An open-source 3D RTM to support CalVal

ERADIATE GSICS Monthly Meeting

Vincent Leroy & Yves Govaerts

Rayference

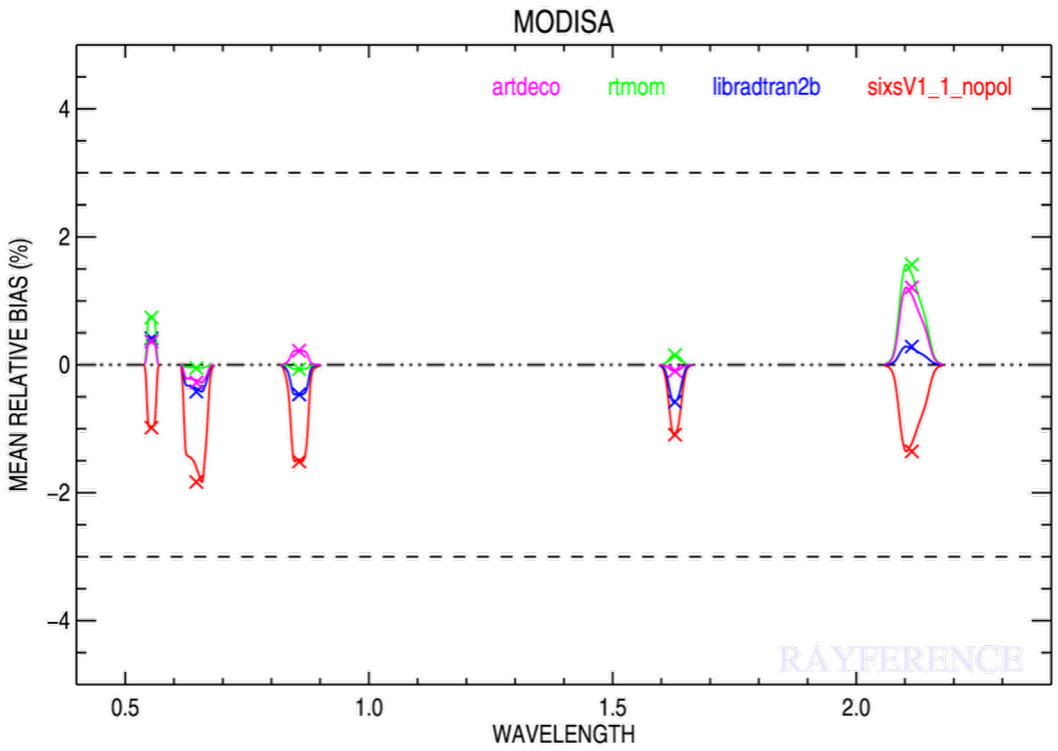
GSICS VISNIR // May 13th, 2021 // Web meeting

esa

Copernicus
Europe's eyes on Earth

rayference

Background



AQUA/MODIS Observations – RTM simulations for Nadir view with 4 different models

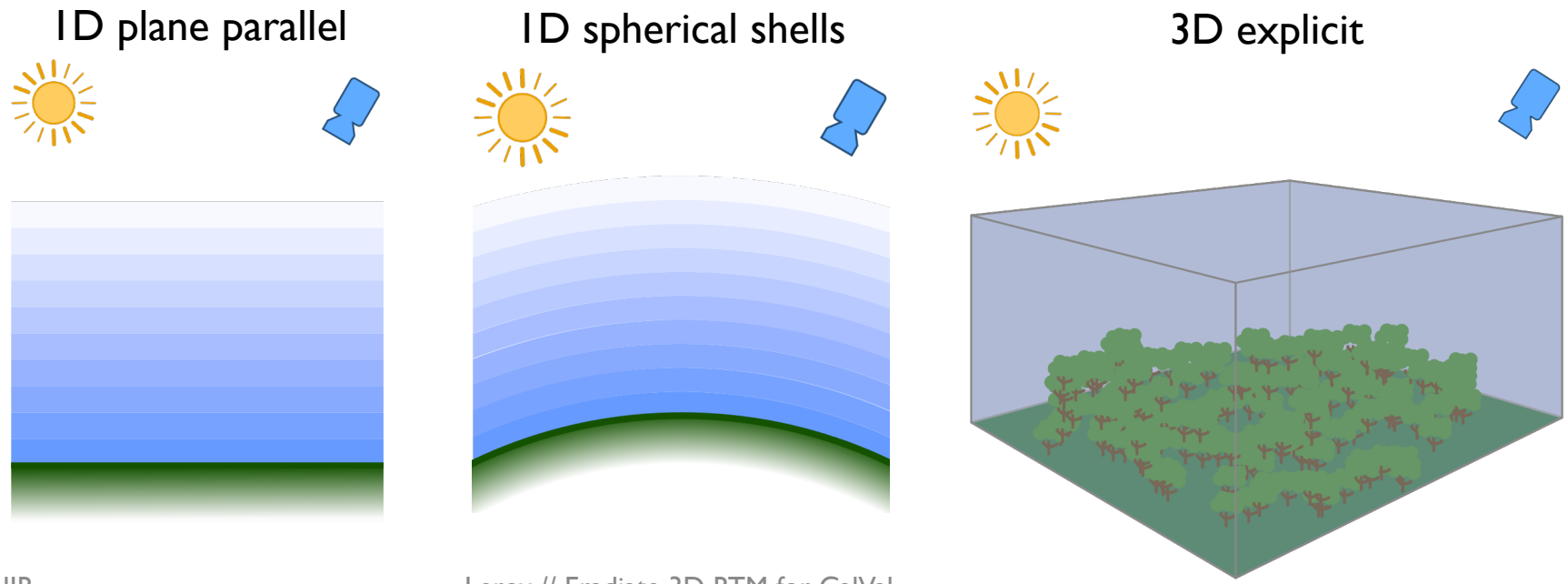
120 clear-sky MODIS observations over Libya-4

- No RTM can currently be trusted as the reference
- Accuracy (~2-3%) is insufficient for applications based on upcoming sensors (~1%)

Eradiate: Purpose & scope (I)

- 3D RTM
  - Flexible and accurate surface and atmosphere description
  - Monte Carlo ray tracing
  - Targeted numerical accuracy: better than 1%
  - Performance matters but speed not highest priority

Geometry

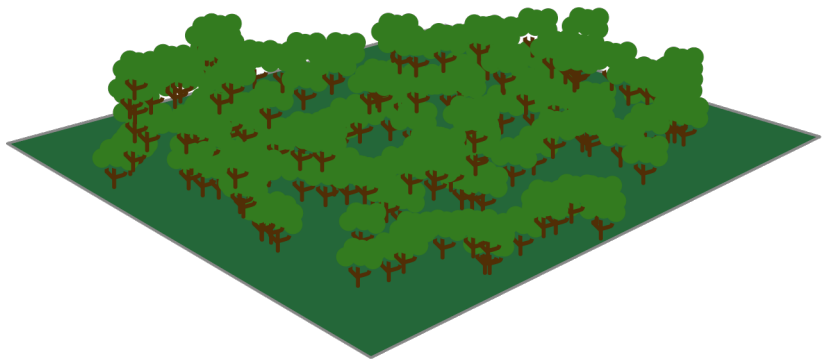


Eradiate: Purpose & scope (II)

- 3D RTM
  - Flexible and accurate surface and atmosphere description
  - Monte Carlo ray tracing
  - Targeted numerical accuracy: better than 1%
  - Performance matters but speed not highest priority

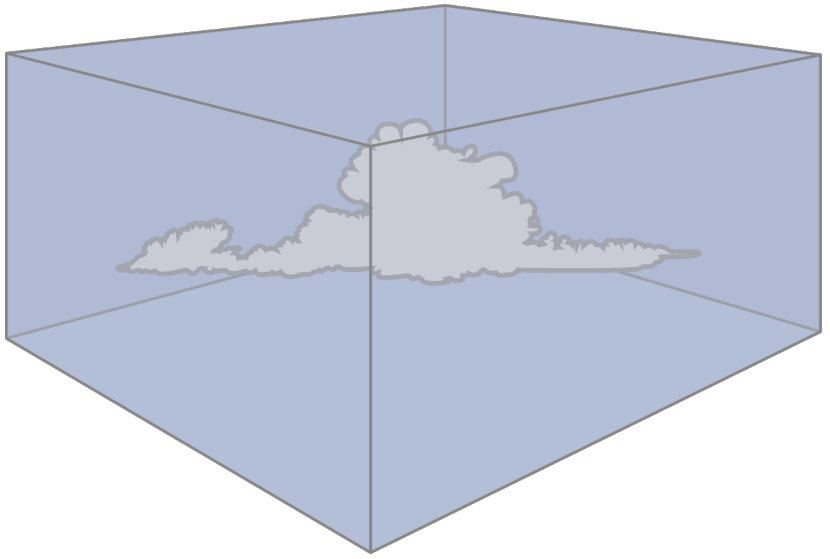
Scene contents

Surface



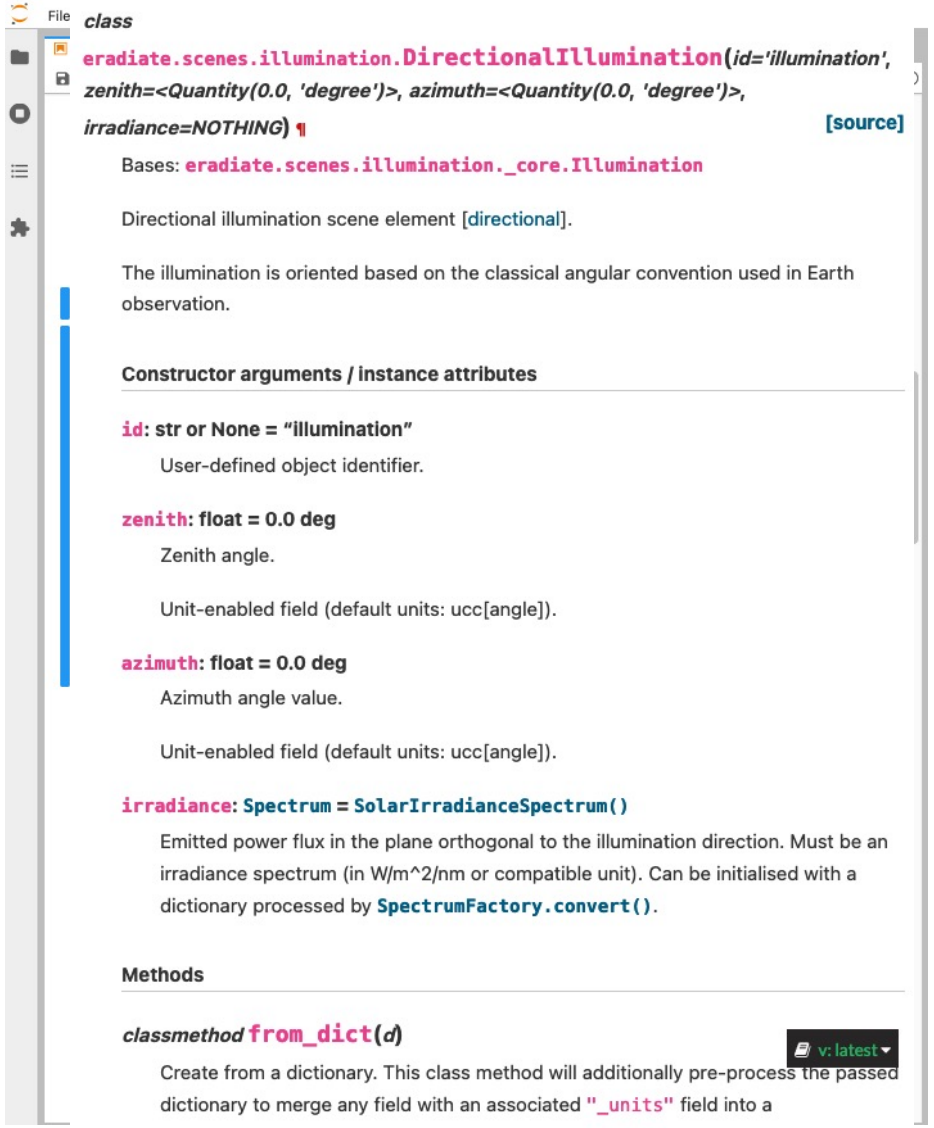
???

Atmosphere / clouds / aerosols



Eradiate: Purpose & scope (III)

- Usability and transparency
  - First-class Python interface
  - Extensible design
  - Modern and comprehensive online documentation
  - Clear data management model
  - Extensive and documented testing



class

eradiate.scenes.illumination.DirectionalIllumination(*id='illumination', zenith=<Quantity(0.0, 'degree')>, azimuth=<Quantity(0.0, 'degree')>, irradiance=NOTHING*) [source]

Bases: eradiate.scenes.illumination._core.Illumination

Directional illumination scene element [directional].

The illumination is oriented based on the classical angular convention used in Earth observation.

Constructor arguments / instance attributes

id: str or None = "illumination"

User-defined object identifier.

zenith: float = 0.0 deg

Zenith angle.

Unit-enabled field (default units: ucc[angle]).

azimuth: float = 0.0 deg

Azimuth angle value.

Unit-enabled field (default units: ucc[angle]).

irradiance: Spectrum = SolarIrradianceSpectrum()

Emitted power flux in the plane orthogonal to the illumination direction. Must be an irradiance spectrum (in W/m^2/nm or compatible unit). Can be initialised with a dictionary processed by SpectrumFactory.convert().

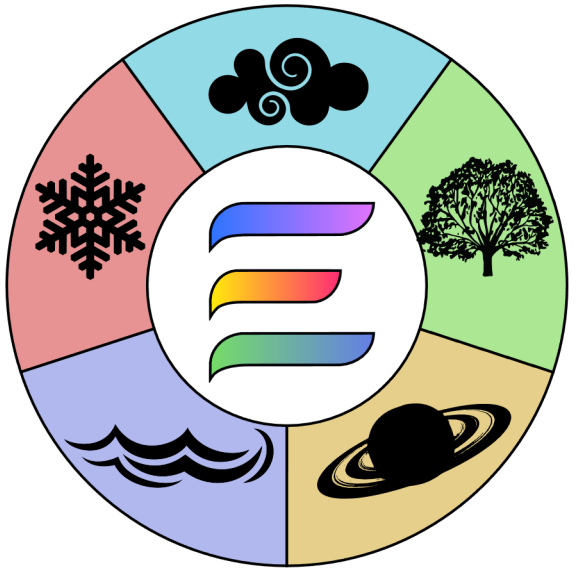
Methods

classmethod from_dict(*d*)

Create from a dictionary. This class method will additionally pre-process the passed dictionary to merge any field with an associated "_units" field into a

Eradiate: Purpose & scope (IV)

- Open source
  - GPLv3 licensed
  - Hosted on GitHub
  - Community involvement: Break boundaries between EO subcommunities
- First public release: Early 2022 (simulation in VIS/NIR/SWIR spectral regions)



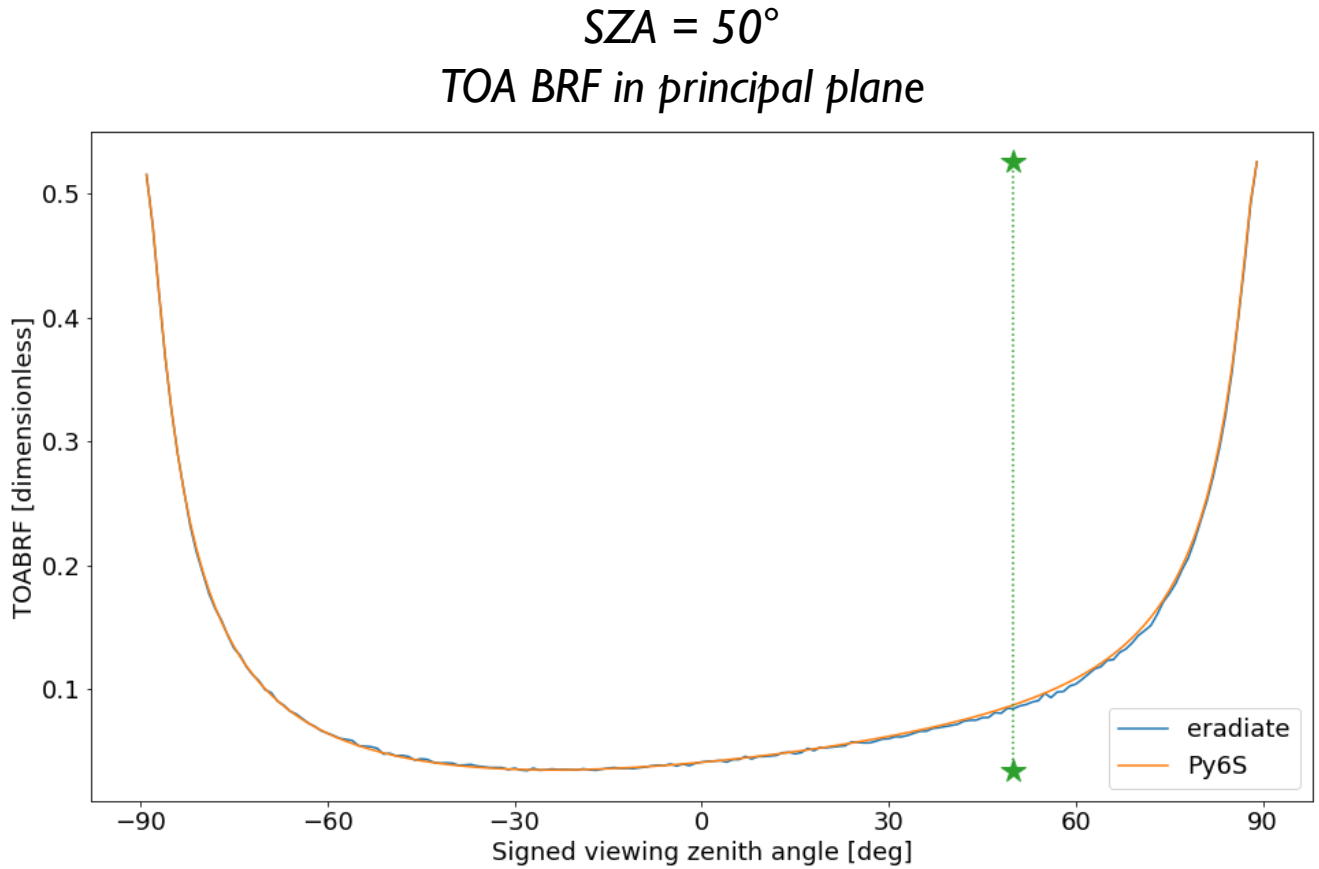
Current Development State (May 2021)

- Early beta state  Many missing features
- Monochromatic mode
- Plane parallel model: Absorption and scattering by gases
  No aerosols / clouds
- Explicit 3D canopies: Objects at surface with no atmosphere

Early results: Plane parallel model

Comparison w/ Py6S (6S 1.1)

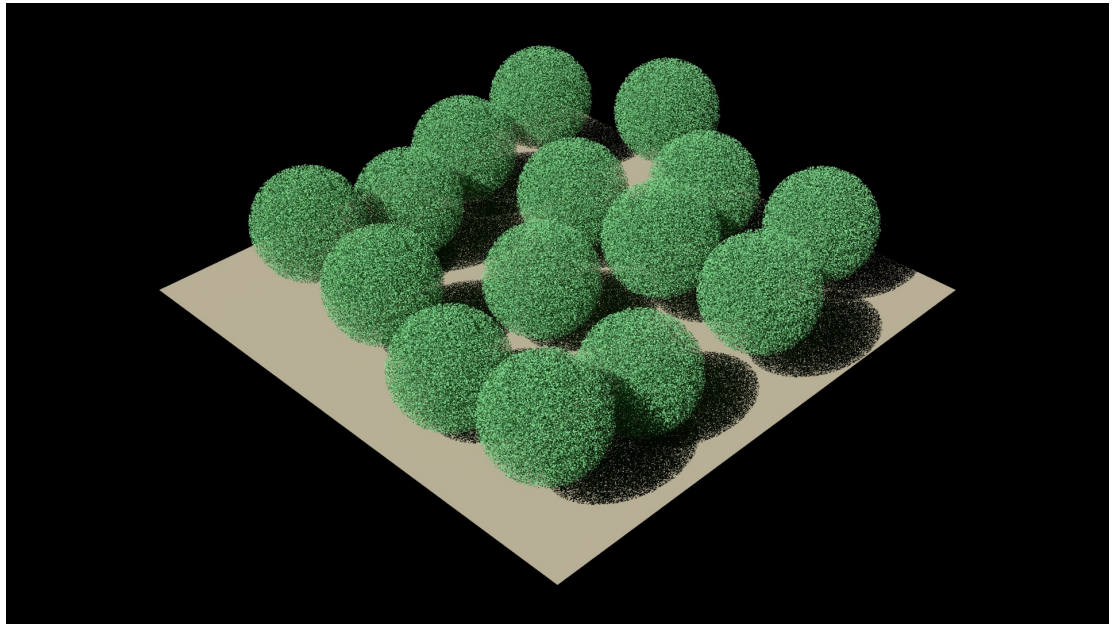
- Black surface
- Only Rayleigh scattering
  No gas absorption
  No clouds
  No aerosols
- Wavelength 550 nm



Early results: Explicit 3D canopies w/o atmosphere

RAMI test case series

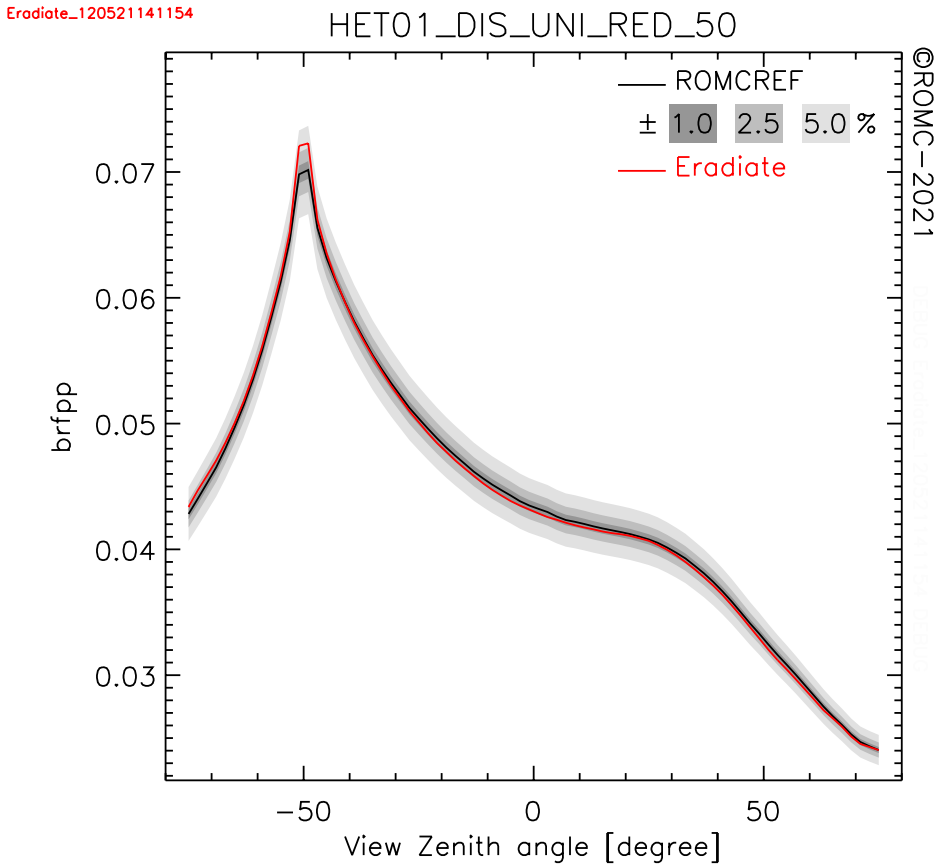
Example: Heterogeneous Discrete Canopy scenario



Unit cell – Scene geometry is periodic

SZA = 50°

TOC BRF in principal plane



Upcoming Work (Late 2021-Early 2022)

- Band mode
- Aerosols and clouds
- Improved performance with new ray tracing algorithm
- Explicit 3D canopy w/ atmosphere
- Earth surface roundedness and topography

Planned Features

Due by late 2021 / early 2022

- Plane parallel geometry for atmosphere
- 1D or explicit 3D surface representation
- Account for Earth surface roundedness
- Monochromatic & band spectral modes

Later

- Polarisation (planned for 2022-2023)
- Open to calibration applications
  - Lunar?
  - DCC?
  - Desert?

A realistic RTM benchmark

- **RAMI4ATM** will launch in 2021-2022
- **Goals**
  - Compare radiative transfer models on scenarios reflecting real-life RTM usage
  - Document discrepancies in results
  - Initiate the build of a community consensus on the best ways to simulate space-based and ground observations with RTMs

More information at

rami-benchmark.jrc.ec.europa.eu/_www/RAMI4ATM.php

Stay in touch

Visit our website

www.eradiate.eu

Subscribe to our newsletter (*Contact* tab)

Visit our GitHub repo

github.com/eradiate/eradiate

FIN

Questions?

vincent.leroy@rayference.eu
yves.govaerts@rayference.eu

This work is sponsored by