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Assessment of soil moisture content using a MultilAyer Radiative transfer Model of soIl reflecTance (MARMIT) in the solar domain

Aurélien Bablet (1,2), Françoise Viallefont (1), Sophie Fabre (1), Xavier Briottet (1), and Stéphane Jacquemoud (2)

(1) ONERA, DOTA, France (aurelien.bablet@onera.fr), (2) IPGP, PSS, France

Soil moisture content (SMC) is a key parameter in Earth surface processes. Indeed, although soil water represents only 0.15% of liquid water around the world, it plays a significant role in the hydrological cycle, modulating the interactions between the land surface and the atmosphere, thereby influencing climate and weather. It is also an essential parameter in agriculture and defense.
It is well known that soils darken when they get wet. The decrease of reflectance at the surface, which is observed in the visible region of the electromagnetic spectrum, can be extended to the shortwave infrared and beyond. Thus, the potential of optical remote sensing techniques to retrieve SMC is investigated by the scientific community. Unlike in situ measurements (neutron probe, dielectric methods...), they provide good temporal and spatial coverage. Many empirical methods have been developed in previous years to infer soil moisture content but they generally depend on soil type and thereby they lack robustness. Conversely, very few physical methods have been investigated. In this study, we evaluate several methods of SMC assessment on seven independent laboratory datasets gathered from the literature or generated by us. They include a total of 217 soils. We compare these methods to MARMIT (MultilAyer Radiative transfer Model of soIl reflectance), a new model based on the Bach model that represents a wet soil as a dry soil covered with a thin layer of water. The two input parameters of the model are the thickness of the water layer (L) and the fraction of wet soil (ε). We first estimate them by inversion of MARMIT. Secondly we link the SMC with the mean water thickness (φ), which depends both on L and ε, using a sigmoid function: this is the calibration step. Then we can infer SMC using the method in the direct way: this is the assessment step. The whole procedure is called “MARMITforSMC”. It globally provides the best results among all published methods (e.g., spectral indices or empirical methods) to retrieve SMC. If the calibration step is applied soil by soil, the RMSE is around 3%, a value comparable to errors found with in situ measurements. Moreover some physical properties of the soil such as porosity or grain size have been also inferred.