Comparison of SEVIRI and buoy derived diurnal warming estimates

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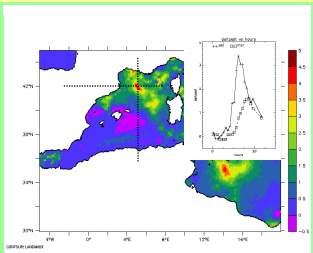
Objectives and methods

Buoy measurements and MSG/SEVIRI derived hourly SSTs are increasingly used in studies of the diurnal cycle of the oceans, or to validate ocean model outputs; it is necessary to intercompare those two sources of information. In a recent paper, (LeBorgne et al. 2012) we compared SEVIRI and drifter diurnal warming (DW) estimates in the SEVIRI field of view. Here we compare SEVIRI DW also to mooring measurements, and we discuss the distribution of the results in various zones of the SEVIRI disk.

To do so we use drifter or moorings measurements from the CMS operational MDB in summer 2011 (June-July-August) where SEVIRI data are extracted in 5x5 pixel validation boxes.

We compare SEVIRI validation box central pixel with buoy derived DW estimates by
1) Selecting cycles with SEVIRI **or** buoy DW daily amplitude (max-min) > 0.5K
2) Calculating daily references (ref) as the mean of « predawn » SST values
3) Calculating DW(t)= SST(t)-ref similarly for buoy and SEVIRI

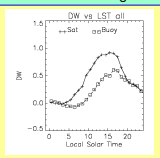


DW field derived from SEVIRI compared with a moored buoy measurement in the Gulf of Lions

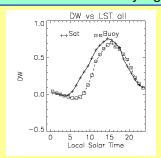
Overall results :

Moorings

When all cases (daily amplitude larger than 0.5 K) are considered, SEVIRI DW estimates are significantly larger than those of moorings but about equal to those of drifters. A 2-3 hour lag is apparent in the morning between the satellite and buoy signals



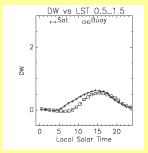
SEVIRI vs moorings



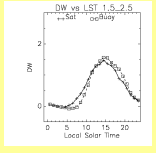
SEVIRI vs drifters

Drifters by daily DW amplitudes

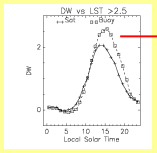
The results sorted as a function of the daily amplitude show That SEVIRI DW become significantly smaller than drifters for high daily amplitudes



0.5>Daily DWmax> 1.5K



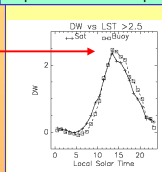
1.5>Daily DWmax> 2.5K



Daily DWmax> 2.5K

Cloudiness filtering

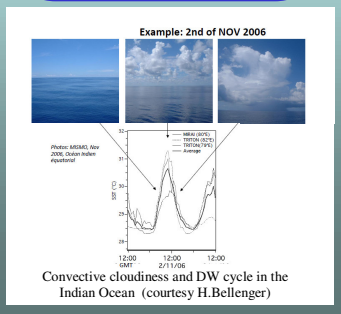
When considering only fully cloud free validation boxes SEVIRI and drifter amplitudes become equal



Daily DWmax> 2.5K
with »fully cloud-free » filter

Overall results : conclusions

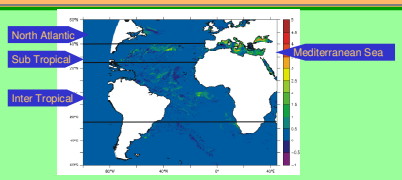
The overall results show (unsurprisingly) that SEVIRI amplitude is larger than that measured by moorings and about equal to that of drifters. The apparent underestimation by SEVIRI for large amplitudes is an artefact from undetected afternoon convection (Bellenger et al. 2010).

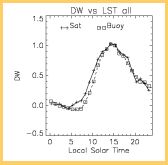
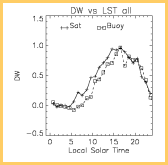
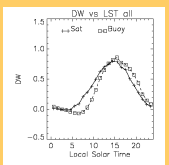
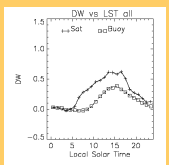


Convective cloudiness and DW cycle in the Indian Ocean (courtesy H.Bellenger)

Discussions per zone:

After a detailed analysis of the results in latitude bands, four zones have been defined:
-Mediterranean Sea
-North Atlantic
-Subtropical North Atlantic
-Inter-Tropical Atlantic



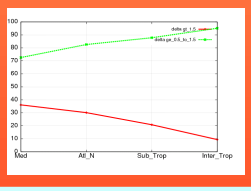
Mediterranean Sea	North Atlantic	Sub Tropical Atl.	Inter Tropical Atl.
Mean SEVIRI cycles compared to drifters when all cases (daily amplitude larger than 0.5K) are considered			
			
Nb cycles : 174 bias: 0.16 std: 0.47	Nb cycles: 78 bias: 0.29 std: 0.75	Nb cycles : 1321 bias: 0.14 std: 0.58	Nb cycles: 802 bias: 0.49 std: 0.57

Results per zone : conclusions

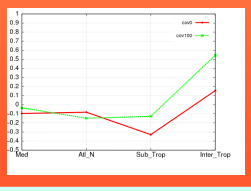
The results per zone shows that :

-The mean values recorded in the inter-tropical area are smaller than those recorded in the North Atlantic ; the mean amplitude decreases with latitude.

- The apparent daily amplitude is affected by subpixel cloudiness mainly in sub-tropical or inter-tropical Atlantic.



Relative frequency of small amplitude cycles (green line) and high amplitude cycles (red lines) as a function of the zone



Mean SEVIRI – drifter maximum daily amplitude for all cases (red line) and 100% clear cases (green line)

Conclusions

1) SEVIRI derived DW estimates are significantly larger than mooring measurement derived estimates

2) SEVIRI derived DW are on the average comparable to those derived from drifter measurements

3) In the morning the SEVIRI derived SSTs start to increase immediately after sunrise, preceding the drifter measurements by about 3 hours

4) In large diurnal warming conditions (daily amplitude larger than 2.5 K), SEVIRI derived SSTs underestimate the diurnal cycle. This occurs mainly in the sub- and inter-Tropical Atlantic, and is due to undetected subpixel cloudiness (afternoon convection)

5) In summer, the relative frequency of large amplitude cases seems larger in the Mediterranean and in the North Atlantic than in the inter-Tropical Atlantic

References:
H. Bellenger, Y.N. Takayabu, T. Ushiyama and K. Yoneyama, 2010, Role of diurnal warm layers in the diurnal cycle of convection over the Tropical Indian Ocean during MISMO, *Monthly Weather Review*, 138, 2426-2433.
P. Le Borgne, G. Legendre and S. Péré, 2012, Comparison of MSG/SEVIRI and drifting buoy derived diurnal warming estimates, *Remote Sensing of Environment*, submitted