Ssalto/DUACS reprocessed DT data set

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1. Introduction

The DUACS delayed time date set was entirely reprocessed.

Our historical altimetry database has been updated to the most recent reprocessed GDR (e.g. : Jason-1 GDR-C from 2009), but also to up-to-date standards (GDR-C or equivalent), on all missions. DUACS-DT itself has been improved here and there (new processing, better transition from TP to Jason, better mapping parameters) and this reprocessing implements all changes introduced in Near Real Time processing.

One should note that this reprocessing was able to benefit from data, algorithms or experience developed various CNES projects and reprocessing. The synergy with Cal/Val and MSL activities helped with the long-term climate-oriented coherency, and a better handling of reference missions and regional MSL. The SLOOP project provided a framework for the computation of new Mean Profiles for all missions, and SLOOP will produce better reference surfaces (Mean Sea Surface [MSS], and Mean Dynamic Topography [MDT_CNES-CLS09_V1.1]) which are used by DUACS for drifting altimetry missions or the computation of Absolute Dynamic Topography.

However due to time or workload constraints, it was not possible to integrate all possible improvements associated to recent projects : ENVISAT GDR-C reprocessing not yet available, ERS reprocessed data from the REAPER project are not yet available, retracked T/P are still being analyzed, and only a fraction of the coastal improvement from PISTACH or Coastalt projects were actually used due to the lack of high-resolution along-track data in DUACS.

Note that the DT-2010 generation falls under the new data policy associated to MyOcean. Consequently, it will not be distributed anonymously as older products were. To access the new dataset, you'll have to subscribe to a nominative data access (www.aviso.oceanobs.com/en/data/registration-form). Barring the lightweight identification needed, the change should be mostly transparent to all scientific and nonprofit users.

This document summarizes the parameters used for the DT-2010 SLA/MSLA products generation and their impact on the product quality.

2. Correction used for DT DUACS production

Here are the main changes introduced in the 2010 reprocessed data set (v3.0.0) :

- T/P : new non parametric Sea State bias solution from N. Tran and S.Labroue with up-to-date standards (e.g. : DAC or wind algorithm) and orbit solution
- T/P : new orbit solution, kindly provided by GSFC
- Jason-1 : GDR-C used from 2009 reprocessing
- Jason-1 : used as a reference mission instead of T/P for 2002-2005
- Jason-2 : all GDR used from the mission beginning
- Jason-2 : used as a reference mission from 2008
- ENVISAT : used in place of ERS from cycle 9, except for missing cycle 15 (still using ERS2 for this 35-day period)
- ENVISAT : new non parametric SSB solution from S.Labroue
- ENVISAT : GDR-C orbits used (from cycle 23)
- GFO : new orbit solution, kindly provided by GSFC. The new solution not being available during complex periods, the GDR orbit is also used with empirical coherency restoration in between
- GFO : new non parametric Sea State bias solution from N. Tran and S.Labroue with up-to-date standards and orbit solution (computed after orbit error minimization on calibrated reference missions)
- ERS : minimization of brightness temperature drift before wet tropo computation (NN)
- All missions : GDR-C or better standards applied whenever necessary (GOT4v7, High Resolution DAC correction...)
- All missions : new mean profiles computed in coherency with the new standards and algorithms. New algorithms were applied to correct for time-averaging period discrepancies (e.g. : T/P != Jason-1) or ocean variability. The new mean profiles are still referenced over 1993-1999 for the sake of coherency, but they integrate a precious information from the most recent missions and datasets.
- All missions : minor upgrades of the editing process and complete re-editing based on new standards and corrections
- All missions : complete re-computation of the empirical cross-calibration and homogenization processes (orbit error reduction using a reference mission, and long wavelength error minimization)
- Reference missions : revisited bias from T/P to Jason-1 and transition from Jason-1 to Jason-2 in order to correct for geographical discrepancies affecting regional MSL studies carried out on DUACS multi-mission maps. Only the inconsistencies which are explained and understood are minimized (update to 2009 knowledge). No geographical minimization is performed between TP-A and TP-B, no waveform leakage correction is applied in this processing (empirical minimization process not fully certified yet).
- Mapping process : updated suboptimal OI process to minimize transition artefacts (increases map computation time by a factor of 10)
- Mapping process : map coverage extended at high latitudes (previously dismissed due to lack of confidence in Mean Profile)
- Mapping process : time resolution increased (first release still on 1 map per week basis, to be increased to 2 or 7 maps per week by mid-2010).

The main reference characteristics for computing DUACS DT SLA and MSLA products are summarised in the following table.

	Duacs 2010 DT product (v3.0.0)						
	j2	J1; j1n	tp; tpn	e1	e2	en	g2
Product standard ref	GDR-C	GDR-C		OPR	OPR	GDR-A (cycles 1 to 22) / GDR-B (from cycle 23)	
Orbit	Cnes POE		GSFC (ITRF2005, Grace last standards)	DGME-04 [Scharroo and Visser, 1998]	DGME-04 [Scharroo and Visser, 1998]	Cnes POE (GDR-A standards for cycles 9 to 22; GDR-C standard from cycle 23)	GSFC** (ITRF2005, Grace last standards)
Ionopheric	From dual-frequency altimeter range measurements		From dual-frequency altimeter range measurements (Topex), from Doris (Poseidon)	Bent model	Bent model (cycle 1-49), GIM model from cycle 50 [Iijima et al., 1999]	From dual-frequency altimeter range measurement (cycle 9-64) and GIM model >cycle 65 [Iijima et al., 1999] corrected from 8 mm bias	GIM model [Iijima et al., 1999]
Dry troposphere	Model computed from ECMWF Gaussian grids (new S1 and S2 atmospheric tides are applied)	Model computed fromECMWF rectangular grids (new S1 and S2 atmospheric tides are included)					
Wet troposphere	From JMR/AMR radiometer further than 50 km from the coasts, From ECMWF model for distances between 10 and 50 km		From TMR radiometer [Scharoo et al. 2004]	MWR	Minimisation of brightness temperature drift [Scharoo et al. 2004] before wet tropo. Correction (NN)	From MWR radiometer further than 50 km from the coasts and corrected from side lobes (from cycle 41), From ECMWF model for distances between 10 and 50 km from cycle 65	From GFO radiometer
DAC	MOG2D High Resolution forced with ECMWF pressure and wing fields (S1 and S2 were excluded) + inverse barometer computed from rectangular grids .						
Ocean tide	GOT4v7 (S1 and S2 are included)						
Pole tide	[Wahr, 1985]						
Solid earth tide	Elastic response to tidal potential [Cartwright and Tayler, 1971], [Cartwright and Edden, 1973]						
Loading tide	GOT4v7 (S1 parameter is included)						
Sea state bias	Non parametric SSB [Gaspar et al, 2002] (using J1 cycles 1 to 111 with GDR-B standards)		Non parametric SSB [N. Tran and al. 2010] (using cycles 21 to 131 with GSFC orbit for TP-A; cycles 240 to 350 with GSFC orbit for TP-B)	BM3 [Gaspar and Ogor 1994]	Non parametric SSB [Mertz et al., 2005](using cycles 70 to 80 with DELFT orbit and equivalent of GDR-B standards)	Non parametric SSB [Gaspar et al, 2002] (using cycles 41 to 60 with GDR-B standards)	Non parametric SSB [N. Tran and S. Labroue] (using cycles 130 to 172 with GSFC orbit**)

	Duacs 2010 DT product (v3.0.0)						
	j2	J1; j1n	tp; tpn	e1	e2	en	g2
Orbit error	Global multi-mission crossover minimization (Le Traon and Ogor, 1998)						
Long wave-lengh errors	Optimal Interpolation (Le Traon et al., 1998)						
Intercalibration	Reference from cycle 11	Reference from cycle 11	Reference from cycle 1 to 354				
	Correction of regional bias J2/J1 deduced from intercalibration phase (~cycle 11- J2)	Correction of golbal biais J1/TP déduced from intercalibration phase (~cycles 11-J1)					
Mean profile	Computed with cycles 11-353 TP data and with cycles 11-250 J1 data; referenced [1993,1999]	TP/J1: computed with cycles 11-353 TP data and with cycles 11-250 J1 data; referenced [1993,1999]		Computed with cycles 1-85 E2 data and with cycles 10-72 EN data; referenced [1993,1999]			Computed with cycles 37-187 G2 data ; referenced [1993,1999]
		TPN/J1N: computed with cycles 369-479 TPN data; referenced [1993,1999]					
Period of use	from cycle 9	from cycle 9	cycles 1 to 481	cycles 15 to 43	cycles 1 to 83	from cycle 9	cycles 37 to 222

3. Impact of the 2010 data reprocessing

3.1. Improved validation and reduction of the number of anomalous structures

Special efforts were done to improve editing processing specially in coastal areas. Editing process and parameterization were better fitted to coastal signal characteristics. Specific editing processing was also applied during the geodesic phase of ERS1. This induced a reduction of anomalous structures that could be observed in the previous DT data set. Examples of such structures are presented in Fig. 1 and 2.

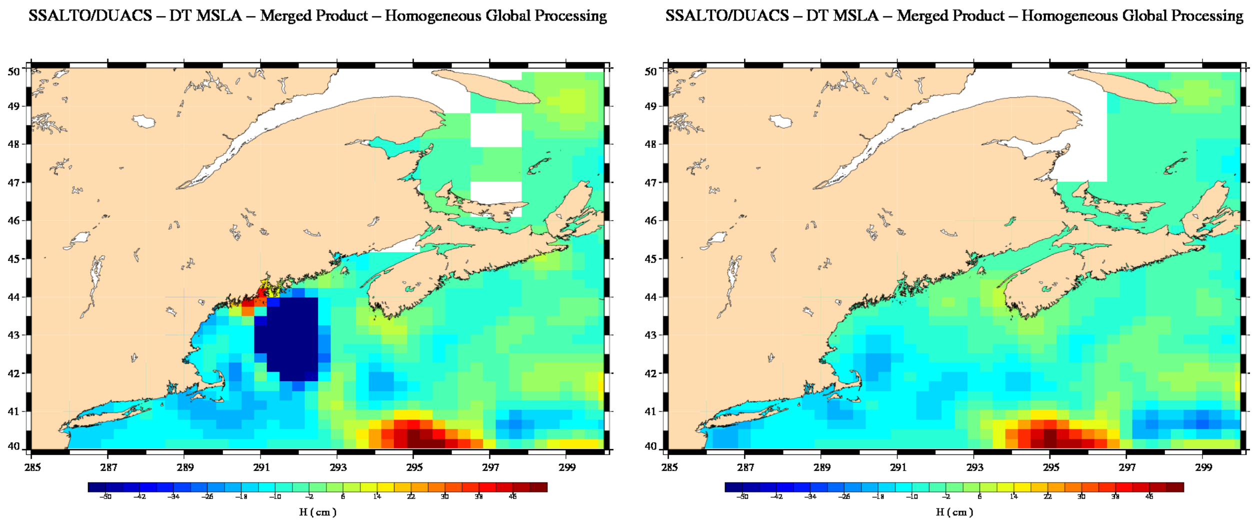

FIG. 1 – *Example of an eroneous structure observed in the MSLA of 8 Feb. 1995 near the US coast in the previous version of the product (left). The onomalie was edited in the reprocessed data set (right) (from ref dataset).*

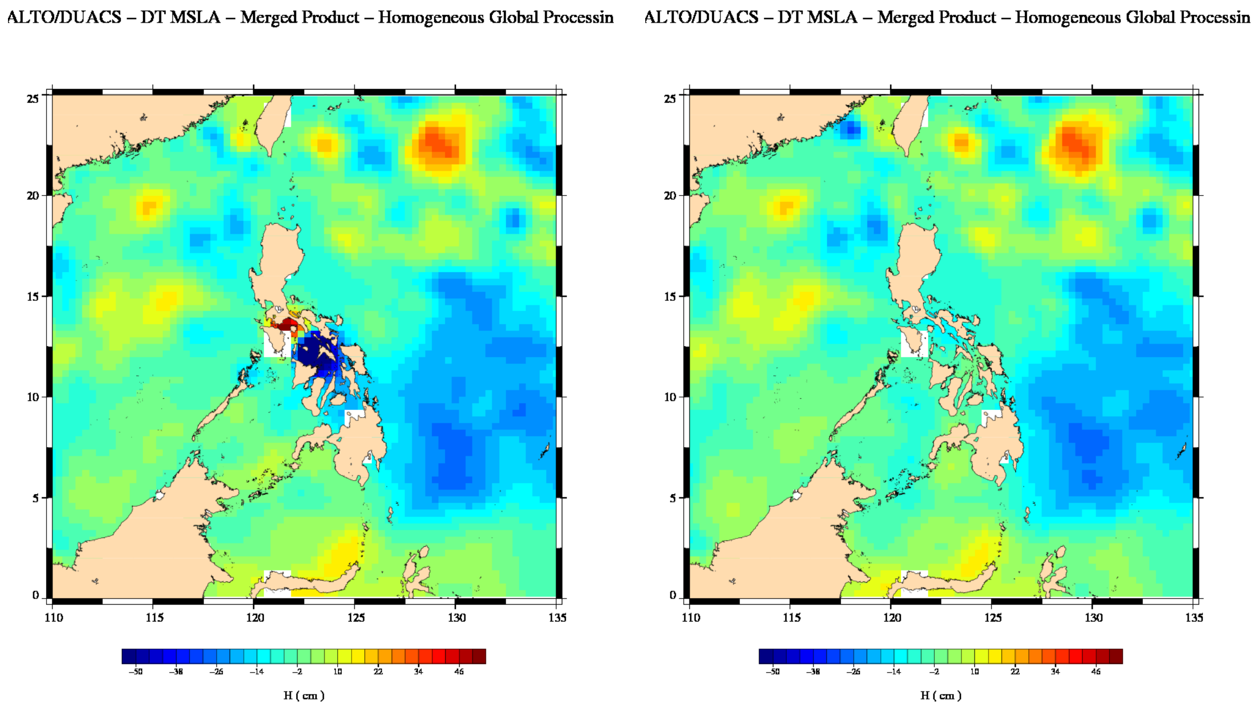

FIG. 2 – *Example of an eroneous structure observed in the MSLA of 12 Mar. 1997 near the Philippian coast in the previous version of the product (left). The onomalie was edited in the reprocessed data set (right) (from ref dataset).*

3.2. New mean profiles and improved data coverage

The reference surface (or mean profiles) used for SLA computation was improved with respect to the previous version, taking advantage of the longer temporal coverage and combining twin missions as ERS2/Envisat or Topex-Poseidon/Jason1.
Improved quality of the mean profiles, combined with higher quality of the altimeter measurement and processing, allowed us to improve the spatial coverage of the data specially in high latitude areas and coastal areas, as illustrated in Fig. 3, 4 and 5.

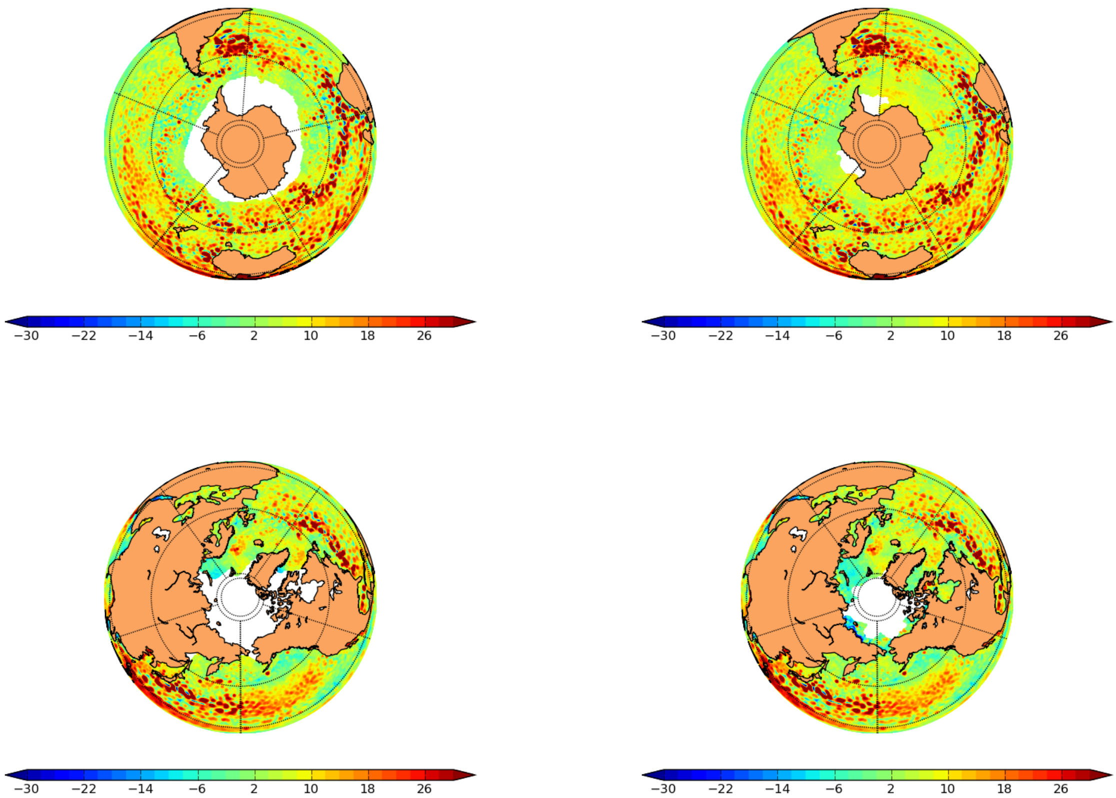

FIG. 3 – *Example of MSLA in the high Latitudes areas. MSLA for day 04/02/2009 in Southern hemisphere and for day 13/08/2008 in Northern hemisphere, obtained with previous version of the product (left) and with reprocessed data set (right)(from upd dataset).*

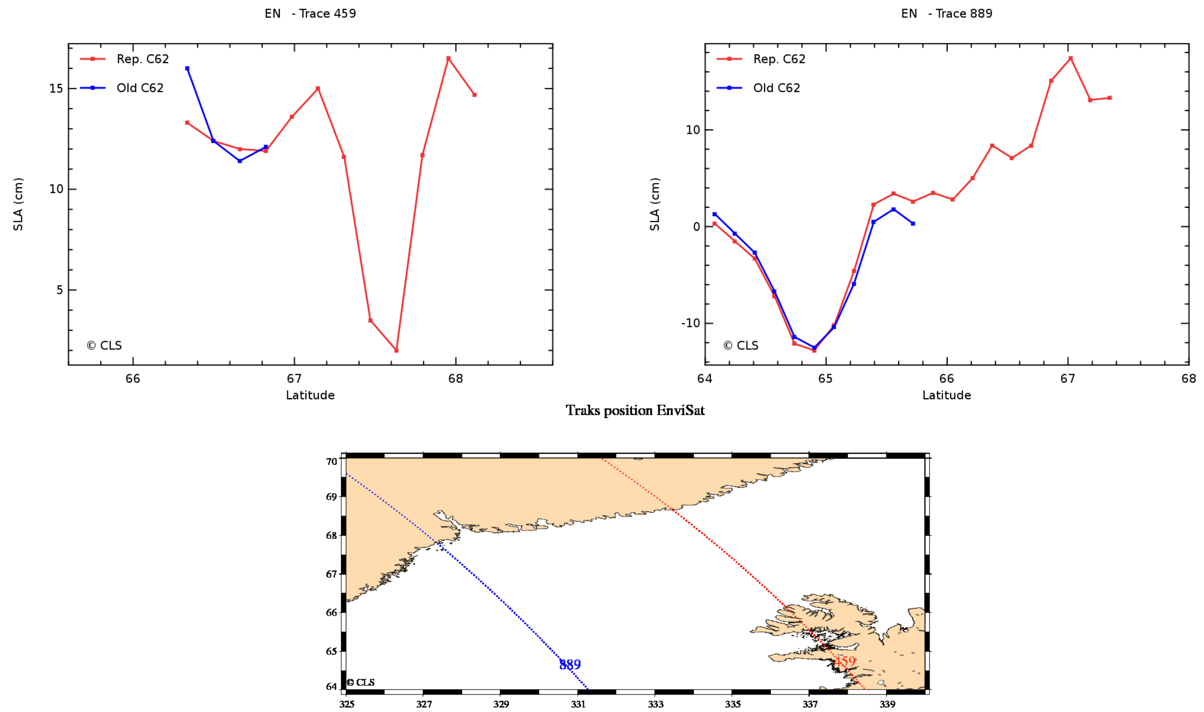

FIG. 4 – *Example of SLA along Envisat tracks 459 and 899 with previous version of the product (blue) and with reprocessed data set (red), for cycle 62 (from upd dataset).*

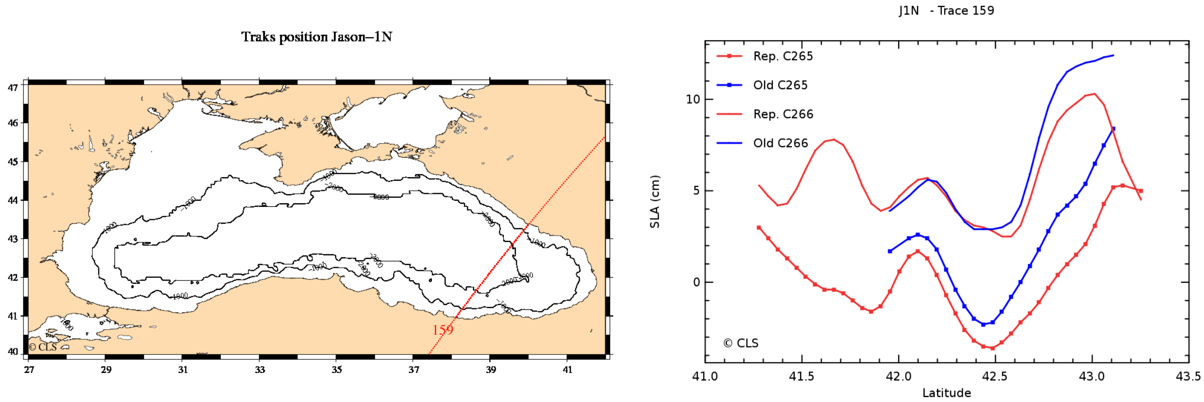

FIG. 5 – *Example of SLA along Jason1-tandem track 159 with previous version of the product (blue) and with reprocessed data set (red), for cycles 265 and 266 (from upd dataset).*

3.3. Improved data correction and impact on the variance of the signal

Environmental and geophysical corrections applied to the signal were improved. This has a direct impact on the signal variance as observed with MSLA products (Fig. 6).

With respect to the previous DUACS DT data set, a global reduction of the variance is observed (2,3cm^2 in the global ocean for the ref data set). This reduction is strongest in the Sumatra/Borneo archipels and North Australian shelves, around the delta of the Amazon and in the North Atlantic European shelves.
At the opposite, an increased variance is observed in high latitudes as observed for example in the North Atlantic, specially around Greenland coast and in Labrador Sea. This increased variance traduces the better observation of the signal as underlined previously (Chap. 3.2.).

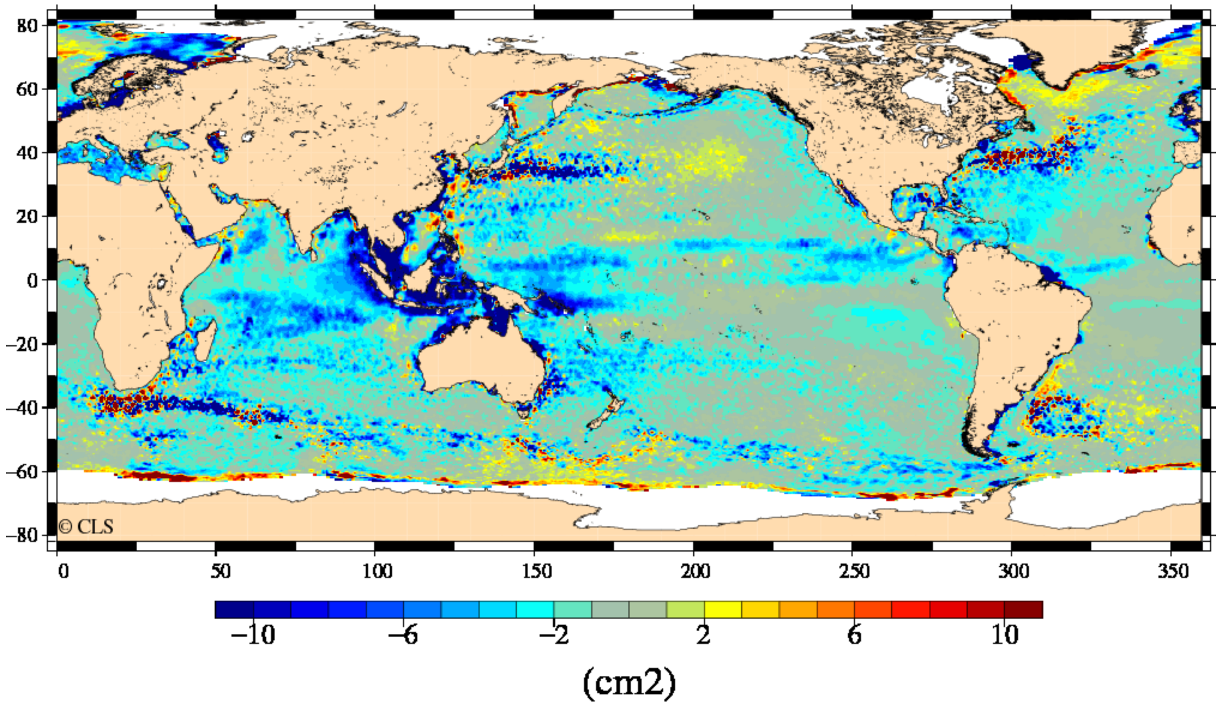

FIG. 6 – *Differences between reprocessed and older data set, of mean MSLA Variance during the period [1993, mid-2009] (from ref dataset).*

3.4. Improved orbits and inter-calibration and impact on mean sea level

Orbits used for the 2010 reprocessing present improved quality with respect to the previous version and offer a better homogenization between the different missions. Inter-calibration of the different missions was also improved using the more recent (more accurate) mission as soon as available.
This has a direct impact on the Mean Sea level trend observed. First, DUACS reprocessed data set allows to follow the sea level trend with the same accuracy than with mono-mission products. Global trend observed with the MSLA is 2.92 mm/year (no GIA correction) (Fig. 7). However,impact on local sea level trend is important with until 2mm/year difference as underlined in Fig 8.

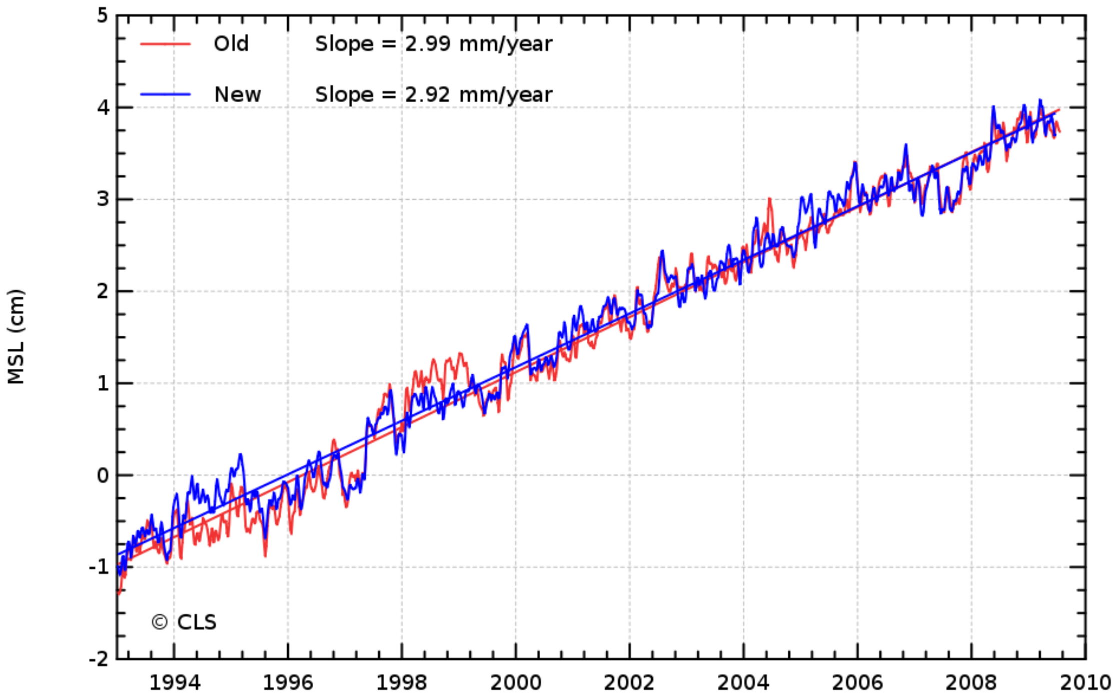

FIG. 7 – *Global Sea Level Trend trend during the period [1993, mid-2009], deduced from reprocessed (red) and older data set (blue) (no GIA correction, seasonal signal removed) (from ref dataset).*

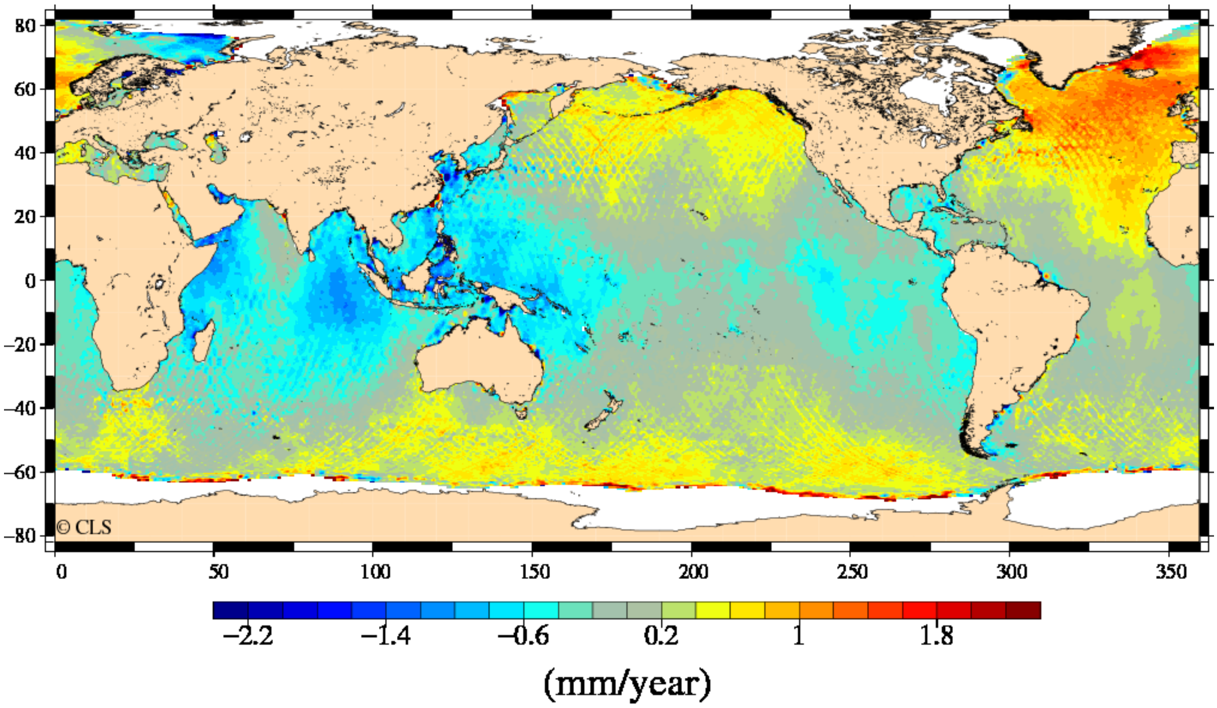

FIG. 8 – *Differences between reprocessed and older data set, of MSLA trend during the period [1993, mid-2009] (from ref dataset).*