



**HAL**  
open science

## Toward the inter-comparison of radiation transfert model for plant modelling application

Christian Fournier, Frédéric Boudon, Michaël Chelle, M. Saudreau, Jérôme Ngao, Gaëtan Louarn, Didier Combes, Christophe Pradal

### ► To cite this version:

Christian Fournier, Frédéric Boudon, Michaël Chelle, M. Saudreau, Jérôme Ngao, et al.. Toward the inter-comparison of radiation transfert model for plant modelling application. IEEE International Conference on Functional-Structural Plant Growth Modeling, Simulation, Visualization and Applications (FSPMA 2016), Nov 2016, QingDao, China. . hal-01400026

**HAL Id: hal-01400026**

**<https://inria.hal.science/hal-01400026>**

Submitted on 22 Nov 2016

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

# Toward the inter-comparison of radiation transfer model for plant modelling application

Christian Fournier<sup>1,2,\*</sup>, Frédéric Boudon<sup>2,3</sup>, Michaël Chelle<sup>4</sup>, Marc Saudreau<sup>5</sup>, Jérôme Ngao<sup>5</sup>, Gaëtan Louarn<sup>6</sup>, Didier Combes<sup>6</sup> and Christophe Pradal<sup>2,3</sup>

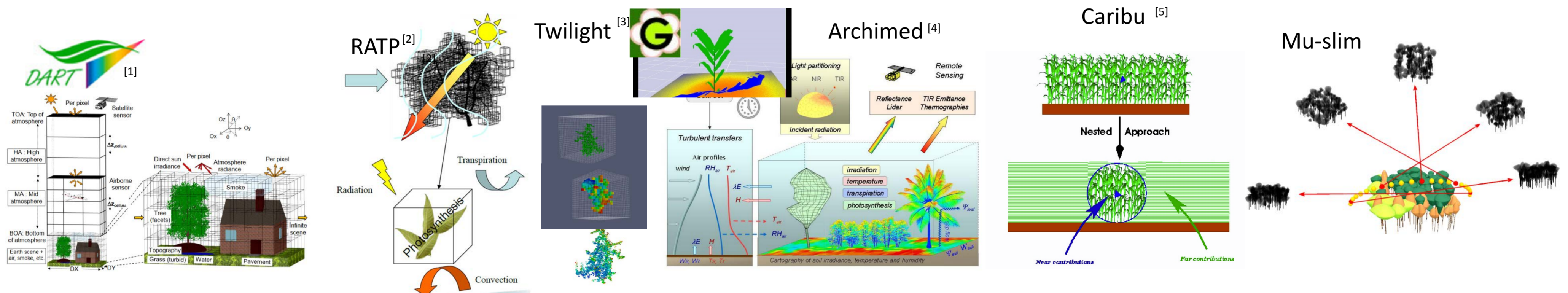
<sup>1</sup>INRA, UMR759 LEPSE, 34060, Montpellier, France, <sup>2</sup>Inria project-team Virtual Plants, 34095 Montpellier France, <sup>3</sup>CIRAD, UMR1334 AGAP, 34398 Montpellier, France, <sup>4</sup>INRA UMR Ecosys, 78850 Thiverval Grignon, France, <sup>5</sup>INRA UMR547 PIAF, F-63100 Clermont-Ferrand, France, <sup>6</sup>UR4 URP3F, F86600 Lusignan, France

## Context

### RT models and FSPM

The simulation of radiation transfer (RT) is used in many FSPM models and applications. This preeminence is explained by the central role of light in plant growth and development, light being both the energetic source of photosynthesis and an important mediator for the adaptation of plant development to their environment (photomorphogenesis). Radiation is also a key component of the energy budget of plant organs and a factor driving stomata. Thus RT models are required to simulate organ temperature, leaf photosynthesis, transpiration and water fluxes within plants. At a larger scale, radiation transfer models allow to quantify the light interception efficiency of complex tree crowns or of a canopy, which are important traits for breeding or crop modeling. They also makes it possible to determine the sharing of light between different individuals and species within natural and artificial plant communities; both in field or controlled conditions

### A large variety of RT models and approaches



Parallel to this variety of applications, different RT models were developed or adapted for use in the FSPM community. Developed in different context and for different objectives, they differ both in their objectives, in terms of spatial and time scales resolved and, as a consequence, on the way they apprehend plant geometry (volumic vs surfacic objects) and on the way they approximate the physics of radiation transfers and light-plant interactions. Their inter-comparison may be useful to choose and optimize a modeling strategy. Still this task is difficult due to difference in interfaces and in specific parameterization protocols.

## How to ease the inter-comparison of RT models ?

### Method

We set-up a software package on the OpenAlea platform, dedicated to the inter-comparison of radiation transfer models. Three light models available on OpenAlea Platform (Caribu, Ratp, Fractalysis) were interfaced with the package.

### Standardization of model interfaces

A unique interface was designed for the three models. Two standardization directions were addressed:

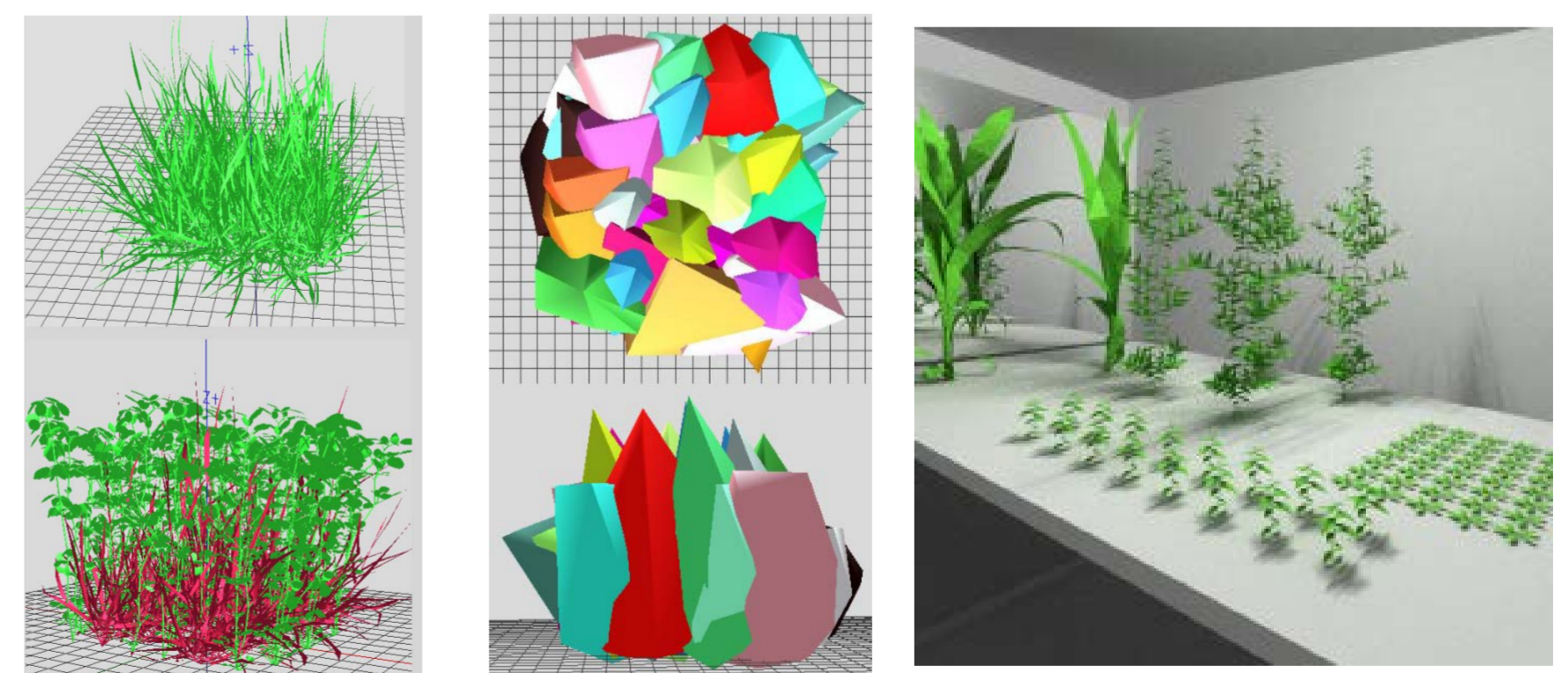
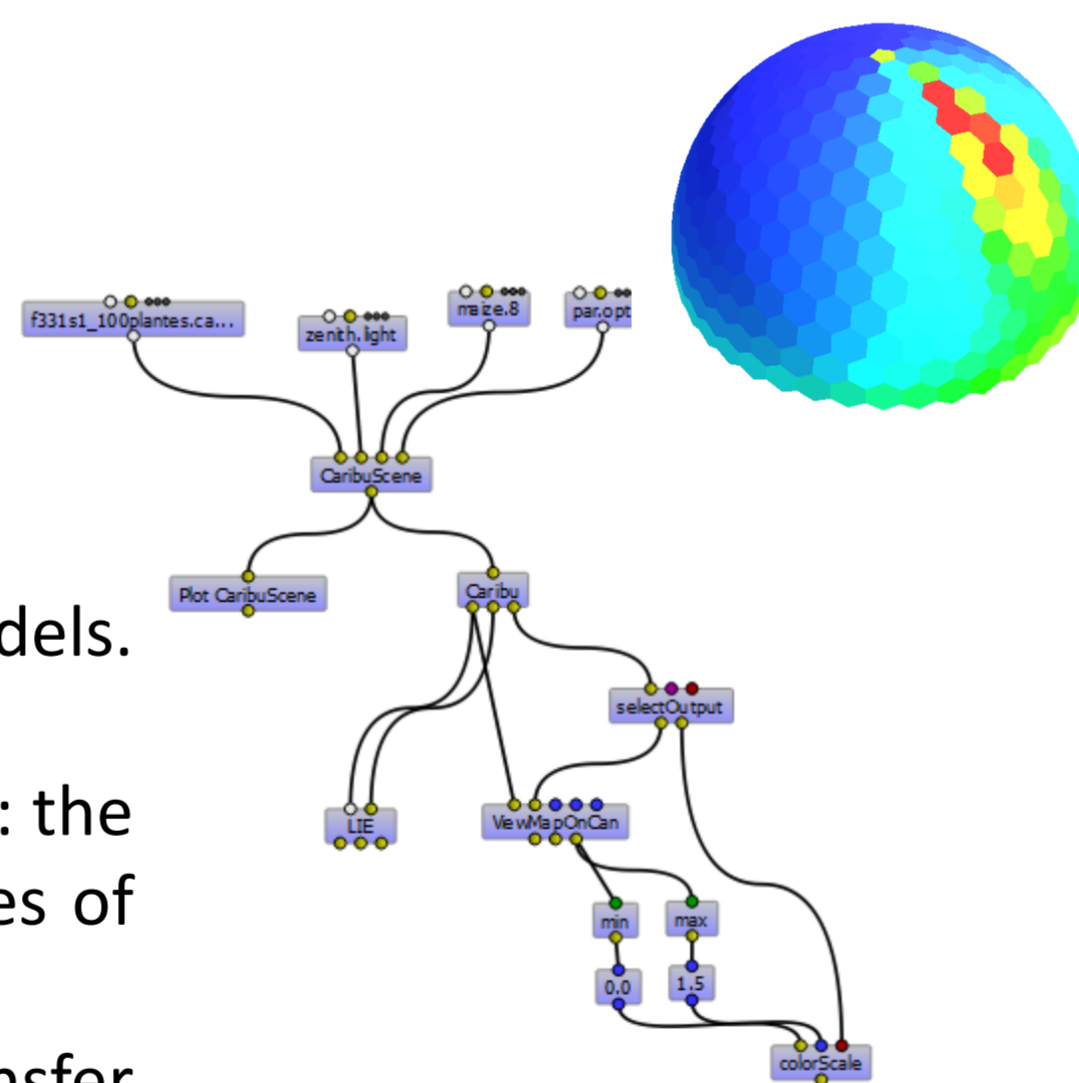
- A standardization of the radiative model inputs : the scene, the light sources, the radiative properties of object in the scene
- A standardization of the call to radiative transfer models

### Define and publish simulation scenario

The package can be used to simulate RT on virtual scenes with the three light models that are available in the OpenAlea platform. This include measured or simulated trees and crops simulated with L-Py or with GroIMP. We currently work at the identification and definition of inter-comparison synthetic scenario representative of these applications. We are also working on metrics to ease the inter-comparisons.

### Share parameterization and post-processing tools

Using RT models requires an advanced expertise for a correct parameterization. The definition of standardized interfaces allow to ease this task by providing shared parameterization tools. We concentrate our effort on light sources by allowing parameterization of natural light condition from meteorological data. This tool implements the weather sky model of Perez et al. and offers a flexible 3D discretization of the sky.



## Future directions

This work is a first initiative towards a benchmark proposal, open to the whole FSPM community, similar to the RAMI initiative for the inter-comparison of radiation transfer model for remote sensing application (RADIATION transfer Model Intercomparison <http://rami-benchmark.jrc.ec.europa.eu/HTML>)

[2] Sinoquet, H., Le Roux, X., Adam, B., Ameglio, T. and Daudet, F.A., 2001. RATP: a model for simulating the spatial distribution of radiation absorption, transpiration and photosynthesis within canopies: application to an isolated tree crown. *Plant, Cell and Environment*, 24: 395-406.

[5] Chelle, M., Andrieu, B., Bouatouch, K. (1998). Nested radiosity for plant canopies. *The Visual Computer*, 14(3), 109-125.\*

[1]. Gastellu-Etchegorry J-P, Yin T, Laurent N, Cajigfingier T, Gregoire T, et al. (2015) Discrete Anisotropic Radiative Transfer (DART 5) for Modeling Airborne and Satellite Spectroradiometer and LIDAR Acquisitions of Natural and Urban Landscapes. *Remote Sensing* 7: 1667.

[4] Dauzat, J., Franck, N., Rapidel, D., Luquet, D., Vaast, P., 2006. Simulation of ecophysiological processes on 3D virtual stands with the ARCHIMED simulation platform. PMA06: The Second International Symposium on Plant Growth Modeling, Simulation, Visualization and Applications, Beijing, P. R. China : PMA06: The Second International Symposium on Plant Growth Modeling, Simulation, Visualization and Applications, 13-17 November 2006, Beijing, P. R. China.

[3] Reinhard Hemmerling, Ole Kniemeyer, Dirk Lanwert, Winfried Kurth, Gerhard Buck-Sorlin. The rule-based language XL and the modelling environment GroIMP illustrated with simulated tree competition. In: *Functional Plant Biology*, 35 (2008), 739-750

[6] Perez R, Seals R, Michalsky J (1993) All-weather model for sky luminance distribution—preliminary configuration and validation. *Solar energy* 50: 235-245.