Paris, February 25, 2022

Estimation of soil water content by optical remote sensing in the solar domain (0.4-3.0 µm) – Application to multispectral and hyperspectral HRS satellite

General information

Funding: CNES postdoc. The successful candidate must submit an application on the website https://apr.cnes.fr before **March 31, 2022**
Workplace: Paris (stays at ONERA in Toulouse)
Duration of the contract: 24 months
Working hours: full time
Expected date of hire: before the end of December 2022
Remuneration: CNES salary scale
Desired level of education: PhD

Background

Soil moisture content (SMC) is an essential variable of the critical zone. It has multiple applications in fields as diverse as agriculture, forestry, ecology, continental hydrology, micrometeorology, defense and planetary science. Soil water varies rapidly in space and time due to the spatial variability of soil physical properties, the discontinuous nature of precipitation, and flow dynamics. Space or airborne remote sensing in the solar domain provides access to surface water content.

Spectral indices have been proposed in the literature to determine SMC from multispectral images (Landsat, Sentinel-2); the analysis of images from hyperspectral sensors (Prisma, EnMap) will require more appropriate spectral analysis methods. IPGP and ONERA have recently developed a radiative transfer model, MARMIT (multilayer radiative transfer model of soil reflectance), which can calculate the spectral reflectance of a "smooth" soil as a function of its gravimetric water content (Bablet et al., 2018; Dupiau et al., 2022). The MARMIT model can be coupled with analytical (RPV, Hapke) or numerical (DART) BRDF (*Bidirectional Reflectance Distribution Function*) models to simulate the spectral and directional reflectance of a wet, rough soil.

Bablet A., Viallefont-Robinet F., Jacquemoud S., Fabre S., Briottet X. (2020), High-resolution mapping of in-depth soil moisture content through a laboratory experiment coupling a spectroradiometer and two hyperspectral cameras, *Remote Sensing of Environment*, 236:111533. https://doi.org/10.1016/j.rse.2019.111533

Dupiau A., Jacquemoud S., X. Briottet, Fabre S., Viallefont-Robinet F., Philpot W., Di Biagio C., Hébert M., Formenti P. (2022), MARMIT 2: an improved version of the MARMIT model to predict soil reflectance as a function of surface water content in the solar domain, *Remote Sensing of Environment*, in press. https://doi.org/10.1016/j.rse.2022.112951

Research activities

Your mission will be to compare different methods/sensors for mapping surface water content in soils for operational purposes. Specifically, you will:

- Build a database of BRDFs of soils at different moisture and surface roughness levels. You will collect data sets already acquired by the different partners in previous studies, and new data sets published in the literature. You will simulate BRDFs of wet and rough soils using the DART ray-tracing model developed by CESBIO.
- Test and compare different SMC estimation methods published in the literature on synthetic remote sensing data, acquired in the laboratory (reflectance spectra) or by an airborne or spaceborne sensor (multispectral and hyperspectral images).
- Propose specific processing chains applied to optical sensors in flight or in preparatory phase. In particular, you will test supervised or unsupervised machine learning methods to process large amounts of remote sensing data.

Desired skills

The candidate must have a PhD in remote sensing, astrophysics, or geophysics, with knowledge of optical radiometry, radiative transfer modeling, image processing, and machine learning. Programming language (Matlab/Python).

Work environment

The work will take place mainly in Paris within the Planetary and Space Sciences team of IPGP / Université de Paris (http://www.ipgp.fr/). The project will be done in close collaboration with ONERA-DOTA (https://www.onera.fr/en/dota) and CESBIO (https://www.cesbio.cnrs.fr/) in Toulouse and with several international research teams. The candidate will interact with CNES in the framework of the HYSP hyperspectral mission and other space mission projects.

Working meetings in Toulouse and occasional missions abroad for conferences or experimental measurements (Italy, USA).

Contact

Contact or send a letter of motivation (describing motivations, experience and qualifications) and a curriculum vitae to:

Prof. Stéphane Jacquemoud, Professor of remote sensing, IPGP, 01 57 27 84 96 jacquemoud@ipgp.fr
Dr. Xavier Briottet, Senior Research Scientist, ONERA, 05 62 25 26 05 xavier.briottet@onera.fr