ANGULAR DEPENDENCE OF THE EMISSIVITY OF BARE SOILS IN THE THERMAL INFRARED

Mira M., García V., Coll C., Valor E., Caselles V., and Galve J.M.
University of Valencia, C/ Dr. Moliner 50, 46100 Burjassot (Spain)

Surface emissivity is an important parameter for determining the long-wave surface energy balance, which is strongly affected by the difference between the land surface temperature (LST) and the sky brightness temperature. This difference is small outside the atmospheric window region (7-14 μm) and any changes in the emitted radiation by emissivity variability are mostly compensated for changes in the reflected sky brightness. However, the difference is the greatest in the atmospheric window, where it is possible to estimate the land surface emissivity from multi-spectral thermal infrared (TIR) remote sensing. Furthermore, if the emissivity is known, the LST can be accurately estimated from TIR radiance measurements. For these reasons, it is necessary to study the factors that influence emissivity, since it must be estimated with the highest possible accuracy. It was observed by [1] that an emissivity variation of 0.06 causes an error of 2.2 K in the LST determination (at 11 μm and for a LST of about 300 K). An accurate knowledge of the angular variation of surface emissivity in the TIR is required to estimate sea and land surface temperature from multi-angle algorithms. Several models have been derived to address angular effects, but relevant data for validating such models are still scarce. The present work presents a set of radiometric measurements to evaluate the variability of TIR emissivities of bare soils due to the observational angular effects. A variety of samples of surface horizons (0-15 cm) of different soil types was selected for the study.

Radiance measurements were carried out with the high-precision multi channel TIR radiometer CIMEL Electronique CE 312-2 [2]. It has six spectral channels: one broad and five narrow channels. The similarity between the CE 312-2 bands and the Advanced Spaceborne Thermal Emission and Reflection radiometer (ASTER) TIR bands allows the application of the temperature and emissivity separation algorithm (TES) for recovering surface emissivities from the ground-based measurements. TES is based on an empirical relationship between the range of emissivities for a set of TIR channels and their minimum value [3]. It was used to calculate the TIR emissivity of the soils at nadir observation. The infrared diffuse reflectance plate "Infragold reflectance standard, IRT-94-100" was used to measure the downwelling sky irradiance (F_{sky}). It allows an accurate determination of F_{sky} since it is only necessary to take a single measurement of radiance coming from the plate at any observation angle. Moreover, this measurement includes the contribution of the surroundings and does not require clear sky or full covered sky conditions. To determine the emissivity of the soils at a certain observation angle different to nadir, a simultaneous pair of radiance measurements were taken each time: a measurement of soil radiance at nadir, and another one at a certain angle. It gives us the absolute variation of emissivity from one angle to another. Then, this method estimates the angular variation of soil emissivity, while the TES method sets the position of the spectral curves. A simple goniometric system was designed to take angular measurements. It allows a complete scan cycle of 16 measurements (from 0º to 75º in a fixed azimuthal angle, at 5º increments) in approximately 10 min.

References

[1] M. Mira *et al.*, 2007, *J. Geophys. Res.*, 112(F4), F04003, doi:10.1029/2007JF000749.
[2] G. Brogniez *et al.*, 2003, *J. Atmos. Ocean Techn.*, 20(7), 1023-1033.
[3] A. Gillespie *et al.,* 1998, *IEEE Trans. Geosci. Remote Sens.,* 36(4)*,* 1113-1126.