SSS variability inferred from recent SMOS reprocessing at CATDS

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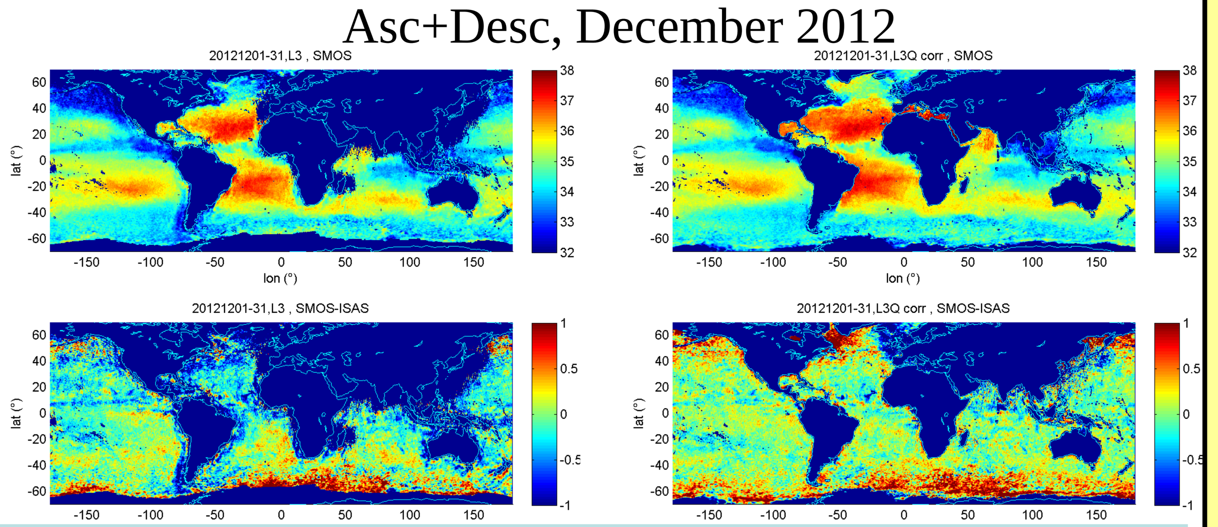
L3P (RE05) L3Q (RE05 corrected)

Asc+Desc, December 2012

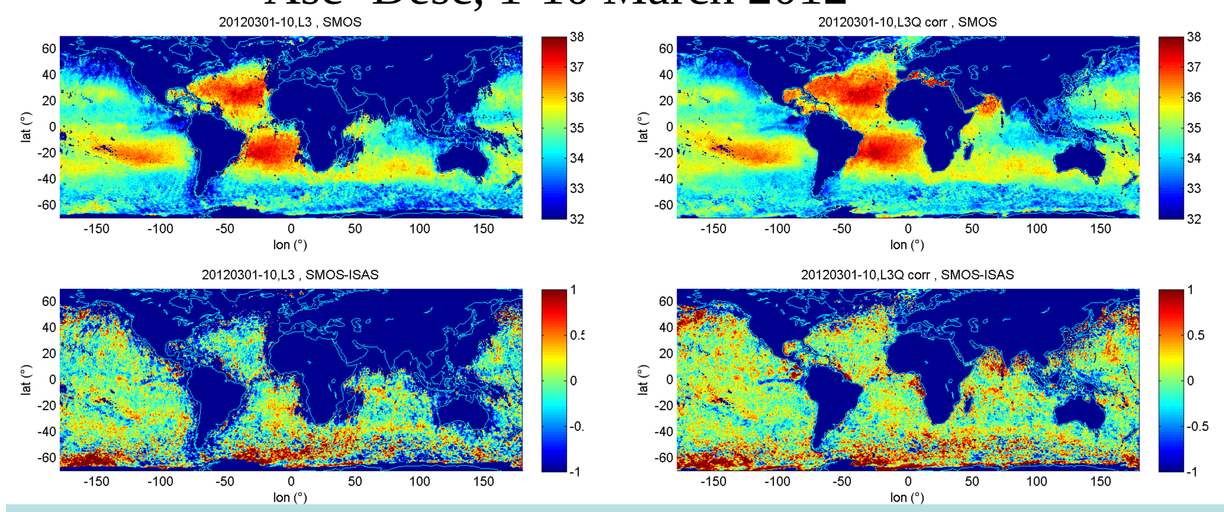


Top: SMOS CATDS level 3 SSS before (left) and after (right) correction. Bottom: Difference with respect to ISAS SSS – Monthly product

The Soil Moisture and Ocean Salinity (SMOS) mission monitors Sea Surface Salinity (SSS) from space since January 2010. This European Space Agency (ESA) Earth Explorer mission provided the first L-band radiometric observations of the Earth using interferometry. SMOS has demonstrated the feasibility of monitoring SSS and its variability from space with a precision of 0.15-0.3 (in regions free from radio frequency interferences (RFI) and more than 1000km away from coasts). Some corrections however still need refinement such as the contamination by the land-sea emissivity gradient, the sun etc… (Boutin et al. 2016 and references herein). A new reprocessing (RE05) and new systematic error corrections have been performed at Centre Aval de Traitement des Données SMOS (CATDS). A particular attention has been put on preserving SSS natural variability in coastal areas, which was not well resolved by previous versions (CEC LOCEAN debias v0 and v1).This allows to much better detect fresh SSS in coastal areas. Systematic errors are reduced by more than 1 locally. The rms difference between the SMOS and Argo-derived SSS field (ISAS products; Gaillard et al. 2016) is reduced by more than 0.1 within 800km of the coast globally. The validation is however challenging due to the high natural SSS variability in coastal areas. We present comparisons with SSS derived from SMAP (Soil Moisture Active/Passive), Argo floats interpolation, ships of opportunity, drifters and TAO moorings.

L3P (RE05) L3Q (RE05 corrected)

Asc+Desc, 1-10 March 2012



Top: SMOS CATDS level 3 SSS before (left) and after (right) correction. Bottom: Difference with respect to ISAS SSS – Decadal product

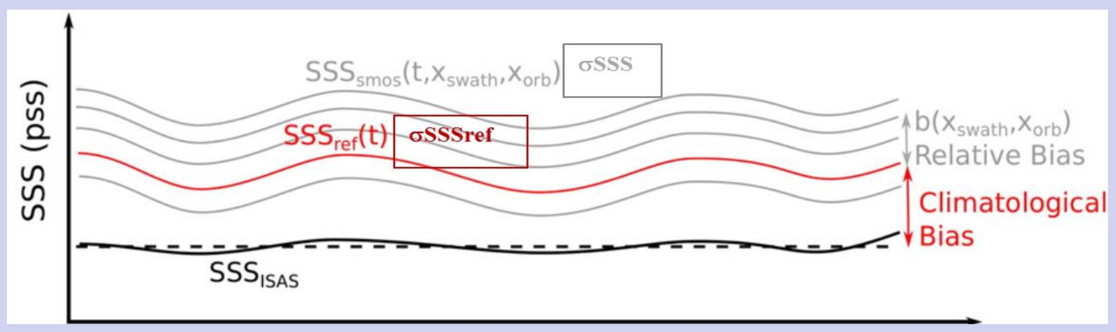
REPROCESSING RE05:

-Same direct models & retrieval scheme as in ESA level 2 ocean salinity (L2OS) version 622 and in CATDS RE04.

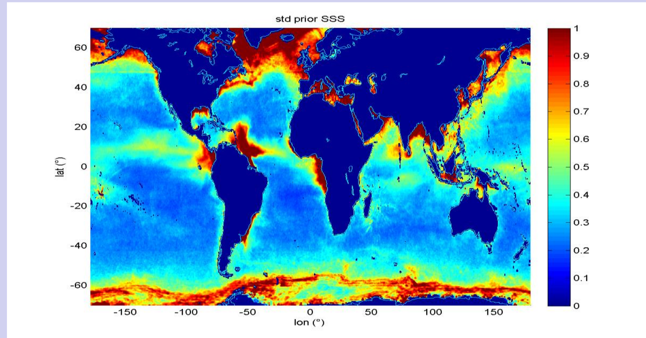
-Main RFIs disturbances sorted out with a stronger filtering at Tb level (3xradiometric noise).

-Systematic errors estimated as a function of the pixel swath location, using the self-consistency of low frequency variations of SMOS SSS (Kolodziejczyk et al. 2016) over 7 years (2010-2016). With respect to earlier versions, we introduce a dependency of σSSSref with SSS natural variability, and of σSSS with the Chi2 quality indicator.(see below).

- We also introduce a North-South seasonal systematic error correction estimated in the Pacific Ocean.

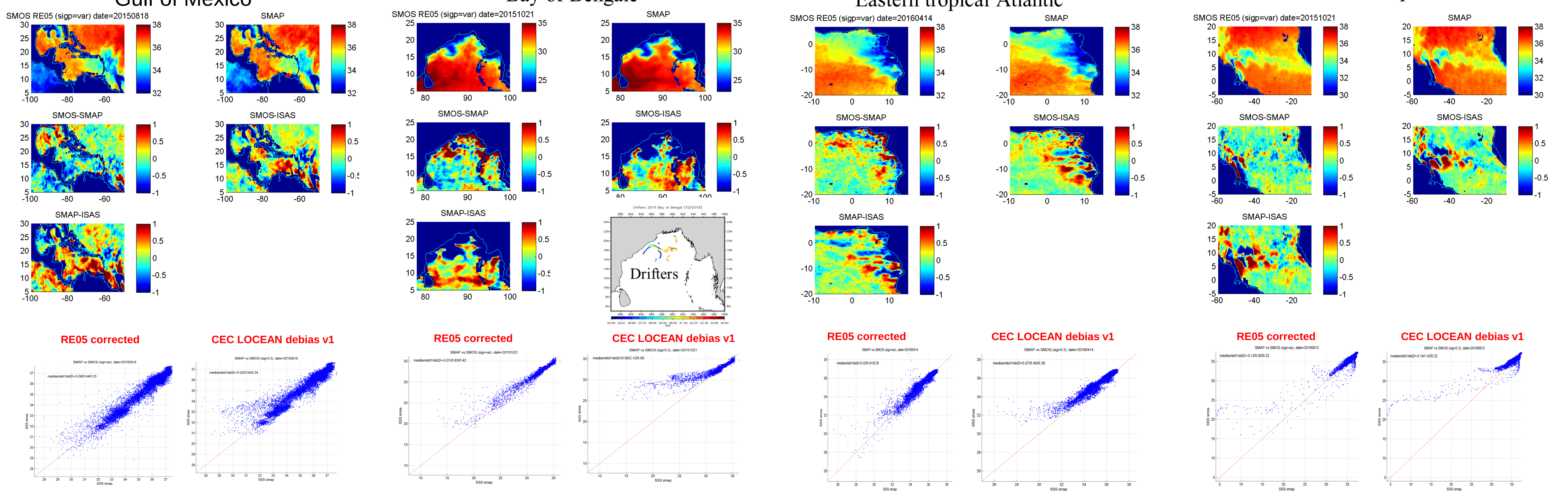


Scheme describing the principle of the self-consistent correction method: for each pixel and each distance to the reference dwell line, the systematic error is estimated by imposing similar low frequency variation of SMOS SSS, within the natural variability (see right figure) and given the theoretical error on the SMOS SSS (σSSS).



SSS variability derived from 7 years of SMOS filtered and corrected SSS (after debiasing and filtering): large values are observed in river plumes and in rainy areas (ITCZ, SPCZ). At high latitudes, contamination by ice and RFI remain to be corrected.

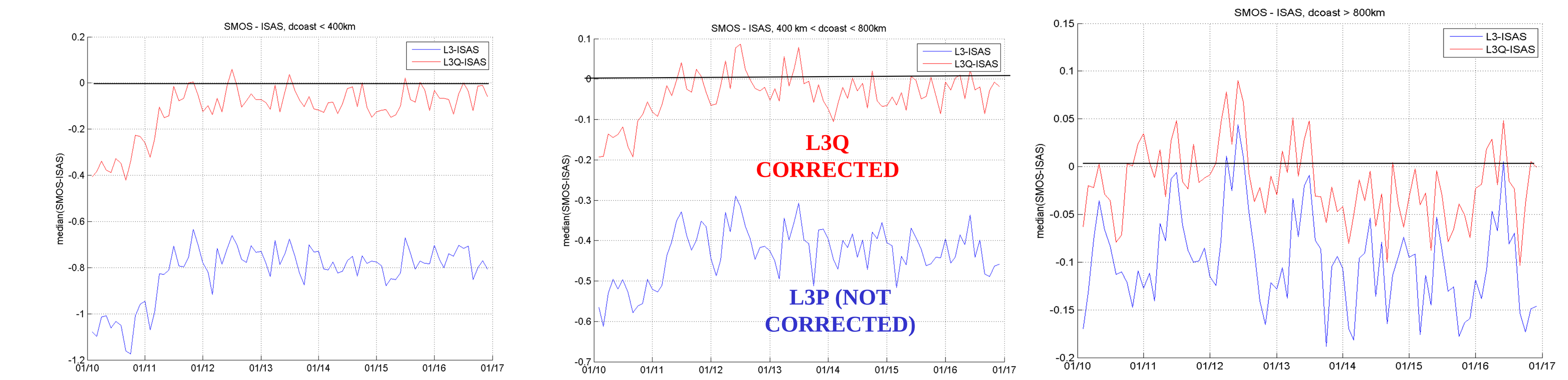
Comparisons of SMOS SSS with SMAP and ISAS SSS in freshwater flux areas in the vicinity of land



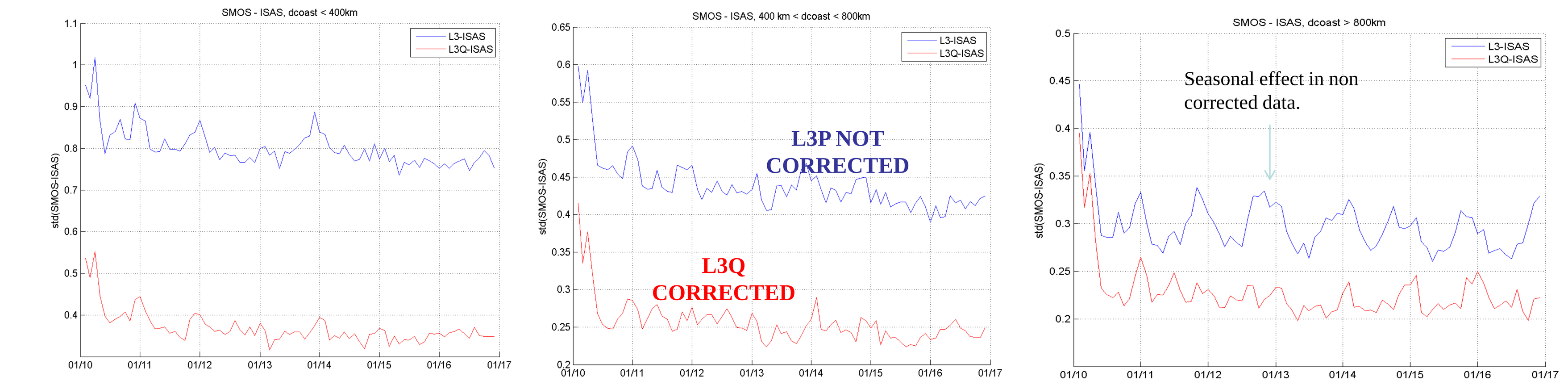
For each region (Gulf of Mexico, Bay of Bengale; eastern tropical Atlantic; Amazone plume): First line: SMOS RE05 corrected (left) and SMAP SSS (CAP v3 algorithm); second line: SMOS – SMAP SSS (left); SMOS –ISAS SSS (right); third line: SMAP-ISAS (left) and in the Bay of Bengale, SSS from drifters sampling the signature of an eddy also sampled by SMOS and SMAP SSS. Last line: scatter plots of the regional maps: RE05 corrected (left), RE05 corrected without taking into account natural variability(right). In regions with strong natural variability, the new correction scheme allows to preserve the strong natural variability of SSS sampled by SMOS which was filtered in previous version. Spatial patterns of SMOS and SMAP SSS are very consistent. Due to their small spatial scale they are hardly accessible using in situ measurements and interpolation (ISAS).

N.B.: in these areas, without correction most pixels are flagged.

Difference SMOS – ISAS SSS



Std SMOS – ISAS SSS



Mean difference and std of SMOS SSS (Ascending + Descending passes) minus ISAS SSS, over the global ocean as a function of time, at less than 400km from coast (left), between 400km and 800km from coast (middle), at further than 800km from coast (right). After correction, the bias in the land vicinity is much reduced as well as the std that becomes less than 0.4 and less than 0.25 in the open ocean.

N.B.: Due to optimal interpolation, ISAS fields are smoothed over a radius ~300km which is not appropriate for validating mesoscale variability sampled by SMOS (50km resolution) and that can be large in coastal areas : in order to minimize the influence of strong local variability in coastal areas on the SMOS-ISAS SSS differences (see comparisons with SMAP), we compute statistics from median (std_L1=(abs(x-median(x)))/0.67).

References:

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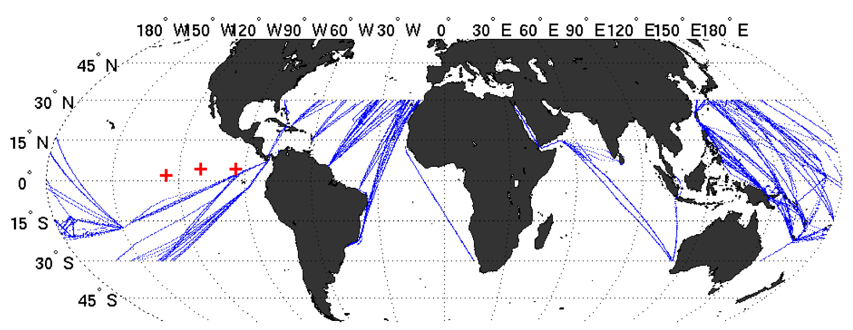
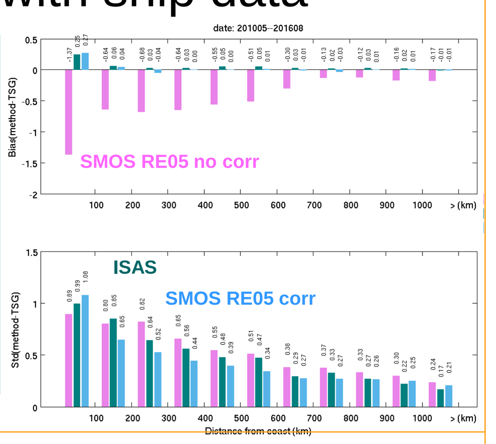
Comparison with ship data

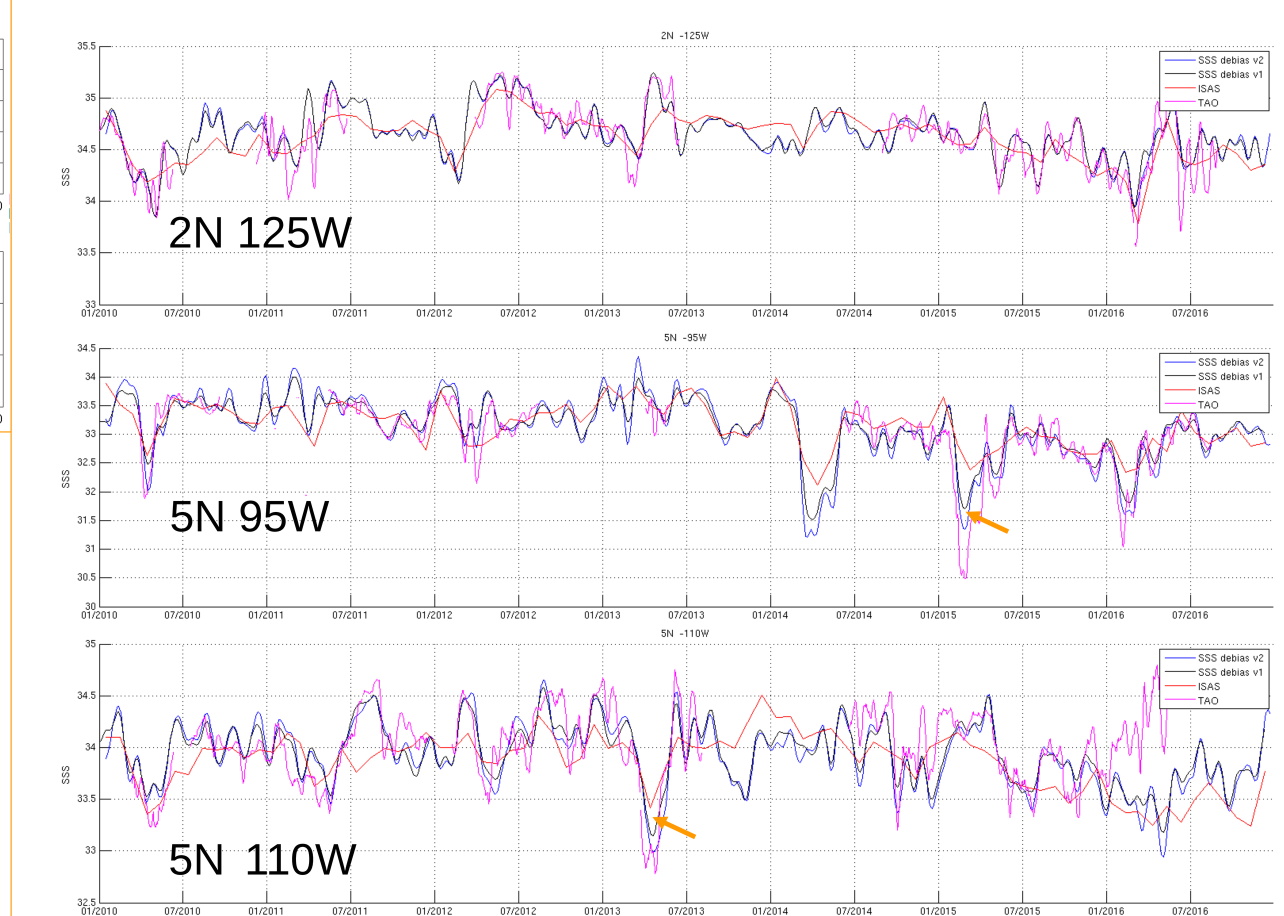


Ships of opportunity transects (from ORE SSS (Alory et al. 2016) and Ute Schüster (pers. Comm.), blue) and TAO moorings (red crosses) used in SMOS-in situ SSS comparisons

Mean (top) and std (bottom) of SSS differences with respect to ship SSS in the tropics, as a function to the distance to coast: (magenta) SMOS RE05 without correction, (blue) SMOS RE05 with correction, (green) ISAS. The bias near coasts is much reduced. Between 100km and 800km from coast, corrected SMOS SSS are closer to ship SSS than to ISAS (see std plots). In the open ocean, std=0.2pss. (50km, 18 day SMOS averages; 30S - 30N ; 2010 to 2016).



Comparison with TAO moorings



7year SSS time series of TAO moorings (magenta), ISAS (red), SMOS SSS corrected with earlier version (black) and SMOS SSS corrected with the new version (blue). In case of strong variability, the new version better preserves it. (18day SMOS CEC LOCEAN)

Summary

We have developped a self-consistent correction method that efficiently corrects large scale systematic errors in SMOS v6/RE04 SSS, except at high latitudes (ice contamination to be studied in future version; RFI in N. latitudes). The new version is being implemented in the CATDS near real time processing (CPDC products to be delivered in May 2017). With respect to earlier version (Kolodziejczyk et al. 2016, CEC LOCEAN debias v1 product), it better preserves SSS variability in regions with strong natural variability. The need for systematic error corrections is expected to decrease in future level 1 processing (improved calibration & image reconstruction in 2018 reprocessings).

Products to be delivered (www.catds.fr) in May 2017: netcdf format, EASE grid:

CATDS CPDC L3P/Q : binned averages 25, 50, 100km, 200km, 1day(L2P/Q), 10day, 1month, reprocessing 2010-2017 and NRT

L3 CEC LOCEAN debias_v2: same retrieval and same debiasing as in CATDS CPDC + gaussian smoothing over 9 & 18days, median filtering over nearest neighbours (~30km) – sampling 25km, 4days – 2010-2016

Acknowledgements:

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