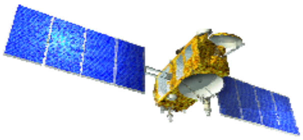
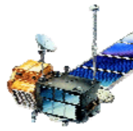
Quality assessment of altimeter and tide gauge data for Mean Sea Level and climate studies





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Overview

This study thus focuses on results deduced from the comparison method between altimetry and tide gauges and the way both types of data are used as input for **(1)** :

1 detecting global and regional drifts in the altimeter Sea Surface Height

2 evaluating new standards in altimeter products

3 providing a cross-comparison indicator on tide gauge using multiple altimetric systems (Jason1&2, Envisat and TOPEX/Poseidon, available on the AVISO website **(2)**)

- (1) Valladeau et al., 2012: "Comparing altimetry with tide gauges and Argo profiling floats for data quality assessment and Mean Sea Level studies". Marine Geodesy 2012, DOI: 10.1080/01490419.2012.718226

- (2) CLS Aviso website: www.aviso.oceanobs.com

Altimeter and in-situ datasets

➢ Altimetry: Along-track (level 2) SSH from satellite altimeters, where standards are updated compared with the official Geophysical Data Record (GDR) altimeter products (see AVISO website)

➢ Tide gauges: In-situ measurements from the GLOSS/CLIVAR "fast" sea level data network (http://ilikai.soest.hawaii.edu/uhslc) are used. This network provides data from 277 tide gauges (Fig. 1), collected by the University of Hawaii Sea Level Center (UHSLC) and updated within a few weeks or a few months

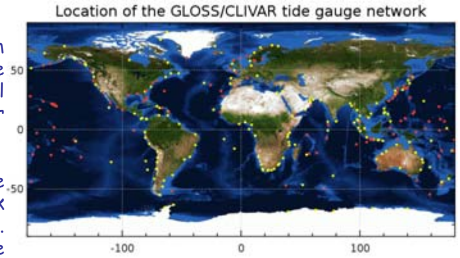


Fig. 1: Location of the 277 Tide Gauges of the GLOSS/CLIVAR network (yellow and red) and the 109 tide gauges with a good quality control (red, see part « Quality assessment of tide gauge time series ») considered in the Altimeter/Tide Gauges global comparison

1 Assessment of altimeter MSL drifts

➢ Collocation Method: maximal correlation criteria derived from theoretical altimeter along track products within a 100 km distance circle (Fig. 2). The main advantage is to reduce the effect of the oceanic variability and the error on the MSS considering the same altimeter point on the theoretical track

➢ Spatial weighting to take into account the non-homogeneous sampling of tide gauges in the whole ocean

➢ Additional quality controls to compute SSH differences for the most reliable time series :
- standard deviation of the differences lower than 10 cm
- at least 70% of valid points in the altimeter time series

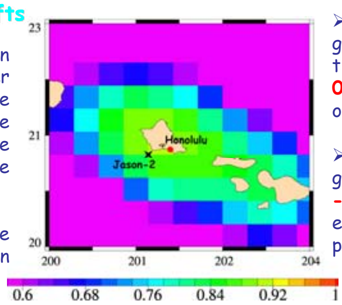


Fig. 2: Computation of the maximum of correlation on Jason-2 from 1/4 x1/4 gridded altimeter products. Red dot: Location of the Honolulu tide gauge. Black cross: Location of the Envisat maximum of correlation

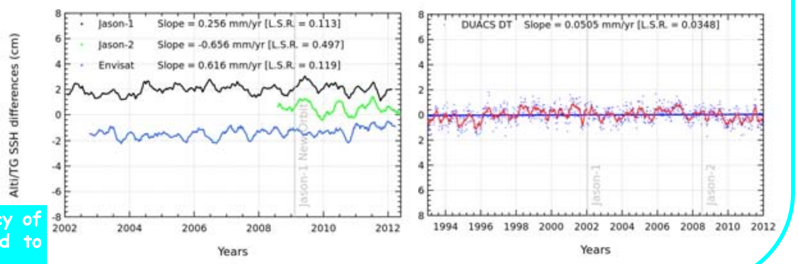
Fig. 3: Monitoring of the SSH differences between Altimetry and Tide Gauges. Left: Jason-1 (black), Jason-2 (green) and Envisat (blue) along-track data. Right: DUACS DT gridded products

➢ Good reliability of both Jason-1 and Envisat global MSL trend estimate with regard to tide gauges on 2002-2012 (respectively **0.3 mm/yr** and **0.6 mm/yr**), within the error of the method of +/- 0.7 mm/yr (Fig. 3 left)

➢ Differences between Jason-2 and tide gauges provide a negative drift of **-0.7 mm/yr**, with a strong formal adjustment error of 0.5 mm/yr, linked to its short time period

➢ On the 1993-2012 time period, the Global Mean Sea Level drift deduced from DUACS DT gridded products and compared with tide gauges is close to **0 mm/yr** with an error of +/- 0.5 mm/yr (Fig. 3 right)

➢ The error budget associated to the sea-level calculation can be assessed at climate scales (see M. Ablain's poster)



Tide gauge measurements are reliable enough to monitor the accuracy of altimeter data, within the error margin of the method, estimated to 0.5 mm/yr for the altimeter time period

2 Sensitivity of Jason-2 GDR-D data

➢ Impact of Jason-2 GDR-D data can be evaluated thanks to tide gauges measurements (Fig. 4)

➢ On the global 2008-2012 time period, the available cycles of GDR-D data seems to slightly reduce the standard deviation of SSH differences (see S. Philipps' poster): Jason-2 MSL trend is now **-0.3 mm/yr**

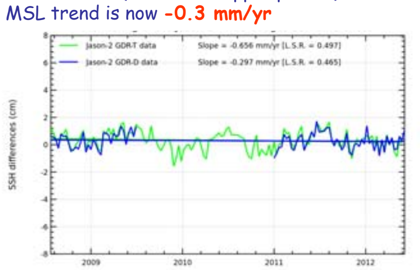


Fig. 4: Comparison of Jason-2 GDR-T and GDR-D data with regard to Tide Gauges

Focus on Jason-1/Envisat altimeter drift detection

➢ Reprocessing of Envisat mission strongly improved the ability of assessing the Mean Sea Level

➢ Drift deduced from the comparison with tide gauges is now 0.7 mm/yr on the 2004-2012 time period (Fig. 5)

➢ Problematic: Jason-1 and Envisat MSL trends over 2004-2012 differ by **+1.0 mm/yr** (see A. Ollivier's presentation). Is the confidence in the altimeter MSL drift greater for one of these missions ?

➢ Using both **tide gauges** and **Argo T/S profiles** (see J-F Legeais' presentation), differences between Envisat and Jason-1 are close to the 1.0 mm/yr difference obtained with the global altimeter MSL differences (respectively **0.9 mm/yr** and **1.4 mm/yr** since 2004, see Table 1)

Absolute values of MSL trends referenced to in-situ datasets suggest that Envisat MSL drift is greater than Jason-1 from 2004 onwards

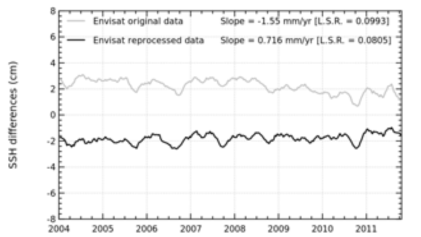


Fig. 5: Monitoring of the SSH differences between Envisat and Tide Gauges before (grey curve) and after (black curve) reprocessing

MSL trend differences (mm/yr) PERIOD: 2004-2012	Altimeter MSL	MSL differences with tide gauges	MSL differences with Argo+GRACE
Jason-1	2.4	-0.1	0.6
Envisat	3.4	0.8	2.0
Jason-1/Envisat differences	**1.0**	**0.9**	**1.4**

Table 1: Comparison of the MSL trend differences between Jason-1 and Envisat using altimeter MSL only, Tide Gauges and Argo T/S profiles

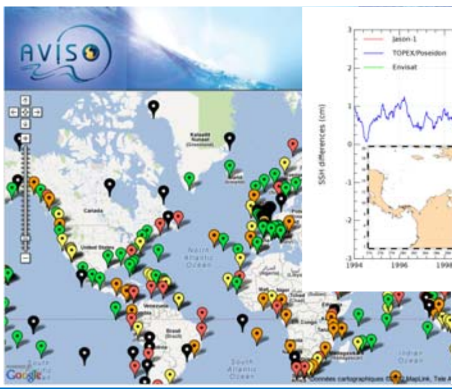
3 Quality assessment of tide gauge time series

➢ Cross-comparison of altimeter and in-situ SSH differences from all altimeter missions (Jason1&2, Envisat and TOPEX/Poseidon)

➢ Tide gauge quality control performed and displayed as a cross-comparison indicator on the AVISO website *http://www.aviso.oceanobs.com/fr/calval/in-situ-global-statistics/index.html* (Fig.6 left)

➢ Used to select relevant tide gauges for altimeter/in-situ comparisons: SSH differences can highlight unusual behavior of the sensor based on the data from the 3 main missions, Jason-1, TOPEX/Poseidon and Envisat between 2002 and 2006 (Fig.6 right)

The comparison of tide gauge measurements with altimeter data makes it possible to detect drifts or jumps in in-situ time series



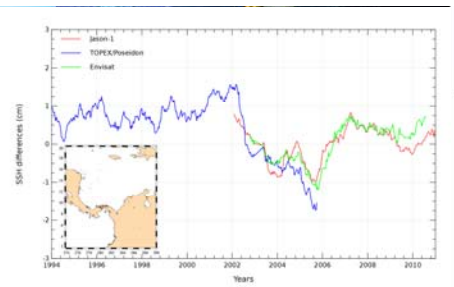


Fig. 6: Left: map of the cross-comparison indicator provided on the AVISO website. Right: SSH differences between the main altimeter data and Balboa tide gauge measurements using an 8 month Lanczos filter (and location of the Balboa tide gauge in the Panama Canal)