Analysis of altimetry errors using in-situ measurements: Tide gauges and Argo profiles

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Introduction

- To date, the global assessment of altimeter data can be performed through:
  - internal assessment of altimeter data (comparison of instrumental corrections with global models, calculation of SSH at crossovers)
  - cross-calibration between altimeter missions
  - **comparison with in-situ measurements** which are used as **external and independent** sources of comparison to better assess the multiple system performances

- In this way, altimetry is compared to tide gauges and Argo floats data in the frame of the SALP project (CNES).

Objectives:

1. Detect global and regional **altimeter MSL drifts or anomalies**
2. Estimate the **impact of new altimeter standards** on SSH estimation

Overview

- Datasets and methodology reminder,
- Global altimetry drifts,
- Evaluation of new standards

Datasets and methodology

Comparison	tide gauges	Argo floats
Altimetry	Cycle by cycle box-average of SLA	Along-track altimetry data
In-situ	Relative SSH time series from • GLOSS/CLIVAR • PSMSL	• Argo T/S profiles from Coriolis GDAC database, • Ocean mass fields from GRACE
methodology	Extraction of the most correlated altimetry time series	Interpolating altimetry at the position of each Argo profile
	• Long time series available, • Dependent on tide gauges distribution, • No open ocean	• Available from 2002 onwards, • global ocean evenly sampled

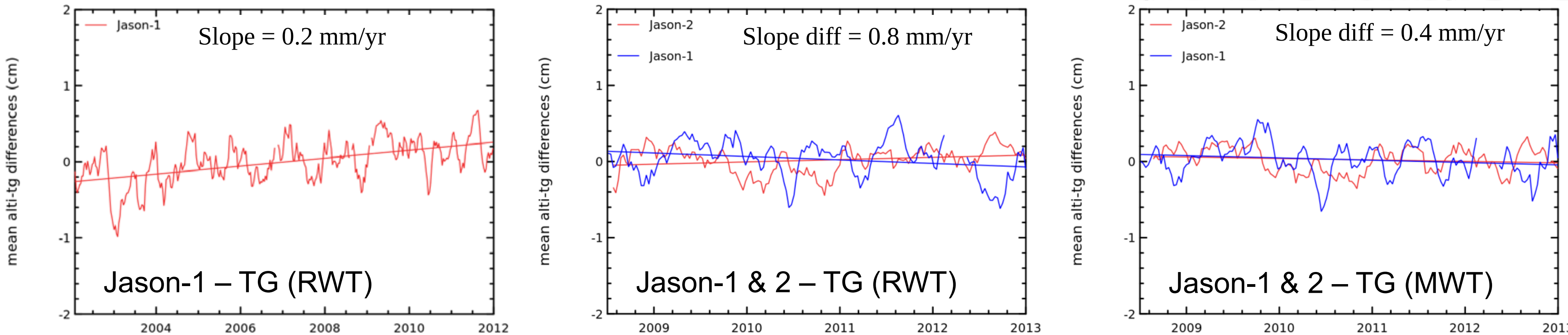
Global altimeter drifts

- Latest results from Jason-1, Jason-2 and Envisat

Global altimetry drifts, Jason-1 & Jason-2

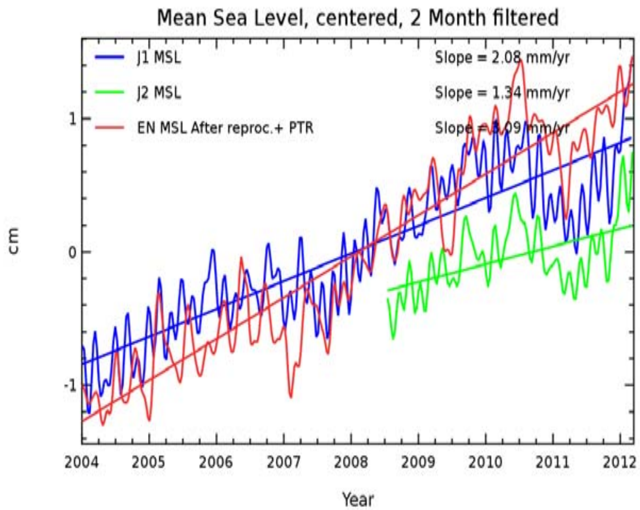
- Jason-1 and Jason-2 GMSL drifts :
  - 0.7 mm/yr using RWT
  - reduced to 0.2 mm/yr when MWT and homogeneous standards are used,
  - => Jason-1 and Jason-2 see the same GMSL evolution, see S. Philipps presentation

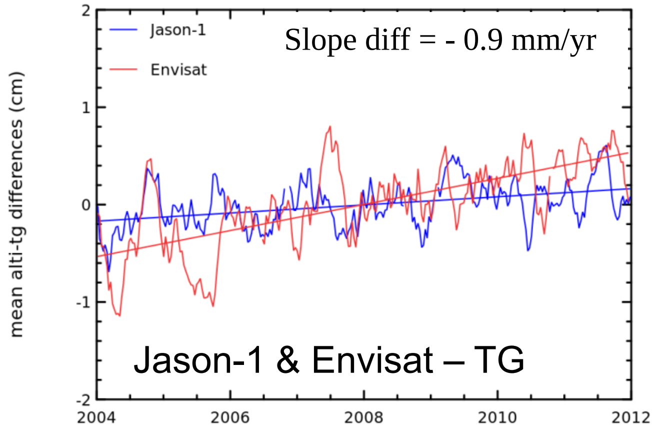
- Comparison to TG data shows that,
  - over the Jason-1 period, no significant drift is observed,
  - there is a 0.8 mm/yr difference between Jason-1 and Jason-2 mean TG differences over 2008/2012 (0.0 mm/yr vs -0.8 mm/yr),
  - this difference is reduced to 0.4 mm/yr when using MWT, and no significant drift of Jason-2 is observed.

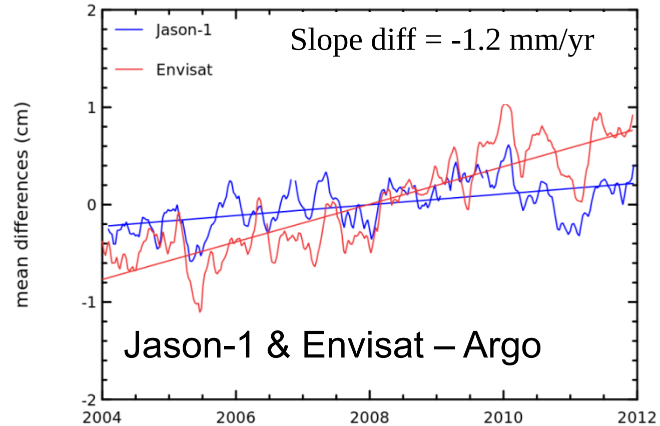


Global altimetry drifts, Jason-1 and Envisat

- Envisat and Jason-1 GMSL trends differ by 1.0 mm/yr over 2004/2012,
- A similar value is observed on alti-TG differences,
- and on altimetry - (Argo+GRACE) differences,







	Jason 1 – Envisat
Altimetric GMSL	-1.0 mm/yr
Altimetry - TG	-0.9 mm/yr
Altimetry – (Argo+GRACE)	-1.2 mm/yr

The combination of different types of in-situ data allow to **detect** and **indicate the MSL drift of Envisat with respect to Jason-1** over the period 2004-2012.

Evaluation of new standards

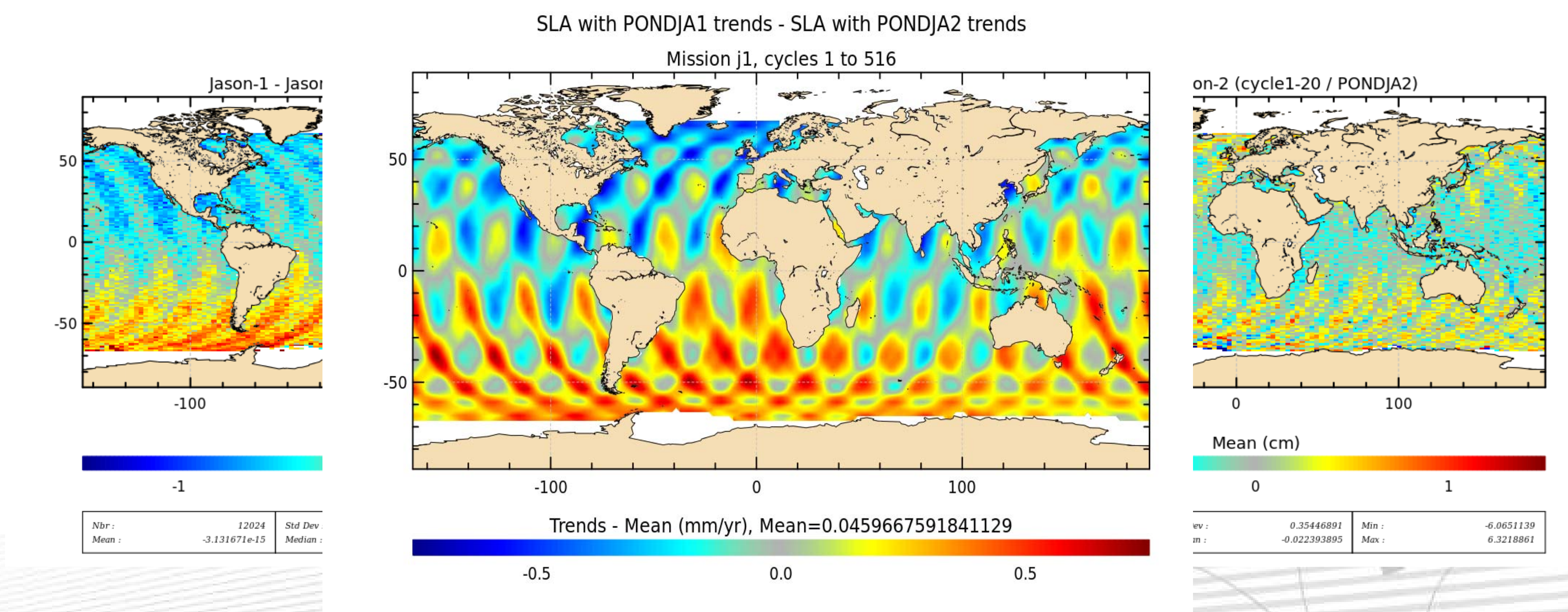
- Jason-1 orbit solution,
- wet troposheric correction on Topex/Poséïdon,
- Assessment of ESA's CCI sea level dataset

Orbits assessment on Jason-1

- Jason-1 GDR-D orbits: calculated with underweighting of DORIS stations in the SAA
    - North/South bias between Jason-1 and Jason-2 over the verification phase,

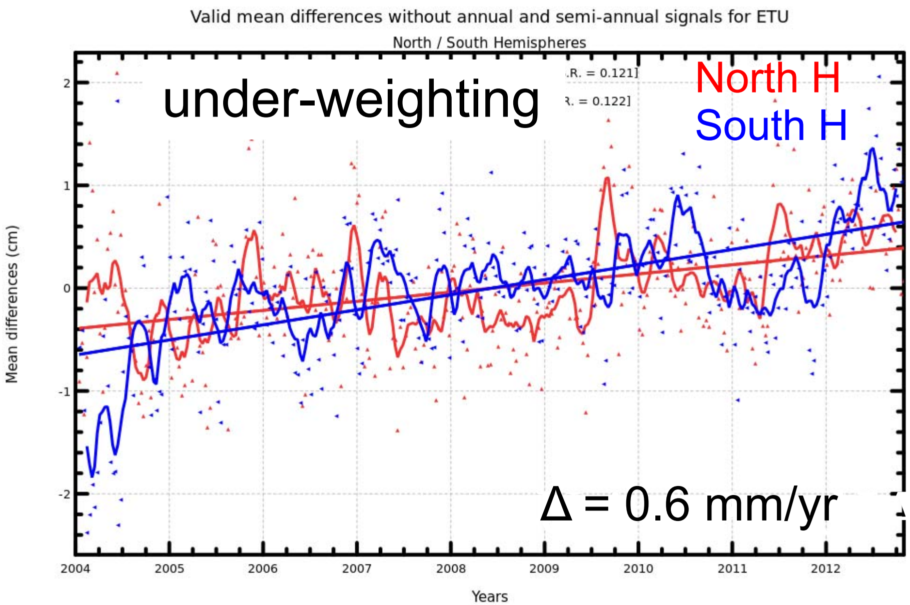
- Test of a new Jason-1 orbit with no underweighting:
    - North/South bias is reduced,

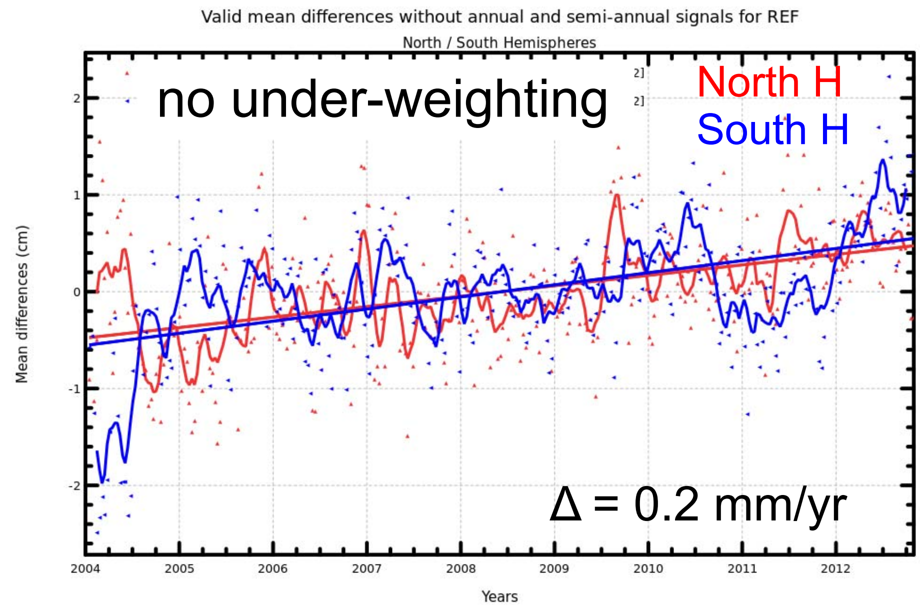
- But Jason-1 regional trends are modified !



Orbits assessment on Jason-1

- Comparison between Jason-1 altimetry and T/S profiles
- separating North /South hemisphere (for |lat| > 20°)





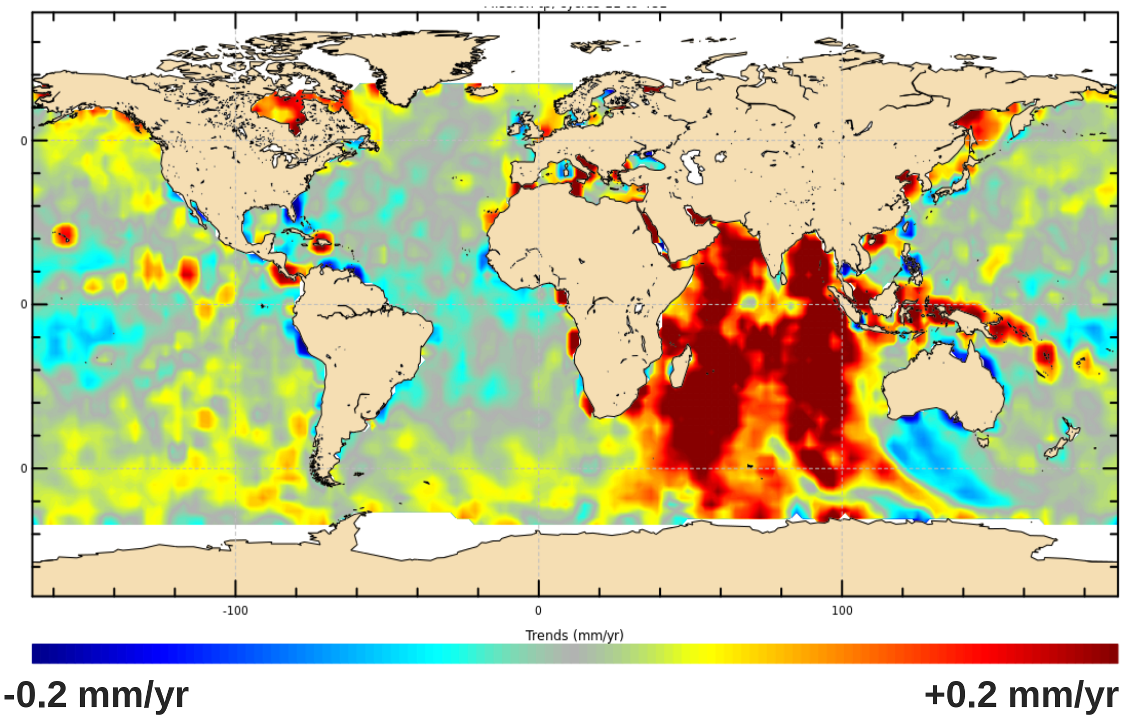
- on Jason1, underweighting of SAA stations leads to **less homogeneous** values for North and South hemisphere trends than without underweighting

The new orbit solution

- improves consistency between Jason-1 and Jason-2,
- improves Jason-1 consistency with Argo data

GPD wet tropospheric correction on Topex/Poseidon

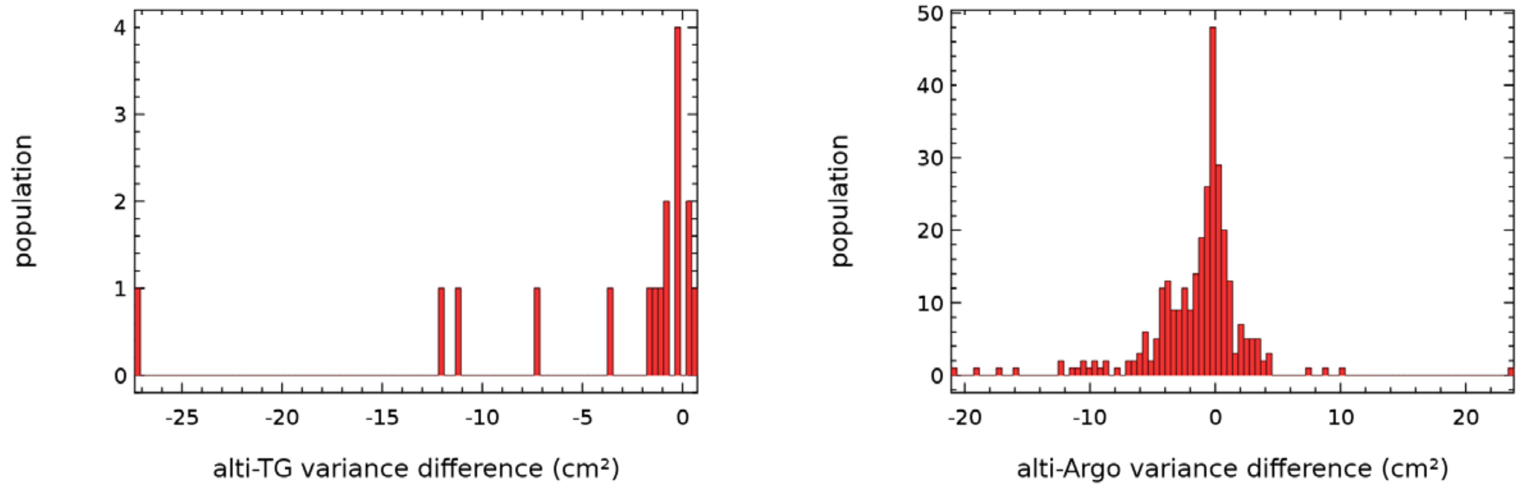
- New tropospheric correction (UoP) for all missions,
- Induces SL trend changes in the Indian Ocean over the Topex period,



- We use Argo and TG data to assess the performance of this new correction with respect to the composite wet tropospheric correction.

GPD wet tropo correction on Topex/Poseidon

- impact on the variance of the altimetry – insitu differences:
  - TG: variance of the differences reduced by 4 cm²
  - Argo: variance of the differences reduced by 1 cm²,

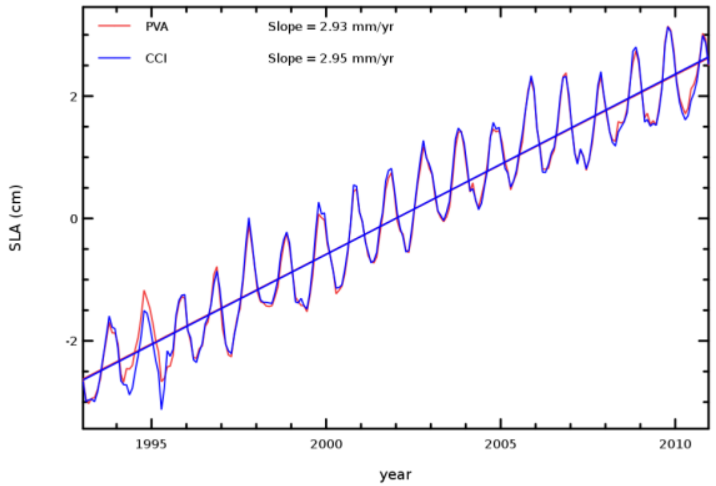


- Argo floats also suggest that the Indian Ocean MSL drift is more consistent with the GPD wet tropospheric correction

Using GPD troposheric correction on Topex
- reduces regional Alti-Argo trend differences between basins
- improves consistency between altimetry and in-situ data

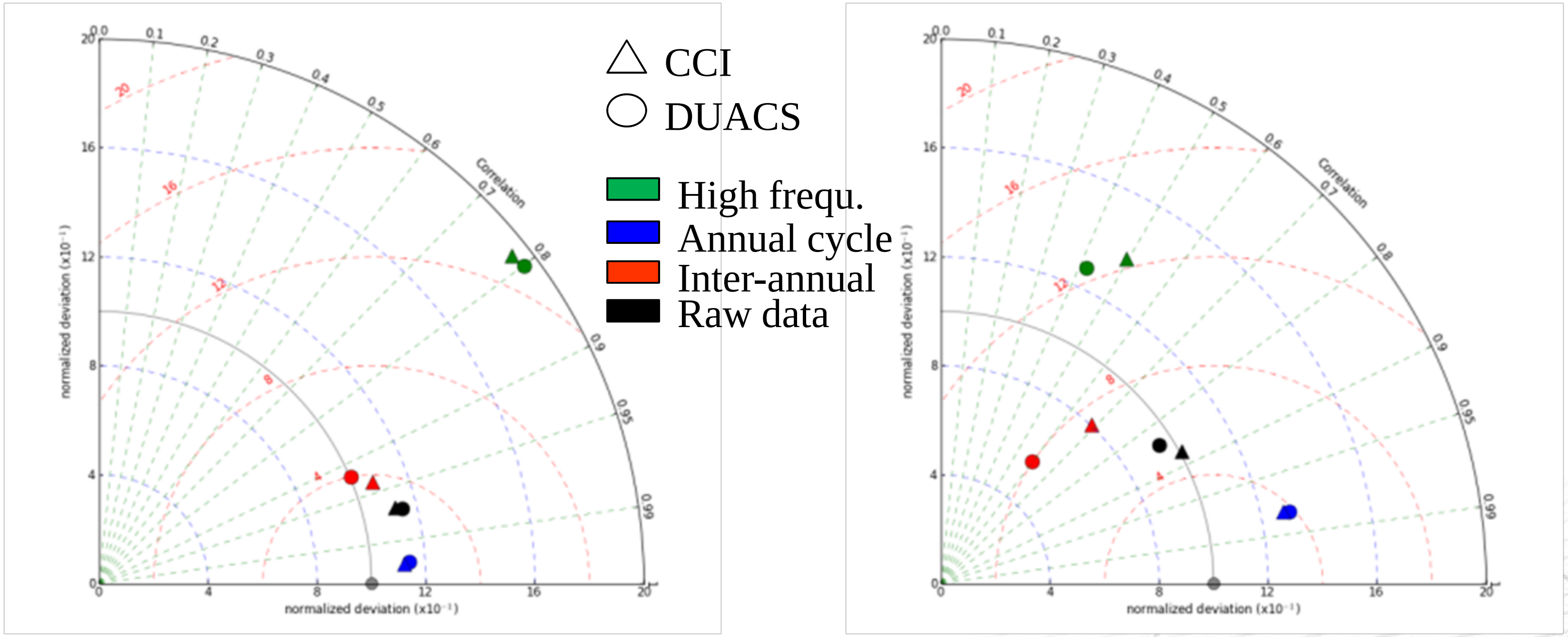
ESA CCI sea level dataset assessment

- Comparing two multi-satellite gridded products
  - SSALTO/DUACS Upd (see Y. Faugere's talk)
  - ESA's Sea Level Climate Change Initiative product (see M. Ablain's talk)
    - climate-oriented,
    - monthly grids
- With respect to in-situ data (TG and Argo) used a as reference,



- Small differences between the datasets considering GMSL:
  - in-situ not useful at global average scale,
  - separation of temporal and spatial scales,

Exploring differences between CCI and DUACS



Tide gauges

Argo profiles

- In situ data provide a very valuable external data source to compare altimetry datasets, even high level (L4) merged products
- considering different time and space scales allows to identify significant signals

Conclusions

- **In-situ data are:**
  - a tool to assess global MSL drifts and jumps
  - an external dataset to evaluate altimeter standards,
    - for mono-mission studies,
    - and for multi-mission gridded datasets,

- **And,**
  - different time/space signals can be usefully investigated

- **Yet,**
  - some processing questions are still open,
    - GIA induced signals,
    - altimetry processing,
  - need for a comprehensive uncertainty estimation,

Conclusions

- knowledge gained comparing past and present satelitte altimetry and in-situ should be applied to present and future missions;
  - CryoSat 2
  - SARAL/AltiKa,
  - Jason-3
  - Sentinel 3
  - Jason-CS
  - …
- eventually, we are trying to ensure the reliability of global and regional MSL estimates

Thank you for your attention