Altimeter SSH comparisons
with Tide Gauges

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Overview (1/2)

- To date, the global assessment of altimeter data can be performed through:

  - The internal assessment of altimeter data (comparison of instrumental corrections with global models, calculation of SSH at crossovers)

  - The cross-calibration between altimeter missions

  - The comparison with in-situ measurements which are used as independent sources of comparison to better assess the multiple system performances

- In this way, Altimetry and Tide Gauges comparison activities are performed in the frame of the 2011-2015 SALP project (CNES) and supported by ESA concerning Envisat

Overview (2/2)

- The studies performed intend to:

  - ➢ The computation of colocated Altimeter and In-Situ datasets

  - ➢ Scientific comparisons of Altimeter and In-Situ SSH differences

  - ➢ The improvement of the processing sequence, and especially:
    - The colocation between altimetry and tide gauges
    - The improvement of in-situ databases

Data and Method

Increasing and improving in-situ datasets

- GLOSS/CLIVAR network: 280 Tide Gauges (blue and red dots)

- REFMAR network: 33 Tide Gauges (red dots)

- In the frame of the MyOcean project, new tide gauges from different providers and delivered by IFREMER are planned to be added in the database
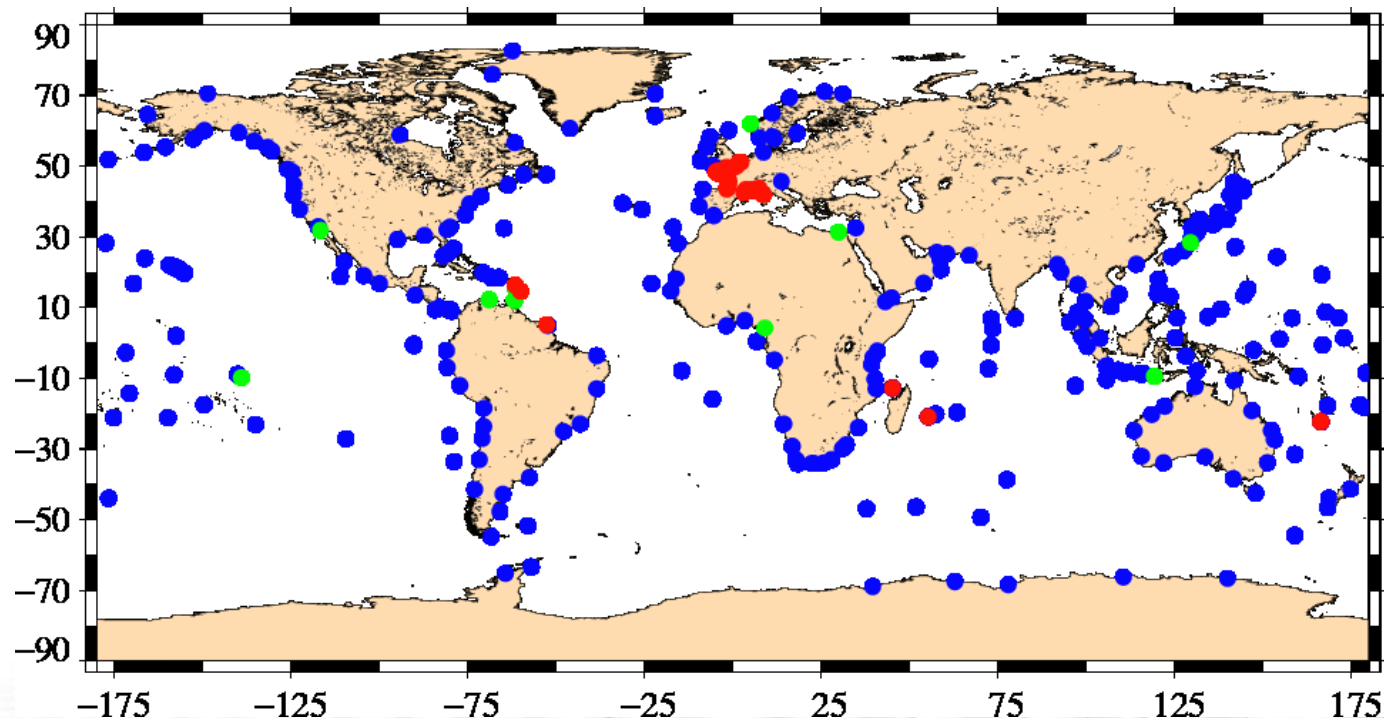
GLOSS/CLIVAR (blue and green dots) and
REFMAR networks (red dots): 313 tide gauges

Colocation method between altimeter data and tide gauges measurements

A method using gridded altimeter SSH products has been developed

Advantages of the computation of mono-mission gridded products:

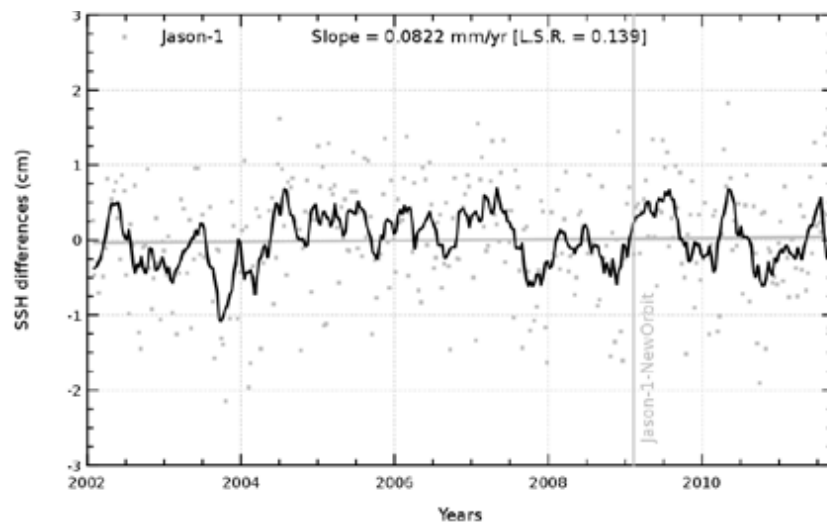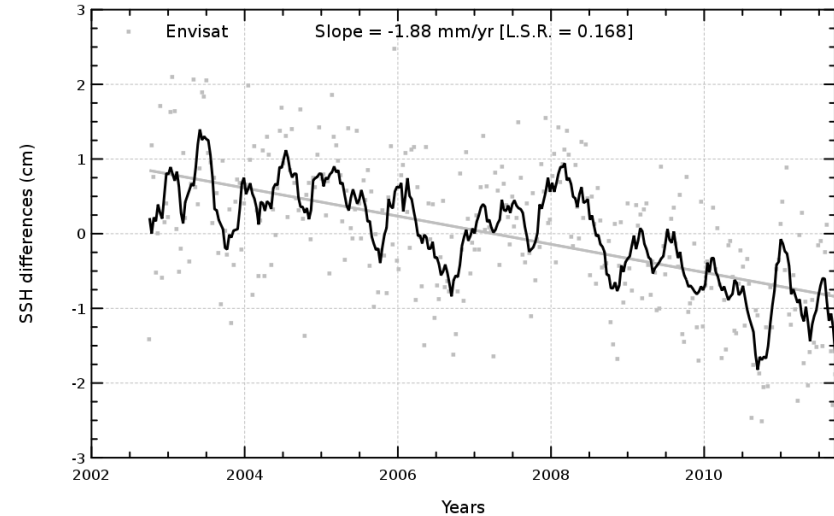- Studies are available on the whole altimeter time period

- As spatial and temporal sampling can be artificially specified, resolutions of Envisat and Jason-1 (for instance) are now comparable (10 days temporal resolution)
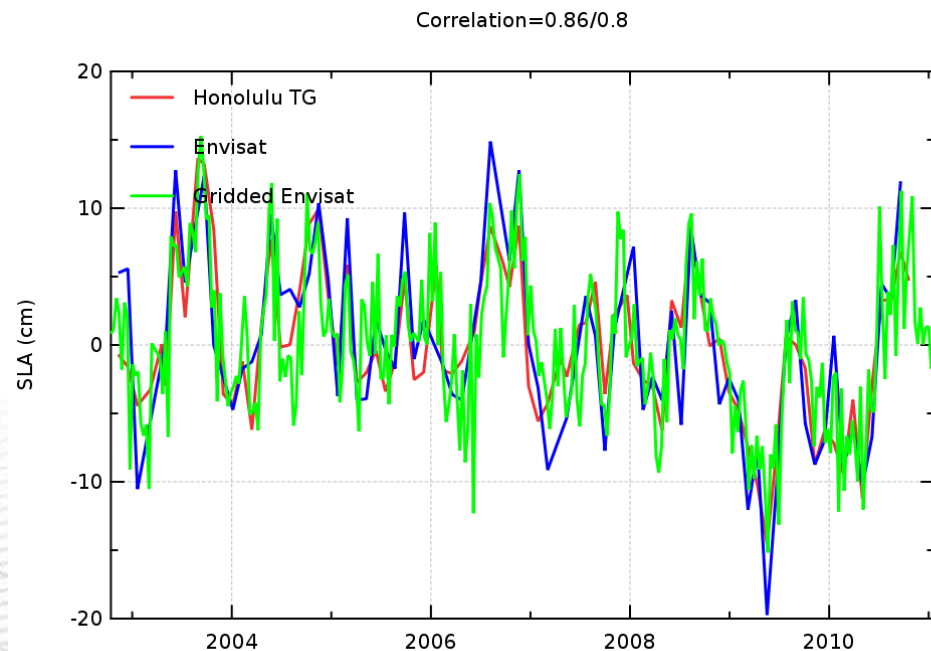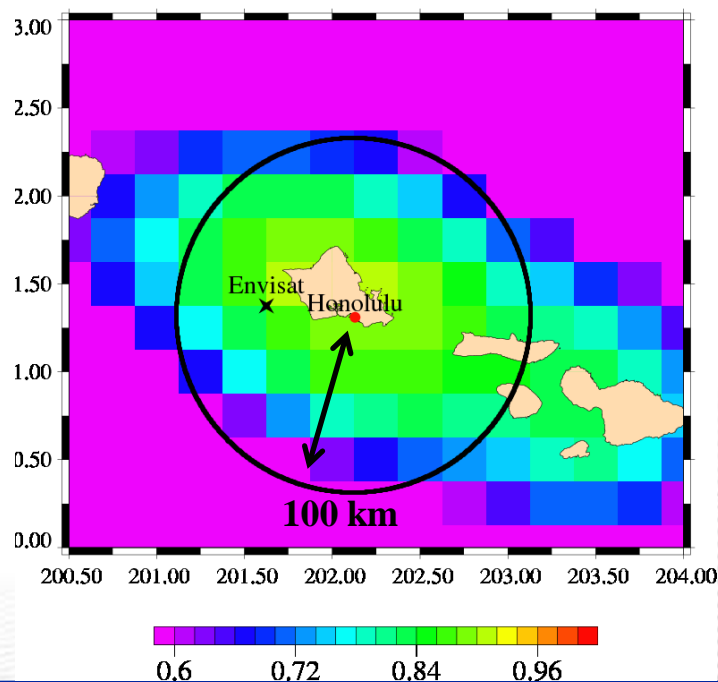
Results concerning the long-term assessment
of the altimeter Mean Sea Level
by comparison to tide gauges
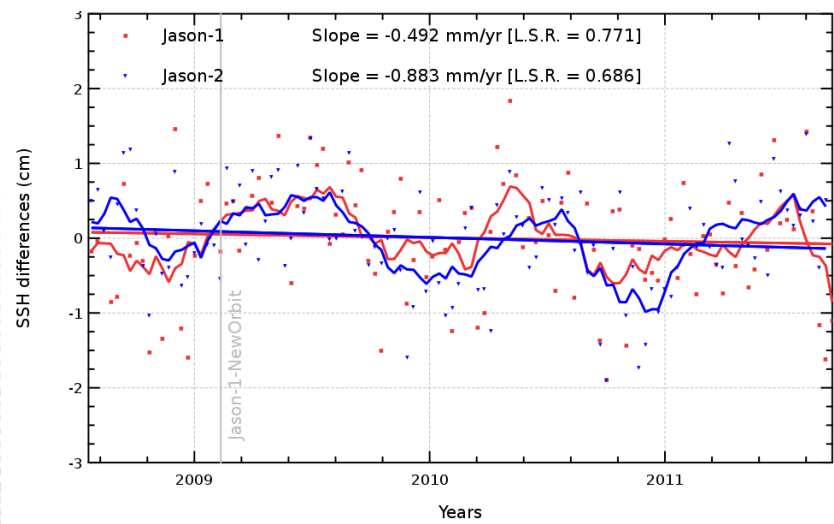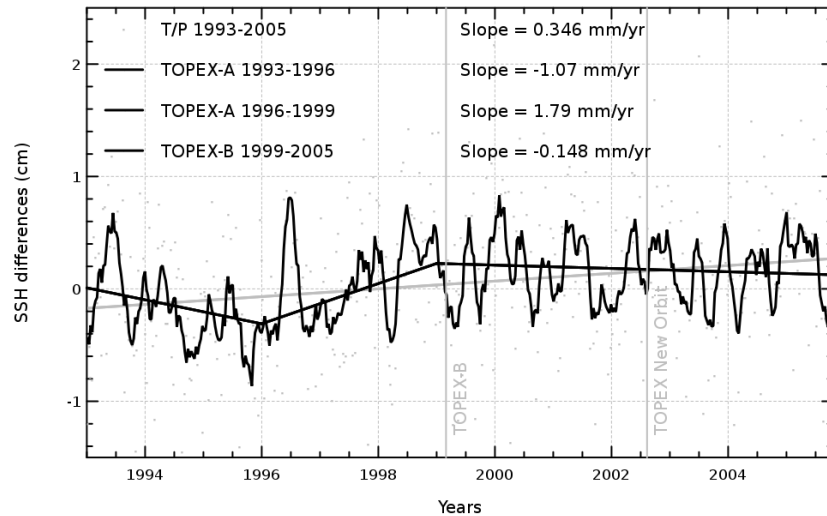
Estimation of the MSL drift over all the altimeter time period

Assessment of new altimeter standards
by comparison to tide gauges

Impact of new altimeter standards on slope differences: Envisat reprocessed data

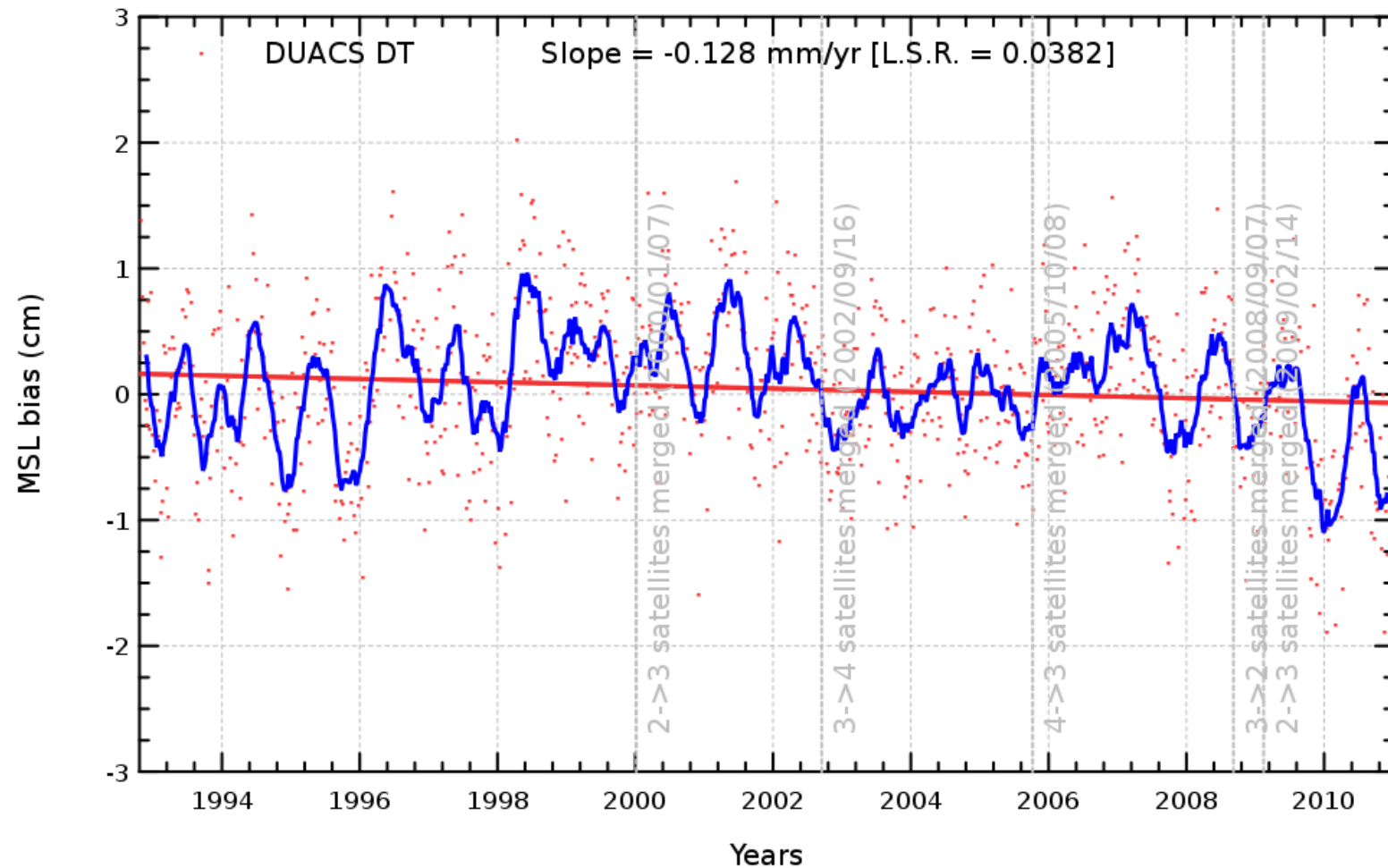- Tide gauges measurements are a way of estimating new standards in altimeter products

- A study has been realized to compare new reprocessed Envisat SSH time series with tide gauges measurements

- On the 2004-2010 time period, the monitoring of Envisat reprocessed data displays an improvement in the consistency with tide gauges. The slope of altimeter versus tide gauges becomes on the same order of Jason-1 results, with a global trend of 0.2 mm/year
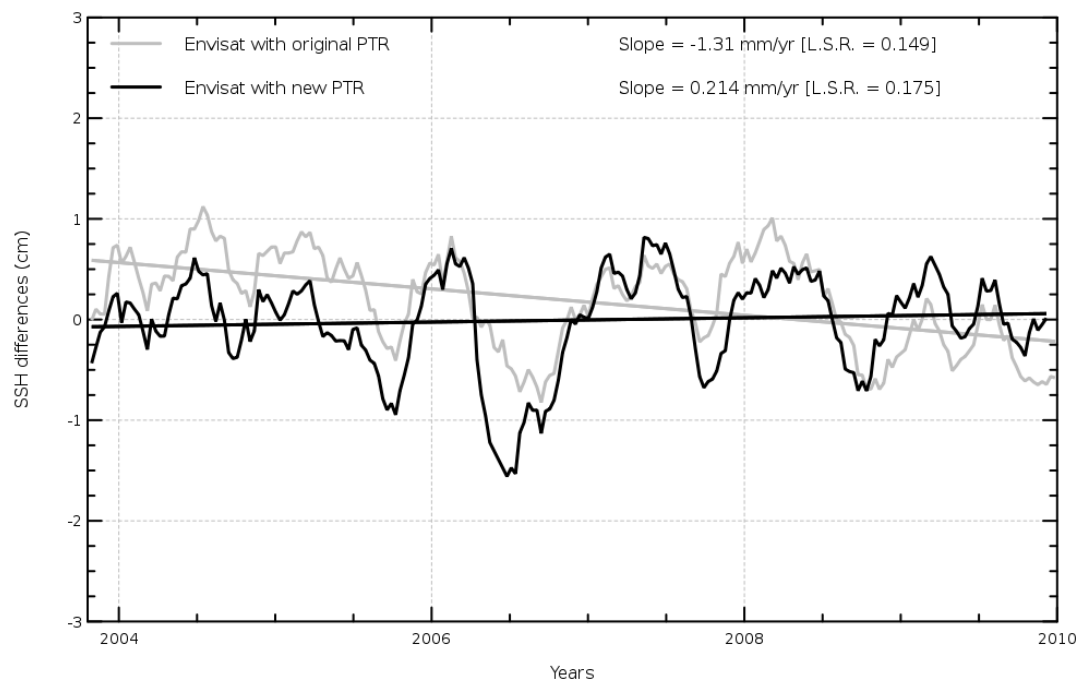
Impact of new in-situ standards on slope differences:
The Glacial Isostatic Adjustment (ICE-5G (VM4) model)

- In order to make the comparison with altimeter data more relevant, the effect of GIA on tide gauges has to be taken into account

- The global trend of the time series considering the ICE-5G (VM4) GIA model is reduced to 0.1 mm/year, which seems to slightly improve the consistency between both datasets

- Importance of the use of GPS beacons at tide gauges locations (Bouin et al., 2010; TIGA project), especially at high latitudes
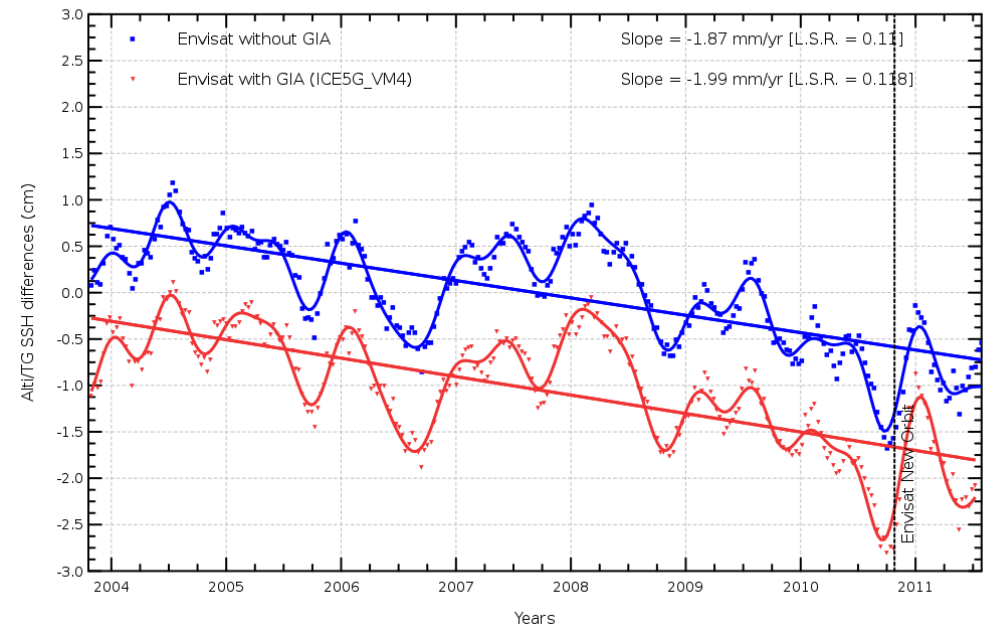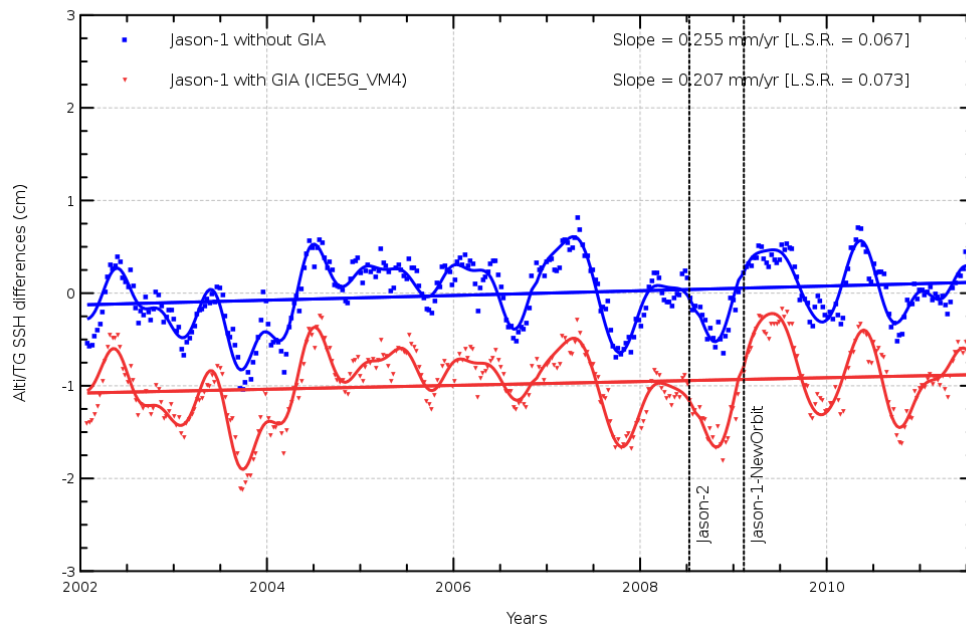
Quality assessment of in-situ tide gauge time series

Quality assessment of in-situ tide gauge time series

- The cross-comparison of altimeter and tide gauges comparisons obtained from all the missions (Jason, Envisat and T/P) allows us to detect the potential drifts or jumps which remain in in-situ time series and have no physical signification (drift of the beacon, anthropogenic sources ...)
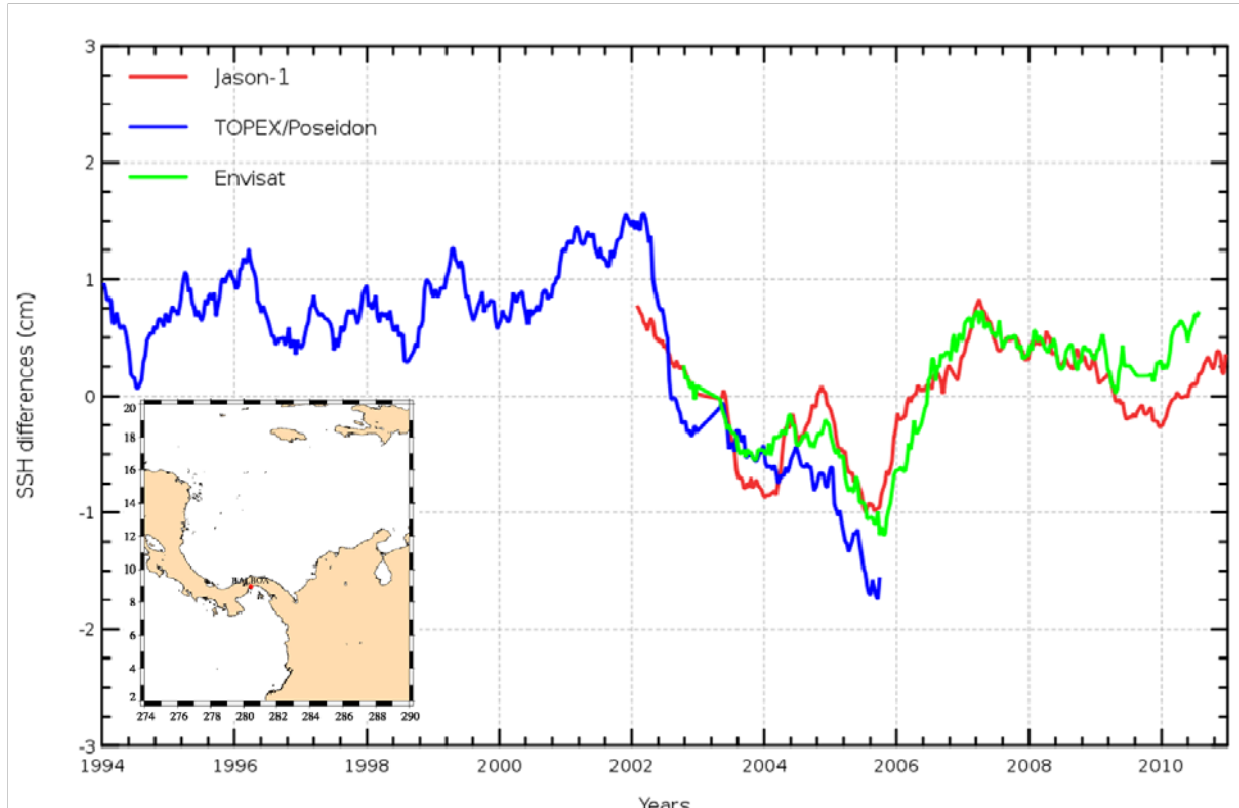
- To date, the quality control consists in 2 criteria:

  -> correlation (> 0.7)

  -> RMS of the altimeter/TG SSH differences (< 10 cm)

- These measures are then corrected or removed to further improve the SSH comparison with altimeters

Senetosa tide gauge information cards

- For instance, Senetosa measurements have been computed as NetCDF files for the 4 main tide gauges (M3, M4, M5 and M7) by Pascal Bonnefond and Olivier Laurain

- These in-situ data will be soon available on the AVISO website (example of quality control for the Senetosa M4 tide gauge on the 2000-2011 time period)

SENETOSA_M4(CN0004)

Tide Gauge identification

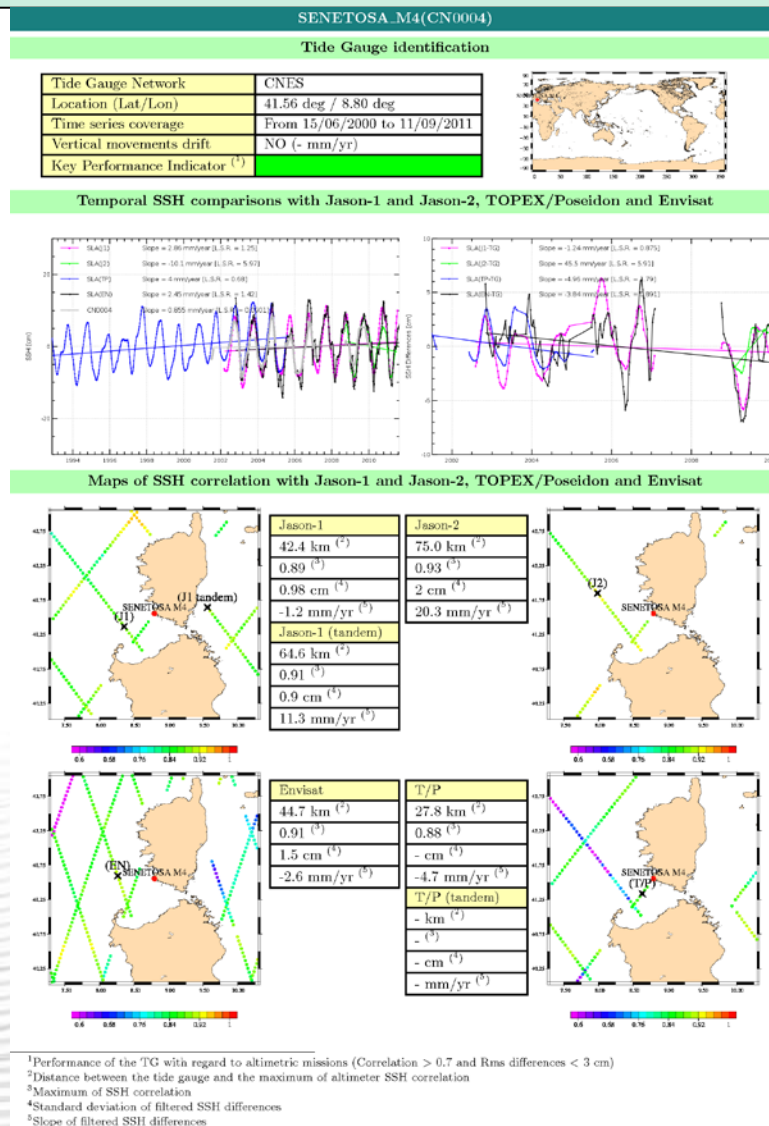| Tide Gauge Network | CNES |
Location (Lat/Lon)	41.56 deg / 8.80 deg
Time series coverage	From 15/06/2000 to 11/09/2011
Vertical movements drift	NO (- mm/yr)
Key Performance Indicator [*]	

Temporal SSH comparisons with Jason-1 and Jason-2, TOPEX/Poseidon and Envisat

Maps of SSH correlation with Jason-1 and Jason-2, TOPEX/Poseidon and Envisat

Jason-1		Jason-2	
42.4 km [2]		75.0 km [2]	
0.89 [3]		0.93 [3]	
0.98 cm [4]		2 cm [4]	
-1.2 mm/yr [5]		20.3 mm/yr [5]	
Jason-1 (tandem)			
64.6 km [2]			
0.91 [3]			
0.9 cm [4]			
11.3 mm/yr [5]			

Envisat		T/P	
44.7 km [2]		27.8 km [2]	
0.91 [3]		0.88 [3]	
1.5 cm [4]		- cm [4]	
-2.6 mm/yr [5]		-4.7 mm/yr [5]	
		T/P (tandem)	
		- km [2]	
		_ [3]	
		- cm [4]	
		- mm/yr [5]	

[1] Performance of the TG with regard to altimetric missions (Correlation > 0.7 and Rms differences < 3 cm)
[2] Distance between the tide gauge and the maximum of altimeter SSH correlation
[3] Maximum of SSH correlation
[4] Standard deviation of filtered SSH differences
[5] Slope of filtered SSH differences

Computation of cross-comparison indicators

- Concerning both GLOSS/CLIVAR and REFMAR tide gauges networks, the quality control is displayed as a cross-comparison indicator on the AVISO in-situ googlemap

- This quality control is a way of selecting relevant tide gauges for the altimeter/in-situ comparisons

Black dots: TG not comparable to any altimeter time series

Red dots: TG comparable to 1 altimeter time series

Yellow dots: same for 2 altimeter time series

Orange dots: same for 3 altimeter time series

Green dots: same for at least 4 altimeter time series

AVISO website:
http://www.aviso.oceanobs.com/fr/calval/in-situ-global-statistics/index.html

Futures

Futures

- Development of a global quality control process for the whole french tide gauges dataset

- Cross validation already in place for Argo array in CLS

- Provide an access to CLS in-situ databases to visualize (and possibly extract) data time series (GoogleEarth, Geoserver) from sensors such as Tide Gauges, Argo T/S profiles, Surface Drifters, Gliders, …

- ftp://ftp.ifremer.fr/ifremer/argo/etc/argo-ast9-item13-AltimeterComparison

- **List of floats to be checked :**

DAC	WMO	INST-TYPE	TYPE OF ANOM
kma	2900434846		spikes
meds	4900116846		offset
meds	51886 831		offset
meds	51887 831		offset
incois	2900783846		offset
coriolis	1900651846		spike
coriolis	5900198842		?
coriolis	6900399841		offset
coriolis	69039 842		drift
bodc	1900141842		spike
bodc	1900454846		spikes

…………
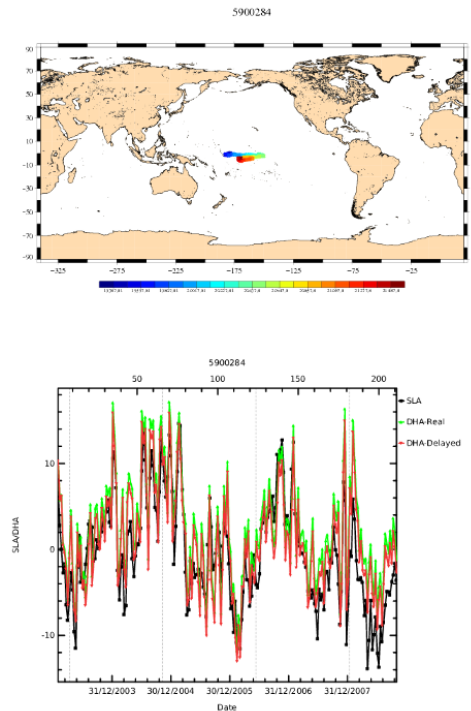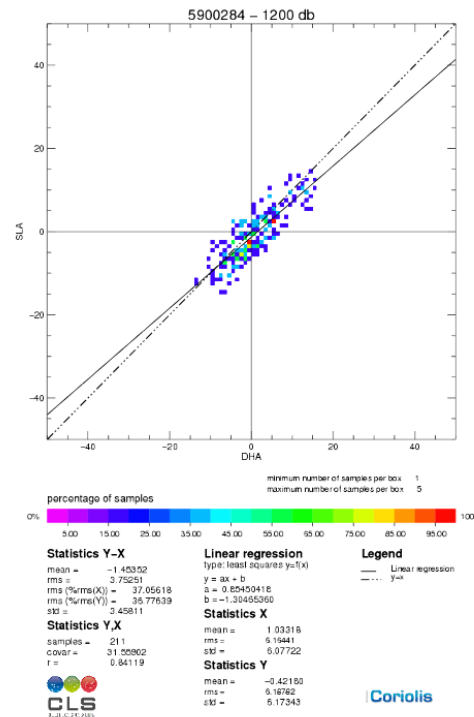
- Feedback relayed to float PI via jcommops (http://argo.jcommops.org/)