



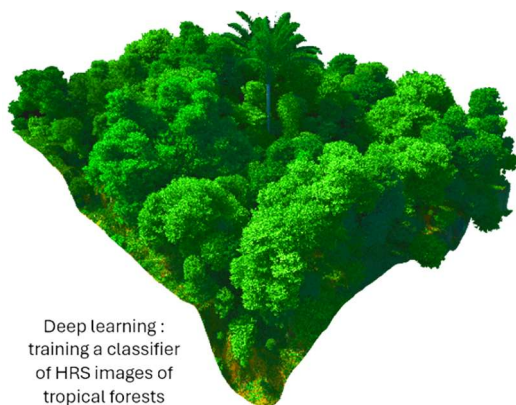
DART Tutorial 2024

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	CESBIO
Contact	jean-philippe.gastellu@cesbio.cnes.fr yingjie.wang@univ-tlse3.fr
Registration	https://selperbrasil.org.br/cursos-e-treinamentos/ Fees 180 \$ 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.



Deep learning :
training a classifier
of HRS images of
tropical forests

Creation of 3D landscape model from Google image



Google map

DART image

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 modeling:

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.umar-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.

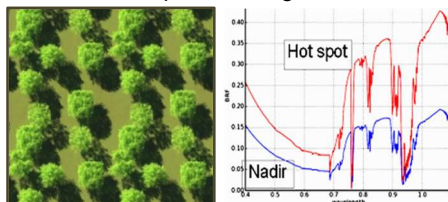
Satellite image inversion



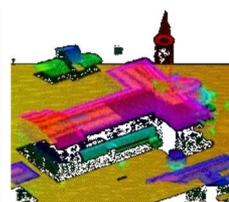
Sentinel-2 image

DART image

BOA & TOA spectral images



LiDAR



Thermal IR

