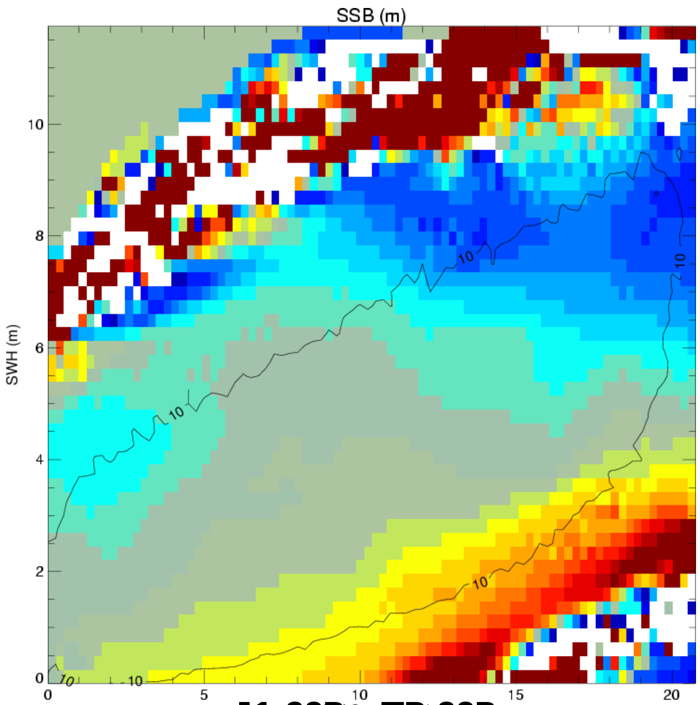
Geographically correlated differences



- Maps of differences computed over different periods (accumulating data in the local average)
- Std. Dev. computed among geographical bins (estimate of map homogeneity)

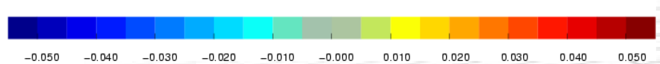
J2 / J1 SSB difference (Labroue, S.)

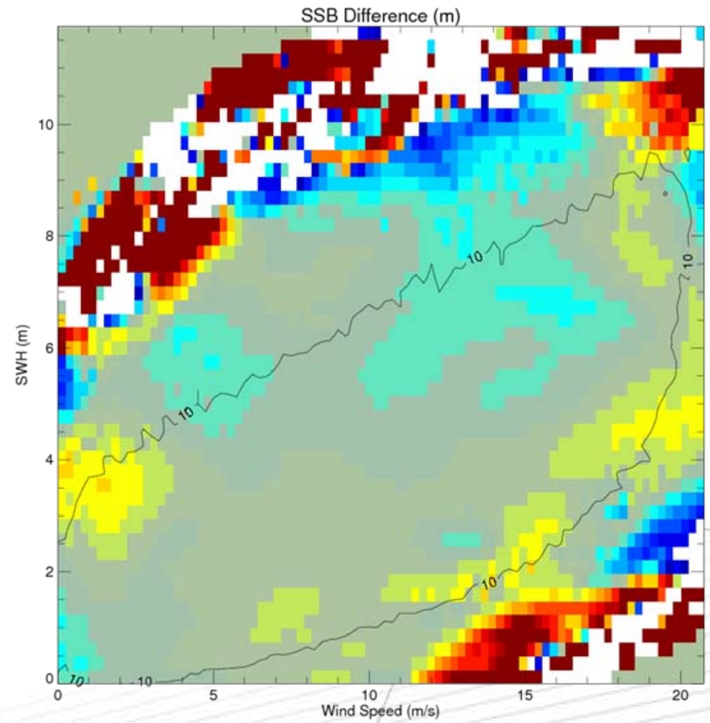
(was one of the main sources of differences between T/P and J1)



J1 SSB - TP SSB

-5 cm **(Hobart OSTST 2007)** +5 cm





J2 SSB - J1 SSB (centred by 1 cm)

-5 cm +5 cm

With only four months of data (J2-J1), we are at the same level of agreement than between J1 and TOPEX after 6 years of studies ….

Summary of main CalVal results

- Very good performances of the overall altimeter system:
  - altimeter OK
  - AMR performs better than JMR
  - Impressive MOE and POE results (even preliminary)
  - No issue detected from CalVal analysis. Fully compliant to specified error budget

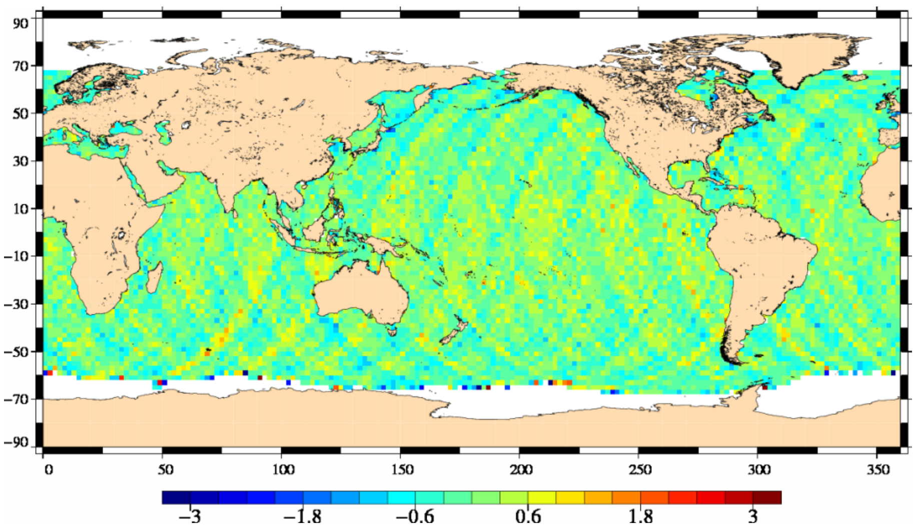
- After 4 months, very good SSH consistency between J1 and J2
  - differences are lower than 0.5 cm and constant
  - as good as between J1 and T/P with 9 months of data and a lot of studies carried out afterwards (2 years of continuous improvements)

Consistency / homogeneity vs absolute performance

- Do we have to ensure a perfect homogeneity between J1 and J2?
  - Consistency is already at a very good level (< 5 mm)
  - Continuity will be ensured between J1 and J2, better than between T/P and J1
  - Constraining J2 to fit J1 as much as possible could raise other concerns that could significantly impact the overall error budget:
    - AMR troposphere correction is improved relative to JMR
    - DORIS receiver is better on J2 than on J1(USO frequency, SAA), more GPS measurements in J2 orbit
    - J1 ageing has to be taken into account
    - Doing the same sometimes produces undesirable effects:
      - Experience from T/P / J1 verification phase: former standards (JGM3) were kept for consistency needs, while new gravity fields would have performed better (as demonstrated afterwards)

Consistency / homogeneity vs absolute performance

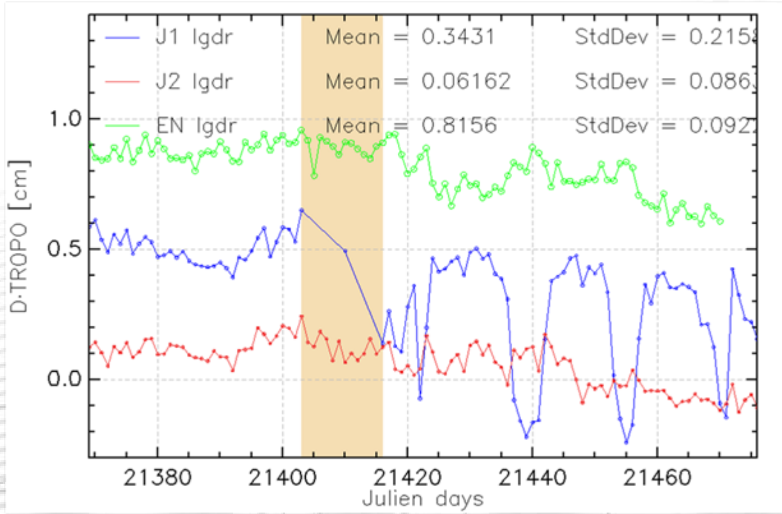
Mean (J2 – J1) differences (cm)



- Can we really improve much?

- Avoiding to propagate J1 errors on J2

differences between radiometer and model (cm)

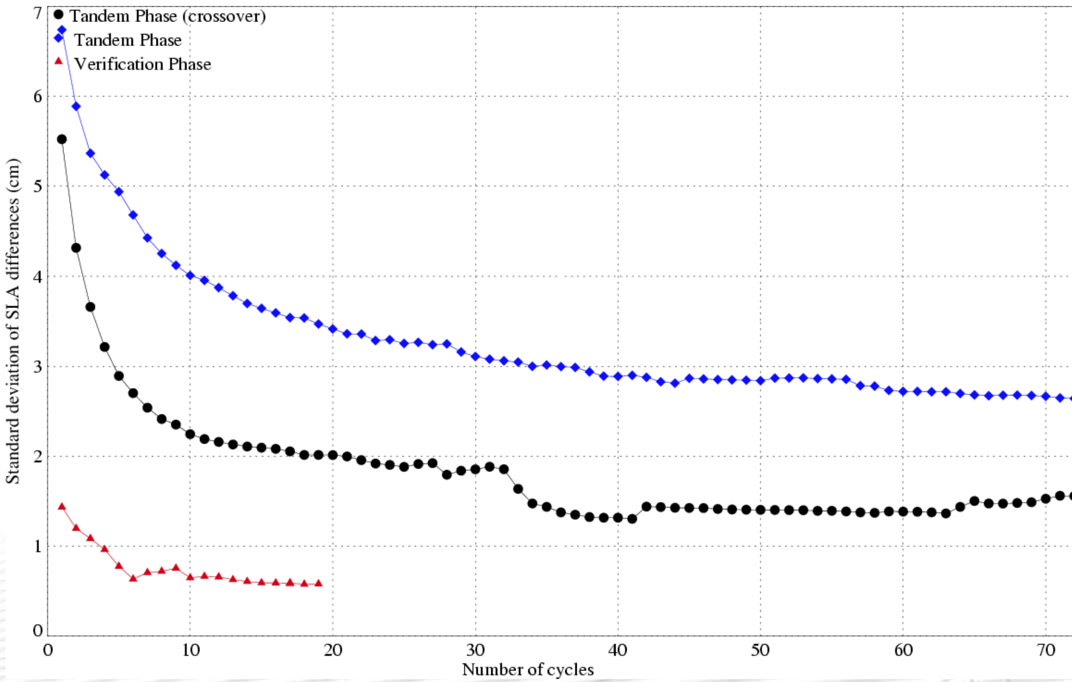


CalVal is a continuous activity

- CalVal activities will not stop just after the exact repeat phase
  - We must continue **to monitor and to improve** OSTM/J2 performances and data quality
  - Many (almost all) improvements in T/P / J1 consistency have been made after the repeat-track period
  - Data from the exact repeat phase will still be used to improve
  - We have other CalVal tools to do so, apart from exact repeat-track analysis (as shown previously on J1):
    - Direct comparisons, for detecting geographically correlated errors
    - Crossovers
    - Use of EnviSat
    - Other techniques, like comparisons to in-situ measurement will also help

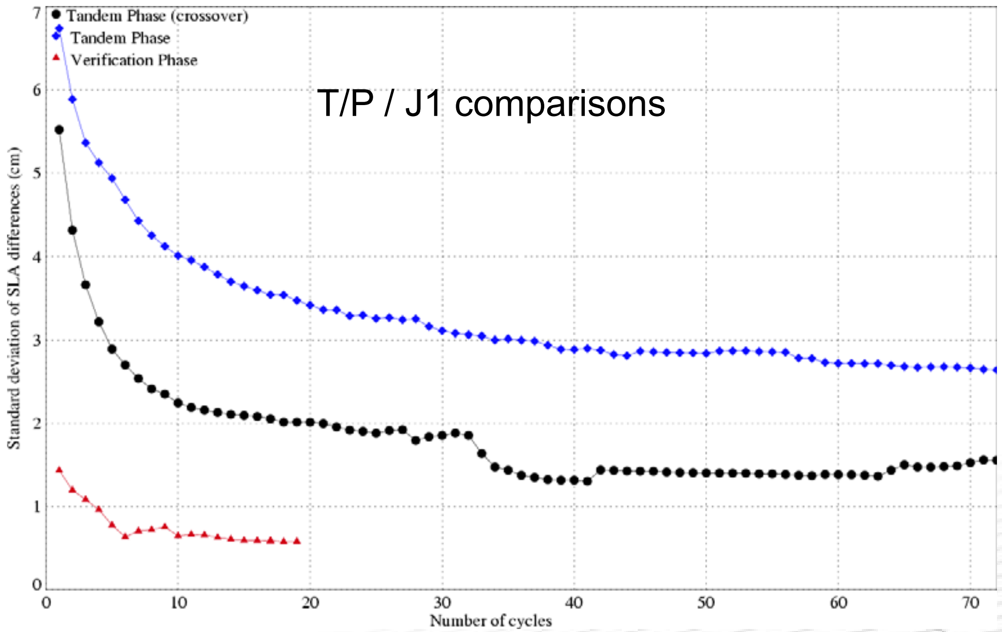
CalVal is a continuous activity

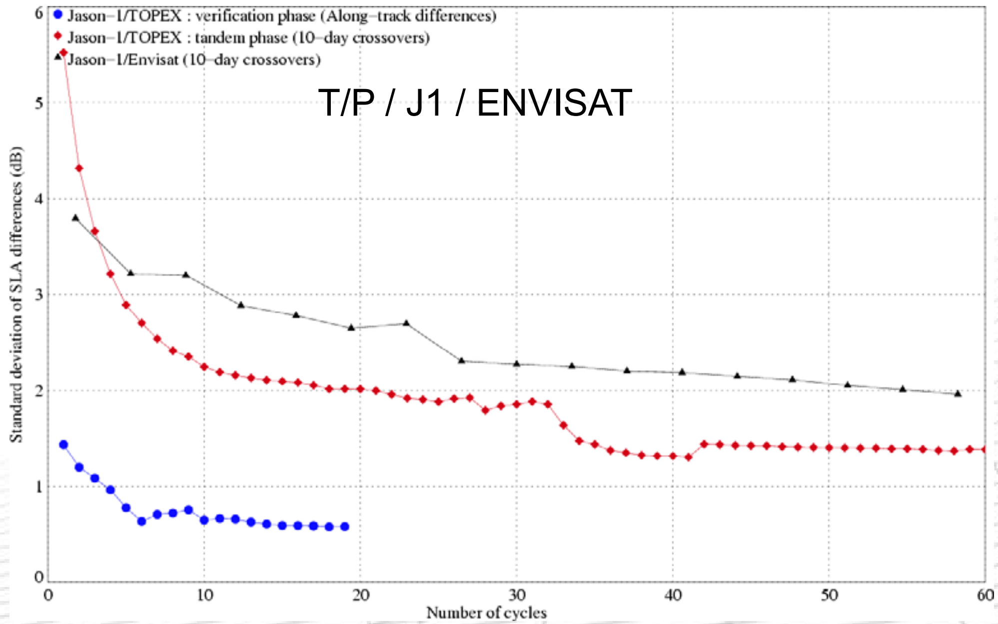
- Estimation of the (T/P – J1) consistency
  - During and after the exact repeat period
  - Using 3 different techniques



CalVal is a continuous activity

- Estimation of global consistency between different missions
  - During and after the exact repeat period
  - Using 3 different techniques

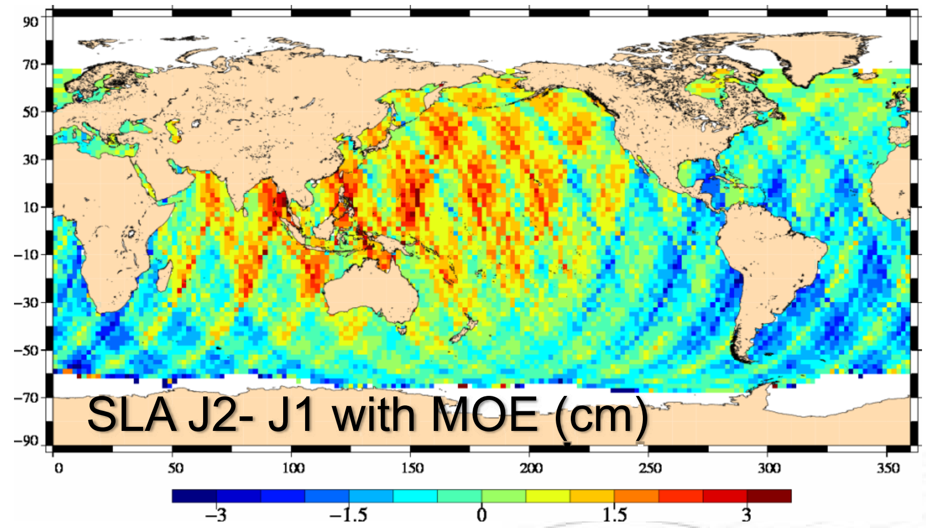


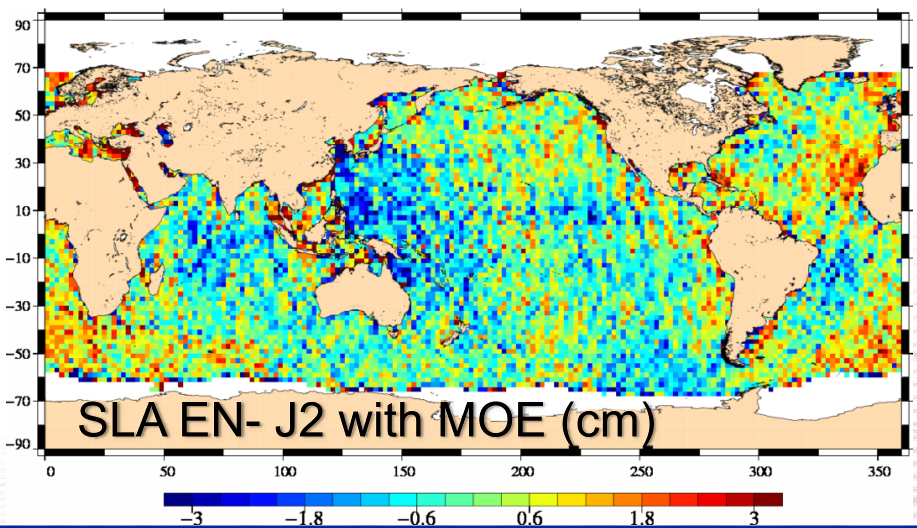


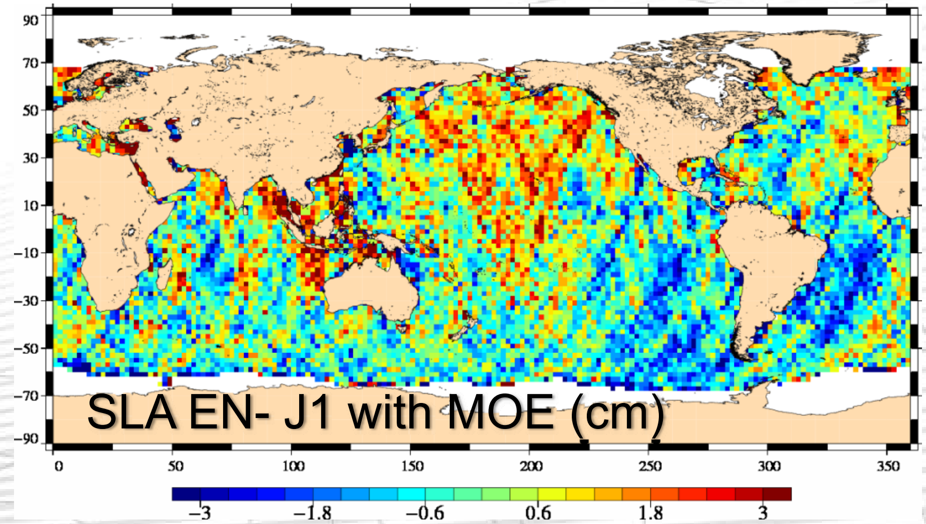
  - Even less precise, other techniques are able to detect changes or to assess improvements

CalVal is a continuous activity

- Shown by M. Ablain in the POD splinter
- Cross-calibration with Envisat used to investigate differences between J1 and J2, even in the repeat-track period!
- Large structures observed in both EN/J1 and J2/J1 maps

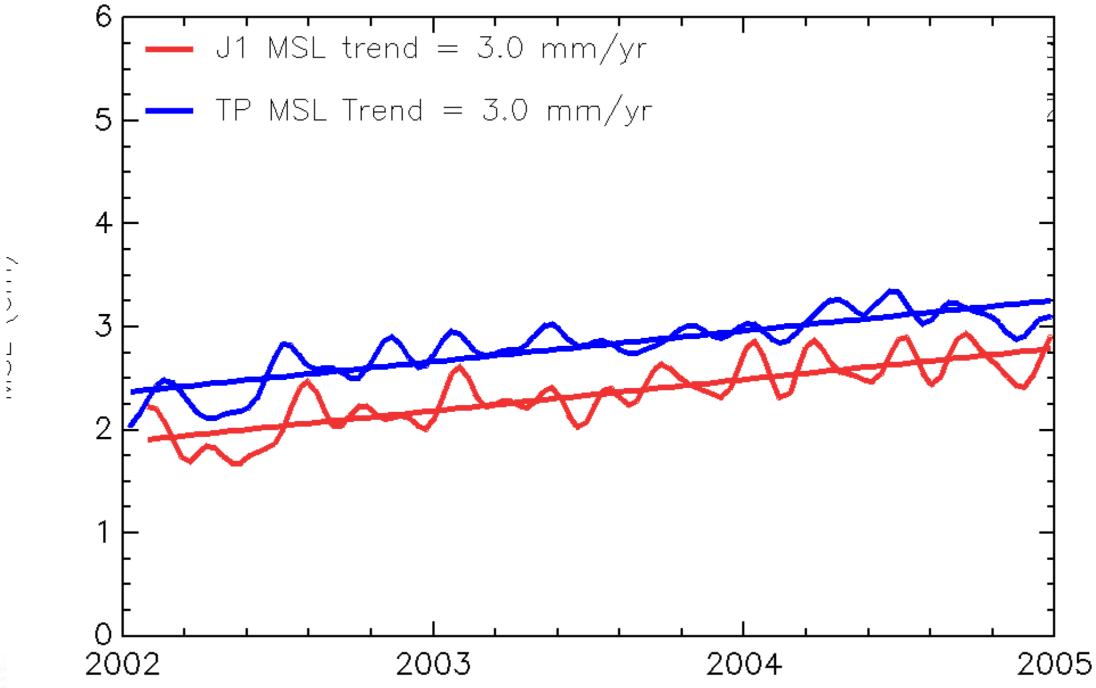






CalVal is a continuous activity

- MSL estimations on different ground tracks, experience of T/P / J1



Conclusions

- CalVal results from analysis of 4 months of data:
  - Very good performances of the overall altimeter system and improvements relative to J1 (AMR/JMR, orbits)
  - No issue detected. Fully compliant to specified error budget
  - Very good SSH consistency between J1 and J2 (differences < 5 mm and constant)
  - Results as good as between T/P and J1 with 9 months of data and several years of studies

- Which issue/application requires further extension of the repeat-track configuration? And what is the accuracy requirement?
  - MSL is the more demanding application in terms of stability:
    - global and local estimates will be possible, as with T/P and J1
  - Seasonal signals not well observed?
    - Would require 2 years for annual signal
    - Will be observed anyway by other means (long time scales)
  - Possible scale error in iono corrections (J1 – J2) shown by S. Desai
    - More cycles would not help too much (observed on each cycle)
    -
  - Other features that have not been discovered so far?
    - Should be visible if they were present
    - Other events can occur (sensor failure…)

- CalVal activities will continue: other techniques, multi-mission

- It's time to feed other applications (than CalVal) for which the mission has been designed
- 4 to 6 months, depending on feasibility, **but we must take the decision today**