Inter-comparison of Sentinel-3a/SLSTR and MSG/SEVIRI derived SST with CMEMS drifting buoy data

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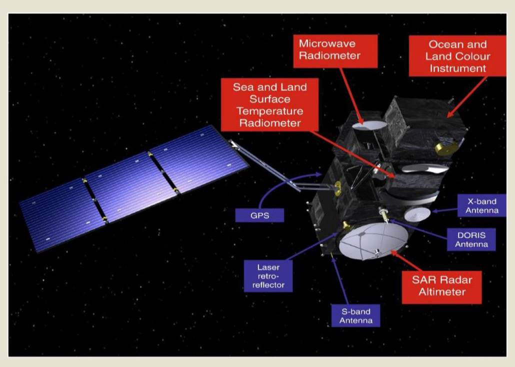
Abstract

The Sea Surface Temperature (SST) derived from satellite measurements is one of the key factors for determining ocean-atmosphere interactions in climate prediction and ocean modeling research. SENTINEL-3a is a European Earth Observation satellite developed to support ocean, land, atmospheric applications. We compared SST_{skin} from the Sea and Land Surface Temperature Radiometer (SLSTR) on board the Sentinel-3a satellite and $SST_{subskin}$ from the Spinning Enhanced Visible and InfraRed Imager (SEVIRI) on board the METEOSAT satellites from January 2017 - February 2018 using the Ifremer Match-up databases (MUDB). The inter-comparison results show that a small average difference of 0.158K between SLSTR WST and buoys, and -0.125K for SEVIRI, but RMS of SLSTR SST_{skin} retrievals are relatively large. The SLSTR WST, D2 and D3 SST_{skin} are better than N2, N3 and N3R. The SST to buoy temperature difference distributions of both SLSTR and SEVIRI have relatively large values near Saharan dust aerosol regions. This research indicates some advices to be used to correct the SST_{skin} of SLSTR.

1. Data

- **In-situ dataset:**
- Drifting buoy measured temperatures from Copernicus Marine Environment Monitoring Service (CMEMS).
- **SRVIRI SST dataset:**
- SEVIRI $SST_{subskin}$ data is a Group for High Resolution Sea Surface Temperature (GHRSST) dataset for the Eastern Atlantic Region from the SEVIRI on the Meteosat Second Generation (MSG-3) satellites (launched 5 July 2012). (http://www.osi-saf.org)
- Spatial resolution: 0.05°
- Area: Atlantic Geostationary Satellite
- Temporal resolution: Every Hour
- **SLSTR SST dataset:**
- SLSTR is a dual-view multi-spectral radiometer on-board the Sentinel-3 series of spacecraft that are part of the European Union's Copernicus program. It has 9 spectral bands that detect top of atmosphere radiation in the VNIR/SWIR/TIR regions.
- Spatial resolution: 1km (thermal infrared channels)
- Mean local overpass time: 10:00AM (descending node)
- SST_{skin} is obtained from measurements in three infrared channels centered at λ = 3.74, 10.85 and 12 µm used for the correction of atmospheric effects.

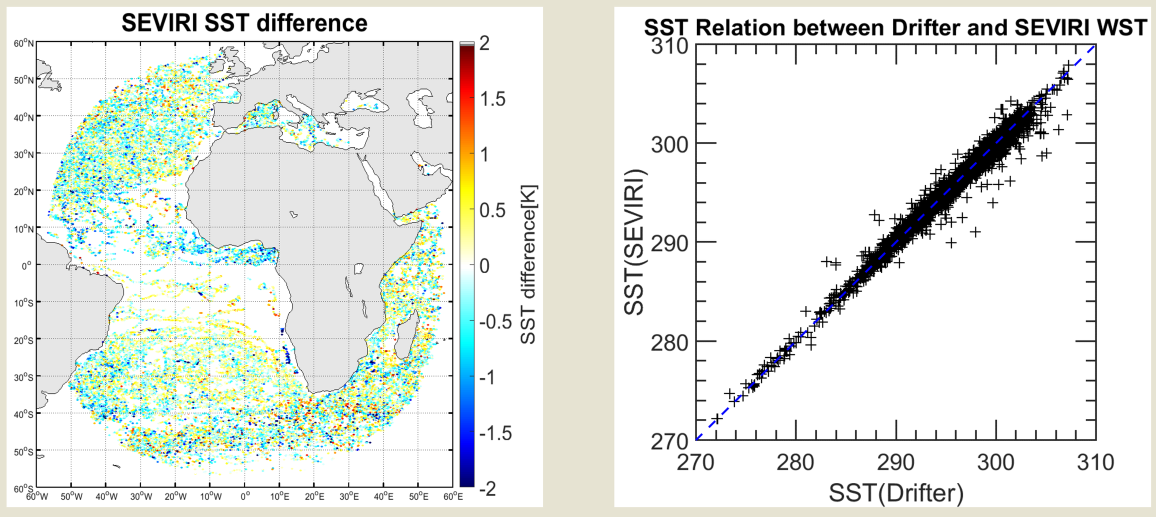


- SLSTR SST_{skin} processing to generate different single-algorithm SST_{skin} products:

Product	Description
WCT.N2	Nadir single view based on channels S8 and S9 at 10.85 and 12 µm
WCT.N3	Nadir single view and all thermal channels (N2 plus S7 at 3.7 µm)
WCT.N3R	Like N3 but using the property of "aerosol robustness".
WCT.D2	Like N2, except that BTs in both the oblique and nadir views are used
WCT.D3	Like N3, except that both views are used.
WST	WST SSTs are atmospherically smoothed to reduce noise introduced in the retrieval process product, which provide the best SST at each SLSTR location.

- **Match-up Details:**
- The SLSTR MDB is generated at Ifremer, Ocean and Sea Ice SAF. It combines multiple sources in the match-ups.
- The co-location criteria used are: 5 km in distance and 1 hour time window and only use the night data.
- **This research Details:**
- Area: 60ºW - 60ºE and 60ºN - 60ºS.
- Time Period: From January 2017 to February 2018.

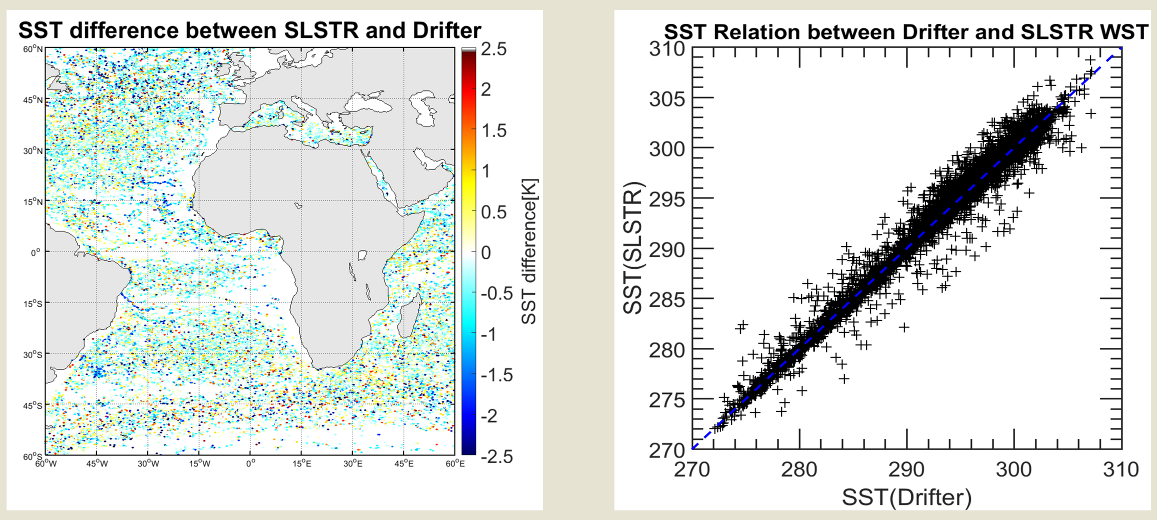
2. SEVIRI Validation



Left: SST difference distribution as indicated by color. SST difference is defined as SEVIRI $SST_{subskin}$ minus Drifter SST. Right: Scatter plot of the $SST_{subskin}$ (SEVIRI) and SST(Drifter).

The SEVIRI $SST_{subskin}$ agrees well with Drifter SST. SEVIRI has a mean bias of -0.125 K, and there is a more negative bias near the Saharan Dust region.

3. SLSTR Validation



Left: SST difference distribution as indicated by color. SST difference is defined as SST_{skin} (SLSTR) minus SST(Drifter). Right: Scatter plot of the SST_{skin} (SLSTR) and SST(Drifter) .

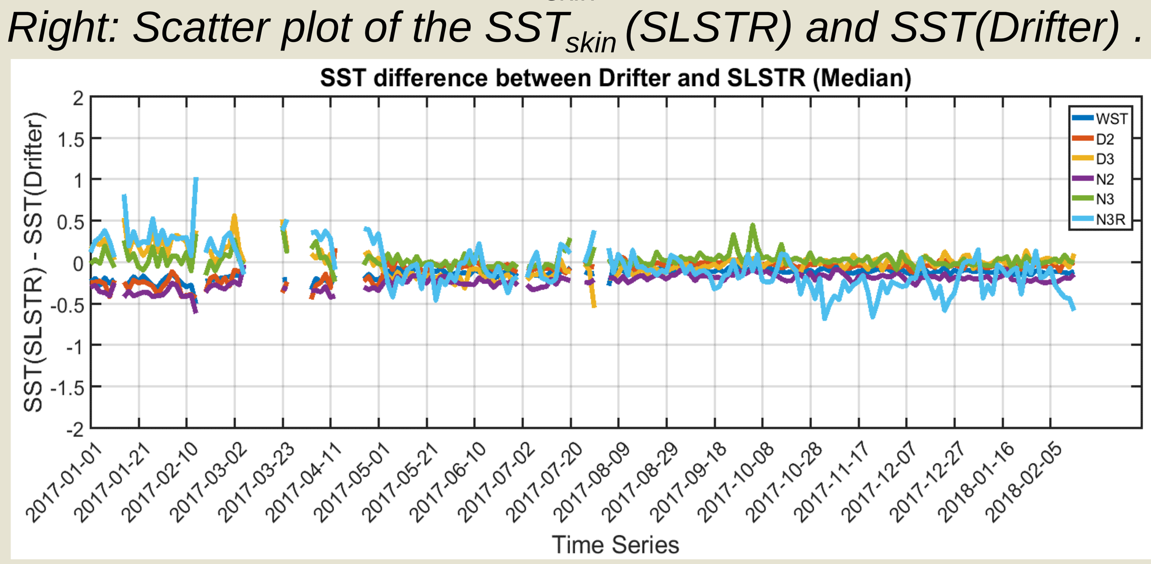


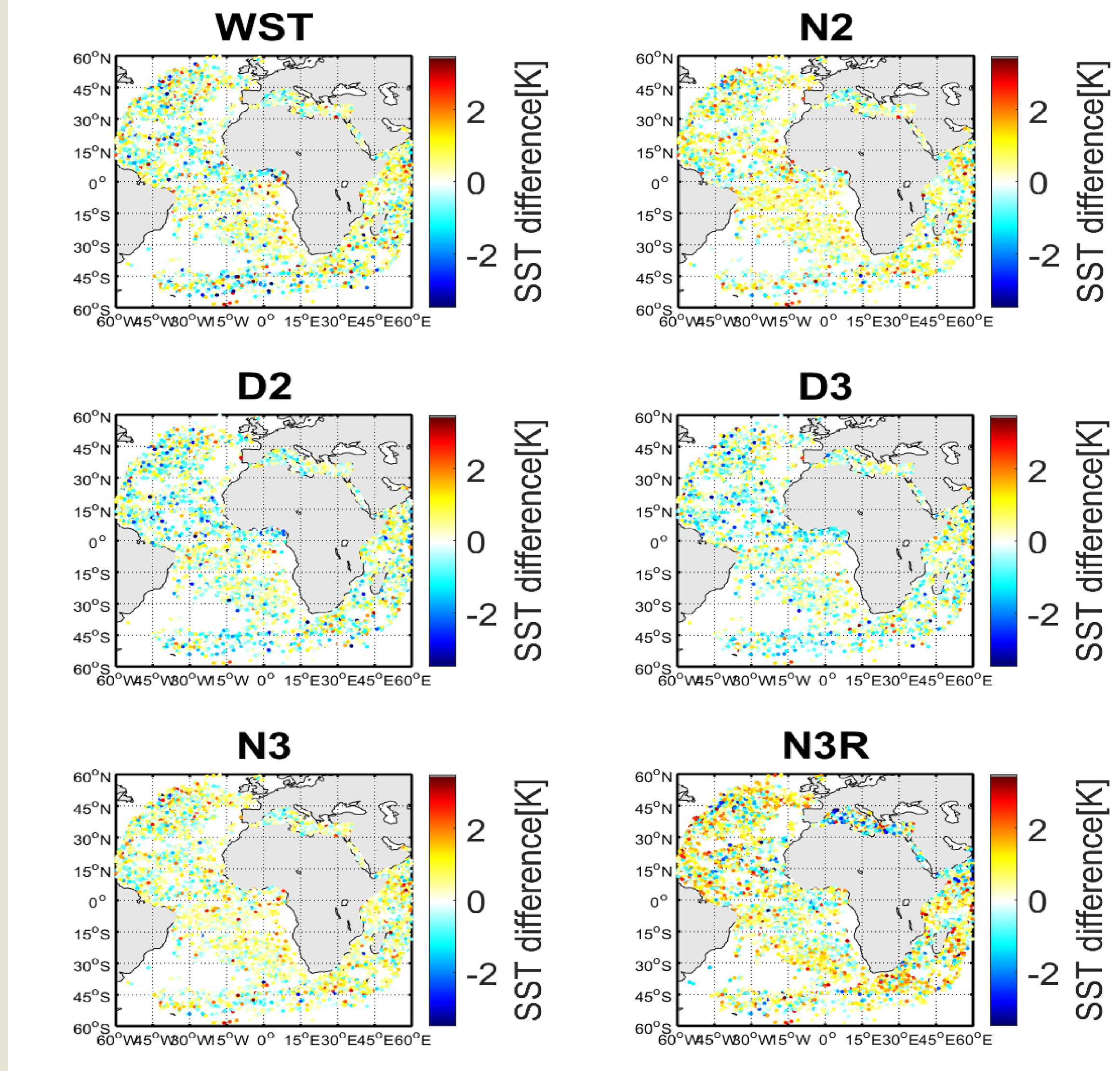
Figure: Median of SST_{skin} difference between SLSTR and Drifters. The SLSTR and Drifters agree well and the SST difference is between ±0.5K. The color indicates different algorithms of SLSTR SST_{skin} products.

Product	For the SLSTR SST vs Drifters SST				
	Number of Matchups	Mean (°C)	Median (°C)	STD (°C)	RMS (°C)
WST	73803	0.158	0.120	0.901	0.916
WCT D2	44017	0.045	0.062	0.829	0.830
WCT D3	35428	-0.122	0.029	1.245	1.251
WCT N2	73440	0.334	0.215	0.774	0.844
WCT N3	67903	-0.186	0.004	1.057	1.074
WCT N3R	67026	0.006	0.103	1.374	1.375

Table: Statistics of errors of SLSTR SST_{skin} vs Drifters SST.

- For this specific region, dual-view (D2 and D3) SST_{skin} retrievals are recommended.
- SEVIRI agrees with drifter temperatures a little better (0.03K) than SLSTR.
- SLSTR has relatively large STDs / RMS at this region

4. SLSTR and SEVIRI Inter Comparison



Distribution of SST_{skin}(SEVIRI) minus SST_{subkin}(SLSTR) of this region. We only use night data to avoid diurnal heating effects.

WST has a relative uniform difference distribution, SLSTR N2/N3 SST_{skin} is warmer than SEVIRI $SST_{subskin}$, whereas D2/D3 has negative difference near the Saharan dust region. N3R has larger RMS differences than others.

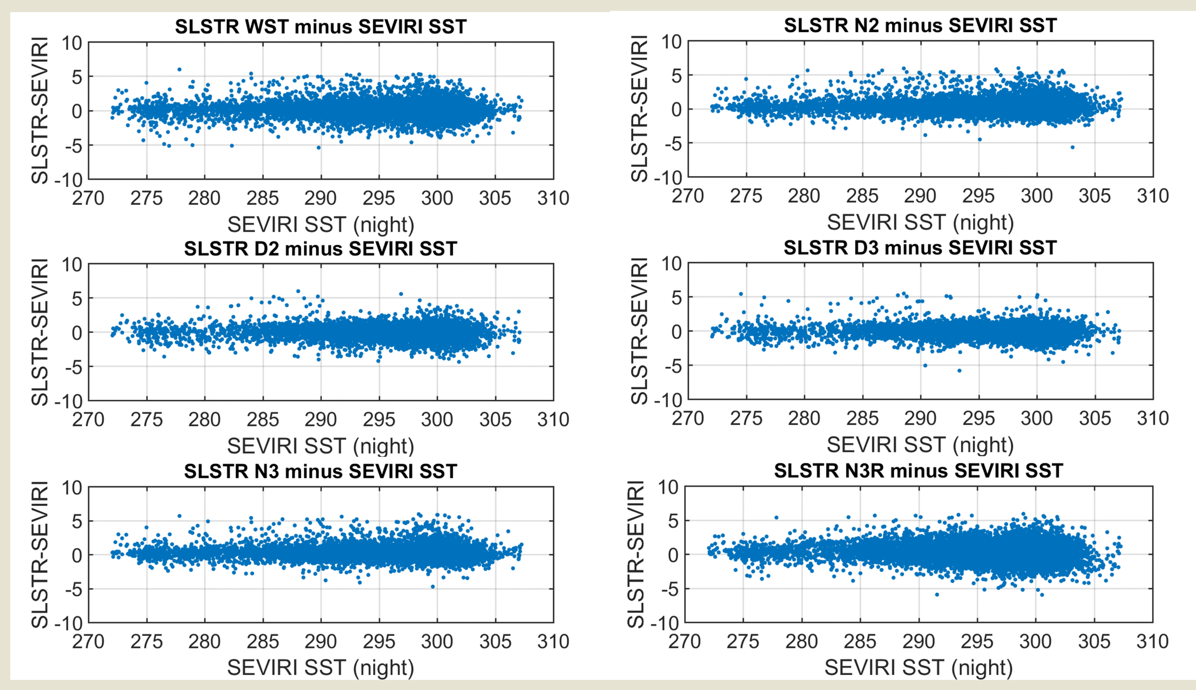


Figure: SST difference between SLSTR and SEVIRI with Temperature. The x-axis is the temperature of the SLSTR.

- D2/D3 difference is not dependent on SST, but N3 and N3R have larger biases at high temperatures (~300K).
- Overall, in situ SSTs and SLSTR satellite SST_{skin} agree quite well with each other. The WST and D2 are best compared to other SLSTR SST_{skin} algorithms products. Effort is still required to provide better SLSTR SST_{skin} data especially to reduce the STDs.

5. Affiliations & Acknowledgements

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