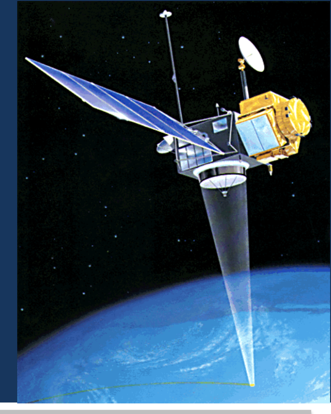
Assessment of the last TOPEX sideB reprocessing



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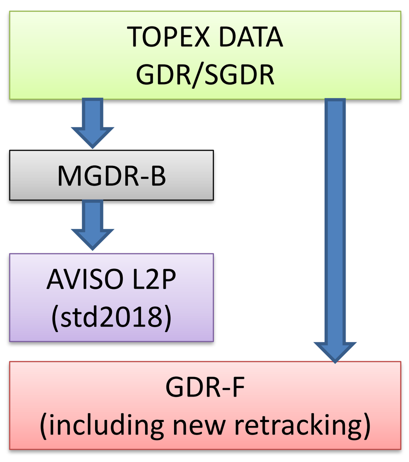
The reference Mean Sea Level (MSL) record strongly relies on four missions: TOPEX/Poseidon and its successors Jason-1, Jason-2 and Jason-3 on the same historical orbit. The global trend uncertainty has been estimated close to 0.5 mm/yr (Ablain et al., 2015) over the whole altimetry period (1993-2013). However, this uncertainty rises (0.8 mm/yr) only considering the TOPEX period (1993-2002) (Ablain et al., 2013). In order to better understand TOPEX errors, JPL and CNES have been working together for several years in order to provide a reprocessed TOPEX altimeter dataset for users.
The TOPEX/Poseidon mission was the first precise altimeter mission specially designed for studying the circulation of the world's oceans. The TOPEX/Poseidon mission furnished altimetry data for 13 years (1992 – 2005). Equipped with a redundant main altimeter (TOPEX) and an experimental altimeter (Poseidon-1, which was operated roughly one cycle in ten), altimeter data were first furnished by the TOPEX-sideA instrument. Nevertheless changes in the sideA Point Target Response (PTR) degraded (from mid-1996 onwards) progressively the altimeter measurements [Hayne and Hancock, 1998]. The main impacts were an increase of Significant Wave Height (SWH), an increase of range rms, and an error on range estimate. Sea State Bias (SSB) was also impacted at it is based on SWH. In February 1999, TOPEX side-A was turned off and TOPEX side-B was turned on.

In order to correct for this PTR drift of TOPEX-A a retracking of the data is necessary. Several retracking releases have been computed over the last years, those analysis have been presented in previous OSTST sessions. For the last two years, CNES and NASA have worked on the reprocessing of the new TOPEX release of Geophysical Data Records. The latest retracking release include results from MLE4 and MLE3 methods. In addition, this new version of reprocessed dataset will include the best geophysical corrections available during this period (provided by CNES in 2018).
In this study, we propose to analyze the impact of this new TOPEX retracking over sideB at a first step. Therefore parameters from the retracking (range, SWH) or based on retracked parameters (SSB) are compared with previous data version. The reference parameters are non retracked data used in CMEMS2018 products (which are based on MGDR-B products concerning altimeter parameters) and updated geophysical and orbit standards. The new solutions are also compared with Jason-1 data. Furthermore mesoscale performances (SSH differences at crossovers) and global mean sea level are also computed and compared to CMEMS2018 standards.

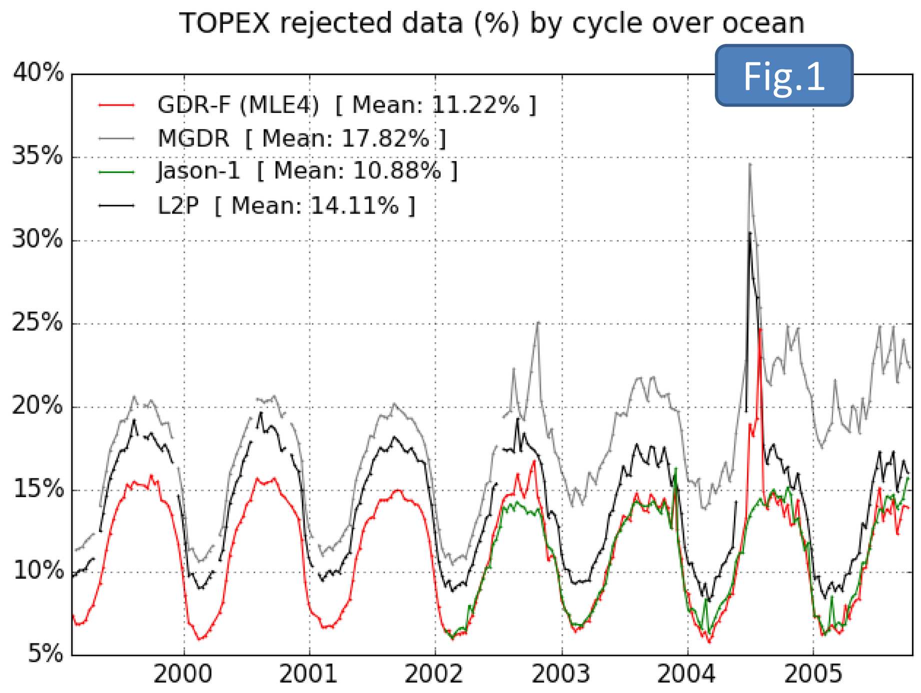
Evolution of TOPEX SSHA standards:

	TOPEX(MGDR-B)	L2P (MGDR-B + updates (standards 2018))	TOPEX (GDR-F)
Orbit	MGDR-B	GSFCstd12/std15	GSFC(dpod2014v04) (ITRF14)
Range	MGDR-B	MGDR-B	MLE4 (ground retracking)
MSS	2001	CNES/CLS 2015	Sol1 = CNES/CLS 2015
Wet Tropo	Rad MGDR-B	GPD+	Radiometer (End of mission calibration)
Dry Tropo	ECMWF OPE	ERA Interim	ERA Interim
Pole Tide	WAHR85	DESAI2015/ mpl2015	DESAI2015/mpl2017
Solid Earth Tide	Cartwright and Edden [1973]	Cartwright and Edden [1973]	Cartwright and Edden [1973]
Ocean Tide	GOT00	FES14A	sol1=GOT4.10 / sol2 = FES14B
InternalTide	N/A	N/A	ZARON (M2,K1,S2,O1)
IB/DAC	Static IB relative to constant pressure.	ERA Interim	ERA Interim with time varying global mean sea level pressure.
SSB	MGDR-B (Parametric, Gaspar)	NonParametric Tran2010	Non parametric (fit to MLE3 and MLE4 retracked data, Vanedmark and Fend, 2019)
IONOPHERIC correction	Dual Frequency	Filtered solution	MLE4



REJECTED DATA

Fig.1



Thanks to L2P updates, AVISO L2P products (std2018) had a lower rate of rejected measurements than MGDR-B (mainly due to improvements in TMR dataset).

The last MLE4 retracking in GDR-F allows to improve the quality of the measurements and lead to an equivalent to Jason-1 rate of rejected data.

SWH

External comparisons : Jason-1 (tandem phase with J1 from TOPEX cycle 344 to 364) and ERA5 model

During tandem phase, TOPEX and Jason-1 are flying seperated by only 1'10'', so that point to point SWH differences can be done

BEFORE

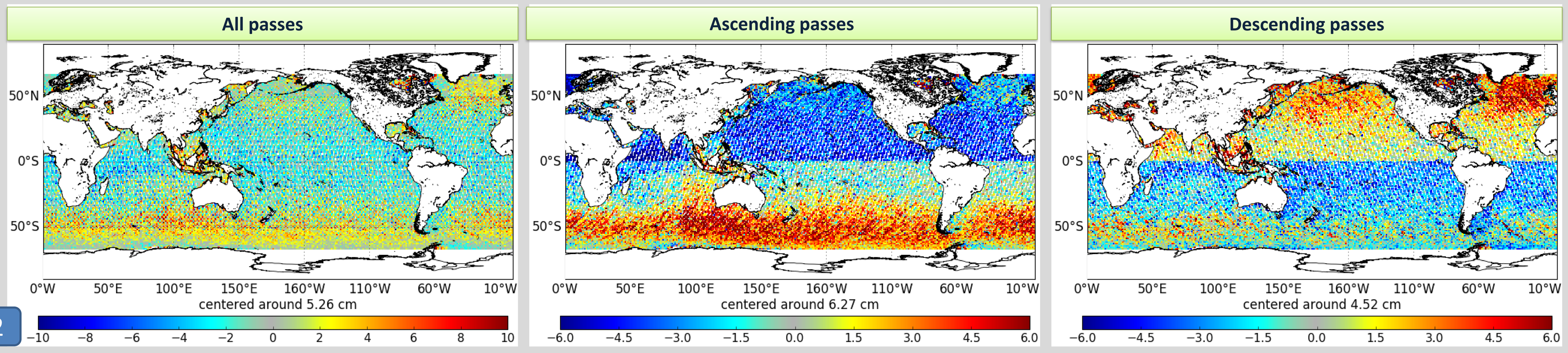


Fig.2

AFTER

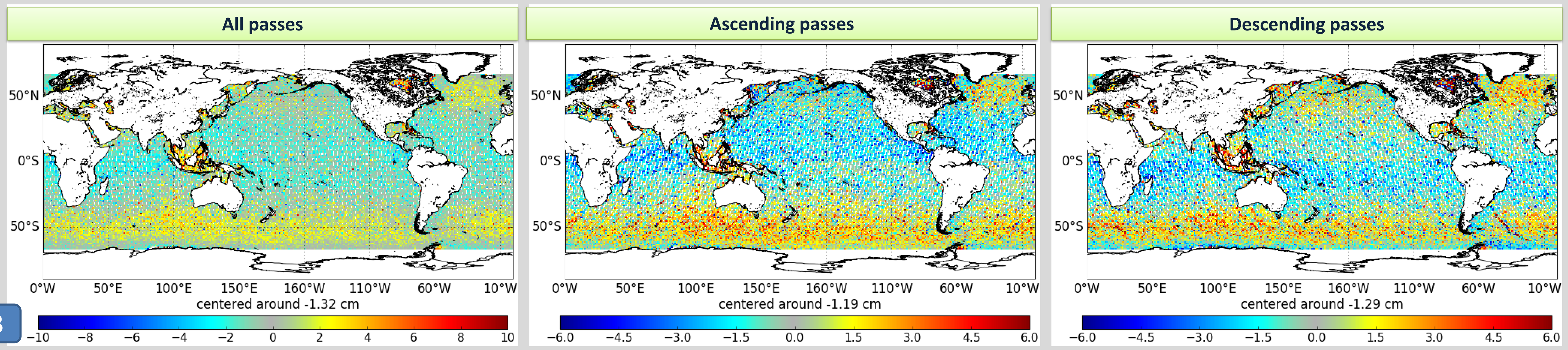


Fig.3

Compared to Jason-1 data during tandem phase, hemispheric biases are significantly reduced between ascending and descending passes. Using the MGDR-B dataset, north / south biases appear against a selection on ascending or descending passes . Ascending and descending passes signatures are more coherent with retracked data than using MGDR-B dataset.

Altimeter SWH are closer to ERA5 model than for MGDR-B. TOPEX and Jason-1 altimeter swh measurements variations to model are coherent. .

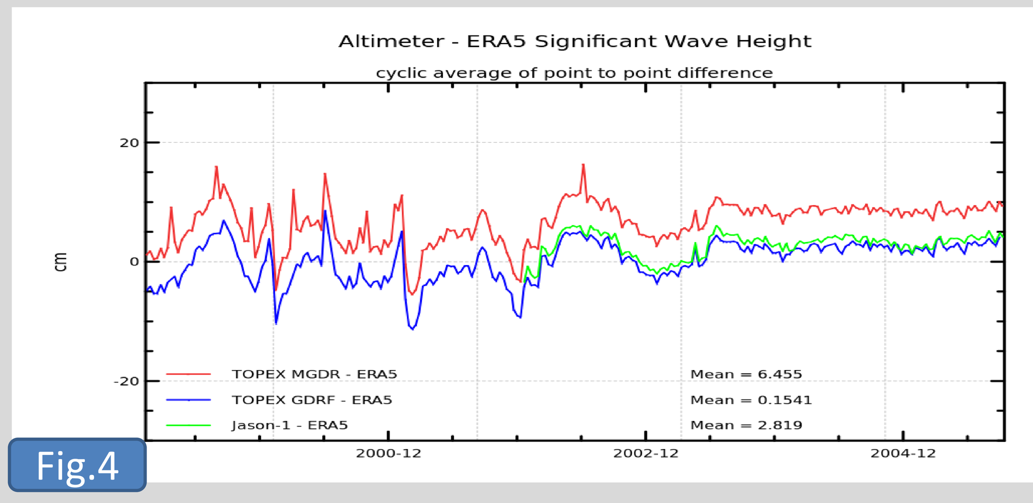


Fig.4

RANGE

External comparisons : tandem phase with J1 from TOPEX cycle 344 to 364

BEFORE

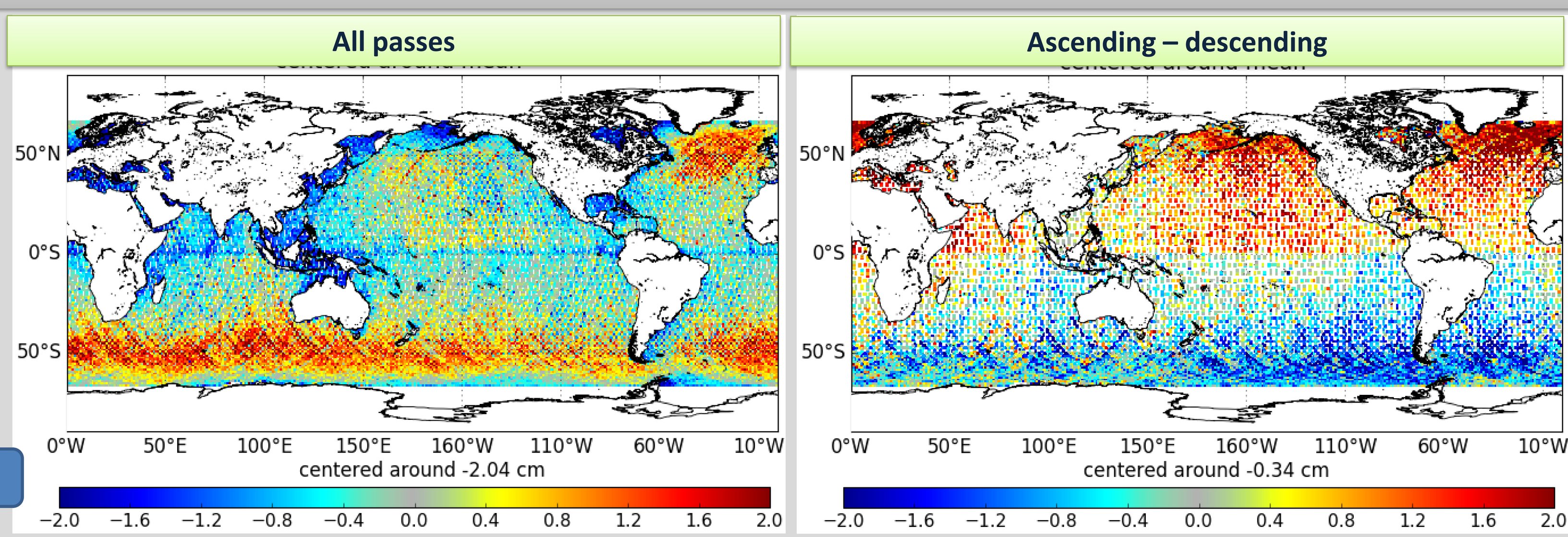


Fig.5

AFTER

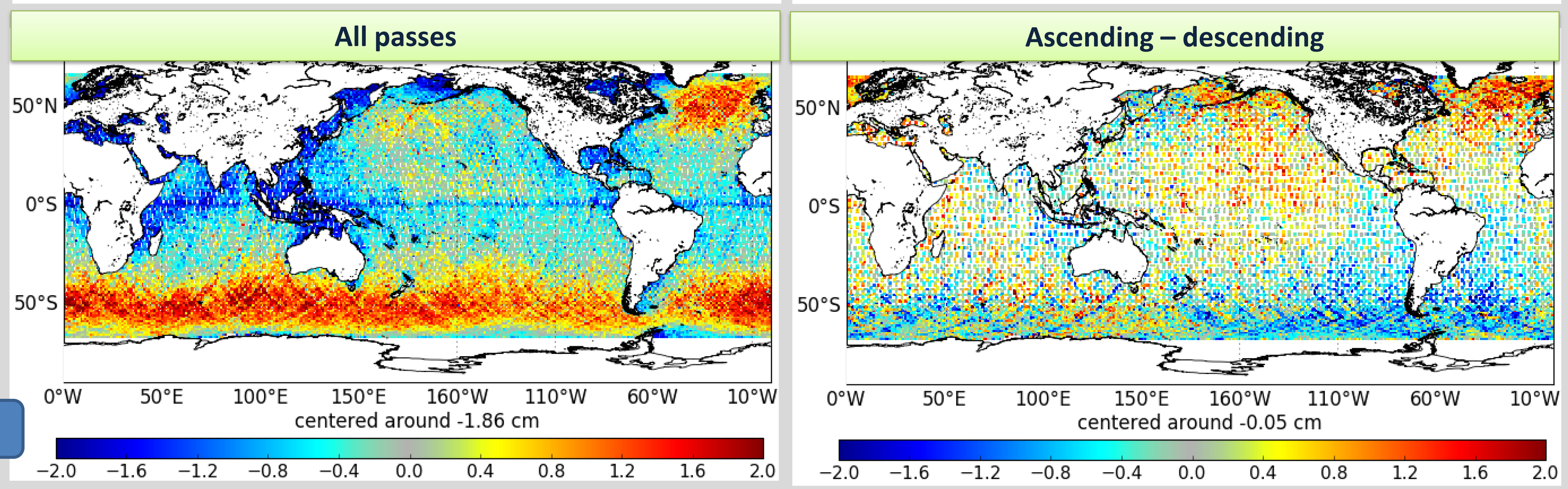


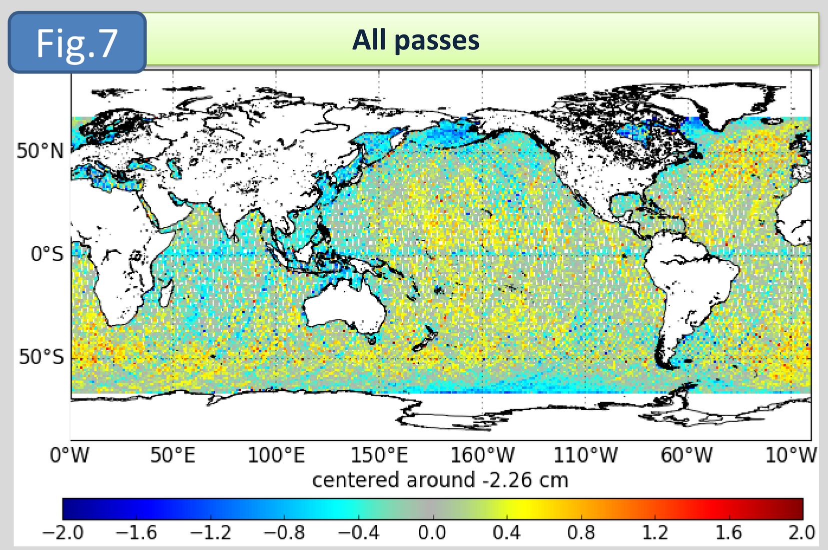
Fig.6

During tandem phase, TOPEX and Jason-1 are flying separated by only 1'10'', so that point to point uncorrected SLA differences can be done (Orbit – Range – MSS)

Using the MGDR-B dataset, north / south biases appear against a selection on ascending or descending passes . These ascending/descending signatures are more coherent with the last dataset than using MGDR-B dataset. The global bias between ascending and descending selection is also reduced by 3mm. Remaining geographically correlated patterns could be attributed to orbit signatures due to differences between the two missions' solutions.

Orbit – range –SSB - MSS

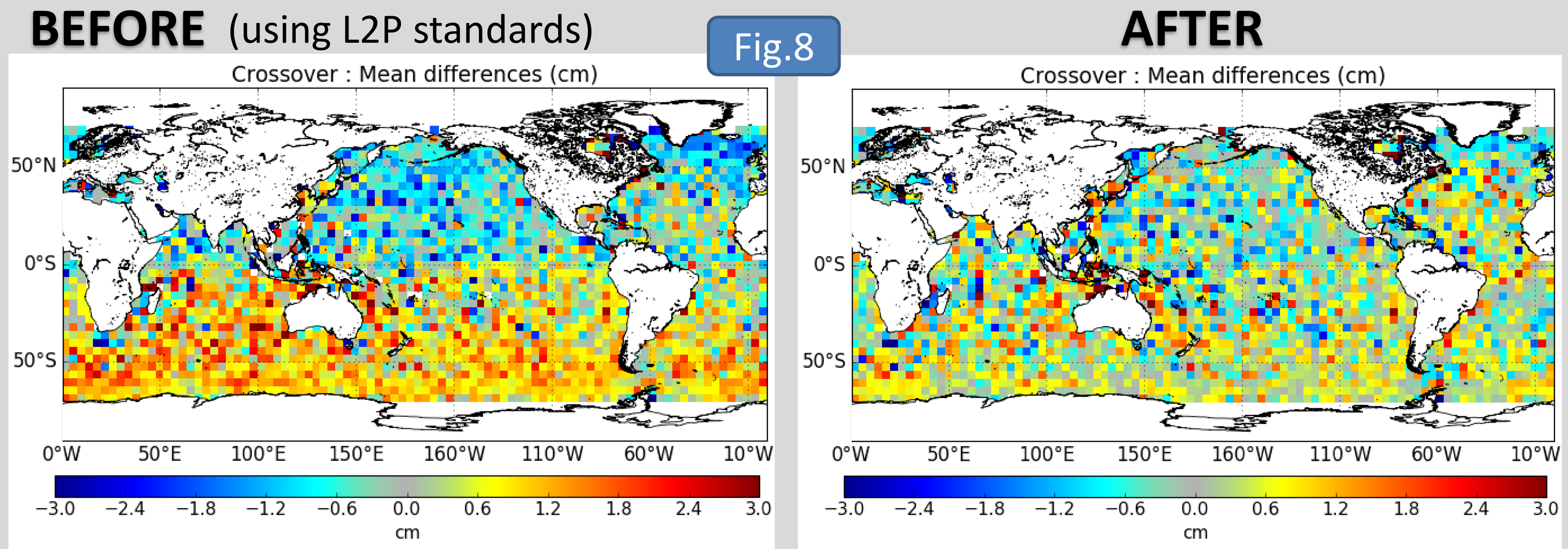
Fig.7



The global analysis of the uncorrected SLA differences between TOPEX and Jason-1 - taking into account all passes - shows a correlation with sea state:
→ Due to differences in retracking methods, SSB differences between TOPEX and Jason-1 are visible [Fig.6: left].
These patterns disappear by taking into account dedicated SSB for both missions [Fig.7].

Performances at crossovers (computed over cycles 344 to 364)

BEFORE (using L2P standards) Fig.8 **AFTER**



Ascending/descending SSH (Sea Surface Height) differences are computed at crossover points for time differences less than 10 days between ascending and descending tracks. This allows us to minimize the contribution of the oceanic variability (mesoscale). A North/South bias was visible using old GDR data, no longer using GDR-F. In addition, mean of SSH differences at crossovers is reduced from 0.31cm with MGDR-B to 0.11cm using GDR-F dataset. Finally, error deduced from crossover analysis is reduced from 3.73cm to 3.5cm (equivalent to Jason-1).

Conclusions

Thanks to the last reprocessing of TOPEX data, range and swh measurements are closer to Jason-1 over the TOPEX/Jason-1 tandem phase. Global and hemispheric biases between the two missions are significantly reduced.

Mean of Sea Surface Height differences at TOPEX crossover points also shows better results, with reduction of hemispheric geographically correlated patterns.

Following these good results on TOPEX SideB reprocessing, TOPEX sideA reprocessing analysis will come soon.

See also :
M. Talpe presentation in *CAL/VAL* session "Global Calibration and Validation of Reprocessed TOPEX Data"
J-D. Desjonqueres presentation in *Instrument Processing session* "TOPEX Data Reprocessing using a Numerical Retracking Approach"

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