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

Characterisation of Permanent LST Validation Sites with Field Surveys and an Unmanned Aerial Vehicle (UAV)

- from ground based radiometer spots to MSG pixel -

Folke Olesen, Frank Göttsche, Annika Bork-Unkelbach

Introduction

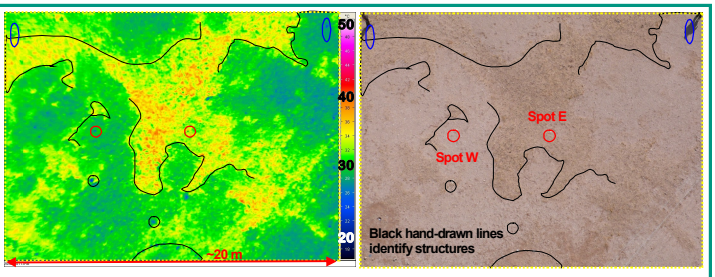
Land Surface Temperature (LST) is an operational product of the Land Surface Analysis – Satellite Applications Facility (LSA-SAF). In order to validate satellite derived LST, KIT operates four stations: Evora (Portugal), Dahra (Senegal), Gobabeb (Namibia, Desert), and RMZ-Farm (Namibia, Kalahari). Precision radiometers Heitronics KT15.85 IIP (9.6-11.5µm, accuracy ±0.3K) measure the surface leaving radiance of the relevant components. Additionally, Evora, Gobabeb, and RMZ have shortwave & longwave radiation budget sensors and all stations record standard meteorological data.

Validation results from Gobabeb demonstrate the excellent quality of the LST product operationally derived by LSA-SAF from MSG/SEVIRI data. Measurements performed with radiometers mounted to a mobile mast and to a car successfully demonstrated that the main station LST are representative for a wider area. However, for long term validation of satellite derived LST the observed surface components and the validation site have to be regularly characterised in more detail. Therefore, larger areas will be covered by the KIT-UAV, which was already flown with a VIS-camera as a proof of concept.

Validation is supported by Eumetsat in the LSA-SAF

The radiometer spots Gobabeb, Namib Desert

Due to their invariance in space and time the gravel plains at Gobabeb are ideal for LST validation. However, the representation of ~ 50 km² with a radiometer FOV of about 10 m² needs proof. The IR and VIS images on the right show the area just north of the 30 m tower. MSG/SEVIRI LST over the plains are in good agreement with spot East but spot West deviates by up to 2°C. By measuring along a 40 km track (see below) it was shown that spot E is more representative of the validation area, as already suspected from similarity in land cover.

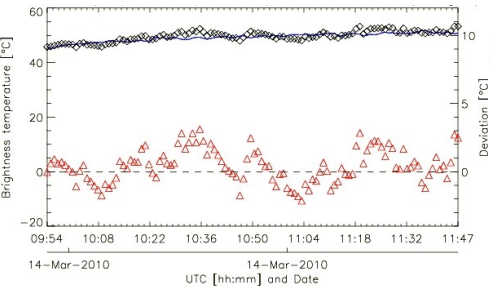


Ground based site characterisation

A radiometer (KT-15) was mounted on a car and driven over a distance of ~40 km.
Namib Desert, gravel planes

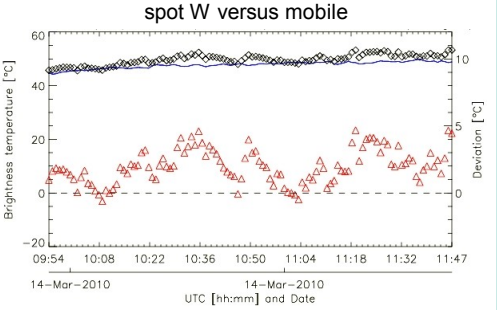
Plots show brightness temperatures of
- mobile radiometer (diamonds)
- spot E and W (lines)
- differences (red triangles)

spot E versus mobile



A stdev of 1.2°C and bias of 0.4°C support the assumption that spot E is representative of the site

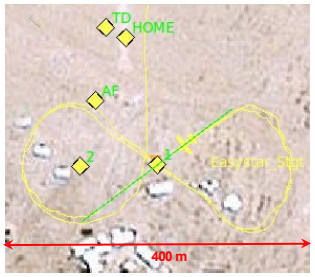
spot W versus mobile



The 1.3°C stdev and 2.0°C bias determined for spot W suggest that it is less representative

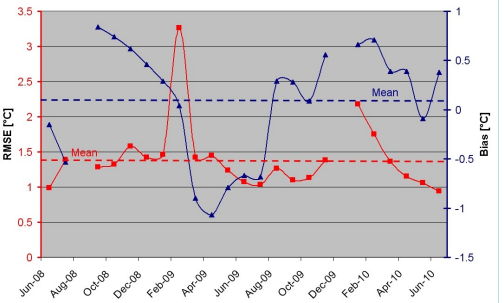
UAV proof of concept in Gobabeb

The next step beyond a ground based moving radiometer is flying: low cost UAV allow frequent measurements to close the gap between the 10 m² radiometer spots and the 50 km² satellite pixel size. The KIT-UAV was flown experimentally over the Namib desert and in the Kalahari. It features accurate navigation, onboard data storage, and a low weight radiometer. Except for the "Paparazzi UAV" hard- and software and the purpose built radiometer only COTS components are used.



The yellow track was flown fully autonomously by the open source Paparazzi UAV, which determines its 3-D location by onboard GPS and controls aircraft attitude with IR horizon detectors. Arbitrary flight patterns can be stored onboard and are accurately reproduced, e.g. the multiple "figures of eight" shown left.

Validation of LST from LSA-SAF



The LST bias between LSA-SAF and Gobabeb is usually less than ±1°C and demonstrates the high quality of the SAF product. However, some temporal variation attributed to the LST-algorithm is observed: this will be investigated in detailed surveys with the mobile radiometer and the UAV.

Open for new ideas

Our stations are located in flat, homogeneous terrains and use towers between 15 m and 30 m height. Data loggers, solar power supplies, and telecommunication have spare capacities and further instruments can be integrated.
The KIT-UAV will be developed to carry about 500 g of payload. We are open for new research ideas – ***so feel free to contact us!***

folke.olesen@kit.edu

annika.bork@kit.edu