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In-situ land surface emissivity retrieved from FTIR spectroscopic measurements at Gobabeb, Namibia

Frank Goettsche, Folke Olesen, and Annika Bork-Unkelbach
Karlsruhe Institute of Technology, IMK-ASF, Eggenstein-Leopoldshafen, Germany (frank.goettsche@kit.edu)

Gobabeb, Namibia (hyper-arid climate) is one of KIT's four dedicated LST validation stations. The network provides validation data to EUMETSAT's Land Surface Analysis – Satellite Application Facility (LSA-SAF). Gobabeb station measures upwelling and down-welling thermal infrared (TIR) radiance for LST determination as well as broadband SW & LW up- and downwelling radiance over the vast and flat gravel plains of the Namib Desert, i.e. the measurements are representative for an area of several 100 km2. All data are provided at one minute temporal resolution. The gravel plains are mainly covered by coarse gravel, sand, and desiccated grass and are highly homogeneous in space and time: this allows validating a broad range of satellite-derived products with a limited number of representative radiance measurements. However, over arid regions the relatively high uncertainty in land surface emissivity (LSE) limits the accuracy with which land surface temperature (LST) can be retrieved. As LSE uncertainty affects LST obtained from satellite measurements and in-situ radiance measurements alike, the determination and validation of LST requires accurate knowledge of emissivity for the areas observed by the ground radiometers and the satellite sensor.

During previous campaigns in-situ emissivities of dominant surface cover types at Gobabeb were obtained with a variant of the so-called 'emissivity box method', which presents a well-established and straight-forward way to determine in-situ emissivity. However, the method is limited in that it retrieves channel-effective emissivities specific to the field radiometer. For validating satellite LST&E products these still need to be matched to the response function of the satellite sensor: this is usually achieved via an empirical regression relationship and introduces additional uncertainty. In contrast, emissivity spectra allow obtaining accurate channel-effective LSE of arbitrary sensors. However, due to the weight and other limitations of most commercially available Fourier Transform Infrared (FTIR) spectrometers, such measurements are usually performed over samples in the laboratory. This often changes important characteristics of natural cover types, e.g. surface structure, composition, and moisture content, and – consequently – also emissivity. In order to collect unaltered emissivity spectra for the Gobabeb site, in January 2015 KIT performed a series of in-situ measurements with a portable Fourier Transform Infrared (FTIR) spectrometer (Bruker EM 27; 4.5 - 14.0 μm). Here, the details of the campaign are given and the retrieved emissivity spectra are compared to the LSE previously obtained with the box method.