DUACS-DT2018 : 25 YEARS OF REPROCESSED ALTIMETRIC PRODUCTS

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ABSTRACT The DUACS system generates, as part as the Copernicus Marine Environment and Monitoring Service (CMEMS), high quality multi-mission altimetry Sea Level products. These products consist in Level 3 (along-track cross-calibrated Sea Level Anomaly SLA) and Level 4 (multiple sensors merged as maps or time series) products and are available in global and regional versions (Mediterranean Sea, Black Sea).

A full reprocessing is carried out and will be made available through the CMEMS. It will cover the entire 1993 – 2017 period and would benefit from major improvements associated with new altimeter correction standards and optimized mapping parameters.

Here, we report the first results of this upcoming multi-mission reprocessing and evaluate associated changes. Several comparisons with independent dataset (along-track, drifters, tide gauges) have been performed.

Processing overview

Detailed information can be found on the CMEMS Sea Level poster from *Faugere et al.* and here:

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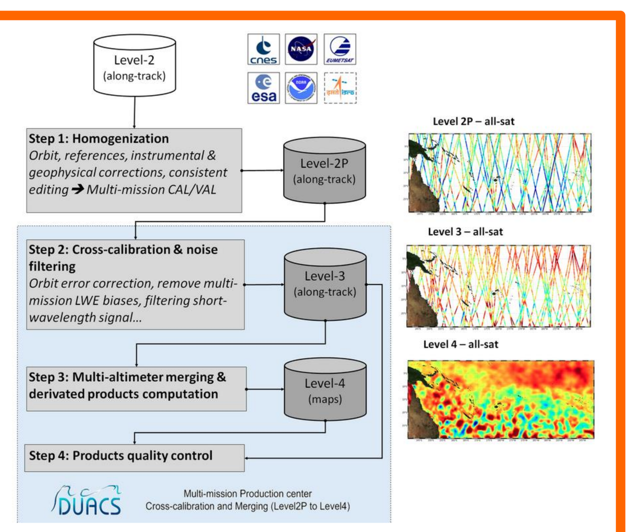
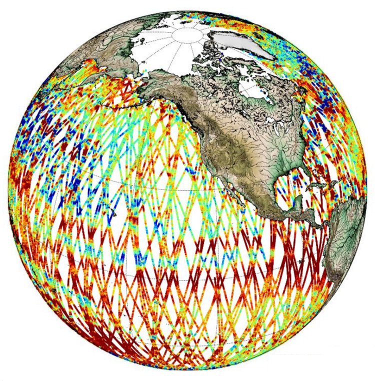


Level2P and Level3 improvement

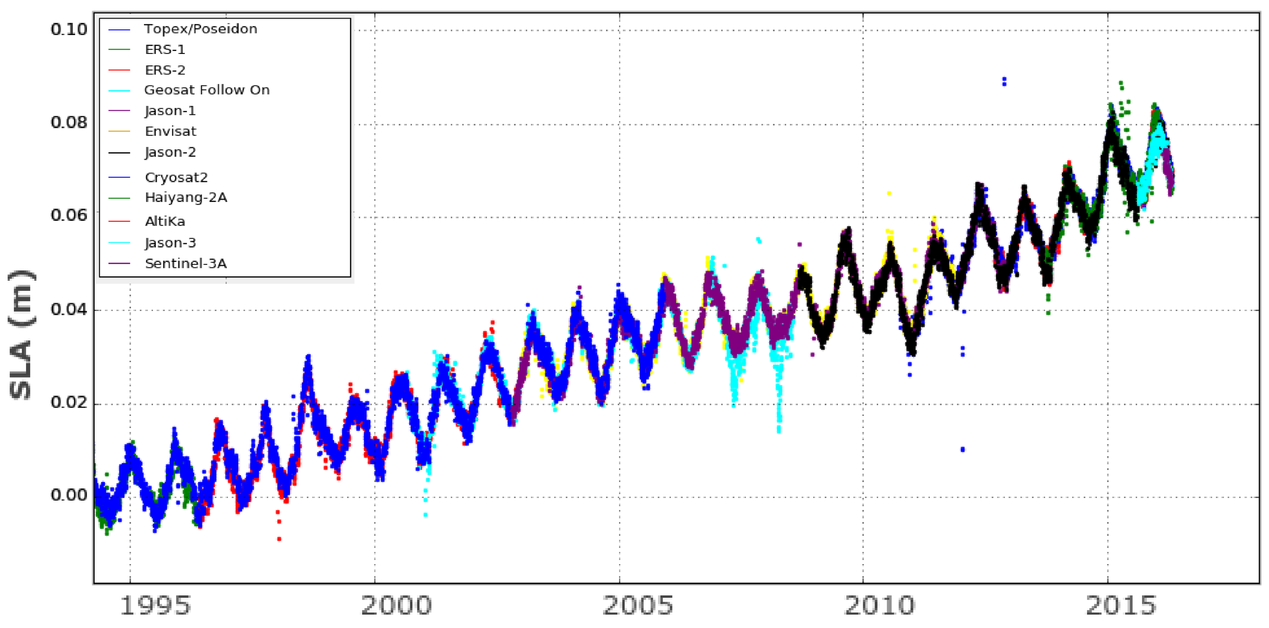


- Use of up-to-date standards. Most important improvement : new MSS (CNES-CLS-2015), new Tide correction (FES2014) and better orbit computation.

NTC L2P	ERS-1	ERS-2	T/P	EN	J1	J2	GFO	C2	AL	H2	J3	S3A
Orbit	Reaper [Rudenko et al., 2012]		GFSC STD15 until c 365,STD12 afterwards	GDR-D	GDR-E	GDR-E	GSFC	GDR-E	GDR-E	GDR-D	GDR-E	GDR-E
Sea State Bias	BM3 (Gaspar, Ogor, 1994)	Non parametric [Mertz et al., 2005] using c 70 to 80 with DELFT orbit and equivalent of GDR-B standards)	Non parametric SSB [N. Tran and al. 2010] (using c 1 to 111 with GDR-C standards and GDR-D orbit)	Non parametric SSB , [Tran, 2015]	SSB issued from GDR-E	Non Parametric SSB [Tran 2012]	Non parametric SSB [Tran et al., 2010]	Non parametric SSB from J1 with unbiased sig0	Non parametric SSB [Tran et al., 2014]	Non parametric SSB from J1	Non Parametric SSB [Tran 2012]	
Ionosphere	Reaper [NIC09 model, Scharroo and smith, 2010]	NIC09 [Scharroo and smith, 2010] (c≤36), GIM [Ijima et al., 1999] (c≥37)	Dual-frequency altimeter range measurements (Topex) [Guibbaud et al., 2015], Doris (Poseidon)	Dual-frequency altimeter range measurement [Guibbaud et al., 2015] (6≤c≤64)/GIM [Ijima et al., 1999] Corrected for 8mm bias (c≥65)	Dual-frequency altimeter range measurement [Guibbaud et al., 2015]	Dual-frequency altimeter range measurement [Guibbaud et al., 2015] Recomputed after SSB C-band update	GIM [Ijima et al., 1999]		GIM [Ijima et al., 1999]		Filtered dual-frequency altimeter range measurements [Guibbaud et al., 2015]	
Wet troposphere	GNSS derived Path Delay [Fernandes et al., 2015]			Obligis et al., 2009	JMR issued from GDR-E	Neural Network correction (3 entries), Fréry et al. In preparation	From GFO radiometer	From ECMWF model	Neural Network correction (5 entries) Picard et al., In preparation	From ECMWF model	From J3-AMR radiometer	From S3A-AMR radiometer
Dry troposphere	Model based on ERA-INTERIM		Model based on ERA-INTERIM	Model based on ECMWF Gaussian grids	Model based on ECMWF rectangular grids	Model based on ECMWF Gaussian grids	Model based on ECMWF rectangular grids	Model based on ECMWF Gaussian grids	Model based on ECMWF Gaussian grids	Model based on ECMWF Gaussian grids	Model based on ECMWF Gaussian grids	
Combined atmospheric correction	MOG2D High frequencies forced with analysed ERA-INTERIM pressure and wind field + inverse barometer Low frequencies			MOG2D High frequencies forced with analysed ECMWF pressure and wind field [Carrere and Lyard, 2003; operational version used, current version is 3.2.0] + inverse barometer Low frequencies					MOG2D High frequencies forced with analysed ECMWF pressure and wind field [Carrere and Lyard, 2003; operational version used, current version is 3.2.0] + inverse barometer Low frequencies		MOG2D High frequencies forced with analysed ECMWF pressure and wind field [Carrere and Lyard, 2003; operational version used, current version is 3.2.0] + inverse barometer Low frequencies	
Ocean tide	FES2014 [Carrère et al., 2015]											
Solid Earth tide	Elastic response to tidal potential [Cartwright and Tayler, 1971], [Cartwright and Edden, 1973]											
Pole tide	[DESAI, 2015]											
MSS	CNES-CLS-2015											

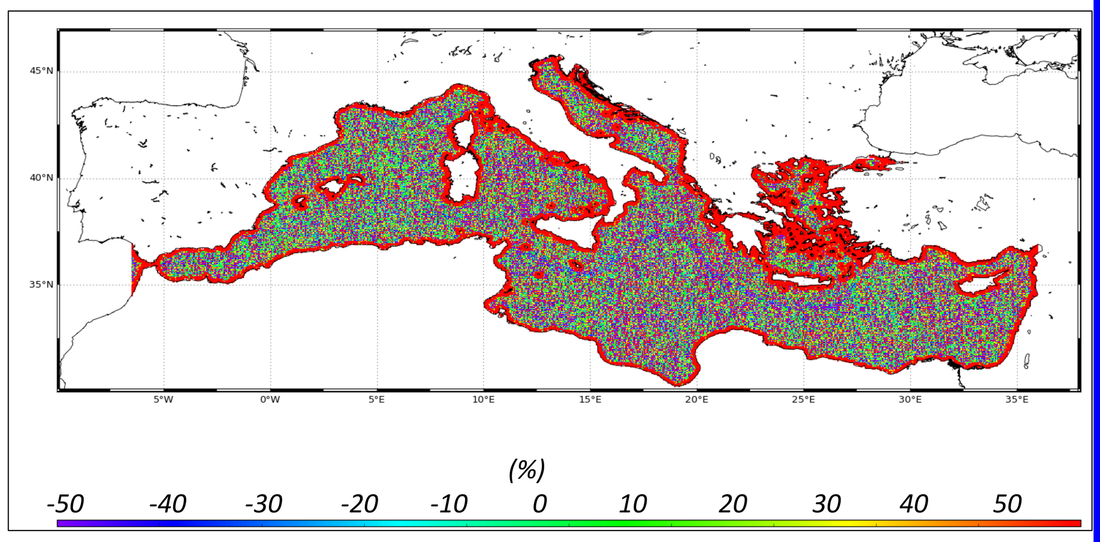
Standards of the different corrections applied on altimetric measurements for the DT-2018 processing. The green cells indicate a change with the previous version DT-2014.

- SLA was arbitrarily calibrated so that mean SLA is null over 1993. All missions are homogenized to ensure the continuity and consistency between all altimeter missions (e.g. global and regional mean sea level).



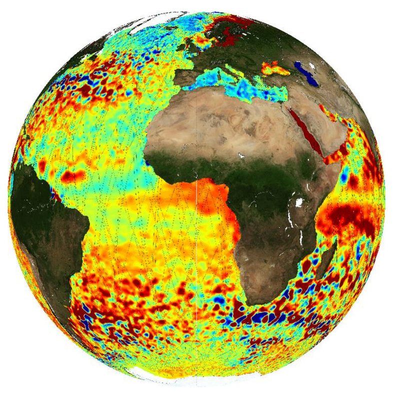
Mean daily SLA (m) for the full reprocessing and for all missions between 1992 and 2017. Computed from L3 daily raw datasets.

- For repetitive orbits, cross-tracks gradients are improved using reference Mean profile updated in order to take into account the new standards and to improve the quality near the coast. For geodetic missions, many points has been gained along the coast by using a more accurate MSS.



Percentage of Along-Track SLA data in the DT-2018 product which were not taken into account in the old version DT-2014. Only geodetic missions are taken into account

Level 4 improvements : from global to mesoscale



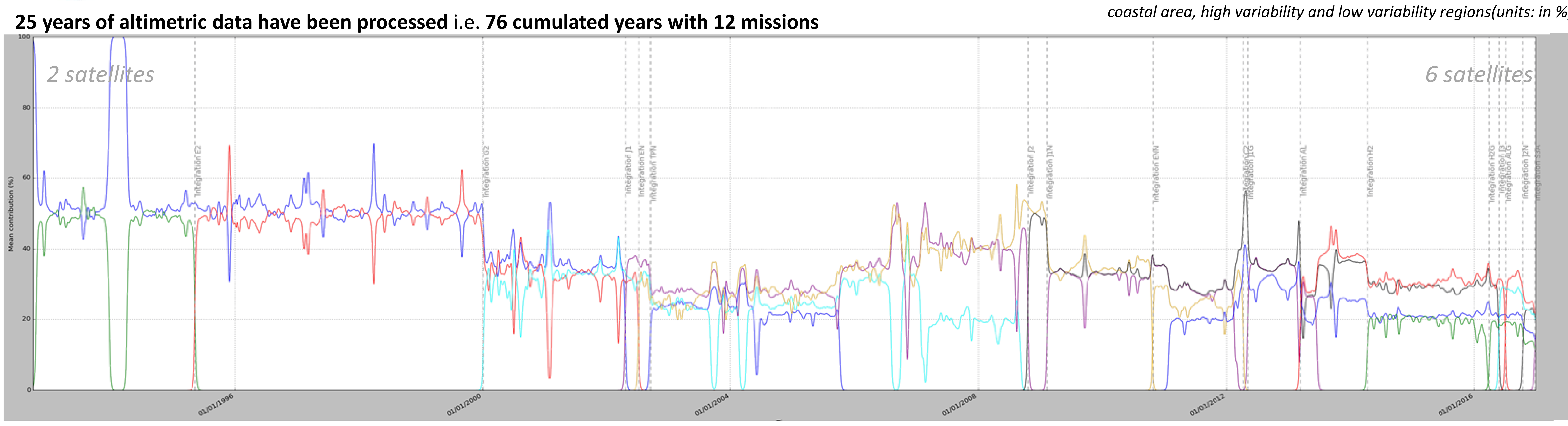
Improvements come from :
New mapping parameters: Optimized spatio-temporal selection of the observations, better a-priori knowledge of the signal variance based on 20 years of altimetry data, tuned correlation scale …

Improvements quantification offshore and on coastal areas

Offshore (> 200km)	Coastal area (<200km)
-3.9%	-7.0%

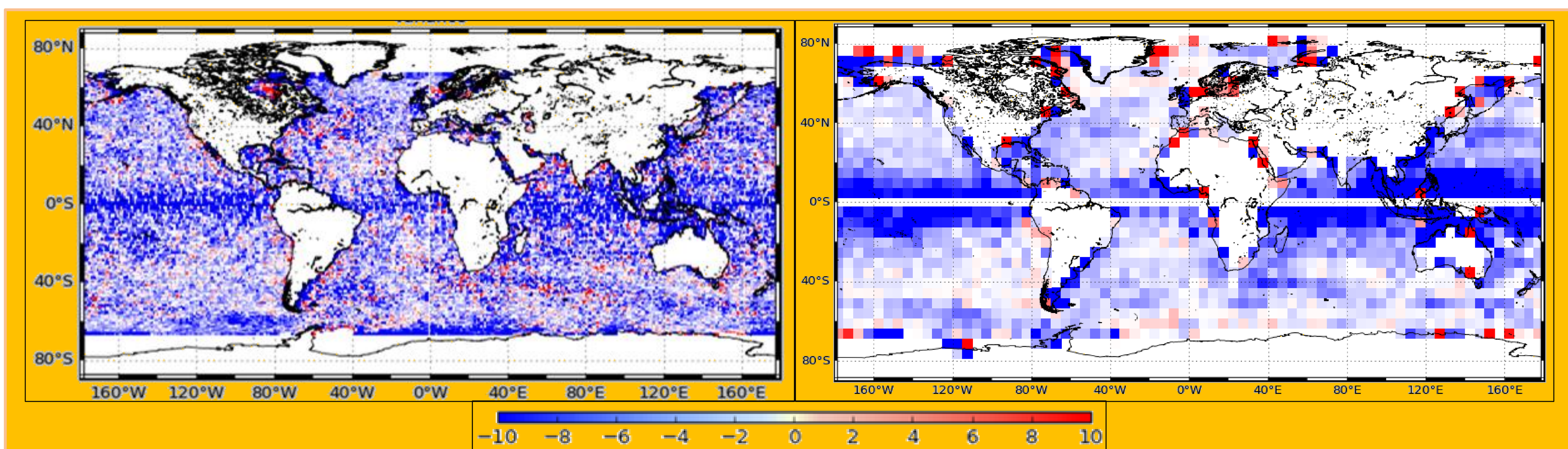
*Tab.: **Summary reduction of variance** betmeen maps and independent along-track by region: coastal area, high variability and low variability regions(units: in %)*

25 years of altimetric data have been processed i.e. **76 cumulated years with 12 missions**



***Relative contribution** of each altimeter in the multi-mission all-sat-merged SLA maps for 1992-2017. The contribution is derived from the degrees of freedom of signal (Unit: %)*

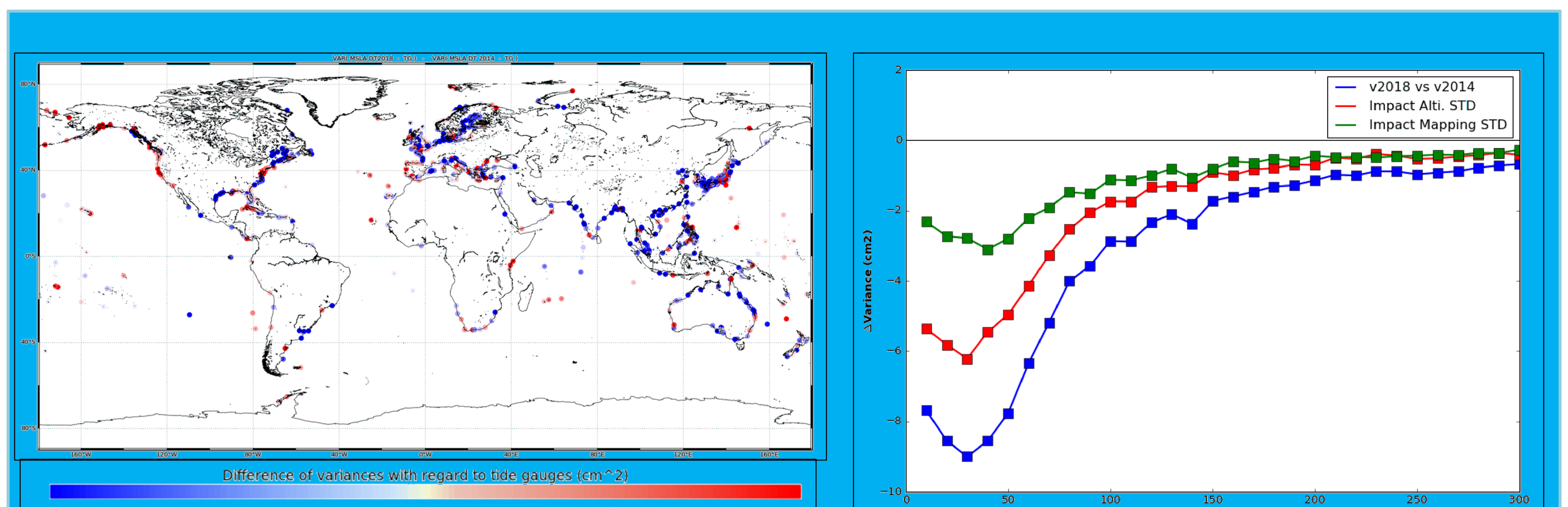
Improvements have been measured using independants datasets:



A) Independent along-track

B) Drifters

*Fig.: **Illustration of the improvement (in blue) / deterioration (in red) DT2018 vs DT2014. A)** Reduction of variance between SLA maps and independent TPN along-tracks (units: in %) **B)** Reduction of variance between geostrophic velocities derived from DT2018 maps and independent drifters data (only the zonal component is displayed, units: in %)*



C) Tide gauges

D) Independent along-track

*Fig.: **Illustration coastal improvement (in blue) / deterioration (in red) DT2018 vs DT2014. C)** Reduction of variance between SLA maps and independant tide gauges (units: in cm²). **D)** Reduction of variance between maps and independent C2 along-tracks as a function of the coastal distance (units: in cm²)*

Conclusions & perspectives

First results are very promising :

- DT2018 products benefit of large scale and meso-scale improvement compared with DT2014
- Largest improvements are found in coastal regions and are mainly associated with new altimetry standards. Offshore improvements are mainly linked to the new mapping parameters.

Perspectives:

- The time series will be extended until mid 2017
- More S3A data will be available : New data (version 02.00) will be included in 2016 and 2017 !

An additional accurate and homogeneous altimeter gridded sea level product based on a stable two-satellite merged constellation will be also distributed in the frame of the Copernicus Climate Service (C3S).

Available in March 2018 in the Copernicus Marine Service (CMEMS) catalogue