Analysis of 58.74-day signal observed on the MSL derived from Jason-1&2 and TOPEX data

M. Ablain, S.Philipps , L. Carrere, G. Valladeau, J.-F. Legeais (CLS)
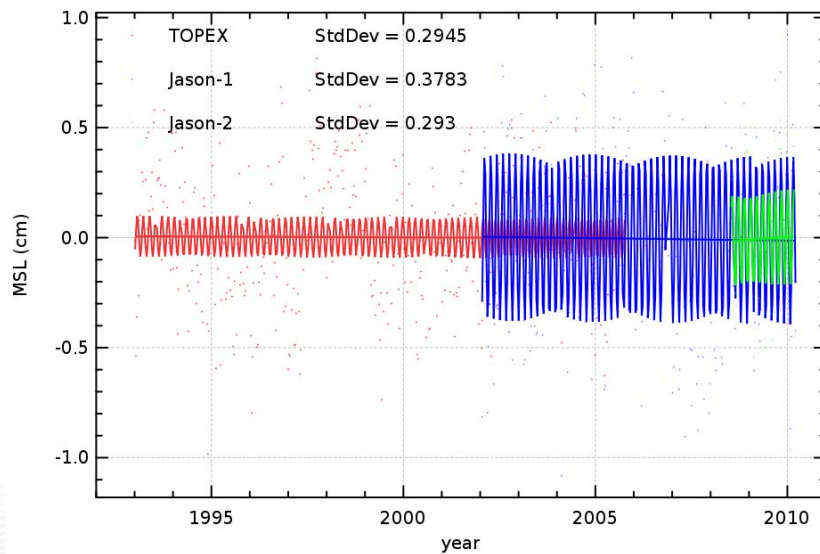E.Bronner, N.Picot (CNES)

Overview

- Objective : understand better the origin of 58.74-day signal observed on the MSL derived from Jason-1&2 and TOPEX data

⇒ Description of the 59-day signal on MSL

⇒ Sensitivity of oceanic tide models on the 58.74-day signal

⇒ Sensitivity of the TOPEX correction: CG_RANGE_CORR
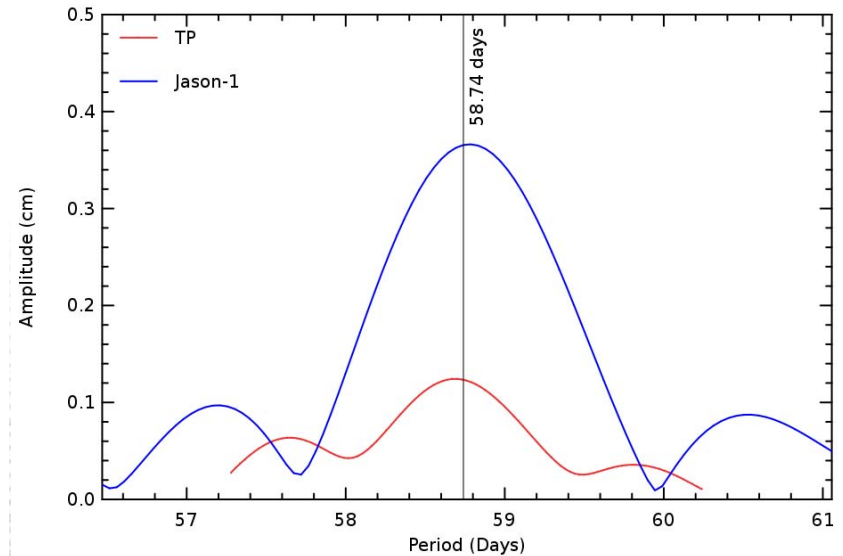
1 - Description of the 59-day signal on MSL

Description of the 59-day signal on MSL

- Global MSL time data series highlight strong 58.74-day signal on Jason-1 & 2 whereas it is smaller on TOPEX.

- Amplitudes are 4 mm for Jason-1, 3 mm for Jason-2 , 1 mm for TOPEX

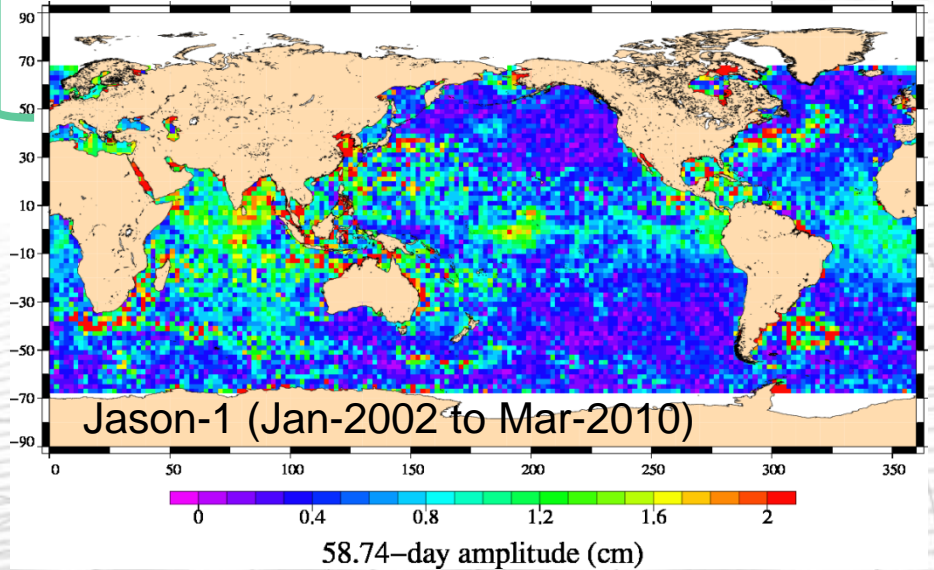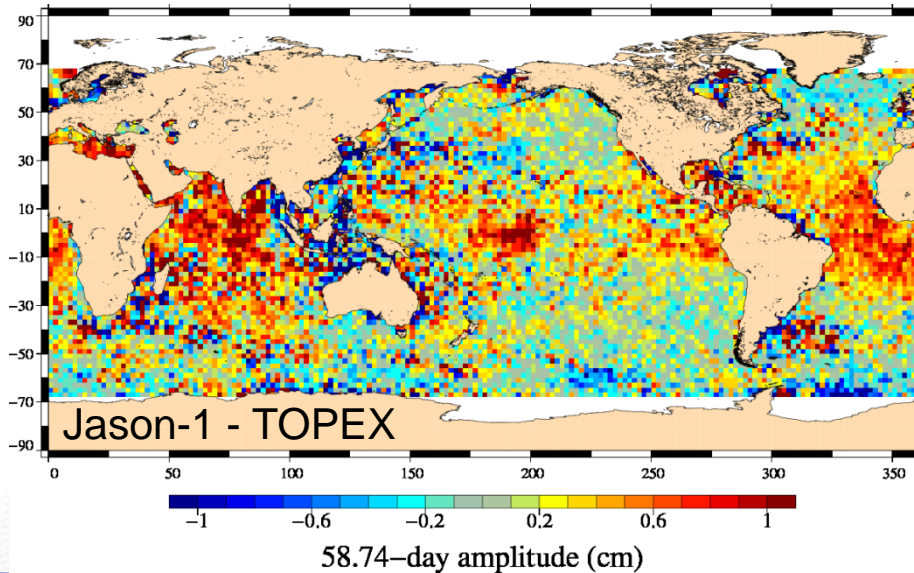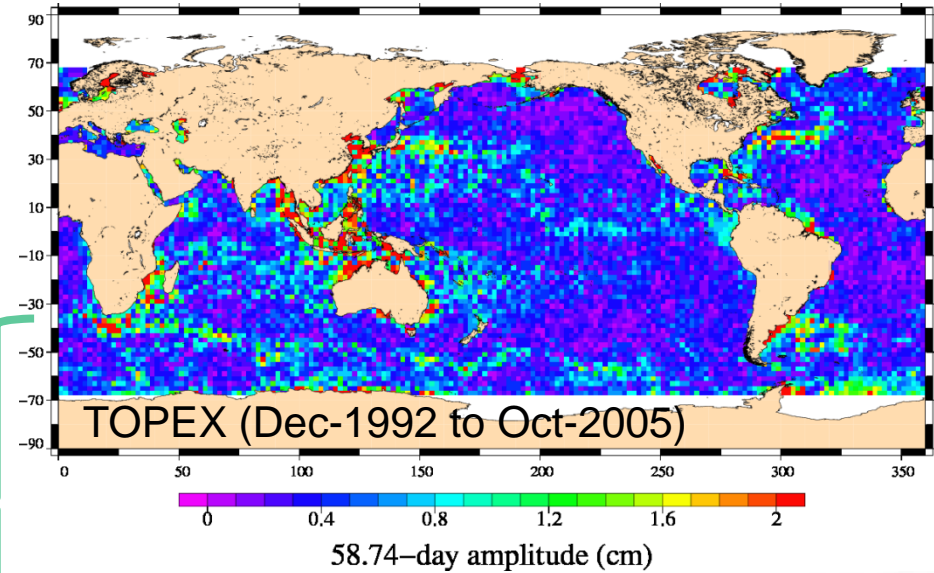| 58.74-day signal on global MSL after removing the global trend	Periodogram on Jason-1 and TP MSL focused on 58.74-day signal

Description of the 59-day signal on MSL

- The maps of 58.74 amplitude signal for Jason-1 and TOPEX show a stronger amplitude of the signal for Jason-1 (> 5 mm) generally between -40° and 40° of latitude.

TOPEX (Dec-1992 to Oct-2005)

58.74-day amplitude (cm)

Jason-1 - TOPEX

58.74-day amplitude (cm)
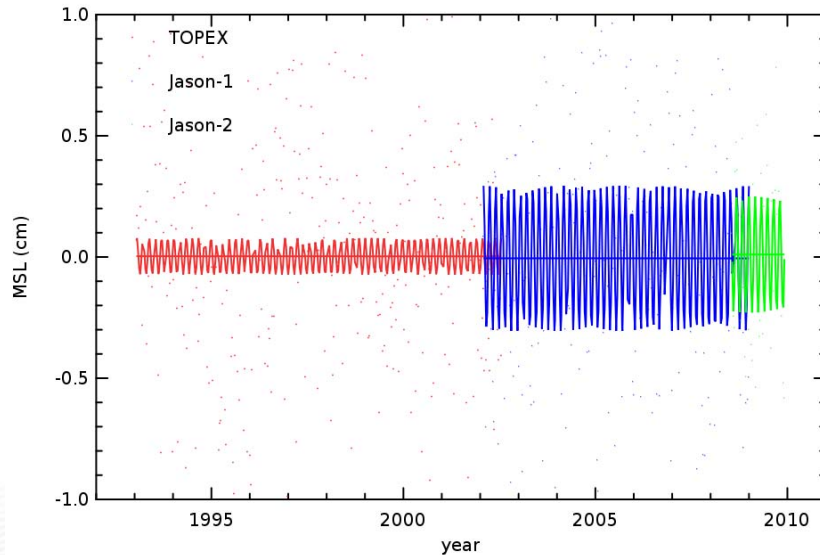

Jason-1 (Jan-2002 to Mar-2010)

58.74-day amplitude (cm)

Description of the 59-day signal on MSL

- The SSH differences between altimetry and tide gauges highlight a 58.74-day signal of ~3/4 mm for Jason-1&2 and ~ 1 mm for TOPEX

- We obtained similar results comparing with T/S profiles (ARGO)

⇒ This result is in agreement with previous analyses and proves that 59-day signal is not a physical signal but an error on altimetry data.

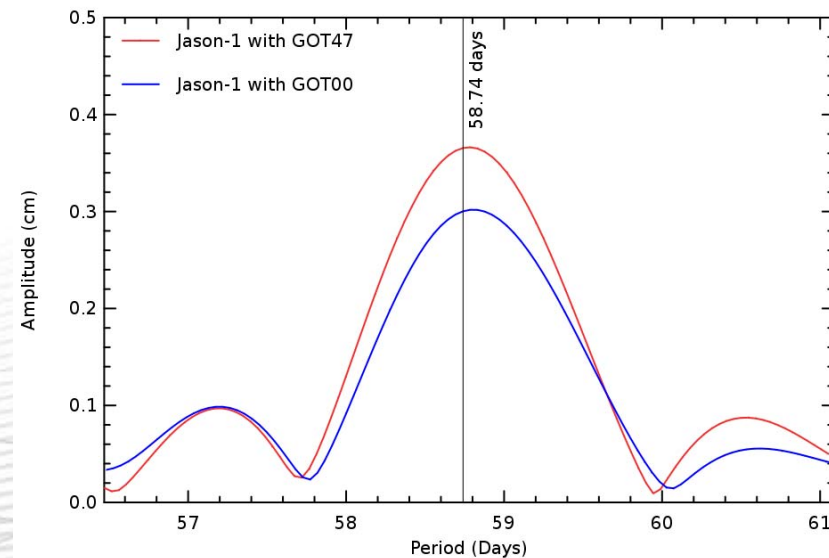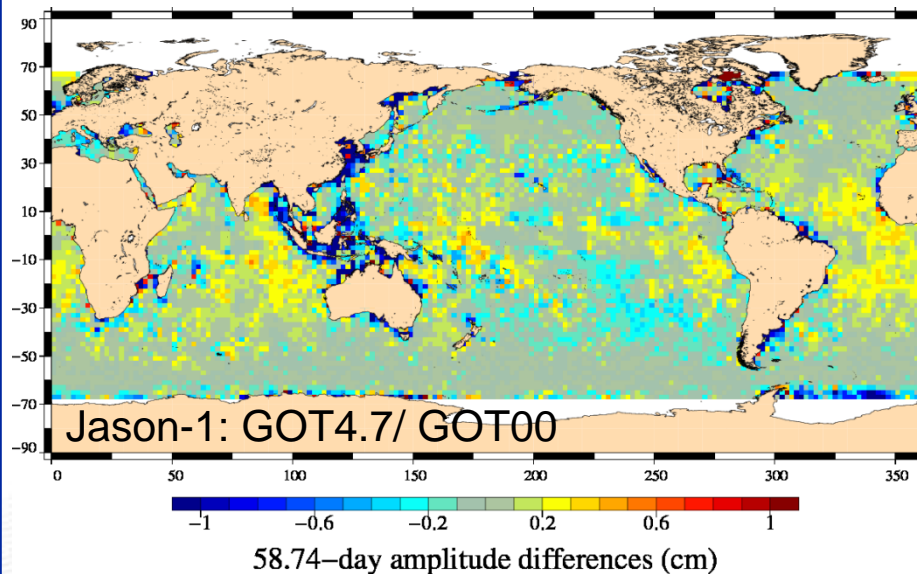| 58.74-day signal on altimetry/tide gauges SSH differences after removing the global trend | Periodogram on altimetry/tide gauges SSH differences focused on 58.74-day signal |
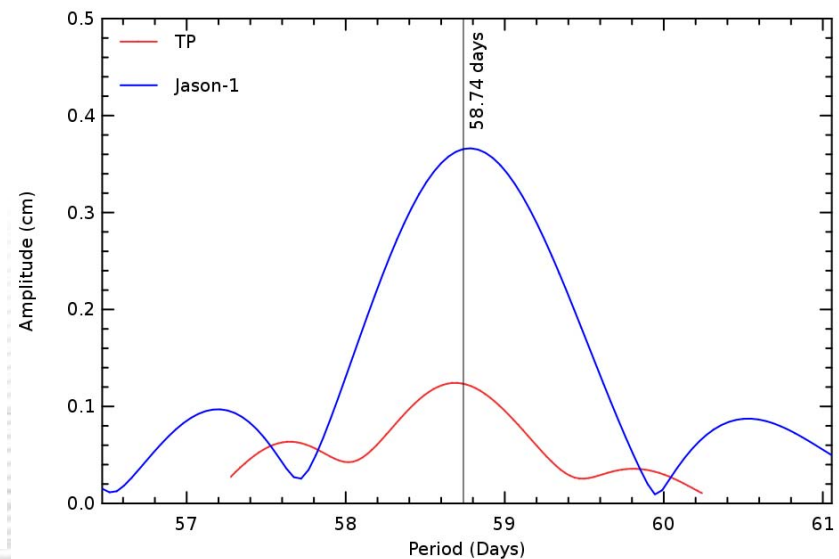
2 - Sensitivity of oceanic tide models on the 58.74-day signal

Sensitivity of oceanic tide models on the 58.74-day signal

- The tidal model can potentially impact the 58.74-day signal in the MSL through the semi-diurnal wave S2 => therefore the sensitivity of oceanic tide models on 58.74-day signal observed on Jason-1 and TOPEX MSL have been studied.

- Impact of using GOT00 instead GOT4.7 in the estimation of the amplitude of the 58.74-day signal is small on the Jason-1 MSL:

$\Rightarrow$ Amplitude differences are especially observed on coastal areas (<5mm).

$\Rightarrow$ Global 59-day amplitude is slightly lower with GOT00 than with GOT4.7 but remains > 3mm

$\Rightarrow$ We obtained a similar result on TOPEX MSL.

Jason-1: GOT4.7/ GOT00

58.74−day amplitude differences (cm)

Jason-1 with GOT47

Jason-1 with GOT00

58.74 days

cnes

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- We have tested also the impact of using FES04 instead GOT47 in the estimation of the spatial amplitude of the 58.74-day signal

- The impact is very strong on the Jason-1 MSL :

$\Rightarrow$ Global 59-day signal amplitude are reduced to 0.5 mm using FES04 !

58.74-day signal on Jason-1 global MSL after removing the global trend

Periodogram on Jason-1 MSL focused on 58.74-day signal

GOT47   StdDev = 0.353   Slope = -0.00468 mm/yr

FES04   StdDev = 0.2425   Slope = -0.00222 mm/yr

Jason-1 with GOT47

Jason-1 with FES04

58.74 days

cnes
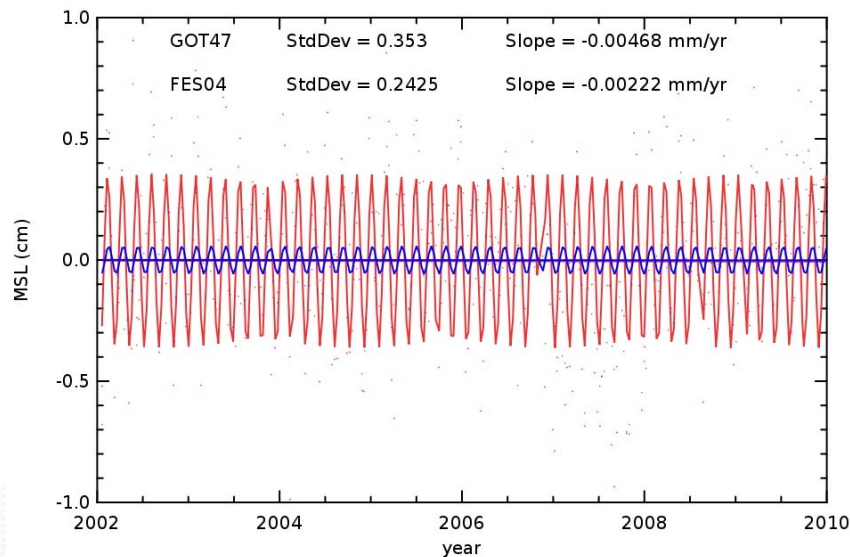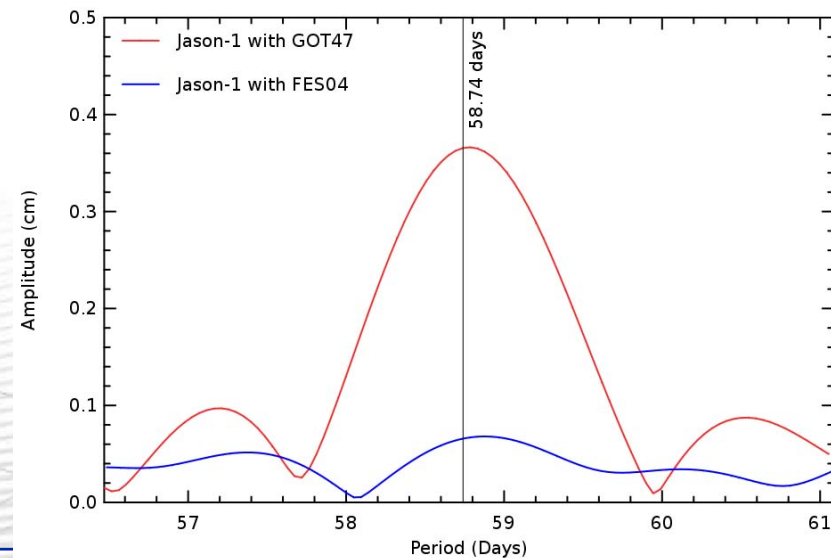CENTRE NATIONAL D'ETUDES SPATIALES

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Sensitivity of oceanic tide models on the 58.74-day signal

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- The impact is very strong on the Jason-1 MSL :

⇒ Global 59-day signal amplitude are reduced to 0.5 mm using FES04 !

⇒ Strong spatial structure amplitude differences are observed on the coasts but also on the open ocean.

⇒ Open ocean patterns are well correlated with patterns previously observed between Jason-1 and TOPEX

Jason-1 : GOT4.7 – FES04

58.74–day amplitude (cm)
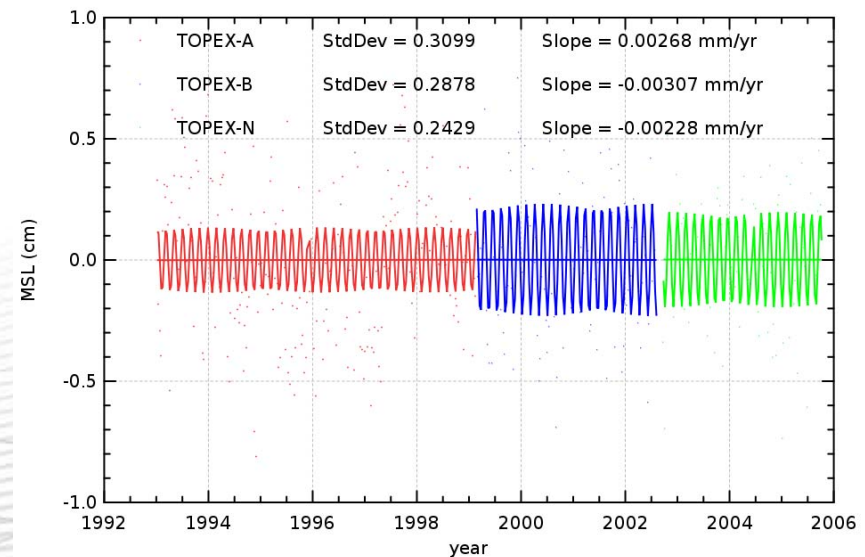
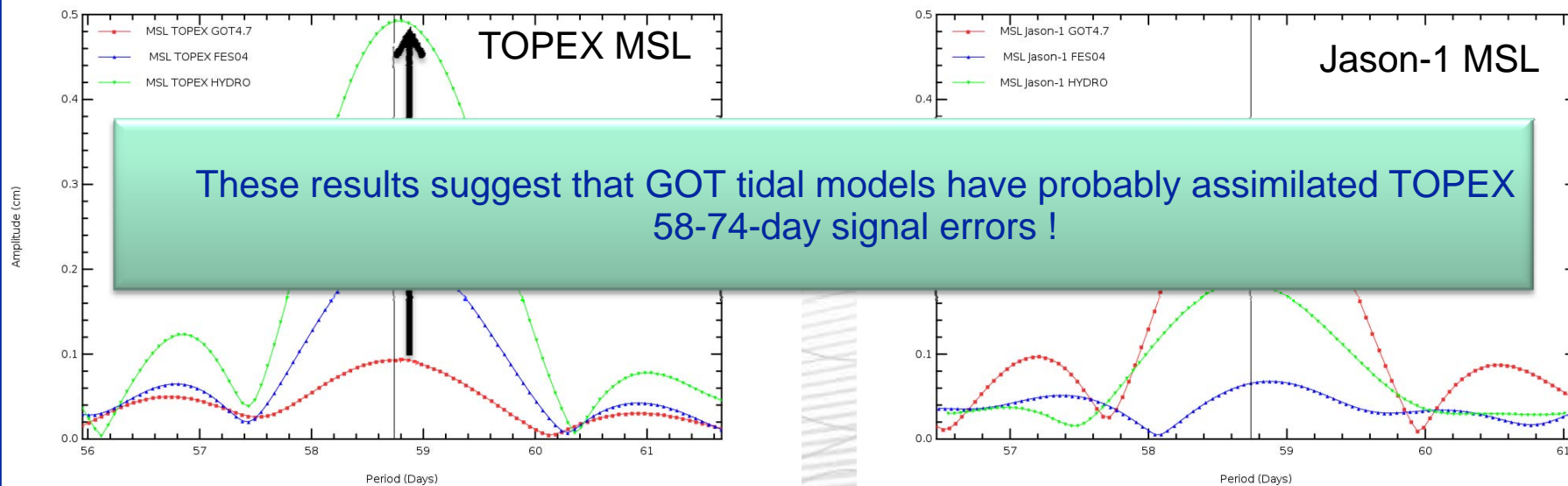Jason-1 - TOPEX

58.74–day amplitude (cm)

Sensitivity of oceanic tide models on the 58.74-day signal

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⇒ Strong spatial structure amplitude differences are observed on the coasts but also on the open ocean.

⇒ Open ocean patterns are well correlated with patterns previously observed between Jason-1 and TOPEX

- We also tested the impact of using FES04 on the TOPEX MSL :

⇒ The global 58.74-day signal amplitude increases from 1 mm to 2 mm

⇒ no change observed on TOPEX-A

- Spatially : we also observed strong patch differences but with an opposite behavior considering both TOPEX sides.

TOPEX-A	StdDev = 0.3099	Slope = 0.00268 mm/yr
TOPEX-B	StdDev = 0.2878	Slope = -0.00307 mm/yr
TOPEX-N	StdDev = 0.2429	Slope = -0.00228 mm/yr

Sensitivity of oceanic tide models on the 58.74-day signal

- We have tested an hydrodynamical model without altimetry assimilation (F.Lyard, LEGOS)

- The global 58.74 day amplitude increases for TOPEX to reach 5 mm:
    - ⇒ + 3.0 mm compared to FES04
    - ⇒ + 4.0 mm compared to GOT4.7

- For Jason-1, the global 58.74 day amplitude is significantly lower, close to 2 mm:
    - ⇒ + 1.5 mm compared to FES04
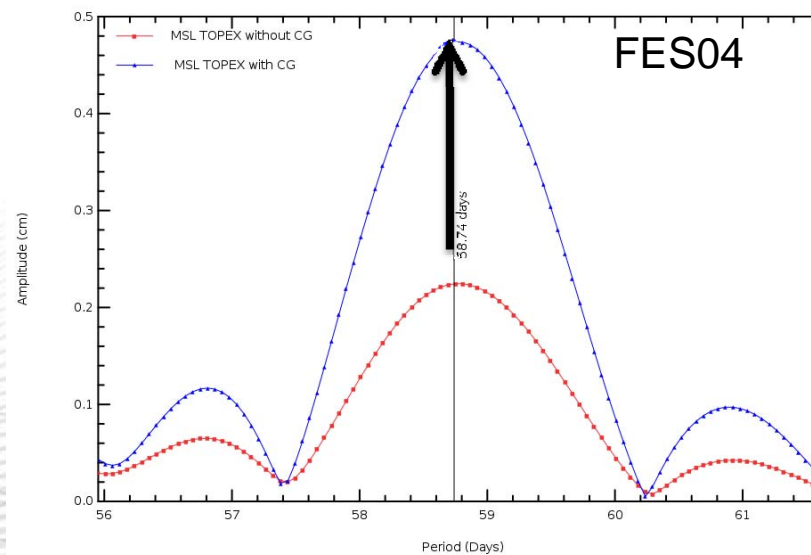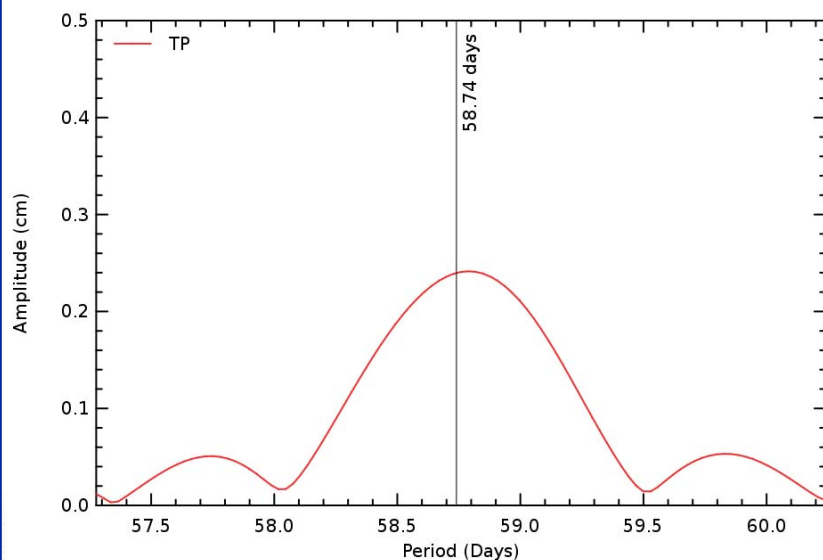   - ⇒ - 2.0 mm compared to GOT4.7

TOPEX MSL

Jason-1 MSL

These results suggest that GOT tidal models have probably assimilated TOPEX 58-74-day signal errors !
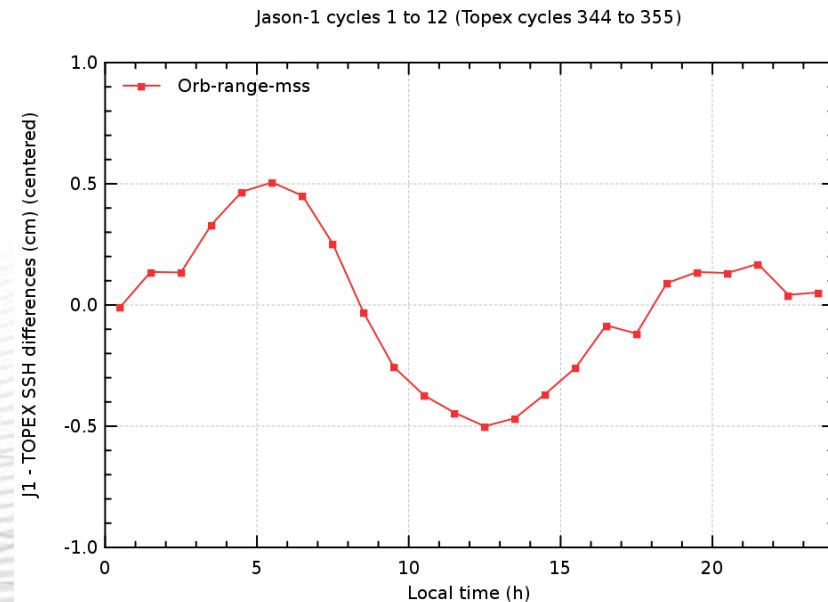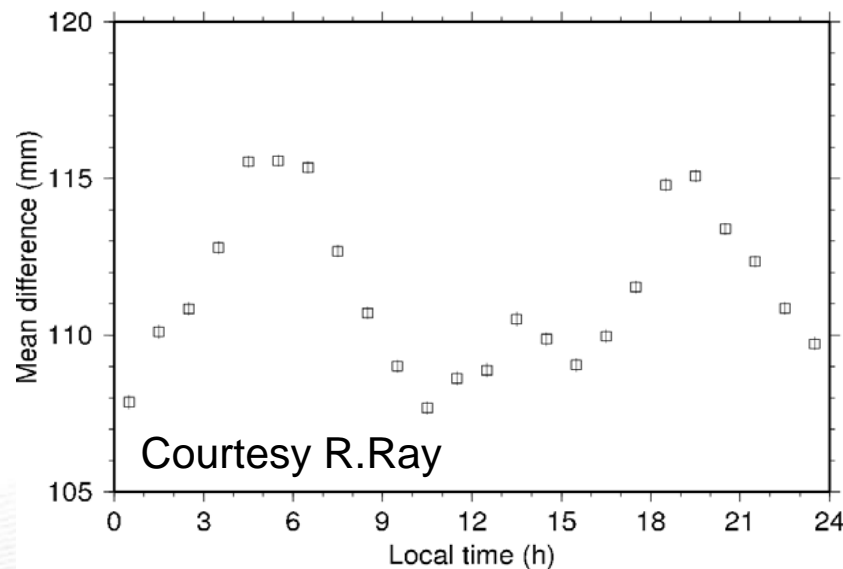
3 - Sensitivity of the TOPEX correction: CG_RANGE_CORR

Sensitivity of the TOPEX correction: CG_RANGE_CORR

- The CG_RANGE_CORR parameter takes into account the variation of center of gravity (solar array deformation)

- This correction has a 58.74-day amplitude signal

- To date, we have not corrected the SSH with this correction, because it does not bring good results :

  ⇒ It increases the 58.74-day amplitude signal on the TOPEX-B MSL :

    ⇒ by 2.0 mm using the GOT00 tidal model.

    ⇒ by 2.5 mm using the FES04 tidal model.

- We calculated the local-time dependence of Jason-1 and TOPEX MSL differences during the Jason-1 verification phase.

- As altimeters measure the same ocean, only [Orbit -Range -MSS] differences are calculated

- R. Ray highlighted a semi-diurnal signal (~4 mm) and therefore a potential 58.74-day signal.

- We reproduced this analysis :

⇒ Without applying CG_RANGE_CORR : similar semi-diurnal signal is obtained

Courtesy R.Ray

Jason-1 cycles 1 to 12 (Topex cycles 344 to 355)

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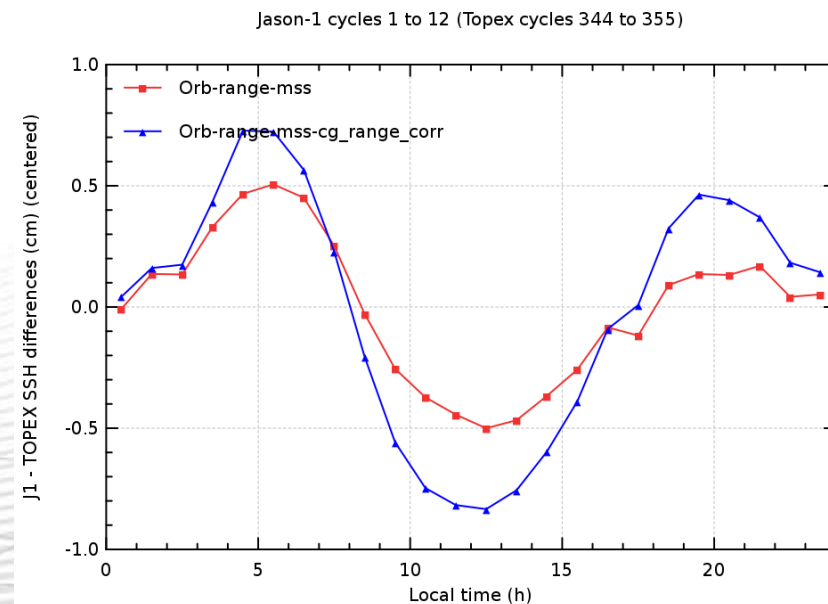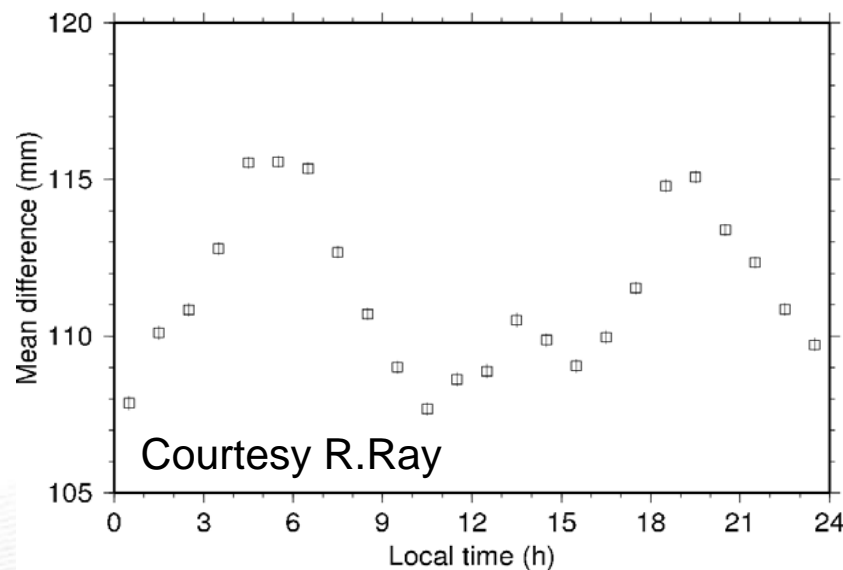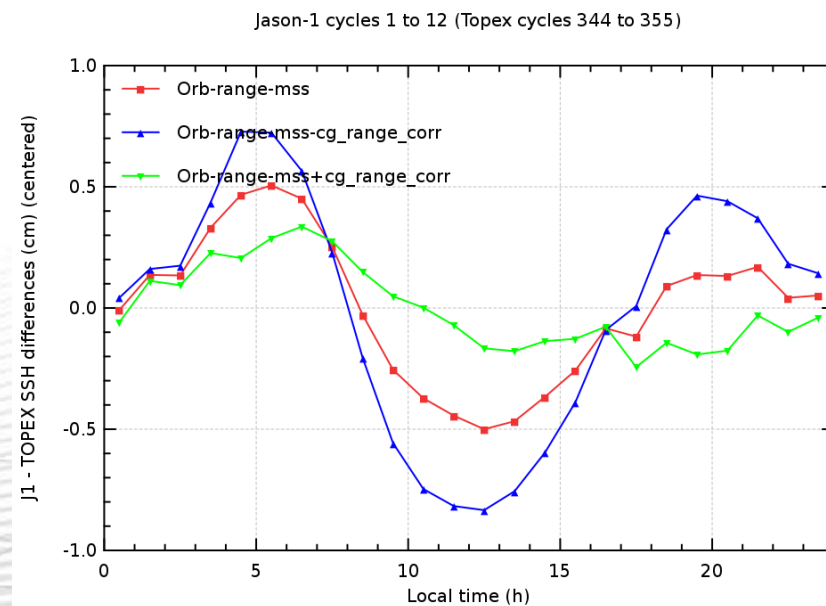CENTRE NATIONAL D'ETUDES SPATIALES

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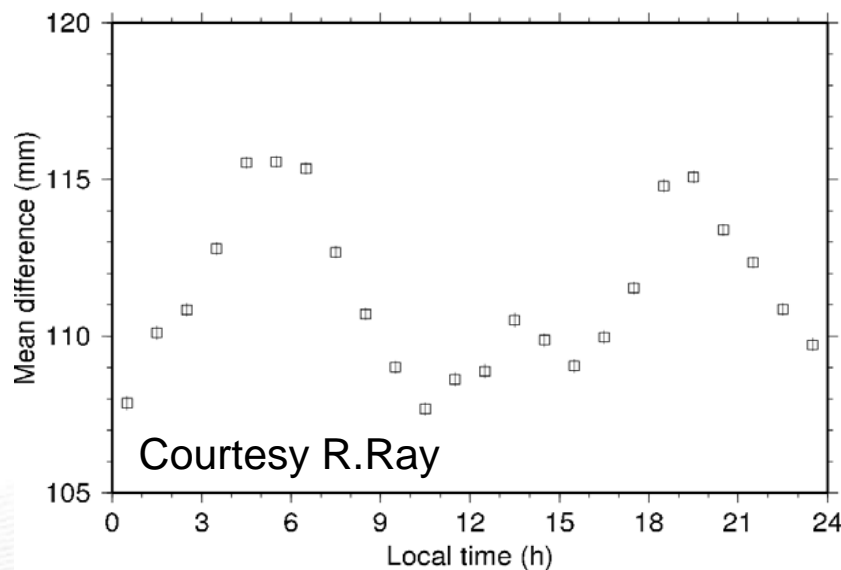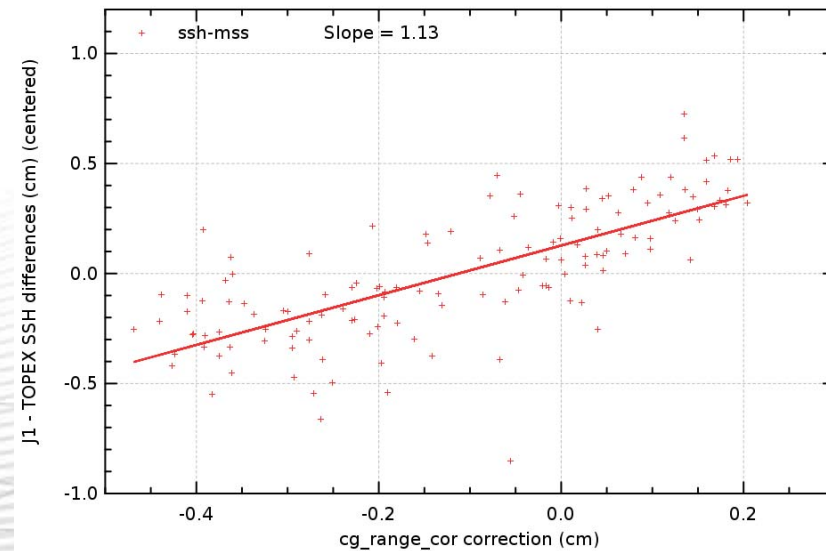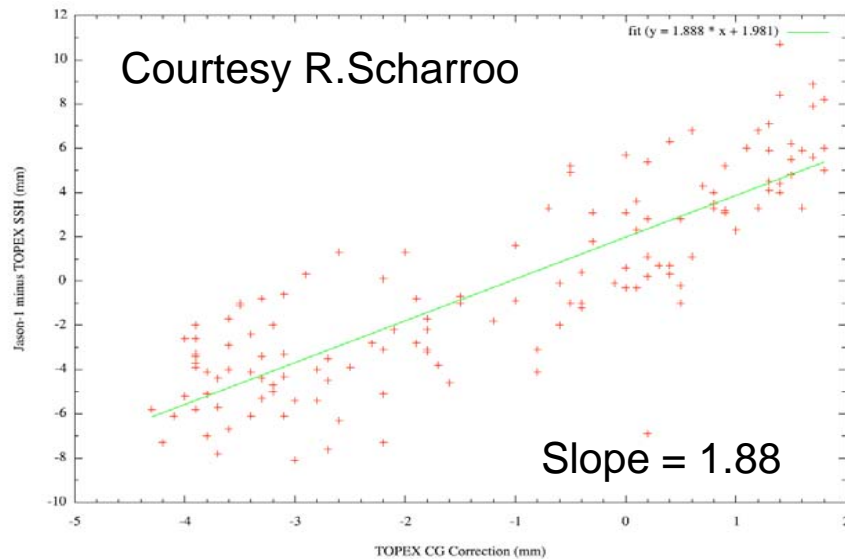Courtesy R.Ray

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⇒ Applying CG_RANGE_CORR with bad sign (+) : semi-diurnal is reduced (-2 mm) !

Courtesy R.Ray

Jason-1 cycles 1 to 12 (Topex cycles 344 to 355)

Orb-range-mss
Orb-range-mss-cg_range_corr
Orb-range-mss+cg_range_corr
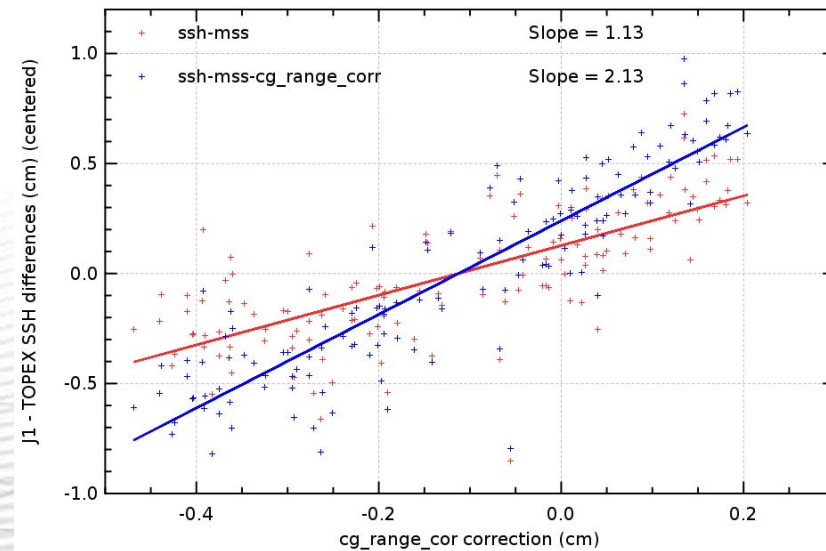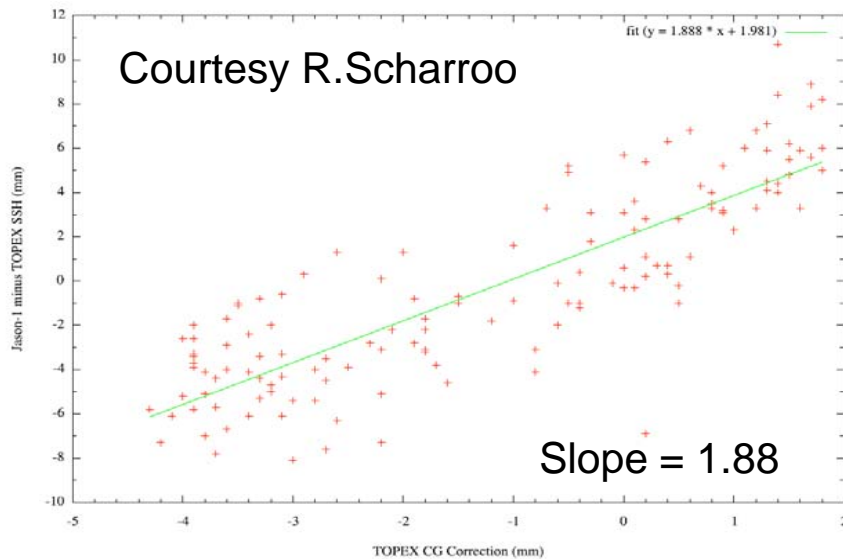
Sensitivity of the TOPEX correction: CG_RANGE_CORR

- We have also computed Jason-1/TOPEX SSH differences (from Jason-1 cycles 1 to 138) versus the TOPEX CG_RANGE_CORR correction

- R. Scharroo showed there is a linear dependence with a factor 2

- We reproduced this analysis :

⇒ Without applying CG_RANGE_CORR : we obtained a linear dependence with a factor 1.1

Courtesy R.Scharroo

Slope = 1.88

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⇒ Applying CG_RANGE_CORR with bad sign (+) : no linear dependence !!!
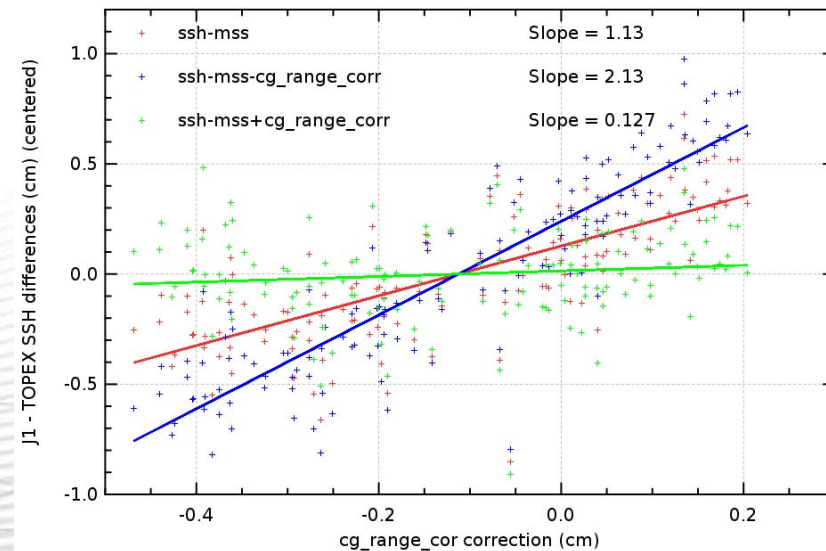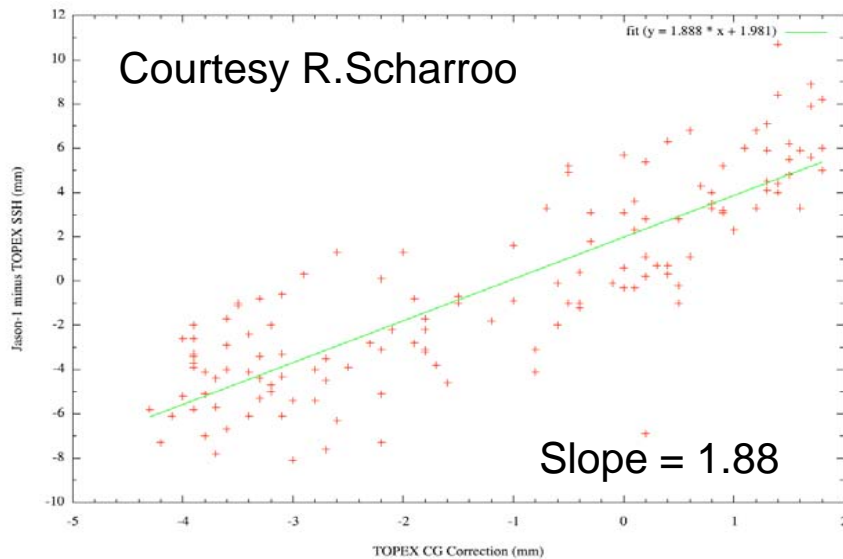
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Slope = 1.88

- Applying the CG_RANGE_CORR with bad sign (+) allows us to homogenize TOPEX and Jason-1 SSH and reduce the 58.74-day signal between both missions.

- This error is on TOPEX data since :

⇒ Applying the CG_RANGE_CORR with bad sign allows us to reduce the 58.74-days signal on TOPEX MSL : -1.5 mm using FES04 model.
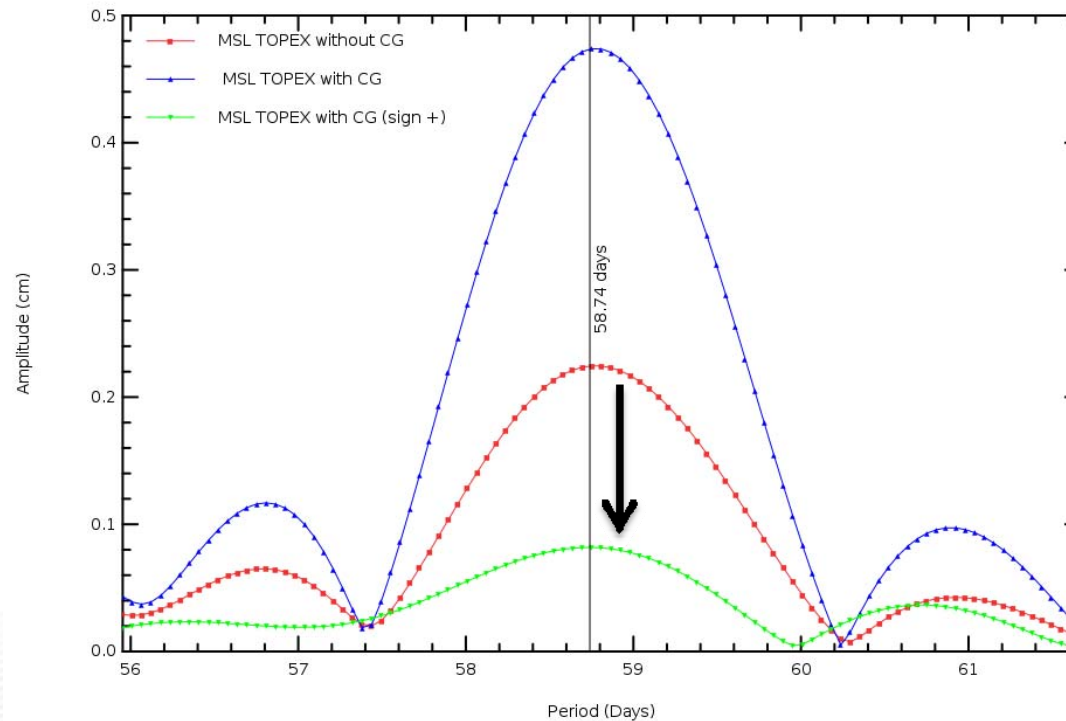
Summary and conclusion

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- The main part of 58.74-day signal observed on the Jason-1 MSL is due the use of GOT models in SSH calculation :

⇒ FES04 model allows us to significantly reduced the 58.74-day signal on Jason-1 MSL

⇒ Using a hydrodynamical model without altimetry assimilation, a 3 mm stronger 58.74-day signal is highlighted on TOPEX MSL than in Jason-1 MSL

⇒ MSL TOPEX errors for 58.74-day signal have been likely assimilated by GOT

⇒ FES04 assimilated also TOPEX data with same errors, but it is less sensitive to altimetry data assimilation than GOT (stochastical model) explaining its better behavior concerning 58.74-day signal.

- TOPEX CG_RANGE_CORR correction explains probably a main part of 58.74-day signal error on TOPEX SSH:

⇒ Applying it with an opposite sign in TOPEX SSH calculation allows us to improve the consistency between Jason-1 and TOPEX

⇒ But it remains discrepancies between TOPEX-A and TOPEX-B in terms of 58.74-day signal not explained

⇒ TOPEX CG-RANGE_CORR correction have probably to be revisited

- Remaining 58.74-day signal on Jason-1 MSL (using FES04) are small (comparison with Jason-2, Envisat and Tide Gauges) :

⇒ High misprinting values on Jason-1 can increase the spectrum energy around 60-day period

Annexes

- Jason-1 / Jason-2 SSH differences versus local time only during jason-2 verification phase (Orbit-range-MSS) display differences between +/- 4 mm but they do not highlight a strong semi-diurnal signal .

- Estimation of its semi-diurnal amplitude is < 1 mm : this is coherent with Jason-1 and jason-2 MSL periodogram over a larger period.
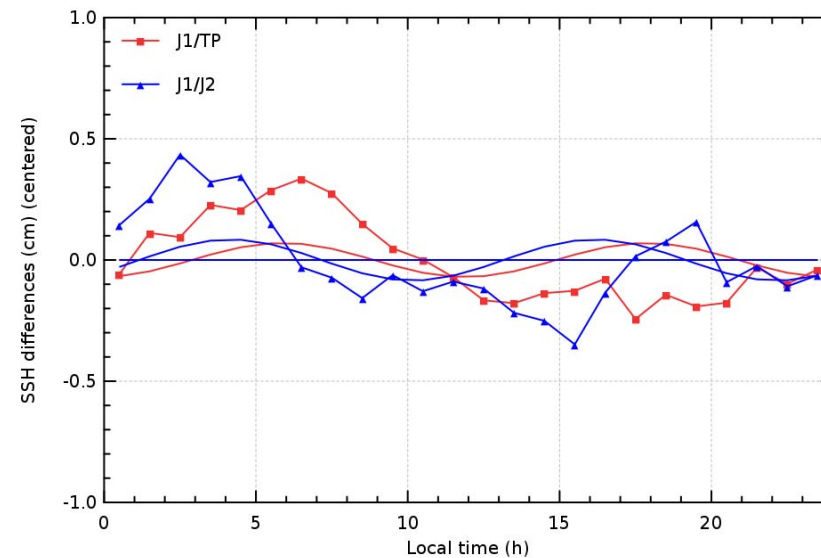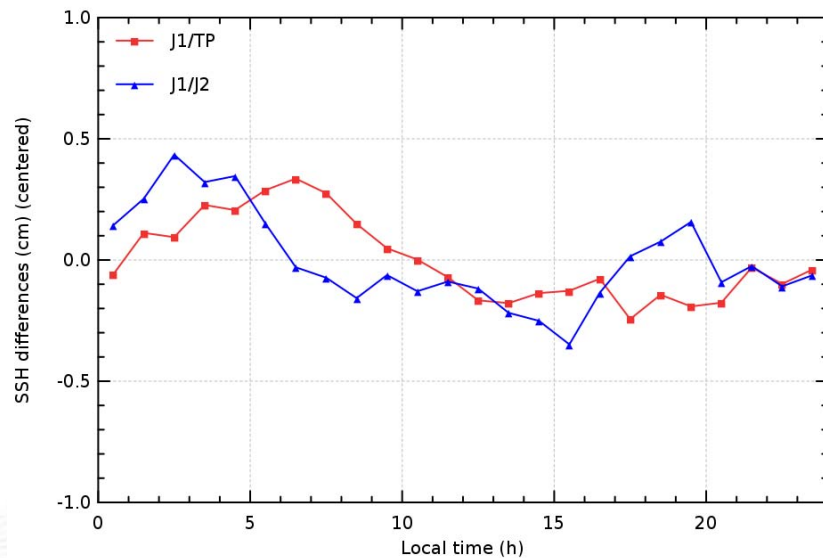
- We use Alti/In-situ SSH differences data to estimate the spatial amplitude of the 58.74-day signal on Jason-1:

⇒ Residual signals are higher in terms of amplitude considering the GOT4.7 tide model in SSH differences with tide gauges and T/S profiles

⇒ The amplitude of SSH differences considering GOT4.7 is about twice the FES04 one, whatever in-situ dataset (TG: 8mm with GOT4.7 / 4mm with FES04, T/S: 3mm/0.5mm)