



Altimetry errors and sea-level uncertainty estimations at climate scales

M.Ablain, L.Zawadzki, P.Prandi (CLS)





- Altimetry measurements errors have been specified at different climate scales (Ablain et al., 2015)

Spatial Scales	Temporal Scales	User Requirements	Altimetry uncertainties SL_cci products
Global Mean Sea Level (10-day averaging)	Long-term evolution (> 10 years)	0.3 mm/yr	< 0.5 mm/yr
	Inter annual signals (< 5 years)	0.5 mm over 1 year	< 2 mm over 1 year
	Periodic signals (Annual, 60-days,...)	Not defined	Annual < 1 mm 60-day < 5 mm
Regional Mean Sea Level (2x2 deg boxes and 10-day averaging)	Long-term evolution (trend)	1 mm/yr	< 3 mm/yr
	Inter annual signals (> 1 year)	Not Defined	Not evaluated
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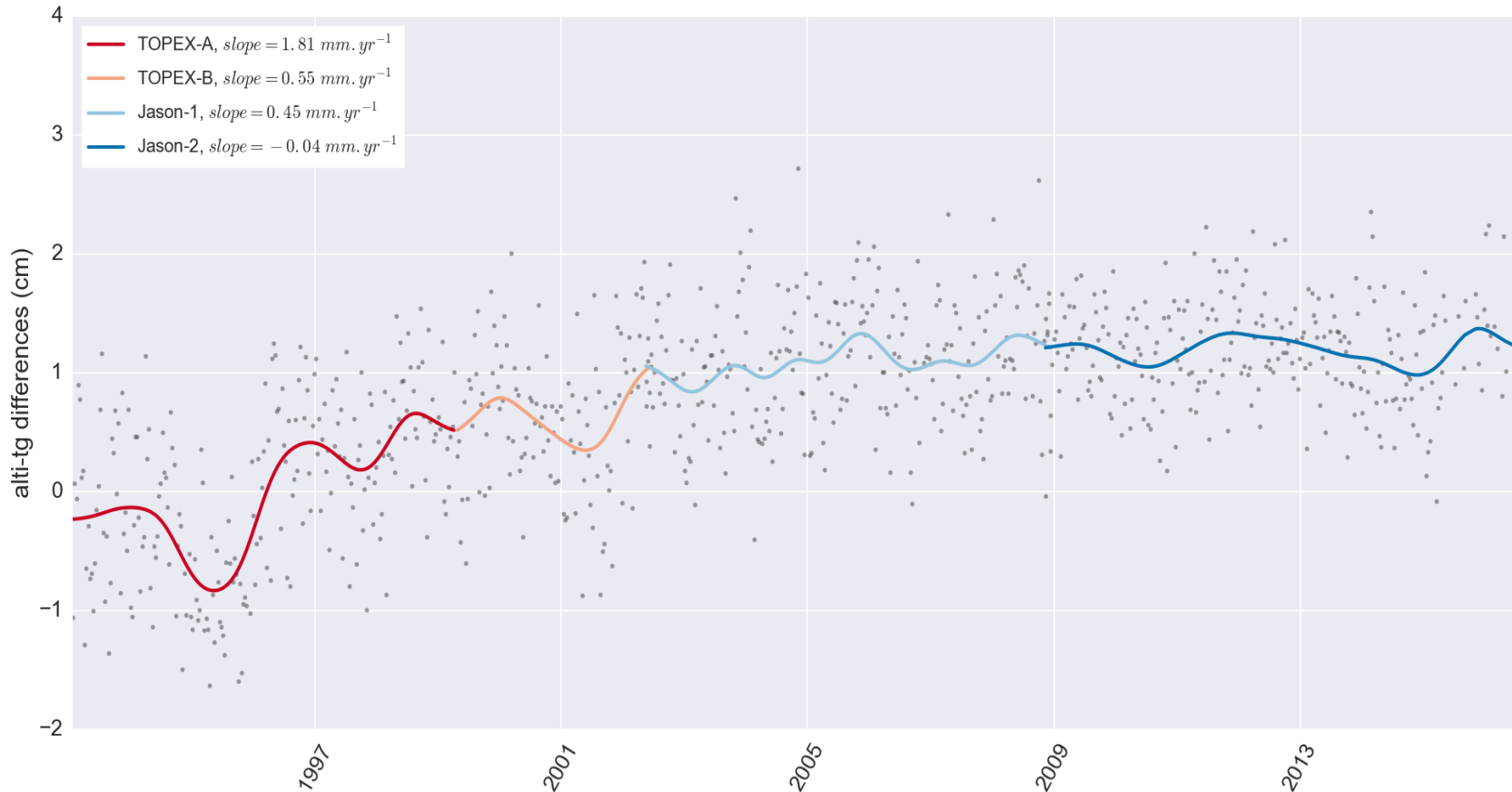
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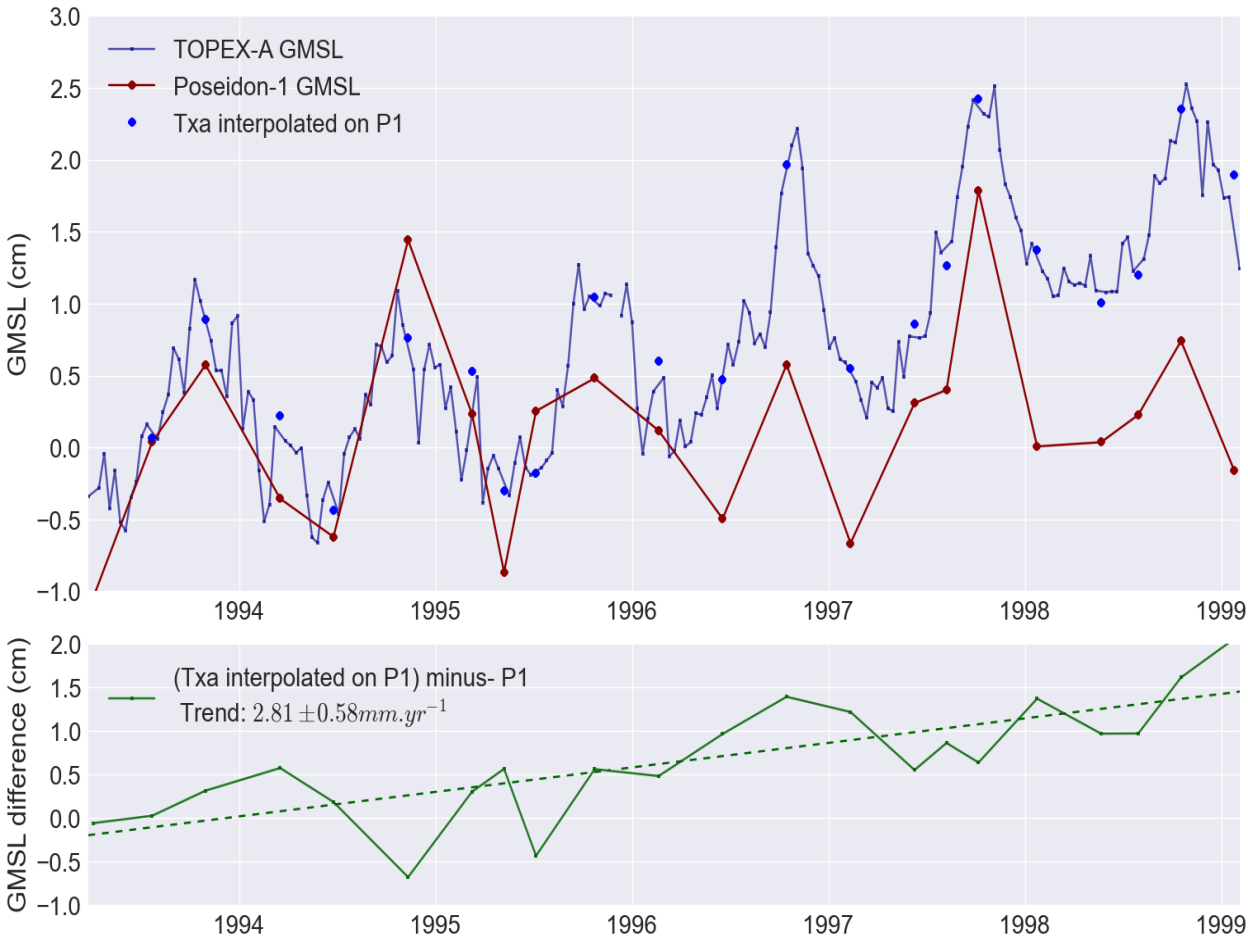
- GMSL trend is 3.3 mm/yr **± 0.5 mm/yr within a confidence interval of 90%**
- Uncertainty is inferred by generalized least squares, where the error covariance matrix is built from altimeter correction uncertainties.
- Main source of altimetry errors are :
 - ⇒ Instabilities of wet troposphere corrections (derived from microwave radiometers),
 - ⇒ Drift on TOPEX altimeter parameters (mainly TOPEX-A),
 - ⇒ Uncertainty on MSL bias to link TOPEX-A and TOPEX-B



- GMSL trend uncertainty is higher over the first altimetry decade [1993-2002] :
 - ⇒ Orbit solutions & atmospheric corrections are less accurate
 - ⇒ Errors on TOPEX measurements : Range, Sigma-0 and SWH instabilities (mainly in TOPEX-A), MSL bias between TOPEX-A and TOPEX-B, wet troposphere radiometer drift
 - ⇒ Cross-comparisons with other systems (altimeter missions, in-situ measurements) are less accurate



Global mean SSH differences between altimetry and tide gauges for the TOPEX, Jason-1 and Jason-2 records (Prandi et al., 2016)



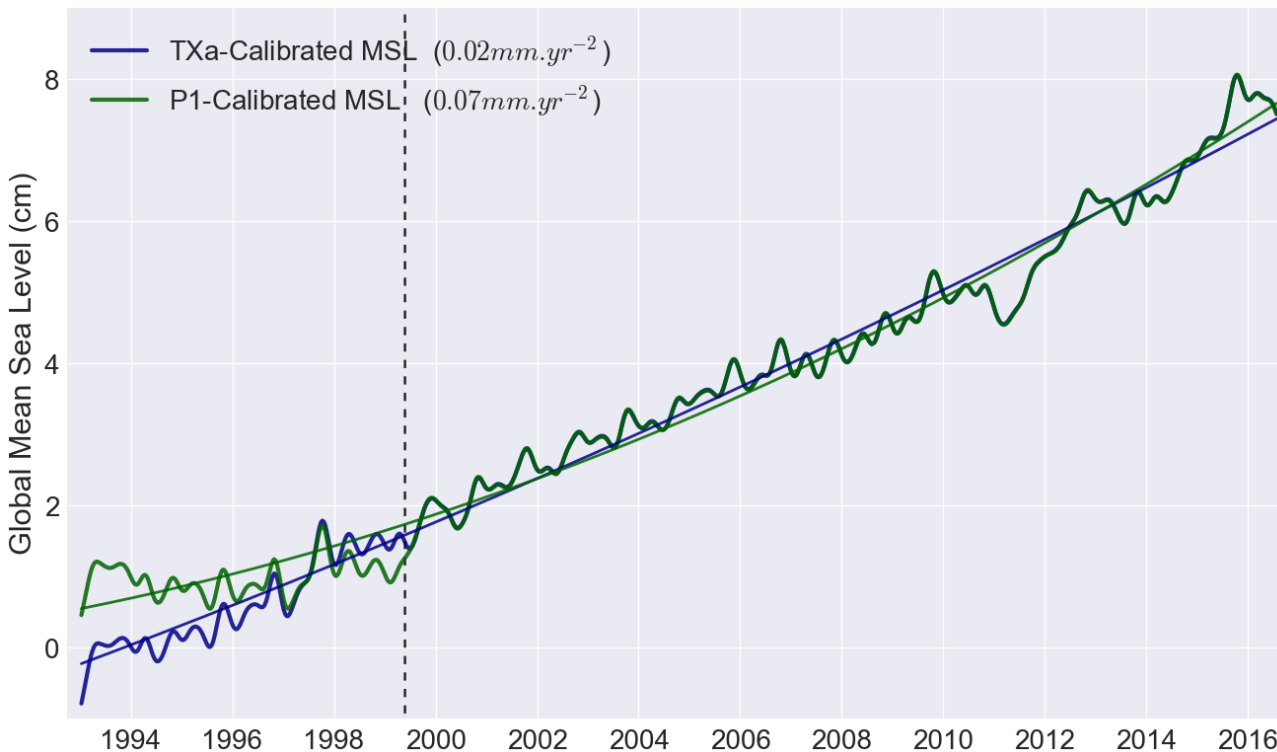
A GMSL drift is detected between TOPEX and Poseidon-1 data : $2.8 \pm 0.6 \text{ mm.yr}^{-1}$

Upper panel: GMSL records. Lower panel: Difference between the interpolated TOPEX-A and Poseidon-1 records

(Zawadzki et al., 2016)



- The on-going reprocessing of TOPEX L2 data (by JPL and CNES) should improve the TOPEX-A stability



After correcting empirically the TOPEX-A drift, an acceleration of GMSL curve is likely observable.



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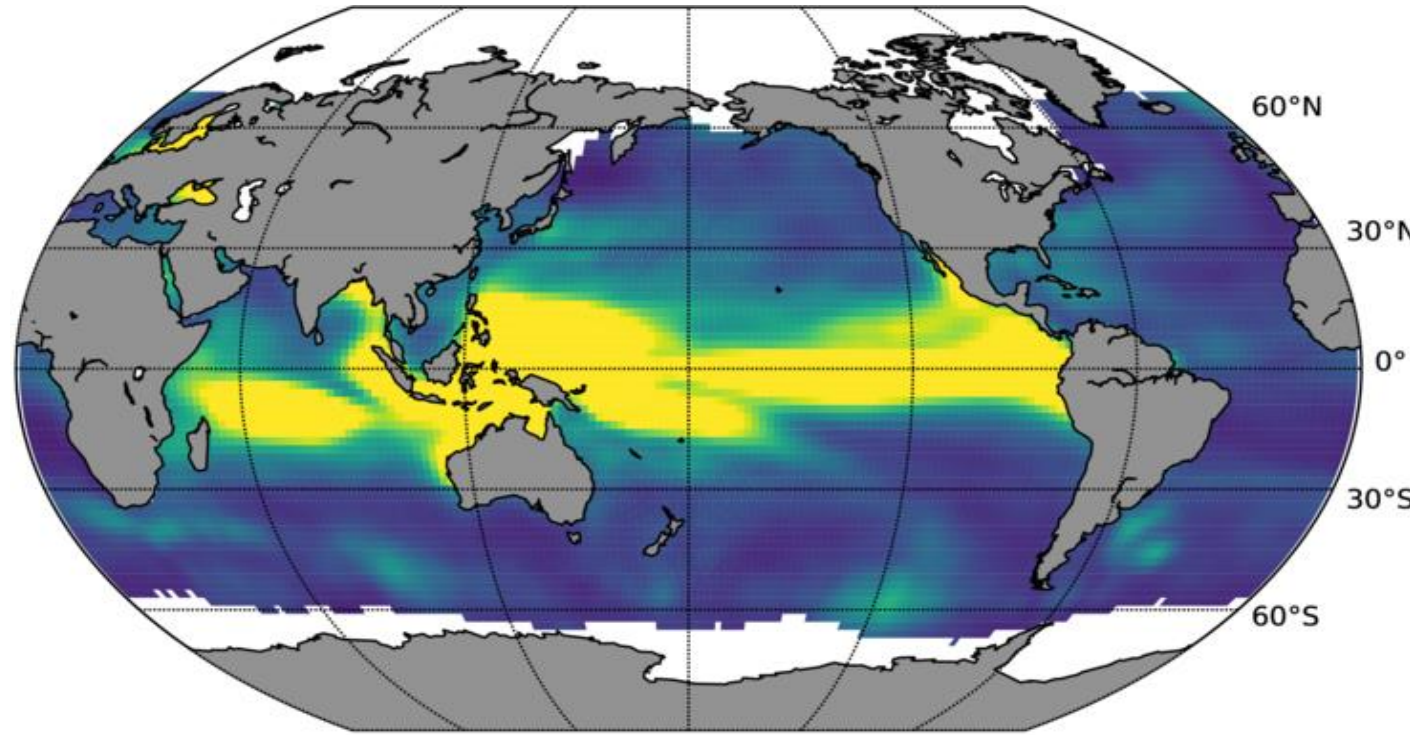


- Similar methods as for the global MSL but at regional scales: (Prandi et al., 2017) paper submitted very soon.
- Main source of errors are :
 - ⇒ The orbit solutions correlated errors (1 mm/yr) at large spatial scales (hemispheric)
 - ⇒ The wet troposphere uncertainties in wet areas (1-2 mm/yr)
 - ⇒ the high frequency correlated noise (< 2 months)
 - ⇒ the low frequency variability of sea-level

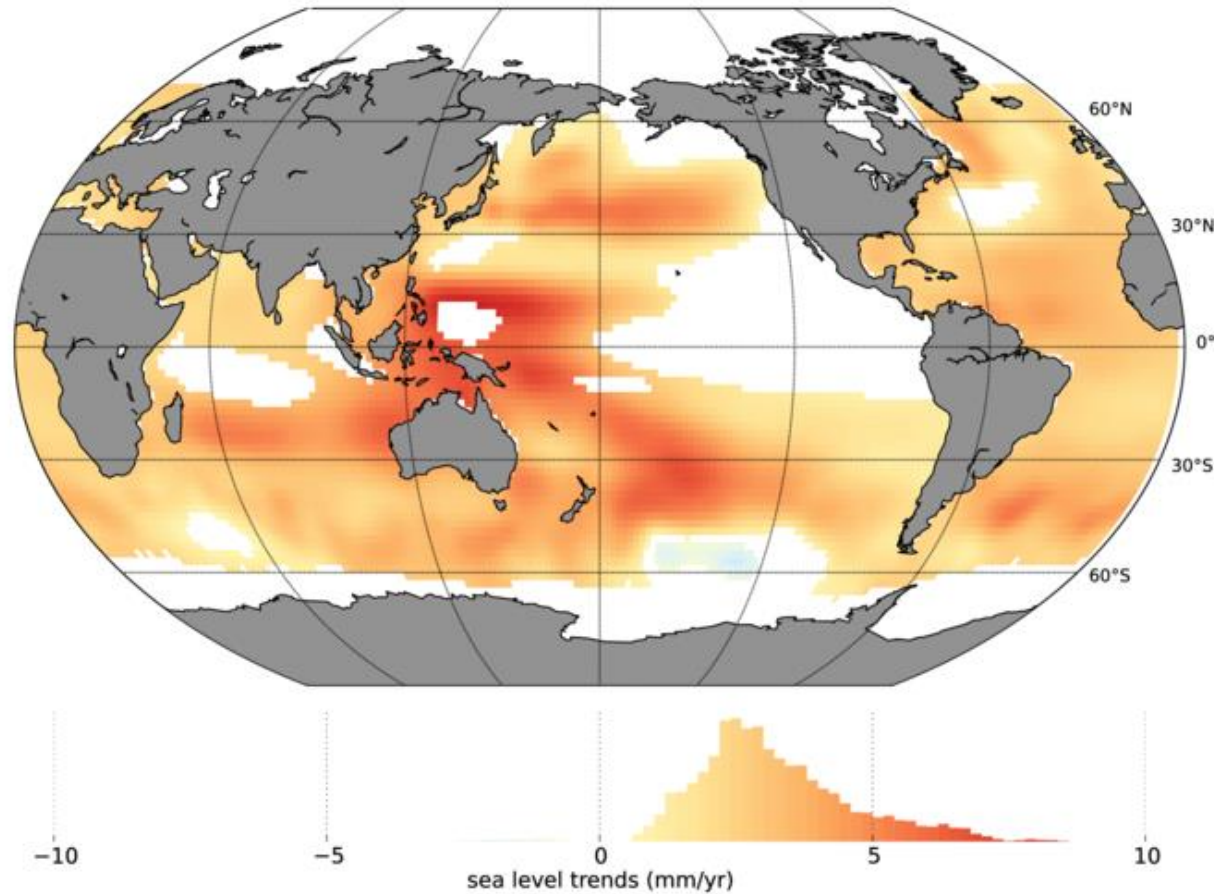


Systematic uncertainties range between 0.5 to 3 mm/yr with a mean value of 0.9 mm/yr (confidence interval of 95%)

Results depend on the a priori description of errors; if the model is wrong to ...
⇒ Accuracy ...
covarian ...
is crucial



Impact of the high frequency correlated noise and the low frequency variability of sea-level will be reduced with longer altimetry time series



82% of the global ocean exhibits statistically significant sea level trends



- Altimetry errors and uncertainty estimations if of great interest : 1) to inform users, 2) to provide feedbacks for spatial agencies
- Altimetry errors and sea-level uncertainties estimations must be continue in CCI+ project:
 - ⇒ To take into account new altimeter missions and new altimeter standards
 - ⇒ To refine the error budget from the long-term evolutions to interannual evolutions
 - ⇒ To improve the mathematical formalism allowing the estimation of FCDR sea-level uncertainties and their propagation into the CDR