Assessment of IASI Land Surface Temperature using Ground-based Measurements

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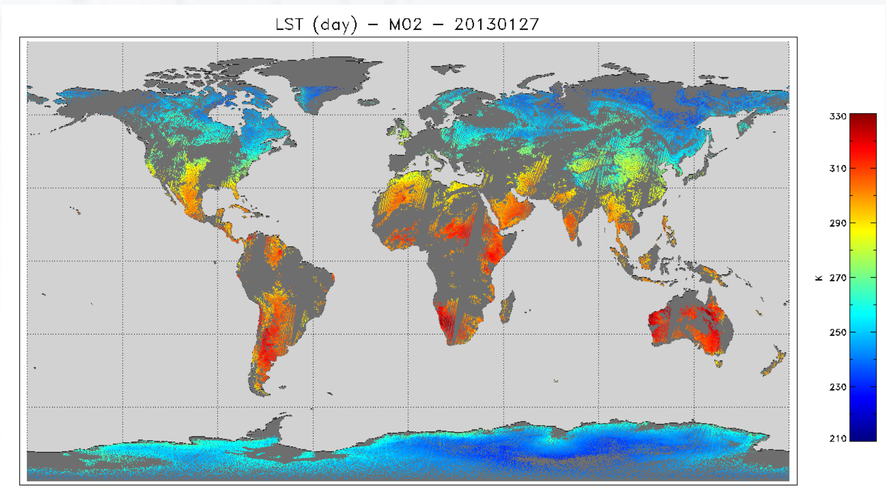
Introduction

The Land Surface Temperature (LST) is one of the main quantities governing the energy exchange between the surface and the atmosphere. The IASI Level 2 Product Processing Facility (PPF) operated at EUMETSAT's Central Facility routinely retrieves geophysical parameters from IASI measurements in near-real time including LSTs.

We have used in-situ measurements from validation stations operated by the Karlsruhe Institute of Technology to assess the accuracy of IASI LST provided by the PPF and an alternative optimal estimation method (OEM) over year 2010.

LST retrieval from IASI spectra

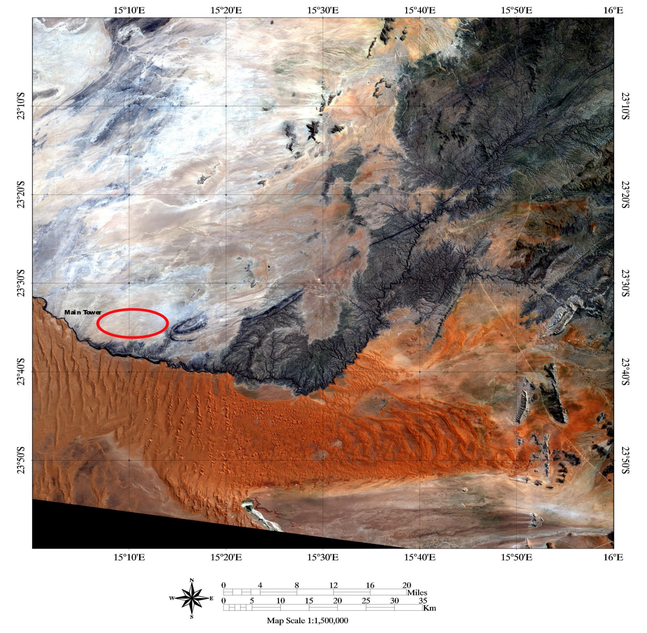
IASI LSTs are retrieved simultaneously with the land surface emissivity by a linear EOF regression under cloud-free conditions. Surface pressure, solar zenith angle and a number of leading PC scores computed from a subset of the radiances are used as predictors. An example of such a retrieval from all measurements performed over one day in daylight conditions is shown below:



Validation stations

The Karlsruhe Institute of Technology operates four long-term LST validation stations equipped with chopped IR radiometers (Heitronics KT15.85 IIP; spectral range: 9.6 - 11.5 μm; absolute accuracy: ±0.3K) measuring ground and sky brightness temperature. These stations have been extensively used for the validation of the LST retrieved from the SEVIRI instrument onboard MSG as they are located in the field of view of the METEOSAT satellites, in three different climate zones:

- Evora (Portugal, temperate Mediterranean, cork oak tree forest);
- Dahra (Senegal, semi-arid, tiger bush);
- Gobabeb (hyper-arid gravel plains) and RMZ farm (Kalahari bush), both in Namibia.

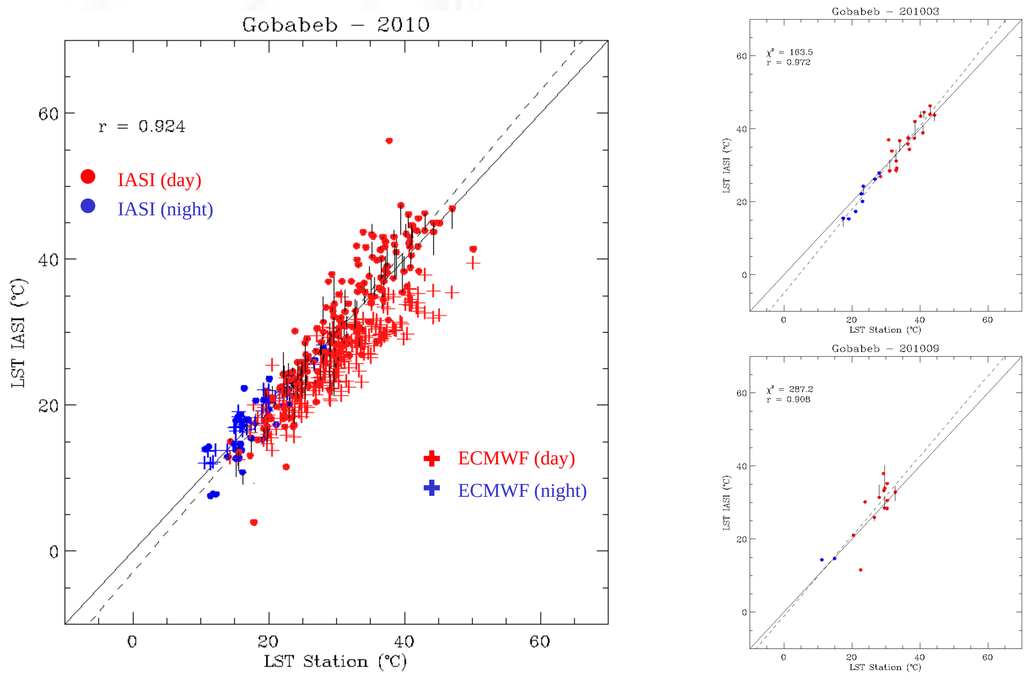


On special interest is the Gobabeb station that is located on large and highly homogeneous (in space and time) gravel plains, close to a sharp transition between sand and gravel as illustrated on the Landsat image on the left.

Results from the comparison

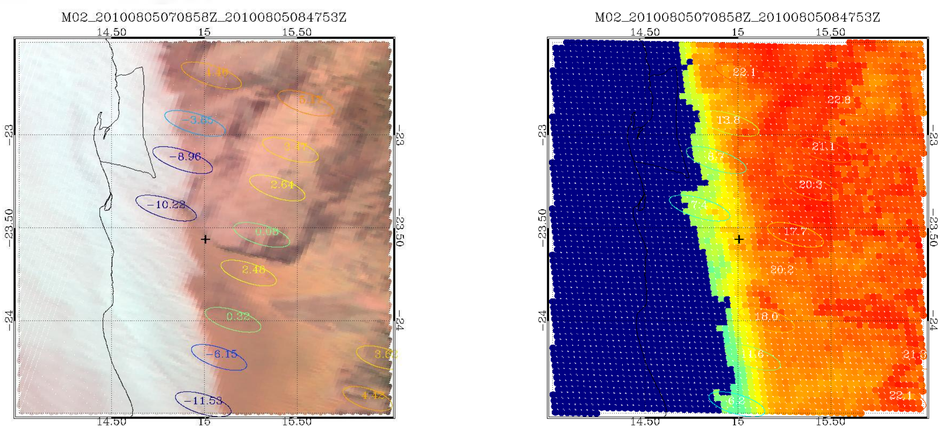
Direct comparison in Gobabeb

IASI overflies the station Gobabeb twice a day between 8 and 9 UTC in the morning and between 20 and 21 UTC in the evening. The figure below shows a scatterplot of LST retrieved from IASI measurements versus the LST measured on the ground over the year 2010. Red dots stand for daylight measurements while blue dots are night-time ones. Only IASI footprints falling within 50 km North-East of the station are taken into account. Apart from a few outliers, identified as problems with the cloud identification, the correlation is in general very high (0.92) and there is almost no bias. The correlation between the satellite products and the in situ measurements varies slightly from month to month, the best agreements being obtained in March (r~0.97) and larger dispersion reported in August/September. The collocated LSTs from ECMWF analyses (blue and red crosses), appear to be biased by several Kelvin at daytime.



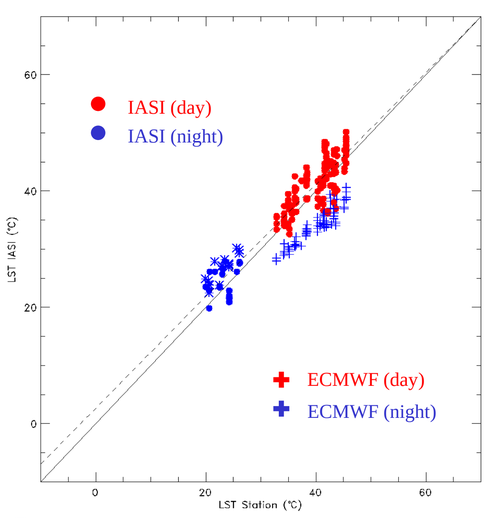
Cloud contamination and geographical dependency

The effect of cloud contaminations and surface properties on the retrievals are illustrated here where all measurements performed around Gobabeb during one pass over a RGB AVHRR image (top) and over a map of the LST retrieved from SEVIRI measurements by the LSA-SAF. This is shown here for the 5th August 2010.



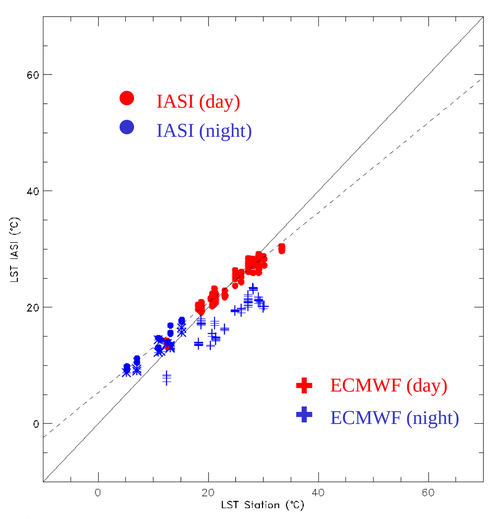
Results for other stations

The LST retrievals have been also been compared with the measurements performed in the stations Evora and RMZ in August 2010.



Evora

IASI LSTs appear to be well correlated with in situ measurements both by day and night, especially considering the location of the station. It lies indeed within a hilly area covered by agricultural fields and evergreen trees (ca. 32%). Noteworthy, most of the positive differences are located East of the station, where a dense acacia tree forest lies.

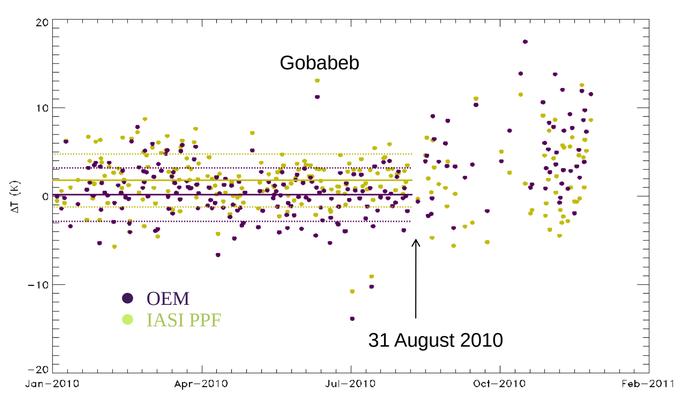


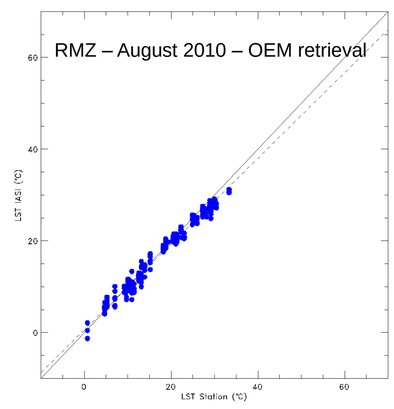
RMZ

The LSTs retrieved in RMZ are very well correlated with the in-situ measurements (although slightly biased by night). This could be due to the location of the station, on a very homogeneous plateau at 1500m altitude of the Kalahari desert for which the emissivity is better characterized than the difficult gravel area around Gobabeb.

An alternative retrieval

Similar comparisons were performed using an alternative LST retrieval based on simultaneous retrieval of LST and emissivity by optimal estimation, developed by Dan Zhou at NASA. The performances of this retrieval, evaluated against the in-situ measurements, does not show a significant improvement for Gobabeb as compared to the linear regression. The figure below shows the time series of the differences between retrieved LSTs using both methods and the in-situ measurement. Noteworthy is the significant degradation of both retrievals after August 2010 that could be due to a particularly wet and cloudy rainy season. The OEM retrieved LST however brings a significant improvement at the RMZ site.





References

Göttsche, F.-M., *et al.*, 2012. Validation of land surface temperature derived from MSG/SEVIRI with in-situ measurements at Gobabeb, Namibia. Int. J. Remote Sensing, **DOI:**10.1080/01431161.2012.716539

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Conclusions

The comparison between IASI LSTs and ground-based measurements has shown that:

- In Gobabeb, the LST can be retrieved with a **bias of 0.24 K** and a **RMS error of 3 K**.
- In **RMZ and Evora**, the time series were too short to draw any significant conclusions. However, the **good correlation between IASI products and in-situ measurements** is encouraging.
- While LSTs from **ECMWF** are in good agreement with the in-situ measurements and consistent with IASI retrievals during night time, they have a **bias of a few K during day time**.

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