DART-EB Modeling of Temporal Series of TIR Radiance and Evapotranspiration Fluxes

Location: CESBIO (Centre d'Études Spatiales de la Biosphère), Toulouse, France
Duration: 6 months, from 03/2025
Supervisor: Yingjie Wang, CESBIO
Collaborations:
- CESBIO: J.P. Gastellu-Etchegorry, J.L. Roujean, A. Gourrat, N. Lauret, J. Guilleux, E. Chevanon.
- University of Bonn, Germany: Z. Malenovsky, O. Regaieg, Q. T. Nguyen.
- CRNS, Tunisia: A. Kallel.

Evapotranspiration is a key process in the functioning of terrestrial surfaces. Its study provides valuable insights into the functional state of vegetation. Monitoring and analysing its temporal evolution is crucial for numerous research fields and applications, including agriculture, forestry, urban environments. The goal of this project is to simulate and study the temporal evolution of thermal infrared (TIR) observations and evapotranspiration fluxes from vegetation canopies, as well as the impact of the 3D structure of the canopy on these two variables. This work will contribute to the preparation of the Franco-Indian TRISHNA (Thermal InfraRed Imaging Satellite for High-resolution Natural resource Assessment, https://trishna.cnes.fr/en/trishna) satellite mission, scheduled for launch in 2026. This mission, with its high spatio-temporal resolution, aims to monitor the water status and stress of terrestrial ecosystems (forests, crops, etc.).

The approach adopted for this study is based on energy balance modelling. The DART-EB model, developed at CESBIO since 1996 (see Pierre Guillevic, 1999) and fully redeveloped starting in 2021 (see Thang Nguyen, 2022), will be used to simulate the energy balance and the associated energy and matter fluxes. This model integrates two types of modelling:

(1) 3D Radiative Energy Balance Modelling
This is achieved through the DART model (https://dart.omp.eu), developed at CESBIO since 1992 and patented in 2003. DART is one of the most comprehensive and accurate radiative transfer models in the field of remote sensing. It simulates remote sensing measurements (e.g., imaging spectrometers, cameras, LiDAR) as well as the 3D radiative balance (absorption, thermal emission, solar-induced fluorescence (SIF), etc.) of natural and urban surfaces, including topography and atmosphere.

(2) Non-Radiative Process Modelling
This involves modelling processes such as evapotranspiration, sensible heat transfer, and photosynthesis, which influence the energy balance of vegetation canopies. By integrating the 3D radiative energy balance from DART, the model computes the spatial distribution of thermodynamic temperatures and evapotranspiration fluxes within the canopy.

Requirements: We are seeking a motivated Master's-level student in the fields of environmental science, remote sensing, physics, or computational modelling. We appreciate a profile with strong background in physics or environmental modelling, proficiency in programming Python, interest in remote sensing and ecosystem science and good communication skills and ability to work collaboratively.

Application: Submit your application (CV and cover letter) to yingjie.wang@iut-tlse3.fr