Karlsruhe Institute of Technology

The EUMETSAT Network of Satellite Application Facilities
LSA SAF
Land Surface Analysis

Institute of Meteorology and Climate Research
Meteorological Satellite Analysis (MSA) Group
http://www.imk-asf.kit.edu/MSA.php

# Continuous validation of LST: results

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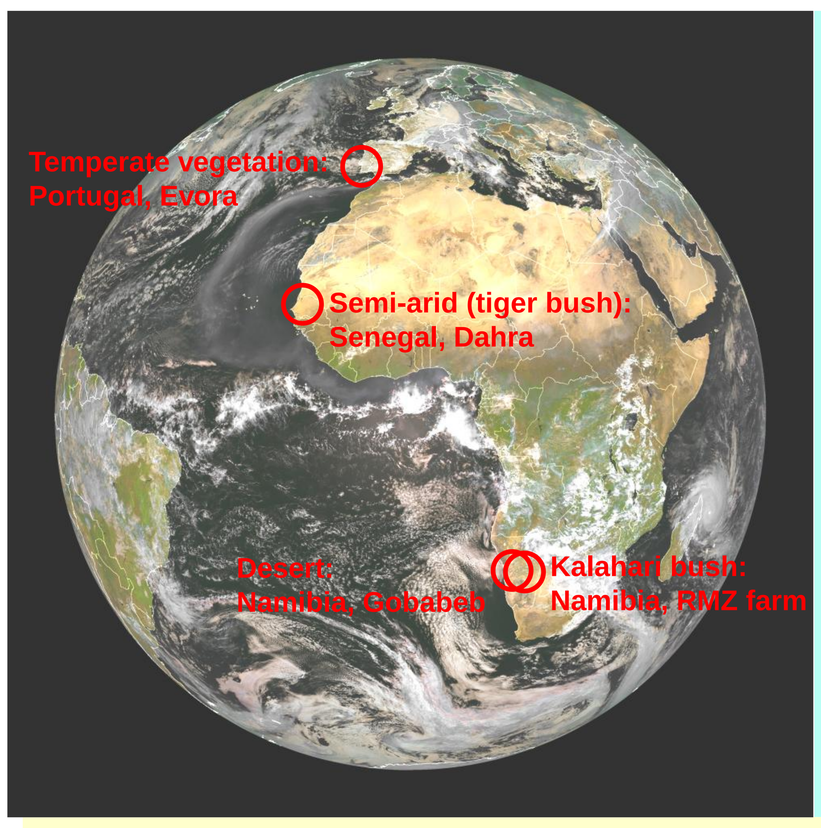
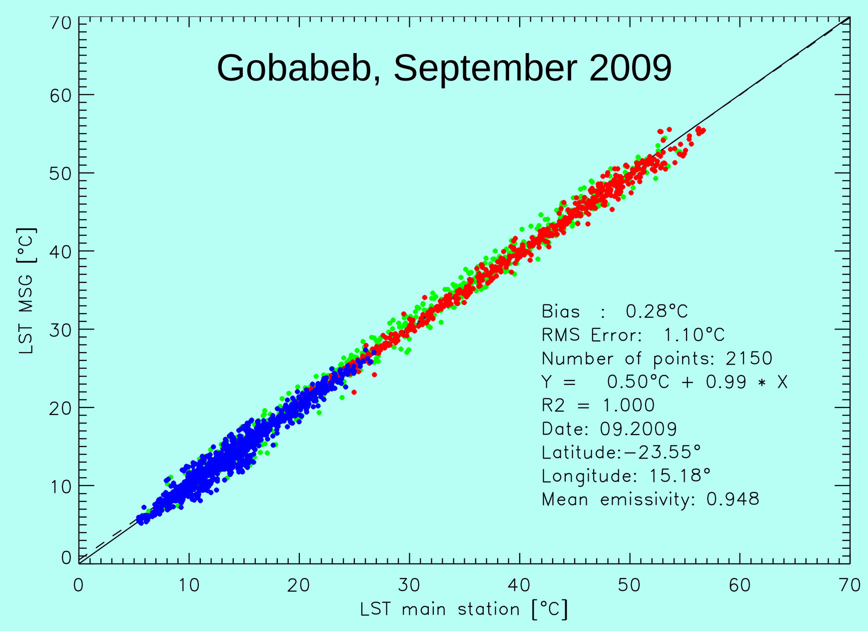
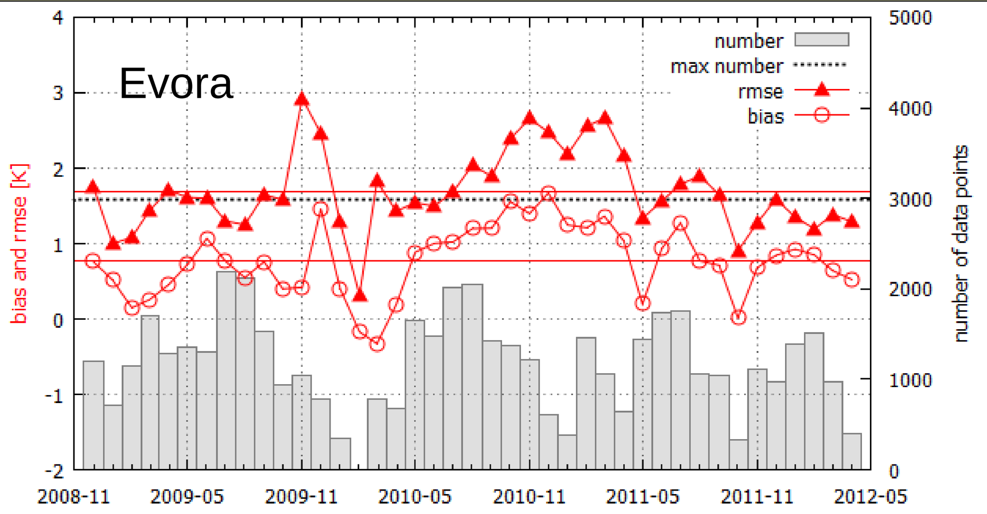



Land surface temperature (LST) is an operational product of the Land Surface Analysis – Satellite Application Facility (LSA-SAF). As a contribution to LSA-SAF, KIT operates four long term LST validation stations within the field of view of the METEOSAT satellites (see left). The stations are located in different climate zones in large, spatially homogenous areas (several SEVIRI pixel). The station's core instrument is the self-calibrating Heitronics KT15.85 IIP radiometer (9.6-11.5µm, accuracy ±0.3K). At least one radiometer observes the ground and one the sky: LSA-SAF emissivity is used to derive LST from these up and down-welling radiance measurements. The colours in the plot on the r.h.s. highlight data in the morning, afternoon, and at night. In-situ data were matched up with SEVIRI acquisition times to within one minute: the small bias & RMSE demonstrate the excellent quality of the SAF LST.

## LSA-SAF LST vs. in-situ LST

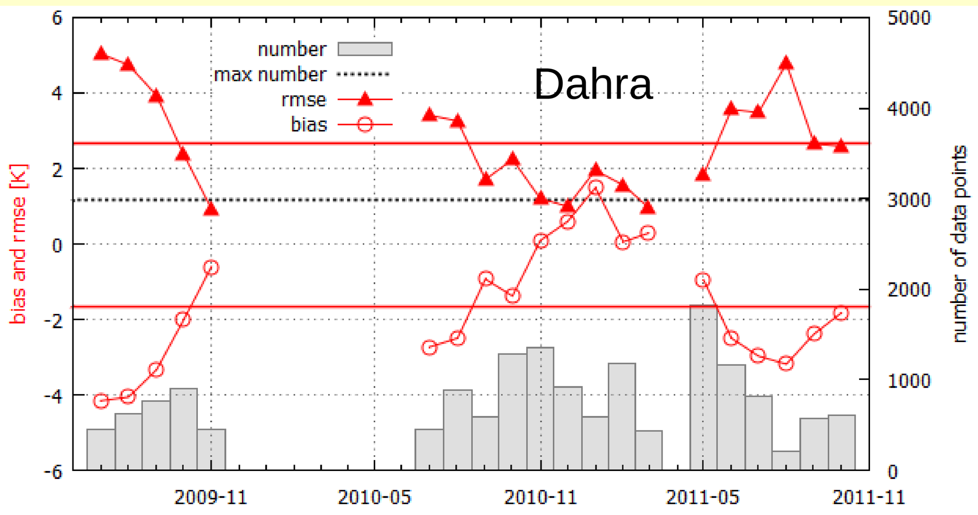



## LSA-SAF LST for MSG/SEVIRI versus in-situ LST



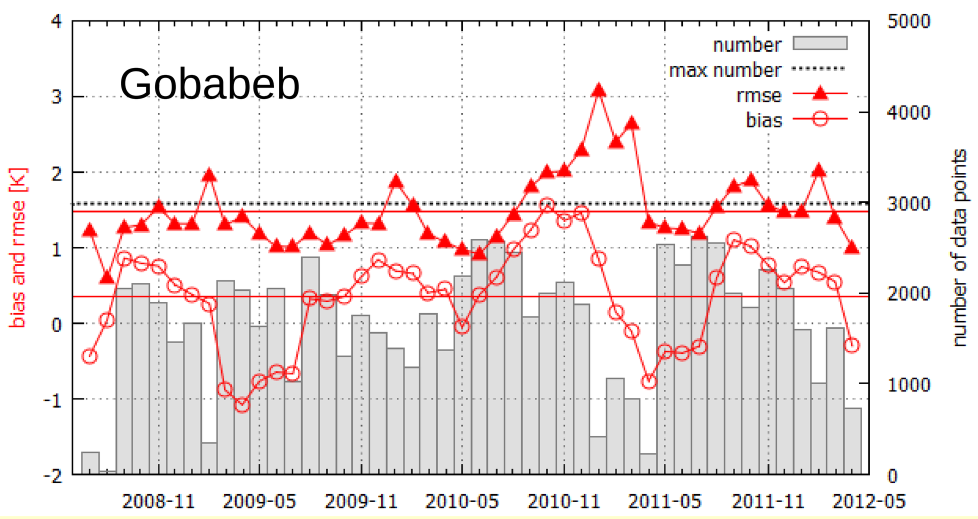

Radiometers observe grass and the crown of an oak tree near Evora, Portugal. A tree crown cover (TCC) of 33% determined for August 2009 gives the best correlation between satellite and in-situ LST. This agrees with the mean TCC of 29% determined by Carreiras et al. (2006).

The mean bias is 0.8 K (i.e. SAF LST is warmer) while the mean rmse is 1.7 K. In Winter and Spring clouds can considerably reduce the number of valid data (e.g. only four in Feb. 2010!). Not shown: night-time SAF LST are systematically warmer than in-situ LST - the cause of these deviations is currently investigated.



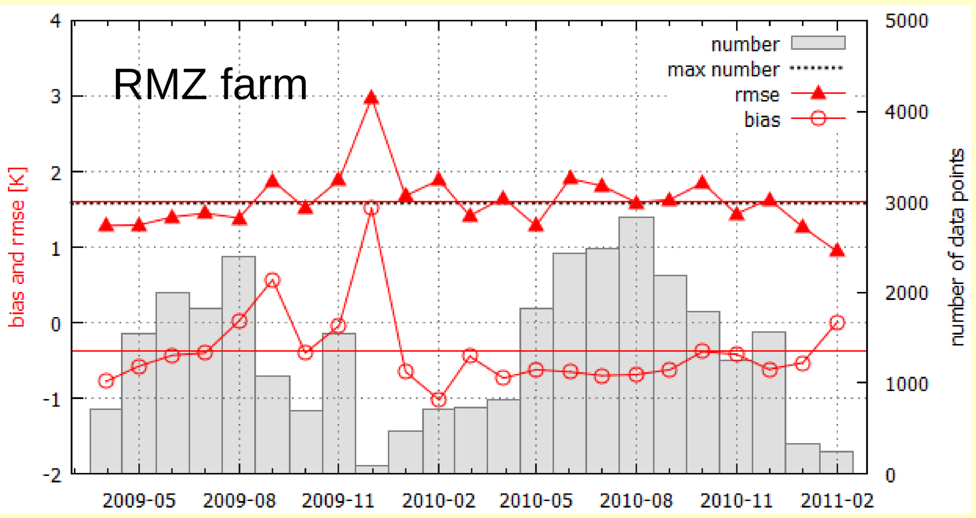

The land cover at Dahra, Senegal, is tiger bush with a TCC of 4%. The long data gap from Dec 2009 to Jun 2010 is due to theft of solar panels. Due to its sub-tropical climate, Dahra has the fewest data points of the four stations (many cloudy satellite pixels).

During the wet season (Jul - Oct) the warm and humid atmosphere is highly challenging for optical remote sensing. For all data (only dry season) the mean bias is -1.6 K (0.1 K) and mean rmse is 2.7 K (1.7 K). During the dry season the agreement between SAF LST and in-situ LST is similar to the other stations.




Gobabeb, Namibia, is located on the large and homogeneous gravel-plains of the Namib desert at 405 m asl. Performing measurements along a 40 km track, Göttsche et al. (2011) showed that the station LST is representative for an area of several 100 km².

The mean bias is 0.3 K and mean rmse is 1.5 K. The bias varies by about ±1K and appears to be partly seasonal. The small (Oct/Nov 2010) and the big rainy season (Jan/Feb 2011) were exceptionally wet and cloudy.




RMZ farm, Namibia, is located in the Kalahari semi-desert at 1400 m asl. From image analysis TCC is estimated as 11% (camel-thorn trees).

In February 2011 RMZ station was re-located to the Kalahari farm “Heimat” at 1450 m asl.

Mean bias is -0.4 K (SAF LST colder), mean rmse is 1.6 K. The LSA SAF algorithm does not account for the reduced atmospheric path due to the station’s high elevation: this may explain the increased regression slopes (not shown) & negative bias. Clouds reduce the number of data points from Dec to Feb.

## In-situ Land Surface Emissivity (LSE) at Gobabeb

Emissivities of relevant surface types were determined for the KT-15.85 IIP radiometer (9.6-11.5µm). $\varepsilon_0$ and $\varepsilon$ are the uncorrected and corrected emissivities of the ‘one-lid emissivity box’ method, respectively (Göttsche and Hulley, 2012). SEVIRI values differ due to its different spectral response functions. N: number of measurements.

| Surface type | $\varepsilon_0$± stderr | $\varepsilon$± stderr | N |
|---|---|---|---|
| Gravel | 0.919 ±0.008 | 0.916 ±0.007 | 10 |
| Gravel (disturbed) | 0.932 ±0.003 | 0.931 ±0.003 | 2 |
| Grass (dry) | 0.964 ±0.012 | 0.962 ±0.013 | 6 |
| Sand (dunes) | 0.930 ±0.004 | 0.928 ±0.004 | 16 |
| Granite (inselberg) | 0.914 ±0.010 | 0.909 ±0.011 | 5 |

### Summary of Results

- The absolute value of the mean and monthly **bias** between LSA-SAF LST and in-situ LST is **generally less than 1 K** (except Dahra)
- Mean rmse is less than 1.7 K for Evora, Gobabeb, and RMZ-farm, whereas mean rmse at Dahra is 2.7 K (dry season: 1.7 K)
- The slopes of linear regressions for Gobabeb and for Dahra during the dry season are generally close to 1.0
- Systematically too high regression slopes are observed for RMZ farm, which is probably related to the stations high elevation
- At Evora, systematically higher night-time SAF LST result in a mean slope of 0.9. Frequently undetected clouds during Winter & Spring.
- **SAF LST and in-situ LST agree well with each other** and the analyses identify specific points for further improvements.

**References:**

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