Supplemental Material

Objective analysis of SMOS and SMAP Sea Surface Salinity to reduce large scale and time dependent biases from low to high latitudes

Nicolas Kolodziejczyk, Mathieu Hamon, Jacqueline Boutin, Jean-Luc Vergely, Gilles Reverdin, Alexandre Supply and Nicolas Reul

Supplementary Information

Submitted in Journal of Atmospheric and Oceanic Technology

Supplementary Information S1

In order to combine SST and SSS to produce density, spiciness and thermodynamcal parameters such as haline contraction, thermal expansion, Absolute Salinity and Conservative Temperature, we have considered RSS OISST MR-IF (Reynolds and Smith, 1994; http://www.remss.com/measurements/sea-surface-temperature/oisst-description/), the OSTIA (Donlon et al., 2012) or ODYSSEA OI SST (Autret et al., 2019). The correlation scale used in this product are about 10 km is to small for consistency with SMOS and SMAP products nominally resolving 45 km.

A more consistent product is the microwave SST products such as AMSR-E/2 that provide binned SST on 0.25° grid. Spectral coherency between TSG SST and AMSR E/2 (black) compared to coherency spectra between TSG SSS and L4 OI SSS (red) is provided by in Figure S1bd. The coherency analysis reveals a general a significant coherency for wavelength larger than 500 km in the Subtropics (Fig. S1d) and 300 km in the Tropics (Fig. S1d). In the Subtropics (Fig. S1b), between 500-200 km SST coherency present an higher coherency (~50%), while SSS coherency is lower, but significant, and drop around 250 km. This may indicate a larger signal to noise ratio for satellite SST. In the Tropics, between 2000-300 km a closer consistency between SST and SSS satellite coherency is observed (Fig. S1.d). Therefore, we have chosen to use the microwave satellite SST AMSR-E/2 to combine with the OI L4 SSS.

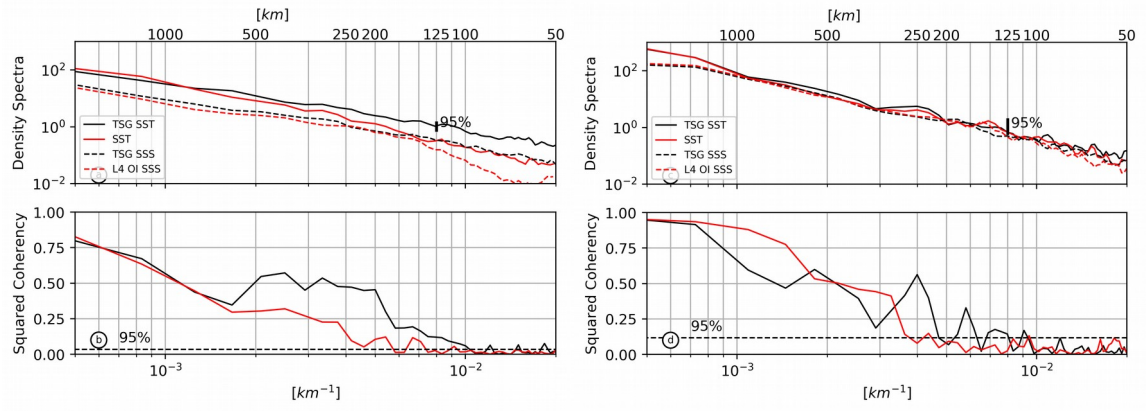

Figure S1: a) Density spectra computed from 88 SSS (dashed black) and SST (solid black) TSG transects ; colocated OI L4 SSS (dashed red) and AMSR-E/2 SST (solid red) across North Atlantic box (50-20°W/10-40°N; see Fig. 10). b) Coherency spectra between TSG SSS transects and colocated OI L4 SSS (red); and AMSR-E/2 SST (black). c) Same as Fig. S1a except for 26 transects across the Tropical Atlantic box (40-10°W/5°S-20°N; see Fig. 10). d) Same as Fig. S1b except for the Tropical Atlantic. Dashed black and vertical line indicate the level of the significance at 95%.

Supplementary Information S2

For the first OI, i.e. the mapping of SSS SMAP and SMOS at the scale of ISAS SSS, the L_{OI1} = 500 km as been chosen. The Figure S2 shows the spectra and coherency computed in the Tropical and Subtropical Atlantic (region described in Fig. 10) along colocated TSG transect for ISAS and the SMOS L3 SSS mapped using a 500 km correlation scale. We have a general agreement of resolved scale in the Tropics and Subtropics (Fig. S2).

Chosen a single correlation space scale for mapping the SMOS and SMAP corresponding to the large scale of ISAS SSS is difficult. It depends on the physical scale of the large SSS features and the sampling and representativity of the SSS provided by the *in situ* netwrok (for Argo) and SMOS/SMAP. Thus, L_{OI1} = 500 km is a trade off for the mapping at large scale.

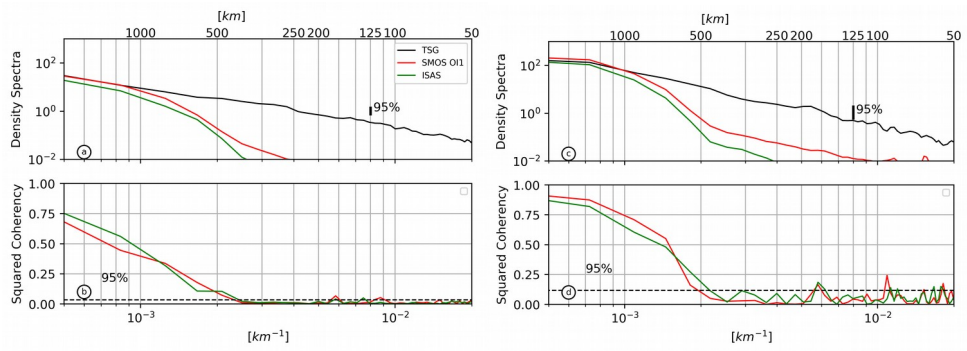

Figure S2: a) Density spectra computed from 88 SSS TSG transects (black); colocated mapping of SMOS OI at large scale (L_{OI1} = 500 km; red); ISAS SSS OI (green) across North Atlantic box (50-20°W/10-40°N; see Fig. 10). b) Coherency spectra between TSG SSS transects and SMOS OI SSS at large scale (red) and ISAS SSS (green). c) Same as Fig. S2a except for 26 transects across the Tropical Atlantic box (40-10°W/5°S-20°N; see Fig. 10). d) Same as Fig. S2d except for Tropical Atlantic. Dashed black and blue lines and vertical line in S2c indicate the level of the significance at 95%.

Supplementary Information S3

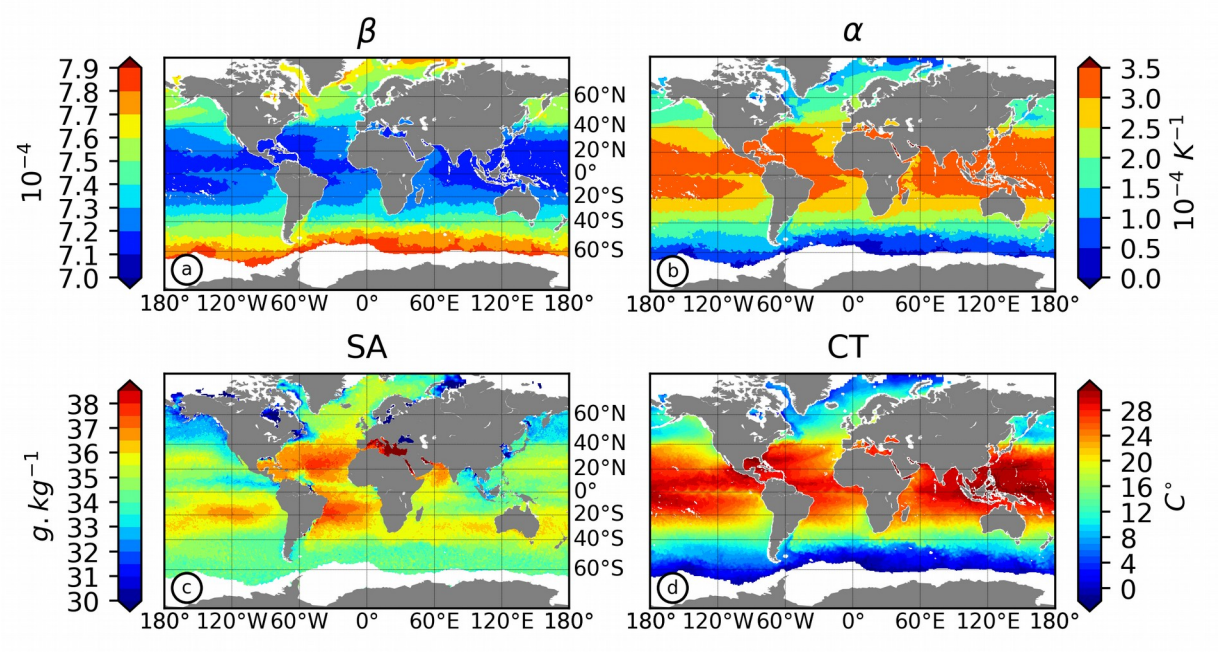

Figure S.3: 15 July 2016 map of a) Haline contraction coefficient; b) Thermal expension coefficient c) Absolute Salinity and d) Conservative Temperature computed from satellite OI L4 SSS (Fig. 6a) and AMSR-2 SST maps (Fig. 6b) using TEOS-10 routines.