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Improved in-situ methods for determining land surface emissivity

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The accurate validation of LST satellite products, such as the operational LST retrieved by the Land Surface Analysis – Satellite Application Facility (LSA-SAF), requires accurate knowledge of emissivity for the areas observed by the ground radiometers as well as for the area observed by the satellite sensor. Especially over arid regions, the relatively high uncertainty in land surface emissivity (LSE) limits the accuracy with which land surface temperature (LST) can be retrieved from thermal infrared (TIR) radiance measurements. LSE uncertainty affects LST obtained from satellite measurements and in-situ radiance measurements alike. Furthermore, direct comparisons between satellite sensors and ground based sensors are complicated by spatial scale mismatch: ground radiometers usually observe some 10 m2, whereas satellite sensors typically observe between 1 km2 and 100 km2. Therefore, validation sites have to be carefully selected and need to be characterised on the scale of the ground radiometer as well as on the scale of the satellite pixel.

The permanent stations near Gobabeb (Namibia; hyper-arid desert climate) and Dahra (Senegal; hot-arid steppe-prairie climate) are two of KIT's four dedicated LST validation stations. Gobabeb station is located on vast and flat gravel plains (several 100 km2), which are mainly covered by coarse gravel, sand, and desiccated grass. The gravel plains are highly homogeneous in space and time, which makes them ideal for validating a broad range of satellite-derived products. Dahra station is located in so called 'tiger bush' and is covered by strongly seasonal grass (95%) and sparse, evergreen trees (dominantly acacia trees) with a background of reddish sand. The strong seasonality is caused by a pronounced rainy season, during which LST retrieval is highly challenging. Outside the rainy season, both sites have relatively large fractions of bare ground and desiccated vegetation: therefore, they are particularly prone to be misrepresented in satellite-retrieved LSEs. In-situ emissivities of dominant surface cover types at Gobabeb and Dahra were obtained with the so-called 'box method', which consists of a sequence of thermal infrared radiance measurements and employs a box with highly reflective inner walls to control the radiation from the environment. The original method was improved by continuously recording the radiance measurements at a sampling rate of one second, which allows the picking of the first undisturbed temperature after changing the box configuration. Furthermore, erroneous measurements, e.g. from incorrectly placing the box on a target, can still be identified and rejected later. In-situ LSEs are compared to emissivity spectra of soil and grass samples and to LSE retrieved from the Moderate Resolution Imaging Spectroradiometer (MODIS) on EOS-Terra.