VALIDATION OF AN ALL-WEATHER LAND SURFACE TEMPERATURE PRODUCT OVER A LONG RAINY SEASON AT THE GRAVEL PLAINS OF GOBABEB, NAMIBIA

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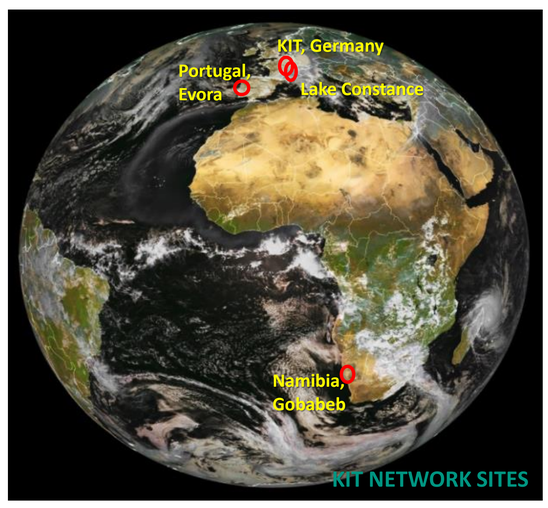
INTRODUCTION

Land surface temperature (LST) is a key variable in a wide variety of studies directly linked to land–atmosphere energy transfer and flux balances and considered by World Meteorological Organization (WMO) and the Global Climate Observing System (GCOS) as one of the essential climate variables (ECVs) for climate change monitoring. However, satellite LST acquisitions are often limited by cloudy skies. Several methods have been proposed in the literature to estimate under-cloud LST from satellite data and merge these with clear-sky LST: these are known as all-weather LST products**. In this study we investigate the accuracy of an all-weather LST product that merges clear-sky MSG/SEVIRI LST at a spatial resolution of 5 km with the surface temperature of a Soil-Vegetation-Atmosphere (SVAT) model (Martins et al., 2019).** This operational product of the Land Surface Analysis - Satellite Application Facility (LSA-SAF) was validated from 2010 to 2012 at KIT's permanent desert validation site Gobabeb, Namibia. The investigated period includes the largest rainfall in Gobabeb's recorded history, which makes LST retrievals challenging due to a) extreme atmospheric conditions and b) changes in biophysical surface properties and, therefore, surface emissivity. The LSA-SAF product and an all-weather LST product from UESTC are investigated within the Dragon 5 project 'All-weather land surface temperature at high spatial resolution: validation and applications' (ID.59318).

Site

Gobabeb Validation site

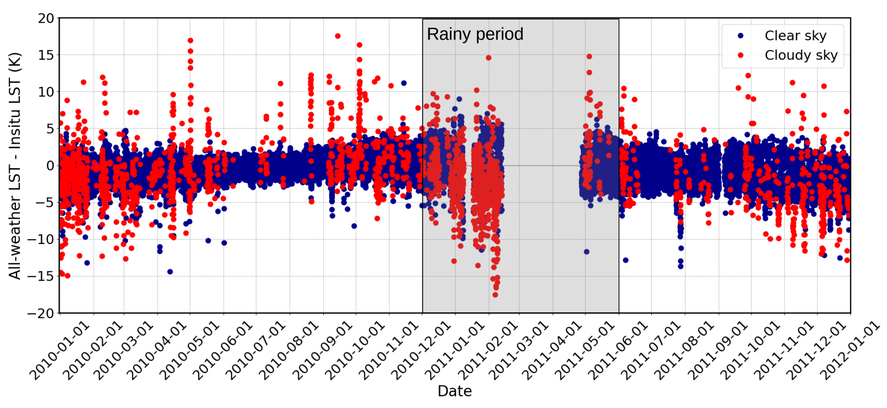
- Location: Namib gravel Plains (Namibia)
- Coordinates: 23.551 °S, 15.051 °E
- Land cover: gravel, sand and dry grass
- Climate: hot desert climate (hyper-arid)
- Annual rainfall: between 0 and 164 mm (historical maximum recorded in 2011)
- The site is thermally homogeneous over thousands of km^2: ideal for LST validation.
- Permanent LST station operates since 2008.



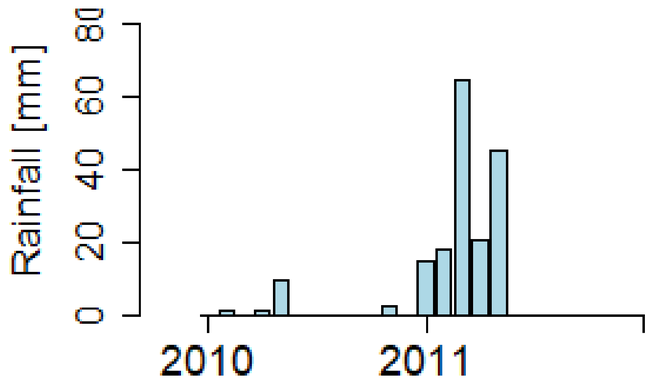
Gobabeb LST station is equipped with:

- Two thermal infrared Heitronics KT15.85 IIP radiometers:
  - spectral range: 9.6 – 11.5 µm
  - Field of view of 8.5°
  - Uncertainty of ±0.3 K
  - High temporal stability (Göttsche et al., 2016)
- Air temperature & humidity sensor (HygroVUE10)
- Remote access & GPS receiver (stable timing)

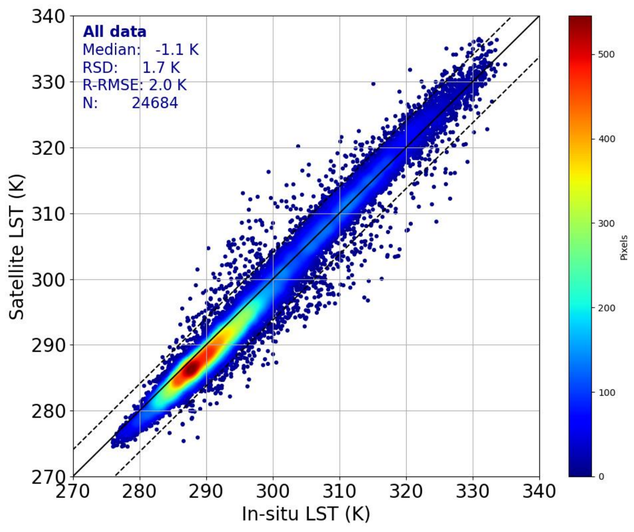
RESULTS

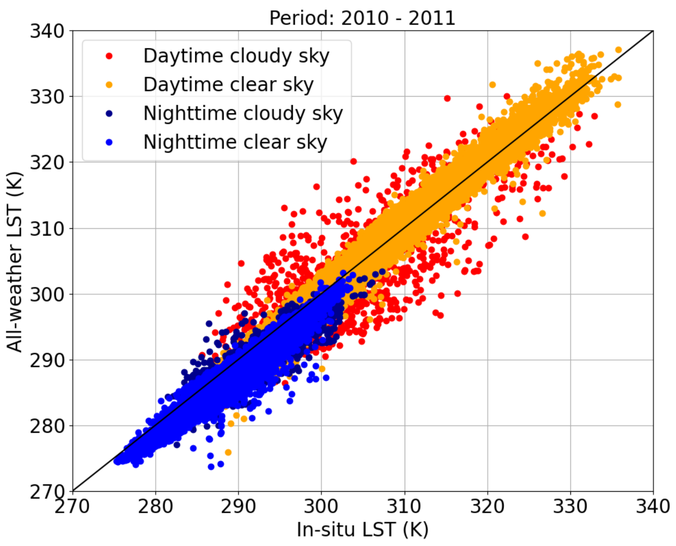


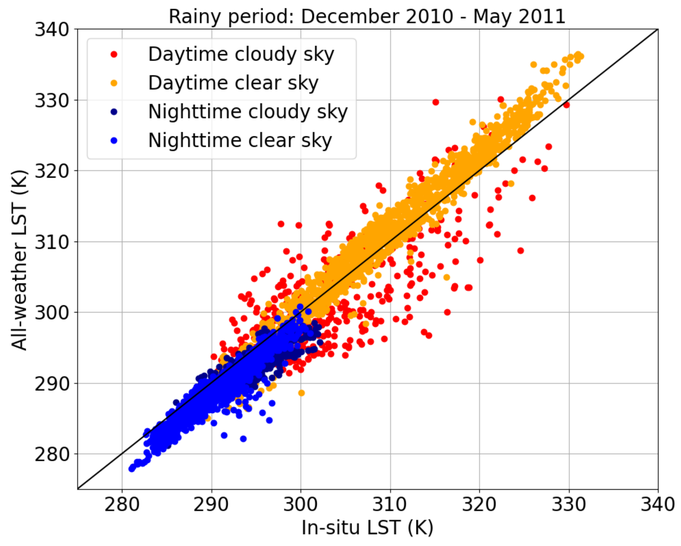
Differences between all-weather LST and in-situ LST for 2010 - 2011 at Gobabeb, Namibia. The data gap during the rainy period was caused by an instrument failure.



Monthly rainfall at Gobabeb for 2010 - 2011. Data from Gobabeb Namib Research Institute (GNRI); adapted from Obrecht (2023).







All-weather LST against in-situ LST acquired at Gobabeb for the entire period of 2010 - 2011 (left) and only the rainy period (right).

2010 – 2011		Median (K)	RSD (K)	R-RMSE (K)	Data points
Daytime	Clear sky	-0.1	1.7	1.7	9426
	Cloudy sky	-0.9	6.0	6.1	1024
Nighttime	Clear sky	-1.7	1.3	2.2	10970
	Cloudy sky	-2.2	2.2	3.1	1452
Overall		-1.1	1.7	2.0	22872

Dec 2010 – May 2011		Median (K)	RSD (K)	R-RMSE (K)	Data points
Daytime	Clear sky	1.1	2.3	2.5	1388
	Cloudy sky	-1.5	6.0	6.2	388
Nighttime	Clear sky	-1.9	1.2	2.2	1294
	Cloudy sky	-2.3	1.7	2.9	485
Overall		-1.0	2.3	2.5	3555

CONCLUSIONS

- For the period 2010 – 2011 the differences between LSA-SAF's all-weather LST and in-situ LST from Gobabeb showed an overall median (R-RMSE) of -1.1 K (2.0 K).
- For the rainy period a slightly smaller median (-1.0 K), but larger R-RMSE (2.5 K) was observed.
- At nighttime the all-weather LST product showed good results under all conditions.
- At daytime under clear sky conditions the median is -0.1 K for the entire period and 1.1 K for the rainy period, which indicates a reduced representativeness of in-situ LST during the rainy period.
- At daytime under cloudy sky conditions large RSD (about 6 K) were observed: these are probably due to larger spatial LST heterogeneity under these conditions.
- The rainy season did not affect the all-weather LST's performance, demonstrating the product's robustness under different and difficult atmospheric conditions.

References

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