AMSR-E, MODIS, In situ Three-way Analysis of SST Error Variance

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Introduction

We have determined the errors in SST observations from three different sources: infrared SSTs from MODIS, microwave SST observations from AMSR-E and in situ SST observations from the existing network of fixed and drifting buoys. A three-way analysis is performed in which all three SST types are collocated using data during the entire AMSR-E record (2002 to 2011). For each valid high-quality AMSR-E SST pixel, an in situ/MODIS match-up was formed by identifying the SST value of a matched buoy that is located within 25 km and three hours of the satellite overpass. Level-2 MODIS data with cloud cover <50% are then averaged to the AMSR-E resolution using the AMSR-E footprint. To improve our estimation of retrieval error, we excluded collocations that may have diurnal warming present. We also corrected for the skin/sub-skin effect in MODIS data. Errors are derived for the latest available satellite products and analyzed as a function of space, time and day/night. Errors were determined to be 0.23°C (in situ), 0.35°C (AMSR−E), and 0.27°C (MODIS).

Methodology

Our goal is to estimate the noise variance of satellite SST L2 data from the AMSR-E microwave and the MODIS infrared radiometers using co-located in-situ SST retrievals. We follow the three-way error analysis used in Gentemann (2014) [1] and O'Carroll et all (2008) [2]. The specific steps to reach this goal are:

- Collocate AMSR-E satellite data with the in situ obs (<3 hours and <10 km).
- Generate the MODIS matchups averaged to AMSR-E SST resolution using the AMSR-E footprint derived in Boussidi et all (2019) [3].
- Apply quality control and generate match-ups.
- Apply high-confident cloud thresholds for MODIS SSTs and generate updated matchups (MODIS sub-fields with less than 20% cloud coverage).
- Correct the skin-subskin effect for MODIS SSTs (Donlon et all [4]).
- Exclude diurnal warming contaminated matchups (daytime with wind <6m/s).
- Apply the three-way error analysis formulas to the final matchups.

Results

Global errors derived for day, night and all matchups are summarized in Table 1. The errors, with day and night data combined, are 0.27K, 0.35K and 0.23K for MODIS, AMSR-E and buoys, respectively. Fig. 1 shows the geographic variation of the derived errors mapped on a 2◦ × 2◦ latitude-longitude grid. Hovmoller plots of the average monthly errors for zonally averaged 2° latitudinal bins are shown in Fig.3.

Table 1: Triple Collocation Derived Individual Satellite and Buoy Standard Deviations.

Dataset	Night		Day		All	
	STD (°C)	N	STD (°C)	N	STD (°C)	N
MODIS	0.28	288.392	0.25	123.555	0.27	411.947
AMSR-E	0.36	288.392	0.34	123.555	0.35	411.947
In Situ	0.23	288.392	0.23	123.555	0.23	411.947

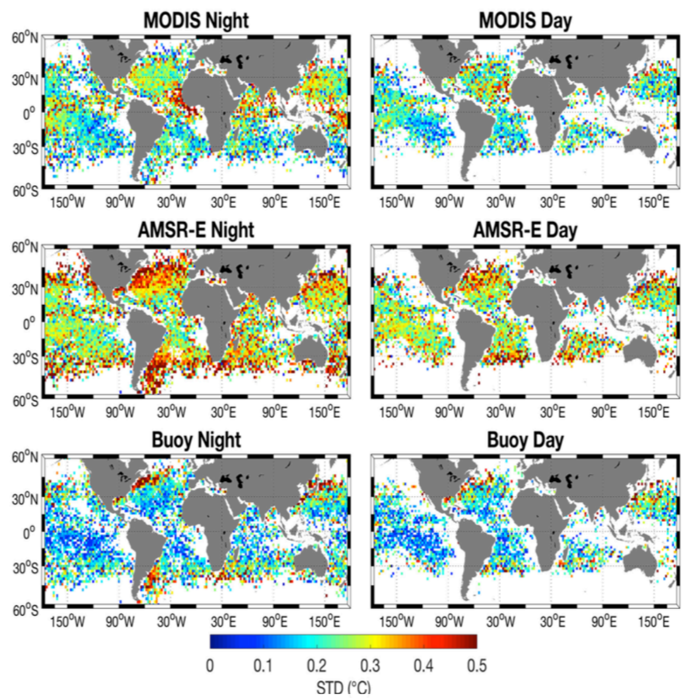

Fig 2: Global distribution of the triple Collocation Derived Individual Satellite and Buoy Standard Deviations.

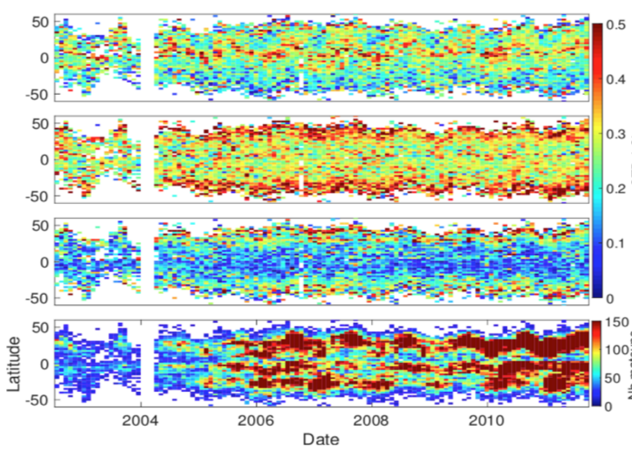

Fig 3: Hovmoller plot for month averages of the individual standard deviations shown by Latitude and Date. From top to bottom: MODIS STDs, AMSR-E STDs, buoy STDs, and number of collocations..

Concluding remarks

The averaged errors found in this study are 0.27K, 0.35K and 0.23K for MODIS, AMSR-E and buoys, respectively. As expected, the buoy measurements have the smallest error in good agreement with (Gentemann, 2014) [1], who found 0.38, 0.28 and 0.20 for MODIS, AMSR-E and buoys, respectively. In this analysis, the IR MODIS SSTs have less error than the MW MODIS SSTs, whereas (Gentemann, 2014) found the opposite. Gentemann [1] only analyzed AMSR-E L3 data, where each pixel is an average of four or five AMSR-E L2 SSTs, which might explain these discrepancies. The relatively high MODIS error found by (Gentemann, 2014) corresponds most likely to errors in cloud removal. She used 4 km L3 MODIS data, assembled by remapping the full resolution L2 fields onto a regular global 4 km, averaged then to the 25 km AMSR-E grid. The cloud fraction threshold for L3 MODIS is unknown. In addition, Gentemann (2014) did not impose a fraction-clear requirement on her match-ups as we did.

References

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GHRSST XX
3-7 June 2019
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