Supporting Information for

Satellite observations of the sea surface salinity response to tropical cyclones

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Contents of this file

Figures S1 to S5 and text

Introduction

This supporting information provides:

1) Figure S1, which shows an example of SSS and SST time series collected (in 2017's hurricane Irma wake) and further used to determine the Tropical Cyclone thermo-haline surface responses,

2) Figure S2 shows the spatial distribution of the density of relaxation stage responses ΔSSS/ΔSST to Tropical Cyclones collected over 2010-2019 from SMOS, SMAP, and both sensor-merged datasets. A small text is provided to describe the distribution (percentage) of collected surface wake data per TC intensity classes on the Saffir-Simpson Wind Scale.

3) Figure S3 shows the two-dimensional SSS and SST median composites as functions of storm intensity and across-track radial distances and normalized with either the radius of maximum wind or the gale-force wind radii.

4) Figure S4 shows the spatial distribution of the pre-storm Mixed Layer Depth (MLD), Isothermal Layer depth and Barrier-layer thickness (BLT) averaged in 1°x1° squares.

5) Figure S5 shows the evolution of the SSS response as function of intensity for 3 types of Barrier layer thickness: very thin (0<BLT<5m), moderately thick (5<BLT<10m) and thick BLs (BLT> 10 m).

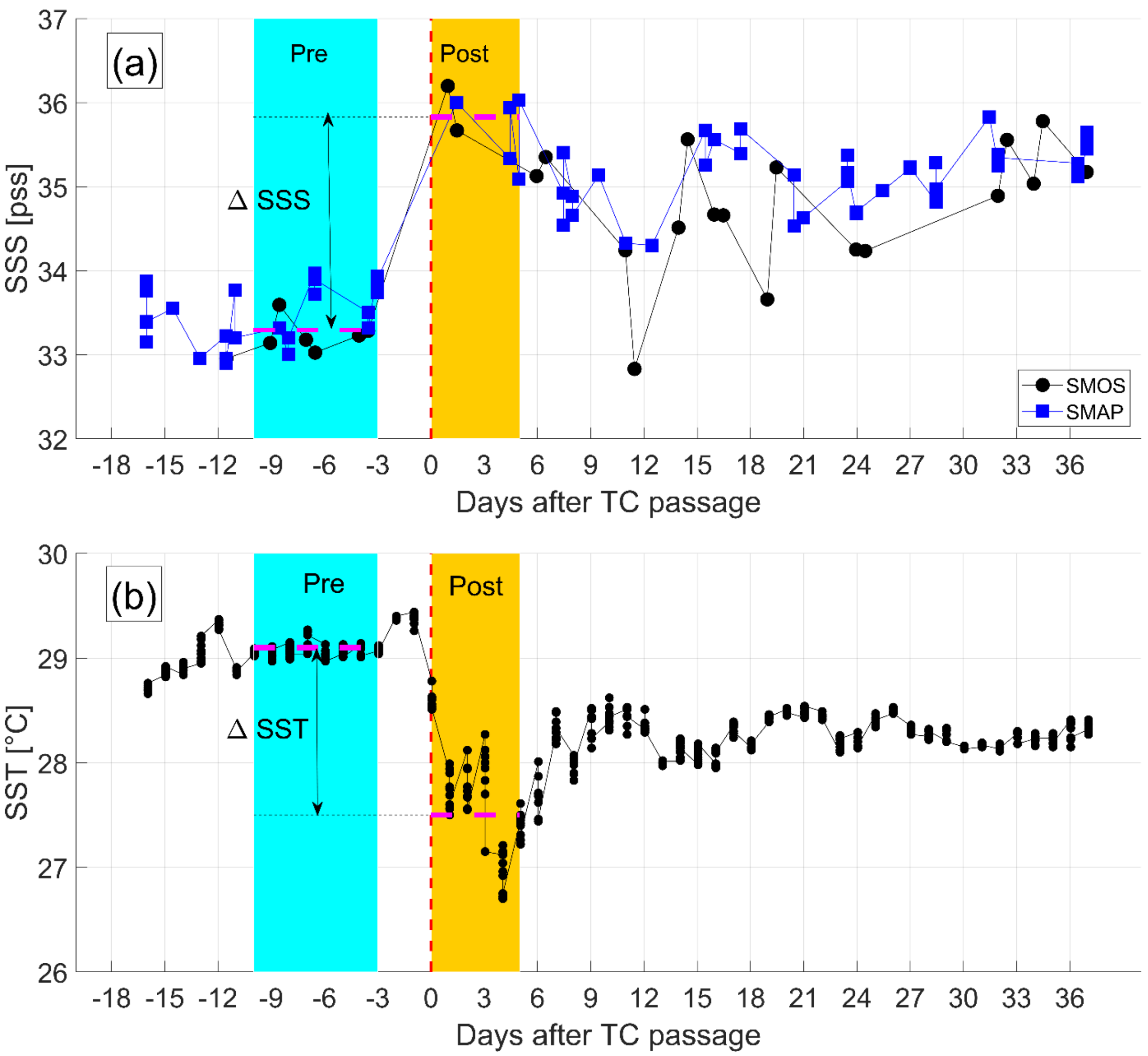

Figure S1: Time series of SSS (a) and SST (b) at latitude 17.25°N; longitude 57.5°W during the passage of Irma (see location indicated by a black cross in Figure 1). In a) the black and blue curves show the SMOS and SMAP SSS, respectively.

The time period for averaging SSS and SST before the storm, i.e., from -10 days to –3 days prior the storms, was selected:

(i) to include at least a week of data to best reduce the noise level in instantaneous satellite SSS data, and,

(ii) we selected -3 days as the closest from storm prior time limit to avoid as much as possible any contamination of the pre-storm SSS condition estimates by forerunner signatures of the storm itself. A TC can also induce heavy rain at large distances from the TC vortex itself when it interacts with other mid-latitude synoptic systems (Wang et al., 2009). These increases in rainfall in areas far away from the TC are generally referred to as remote, distant, or indirect effects of a TC on precipitation (Schumacher et al., 2011). In addition, the -3 days limit is sufficiently close in time from the storm arrival to best remove intrinsic oceanic variability impacts on SSS.

The averaging period after the storm, i.e., from 0 to +5 days, was selected as the peak ocean SST cooling after cyclone passage can persist up to 5 days (Dare and McBride, 2011).

Time series were collected over a longer period for future analyses of the temporal relaxation of SSS as a surface response to TCs becomes in general insignificant approximately 40 days after a TC's passage (Vincent et al., 2012).

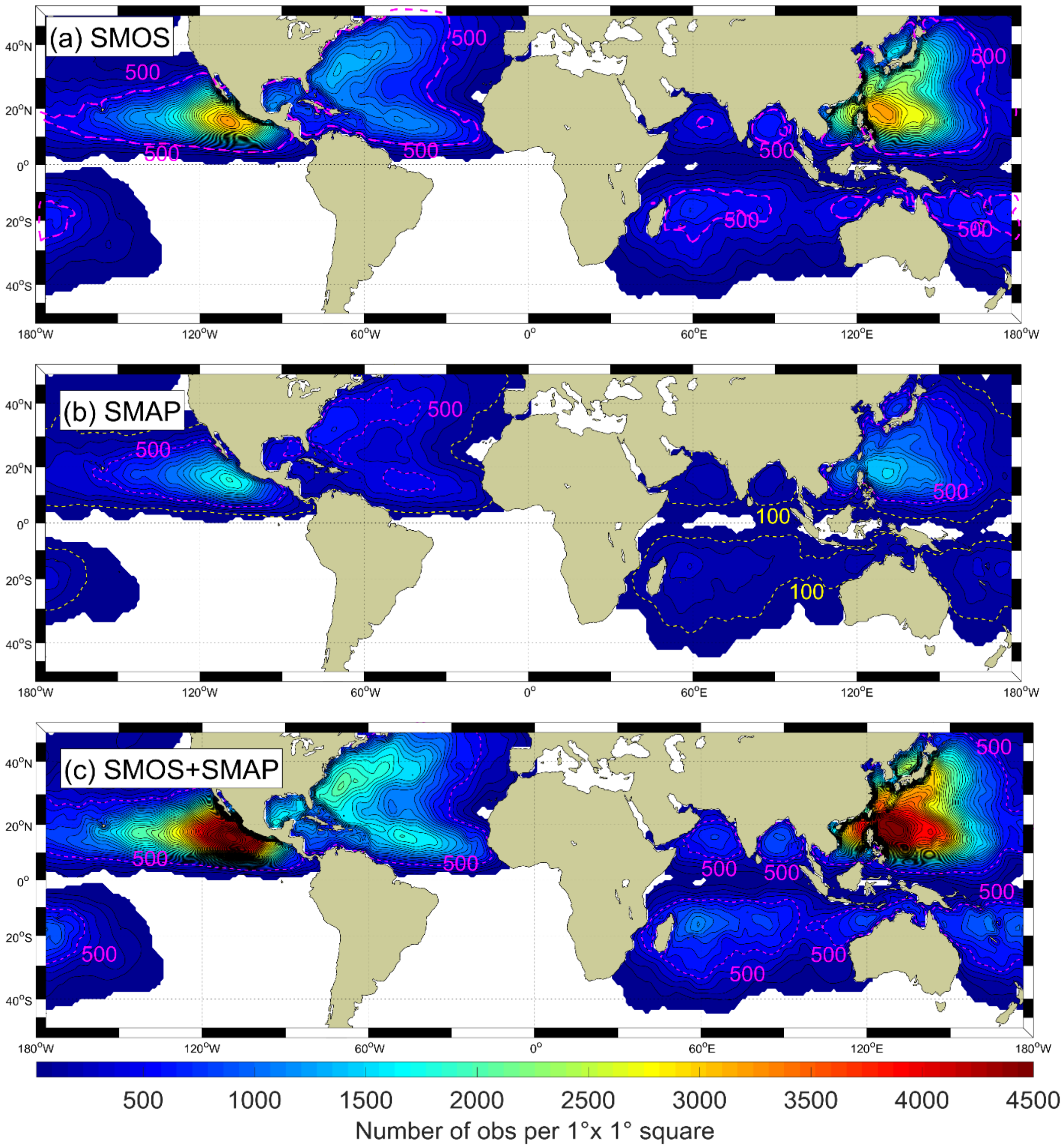

Figure S2: Density of haline wake observations used in this study per 1°x1° boxes for (a) SMOS, (b) SMAP, and (c) merged SMOS and SMAP datasets. Contours at N=100 and N=500 observations per 1°x1° boxes are provided in yellow and magenta, respectively.

The distributions of SSS/SST response samples as a function of TC intensity given by the Saffir-Simpson Wind Scale (SSWS, Schott et al., 2012) are as follows:

- 30% of the data were acquired after the passage of Tropical depression ($20 \leq V_{max} < 34$ kt),
- 43.8% after Tropical Storms ($34 \leq V_{max} < 64$ kt),
- 12.2% after Category 1 ($64 \leq V_{max} < 83$ kt),
- 5.1 % after Category 2 ($83 \leq V_{max} < 95$ kt),
- 4.5% after Category 3 ($83 \leq V_{max} < 112$ kt),
- 3.4% after Category 4 ($112 \leq V_{max} < 135$ kt) and,
- only 1 % after Category 5 ($V_{max} \geq 135$ kt) TCs.

Note that 1% of the database represents 85,000 wake samples.

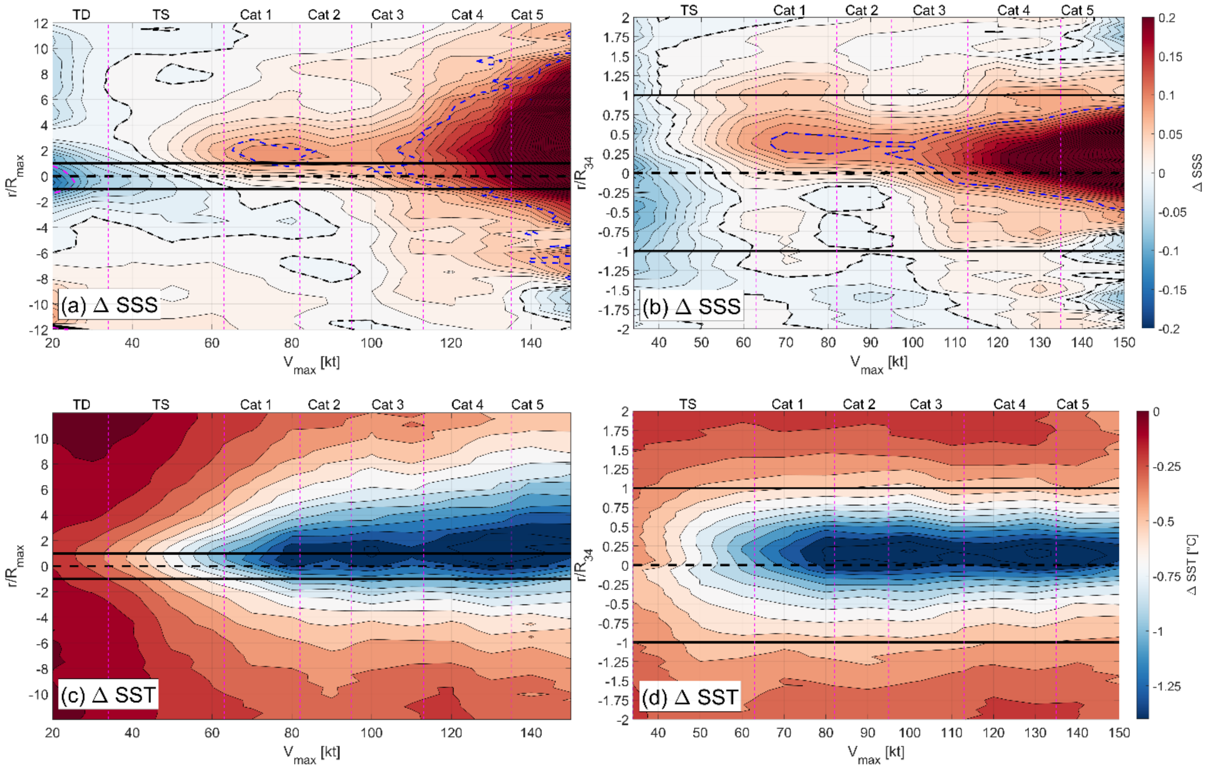

Figure S3: Composites of the median SSS (a,b) and SST (c,d) responses as a function of storm intensity V_{max}(x-axis, bin width 10 knots) and of the normalized across-track radial distance (y-axis). Radial distance from the storm center track is normalized with either (a,c) the radius of maximum wind speed R_{max} (bin width of 1/2), or (b), the gale force wind (34 kts) radius R_{34} (bin width of 1/16).

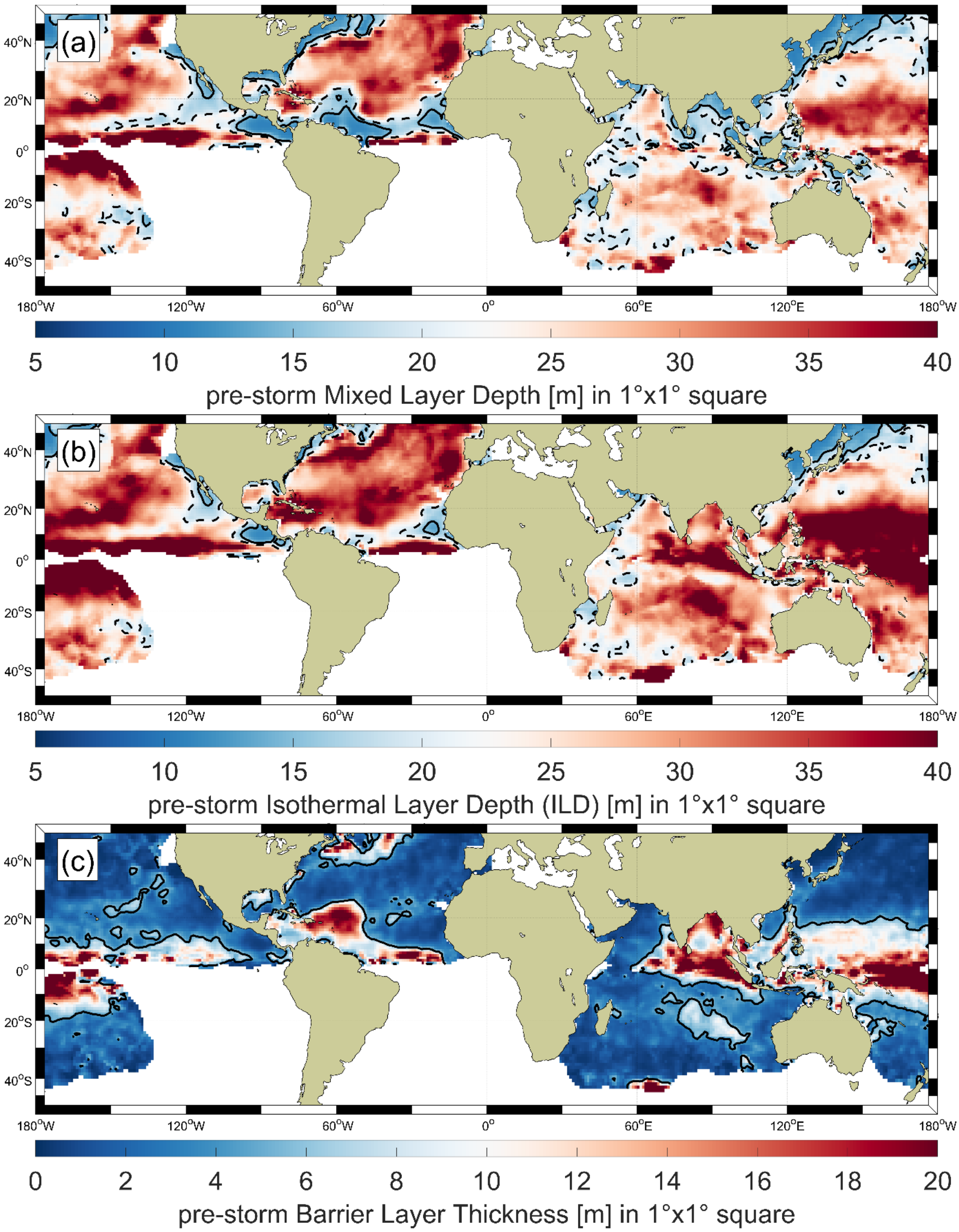

Figure S4: Spatial distribution of the pre-storm (a) Mixed Layer Depth (MLD), (b) Isothermal Layer Depth (ILD) and (c) Barrier-Layer Thickness (BLT) averaged in 1°x1° squares. The thick solid and dashed black contours in (a,b) indicate MLD or ILD =15m and MLD or ILD=20 m, respectively. In (c) the thick black contour is for BLT=5 m. These quantities were inferred from ISAS in situ analyses.

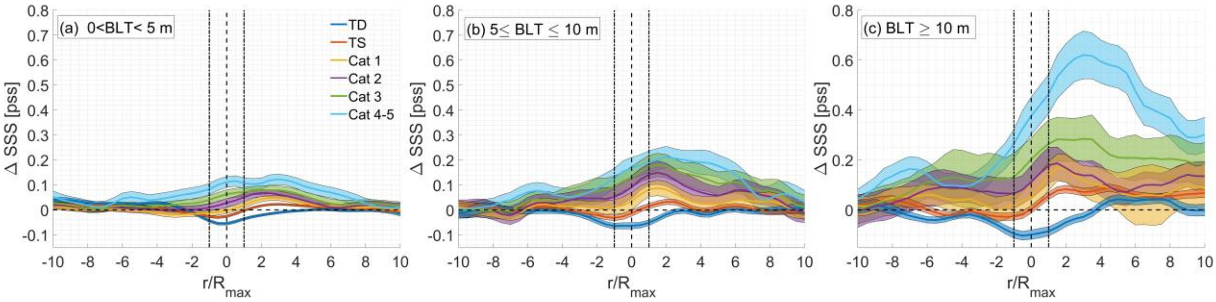

Figure S5: Radial (x-axes) distributions of the median relaxation stage SSS responses to TC as function of intensity (color) and pre-storm Barrier-Layer Thickness (BLT). In (a) 0< BLT< 5 m, in (b) 5< BLT <10 m and in (c) BL is thicker than 10 m.