Data Quality Assessment of in situ and altimeter observations through two-way intercomparison methods

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Context & Objectives

Intercomparison methods also called multi-observations **CalVal** (Calibration/Validation) methods are widely used between **in situ** and **satellite** data to **assess the quality** of the latest. The stability of the different altimeter missions is, for example, commonly assessed by comparing altimeter sea surface height measurements with those from arrays of independent **tide gauges** [*Mitchum, 2000*; *Valladeau et al., 2012*]. Other examples include the validation of altimeter velocity products with **drifting buoys** observations provided by the Global Drifter Program (GDP) [*Bonjean and Lagerloef*, *2002*; *Pascual et al*., *2009*] that are also used for the systematic validation of satellite SST thanks to their in situ surface temperature measurements. In turn, comparison of in situ and altimeter data can also provide an indication of the quality of the in situ measurements [*Guinehut et al.*, *2009*; *Rio et al, 2012*].

We present here the two-way intercomparison activities performed at CLS for both **space** and **in situ observation agencies**, and why these activities are required steps to obtain accurate and homogeneous datasets:

(1) Assessment of the stability of altimeter missions through SSH comparisons with tide gauges (SALP program)
(2) Detection of drifts or jumps in altimeter missions through SSH comparisons with the Argo array (SALP program)
(3) Detection of drifts or jumps in Argo floats time series through SSH comparisons with altimeter observations (Ifremer/Coriolis center)
(4) Detection of drog loss of surface drifting buoys and computation of a correction term for wind slippage through combine use of altimeter and wind observations

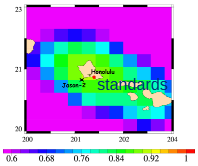
(1) Stability of altimeter missions through comparison with tide gauges

- **Data & Method (Valladeau et al., 2012a,b)**

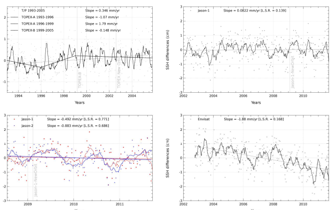
Tide gauge measurements from the GLOSS/CLIVAR "fast" sea level data network (http://ilikai.soest.hawaii.edu/uhslc)

Along-track (level 2) SLA from satellite altimeters with updated compared to the official GDR altimeter products

Collocation Method: maximal correlation criteria derived from theoretical altimeter along track products within a 100 km distance circle



- **Assessment of TOPEX/Poseidon, Jason-1, Jason-2 and Envisat MSL drifts**



Detection of potential drifts or jumps in altimeter time series: by analyzing the collocated altimeter and tide gauge SLA differences

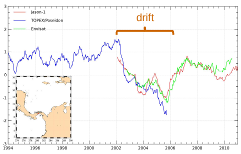
Impact of new altimeter standards (orbit solution, geophysical or instrumental correction, retracking algorithm): by comparison of collocated altimeter/tide gauge SLA

Sea level differences between altimeter and tide gauges (cm)
Dots: 10-day cycle. Curve: 60-day filtering

- **Quality assessment of in situ tide gauge time series**

Since spurious drifts or jumps can remain in tide gauge time series, a quality control is performed to select relevant in-situ measurements for the altimeter/tide gauges comparisons

The tide gauge quality control is performed:
- by comparing altimeter/tide gauges SLA differences using the four main missions
- by correlating altimeter and in situ SSH time series



SLA differences between the main altimeter data and Balboa tide gauge (cm)

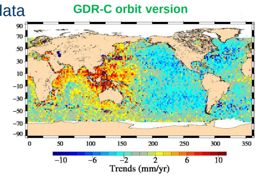
(2) Drifts or jumps in altimeter missions through comparison with Argo floats

- **Data & Method (Valladeau et al., 2012a)**

Collocated DHA + Grace / SLA

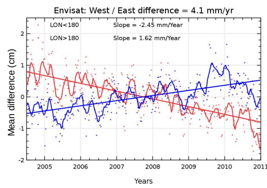
SLA maps derived from 10-days box-averaged along-track data
Argo Coriolis-GDAC data base, DH-900 dbar – synth. clim.
Grace (http://grace.jpl.nasa.gov – Chambers, 2006)

- **Regional MSL trend differences between Jason-1 and Envisat** (not reprocessed)
  - Large longitudinal structures when **GDR-C orbit** are used: ±**3mm/yr**

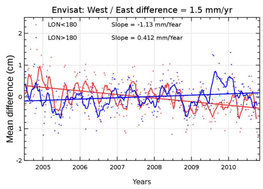


- **East/West SLA differences between Envisat and Argo+Grace data**
  - Strong trend difference for Envisat (ΔEast/West = **4.1 mm/yr**) instead of **-0.1 mm/yr** for Jason-1.

➔ The anomaly is mainly observed on **Envisat**

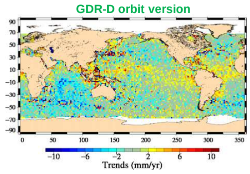


- **Test of the impact of new preliminary CNES GDR-D orbit solutions** (where long-term evolution of gravity field has been improved)



Strong impact on the East/West trend difference on Envisat, now reduced to **1.5 mm/yr**

Improvement of regional trend differences between Jason-1 and Envisat



(3) Validation of Argo floats through comparison with altimeter observations

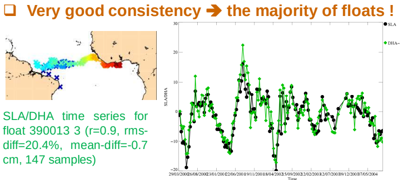
- **Data & Method (Guinehut et al., 2009)**

For each Argo float time series : DHA = DH – Mean-DH / SLA

DH : Argo Coriolis-GDAC data base
DH calculated from T/S profile using a reference level at 200/400/900/1200/1900dbar
Mean-DH : Argo synthetic climatology
SLA : AVISO combined maps – co-located in time and space to the Argo measurements

- **Differences between DHA and SLA can arise from :**
  - Differences in the physical content of the two data sets ➔ use of mean statistics
  - Problems in SLA ➔ assumed to be perfect for the study
  - Problems in the Mean-DH / Inconsistencies between Mean-DH and DH ➔ use of synth. clim.
  - **Problems in DH** (i.e. the Argo data set)

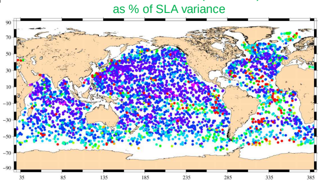
- **Very good consistency ➔ the majority of floats !**



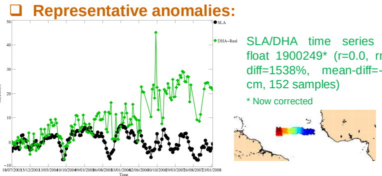
SLA/DHA time series for float 390013 3 (r=0.9, rms-diff=20.4%, mean-diff=-0.7 cm, 147 samples)

- **Questionable floats can be extracted by comparing to the neighbors**

Rms of the differences (SLA-DHA) as % of SLA variance



- **Representative anomalies:**



SLA/DHA time series for float 1900249* (r=0.0, rms-diff=1538%, mean-diff=-9.0 cm, 152 samples)

* Now corrected

- **Diffusion of the results**
  - About 10 new floats extracted every 3 months
  - Diffusion through the AIC, PI and DM-operators are asked to correct the anomalies

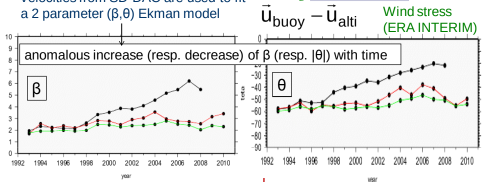
(4) Drogue loss of surface drifting buoys through combine use of altimeter and wind observations

Context: Spurious trend in global surface drifter currents (SD-DAC) dataset due to anomalous drogue loss detection recently identified (Grodsky et al, 2011, Rio et al, 2011)

Altimeter, wind stress and drifting buoy velocities from SD-DAC are used to fit a 2 parameter (β,θ) Ekman model

$$\vec{u}_e = \beta \vec{\tau} e^{i\theta}$$

$\vec{u}_{buoy} - \vec{u}_{alti}$ — Wind stress (ERA INTERIM)



— ALL
— First three months of each trajectory only (Grodsky et al, 2011)
— Only drifters identified as drogued by our method (α_{best}>0.3%)

Development of a method to detect the drogue loss (Rio, 2012)

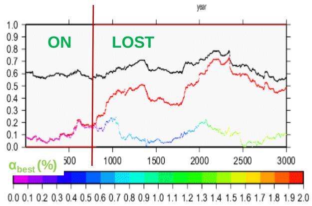
✓ Computation of a **new Ekman model** from the first three months of the AOML drifter trajectories (by latitudinal band and by month - spatial and seasonal change in stratification)

✓ Computation along the drifter trajectories (only trajectories longer than 200 days are considered**) vectorial correlation between the wind :**

1- **Vbuoy-Valti vs Wind**
➔ Altimetric geostrophic currents (AVISO) subtracted from the drifter velocity

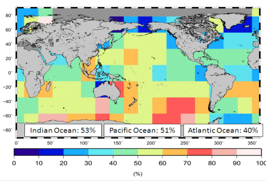
2- **Vbuoy-Valti-Vekman vs Wind**
➔ Ekman currents then subtracted

3- **Vbuoy-Valti-Vekman-α_{best}Wind vs Wind**
➔ α_{best}Wind then subtracted (α= α_{best} minimizes the vectorial correlation between the 'residual' velocity and the wind)



We consider that the drogue is lost at the first occurrence of α_{best}>0.3%

➔ **48% of the total « drogued » SD-DAC dataset with important spatial variability**



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Summary & Future work

- **Efficient methods** : efficiency & limitations now well known
- **General consistency check** of the whole **Argo** data set & the whole **surface drifting buoys** data set & the whole **tide gauge** data set & of the different **altimeter missions** ➔ consistent datasets to be used together for climate studies or in assimilation/validation tools
- Continuous improvement of the methods
- Results to be updated on a regular basis

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