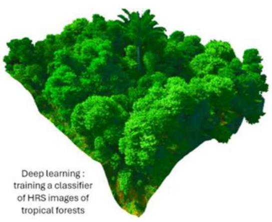
DART Tutorial 2024

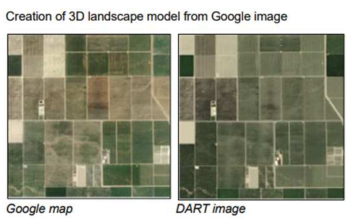
A tutorial on DART is offered at UFPA (Belém, Brazil) alongside the ISPRS-SELPER remote sensing symposium, on November 2-4, 2024

Location	Universidade Federal do Pará (UFPA) Rua Augusto Corrêa 01, Guamá, Belém, BRAZIL	
Dates	November 2-4, 2024 (3 days), 8h30 – 18h00	
Organization	SELPER-Brasil	
Training and Scientific Support	Center for Space Studies of the BIOsphere (CESBIO)	
Contact	jean-philippe.gastellu@cesbio.cnes.fr yingjie.wang@univ-tlse3.fr	
Registration (together with registration for the event)	Fees 180 US $ Include course and technical assistance before and after course, lunch, coffee break, cocktail dinner on November 4 Dinner on November 2 and 3 is optional with additional fee of 25 $ each Practical information will be sent to registered trainees for transport and accommodation	
Recommendations	Before the tutorial: Get a free DART license (https://dart.omp.eu) Discover User Manual Transmit your case study	At the tutorial: Bring a "good" laptop

The DART model

DART (Discrete Anisotropic Radiative Transfer) is an ever-evolving radiative transfer model developed since 1992 at CESBIO (https://dart.omp.eu). It simulates the 3D radiative budget (RB), including sun induced chlorophyll fluorescence (SIF), and remote sensing (RS) satellite, airborne and in-situ signals (spectroradiometer image, LiDAR FWF, SPL, point cloud) of natural and urban landscapes, from visible to thermal infrared. It is a reference tool for a wide range of RS studies (sensitivity studies, inversion of RS images, design of new RS sensor, etc.). Licenses are free for research and education.





The objective of the tutorial is to discover/deepen DART theory, functionalities and use:

1) Short review of physical bases
2) DART theory, functionalities and novelties (DART-Lux bi-directional MC, texture, etc.)
3) Study of schematic cases through prepared exercises
4) Presentation of Pytools4DART
5) Case studies of interest to each participant

1. **SHORT REVIEW OF PHYSICAL BASES** (optical remote sensing, radiative budget)
Radiance, reflectance, emissivity, brightness temperature, radiative budget, etc.

2. **DART THEORY AND FUNCTIONALITIES**
a) **Theory**: standard DART-FT and latest DART-Lux (bi-directional Monte Carlo)
b) **Major functionalities** (interactive presentation)

- Mode of operation: spectroradiometer (modes R, T, R+T), LiDAR, RB.
- Landscape modelling:

Geometry: scene dimensions, spatial resolution, topography, coordinates, etc.
Components: * directly simulated trees, houses, crops, topography, etc.
* imported 3D element and landscape (urban database, tree, etc.)
*4 basic elements (facets, turbid (vegetation), fluid (air, water), atmosphere).
Optical properties: surface (anisotropic facets) & volume (turbid, fluid and air)
Atmosphere: gas and aerosol vertical profiles.

- DART remote sensing (RS) and radiative budget (RB) products
- LUT (SQL database) creation/management with the DART sequencer
- Post processing tools: correction of topographic effects, satellite broad bands
- Use of command lines: DART, its modules and its sequences

3. **PRACTICE OF DART WITH EXERCISES, FROM SIMPLE TO COMPLEX**

3.a *Flat surfaces* - *VIS/ NIR / TIR spectral domains*
Basic DART functionalities are introduced with simple 2D landscapes: scene creation, simulation of images (irradiance, albedo, exitance, directional radiance / reflectance / brightness temperature), radiative budget, sequence of simulations (landscape reflectance spectra, satellite broad bands, time series, etc.).
Example of basic case study: for which experimental / instrumental configuration, can we detect a fire in a thermal infrared (TIR) pixel? Can we distinguish ice and ground TIR pixels with the same thermodynamic temperature?

3.b *Simulation of realistic 3D landscapes*
The presentation focuses on functionalities / landscapes of interest to attendees:

- Atmosphere simulation: gas and aerosol models, atmosphere geometry, etc.
- Creation of complex forest, agricultural or urban scene with topography, etc.
- Importation of 3D elements and /or landscapes
- Simulation of fluorescence, LiDAR, etc.

4. PRESENTATION OF PYTOOLS4DART (https://gitlab.com/pytools4dart/pytools4dart)
API python created by TETIS (www.umr-tetis.fr) for DART massive simulations.

5. IMPLEMENTATION BY EACH PARTICIPANT OF HIS/HER OWN CASE STUDY

- Radiative budget: forest, urban landscape, etc.
- Scene creation (forest, crop, etc.) with imported 3D objects (tree, maize, etc.)
- Sensitivity studies (e.g., variation of forest reflectance / brightness temperature with LAI, view
- direction, topography, thermodynamic temperature).
- Inversion of satellite image of city as map of optical property per urban element
- LiDAR: waveform, solar noise, 3D points derived from waveforms etc.