Modeling spectral and directional soil reflectance in the solar domain (400-2500 nm) as a function of soil moisture content

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Abstract:

This PhD, which results from a collaboration between IPGP and ONERA in Toulouse, follows the exploratory work by Aurélien Bablet in the frame of his PhD thesis (IPGP-ONERA). On this occasion, he developed a radiative transfer model called MARMIT (MultilAyer Radiative transfer Model of soIl reflectance), which was one of the first physically-based model to predict soil reflectance as a function of soil moisture content (SMC). The inversion of MARMIT enables to assess soil surface humidity, an important variable of the critical zone for many domains such as agriculture, hydrology or planetology, remotely. The main objective of this PhD is the improvement of the MARMIT model and its multi-scale validation using hyperspectral data: field measurements, airborne images (metric spatial resolution), and satellite images (decametric spatial resolution).
The MARMIT model depicts a wet soil as a layer of dry soil covered with a thin slab of pure liquid water. A multi-reflection process takes place in the water film. The reflectance of the wet soil explicitly depends on two parameters: L, the thickness of the water layer, and ϵ, the fraction of ground covered by water. Assuming that the reflectance spectrum of the dry soil is known, the parameters L and ϵ can be retrieved by minimization of the least-square difference between the measured and predicted reflectances. Then, these parameters are linked with SMC by an empirical calibration relation that differs from one soil to another. The dependency of this calibration on the soil type is a current limitation of the MARMIT model for an application to remote sensing.

Keywords: remote sensing, optics