



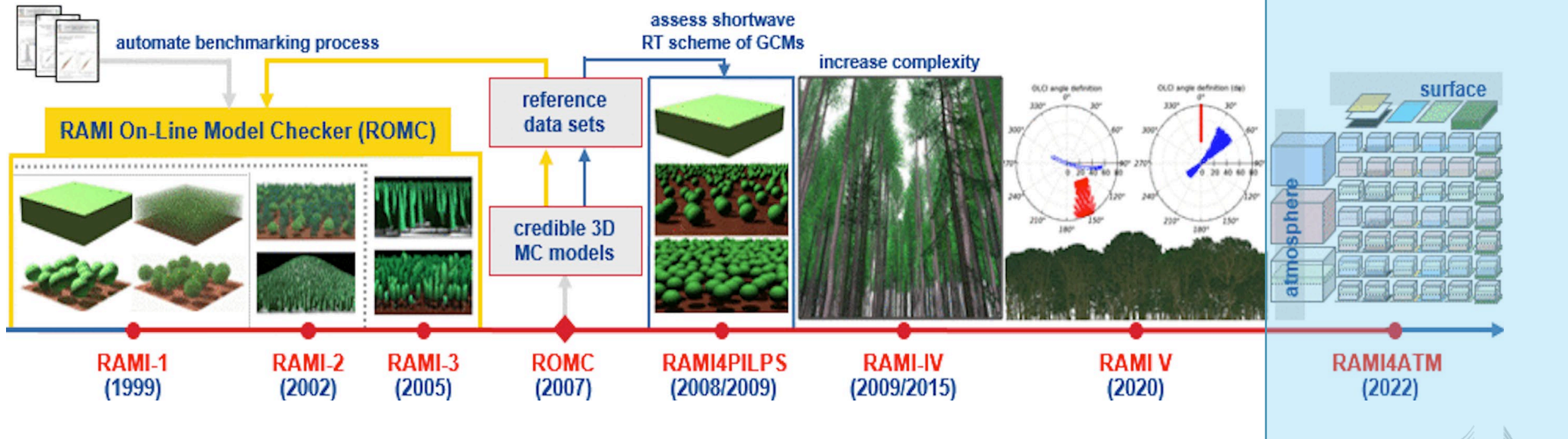
# The Radiation Transfer Model Intercomparison for Atmosphere: RAMI4ATM Initiative

LPS 2022, 23 May 2022

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1: EC JRC, 2: Rayference

# Radiation Transfer Model Intercomparison exercise

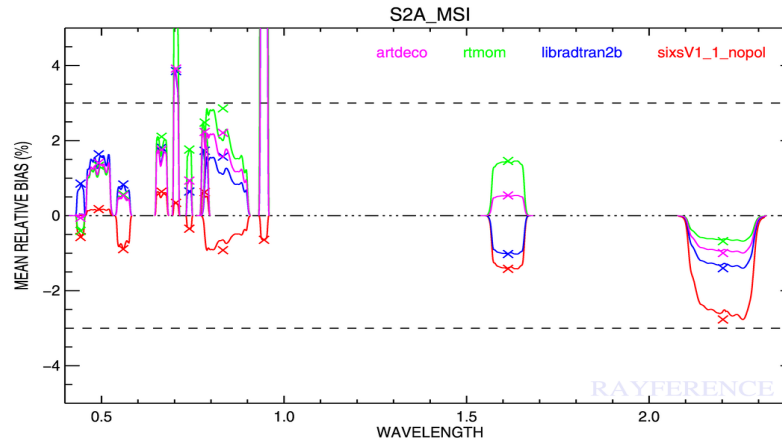
- 3D Radiative Transfer model independent assessment
- 20+ years activities (five phases, ROMC and RAMI4PILS)
- Blind concept
- Increased complexity of scenarios and experiments
- Oriented to vegetated surfaces
- Oriented to satellite and in situ observations



# Background

Many radiative transfer models have been developed and are widely used in Earth Observation:

- **Calibration**



- **Atmospheric correction or sensitivity analyses**

- The uncertainties of these models have **not** been clearly assessed in **realistic usage conditions** when supporting typical Earth Observation applications by remote sensing scientists.



RAMI4ATM is a **new** initiative dedicated to the benchmarking of **coupled surface-atmosphere** radiative transfer models. **It is primarily oriented to RTM users.**

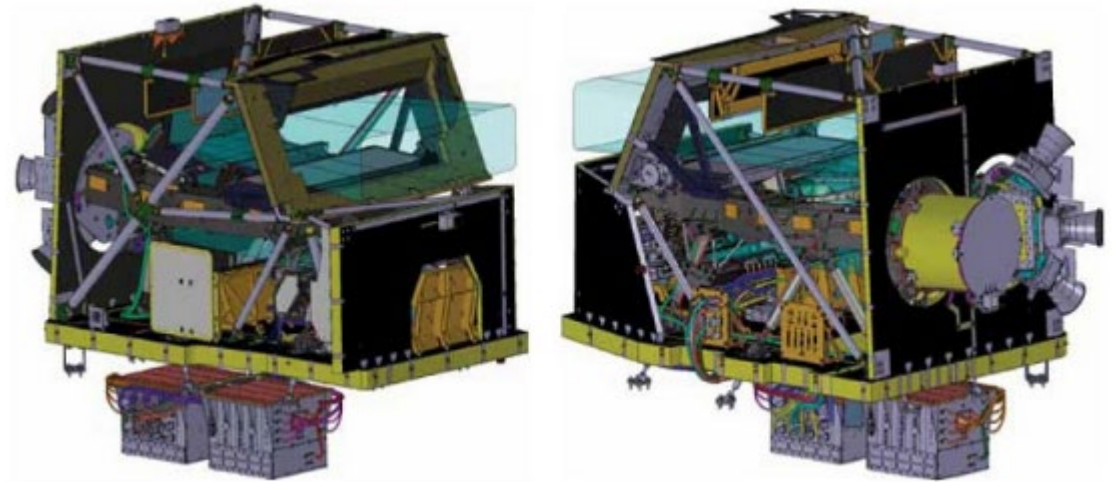


<https://rami-benchmark.jrc.ec.europa.eu/>

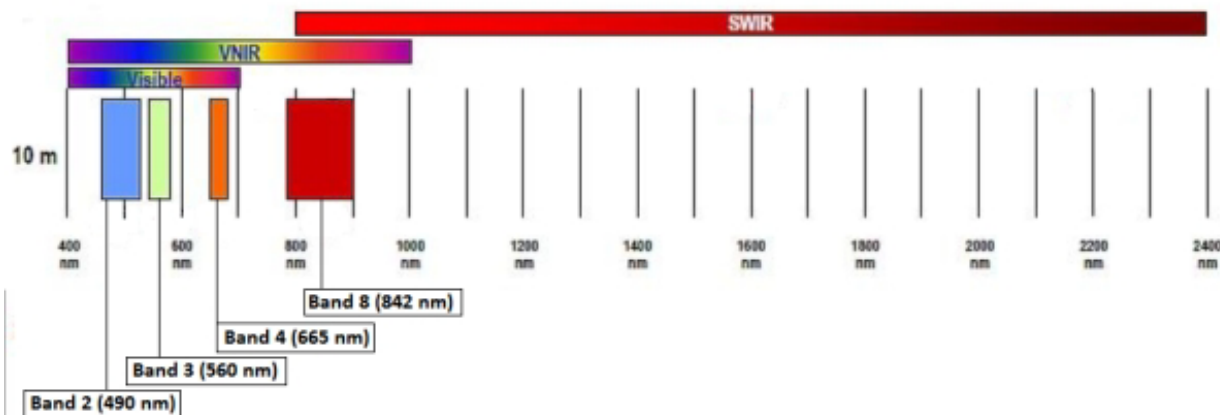


# Sentinel-2

	Band	Centre	Width
Blue	MSI 2	492,4nm	66nm
Green	MSI 3	559,8nm	36nm
Red	MSI 4	664.6nm	31nm
NIR	MSI 8a	864,7nm	21nm
1,6µm	MSI 11	1613nm	91nm
2,1µm	MSI 12	2202nm	175nm

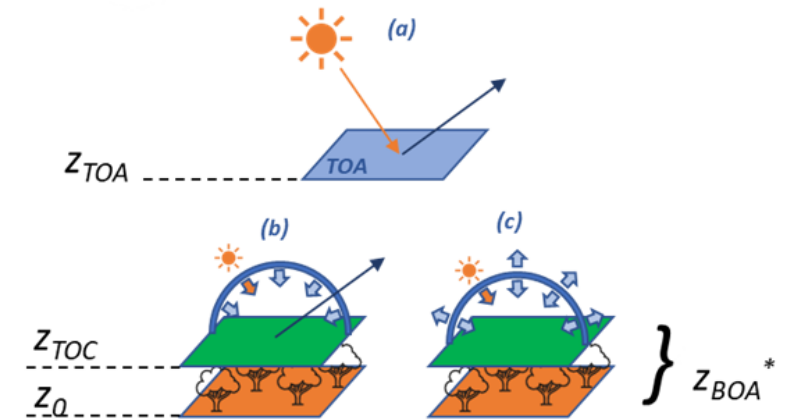


MultiSpectral Instrument (Airbus Defence and Space) source: [sentinels.copernicus.eu](https://sentinels.copernicus.eu)

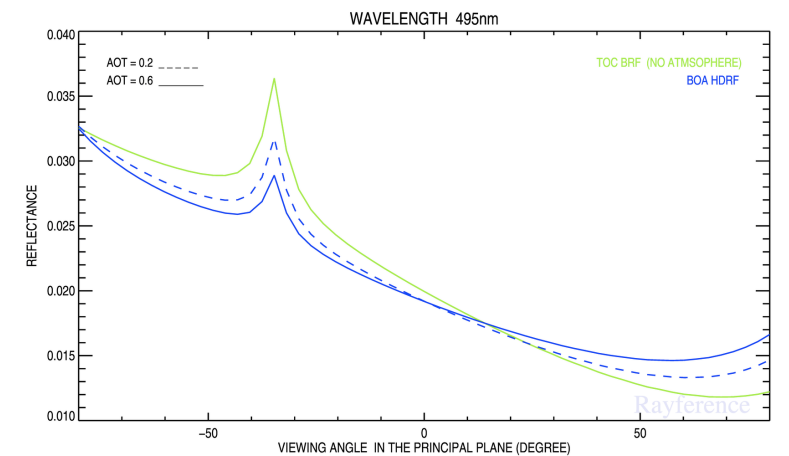


# Measurements

<meas> Identifier tag	Link to Format file description	Level of the measurement
bhr	<a href="#">Bi-Hemispherical Reflectance</a>	BOA
hdrfpp	<a href="#">Hemispherical Directional Reflectance Factor in the principal plane</a>	BOA
hdrfop	<a href="#">Hemispherical Directional Reflectance Factor in the orthogonal plane</a>	BOA
brfpp	<a href="#">Bi-directional Reflectance Factor in the principal plane</a>	TOA
brfop	<a href="#">Bi-directional Reflectance Factor in the orthogonal Plane</a>	TOA



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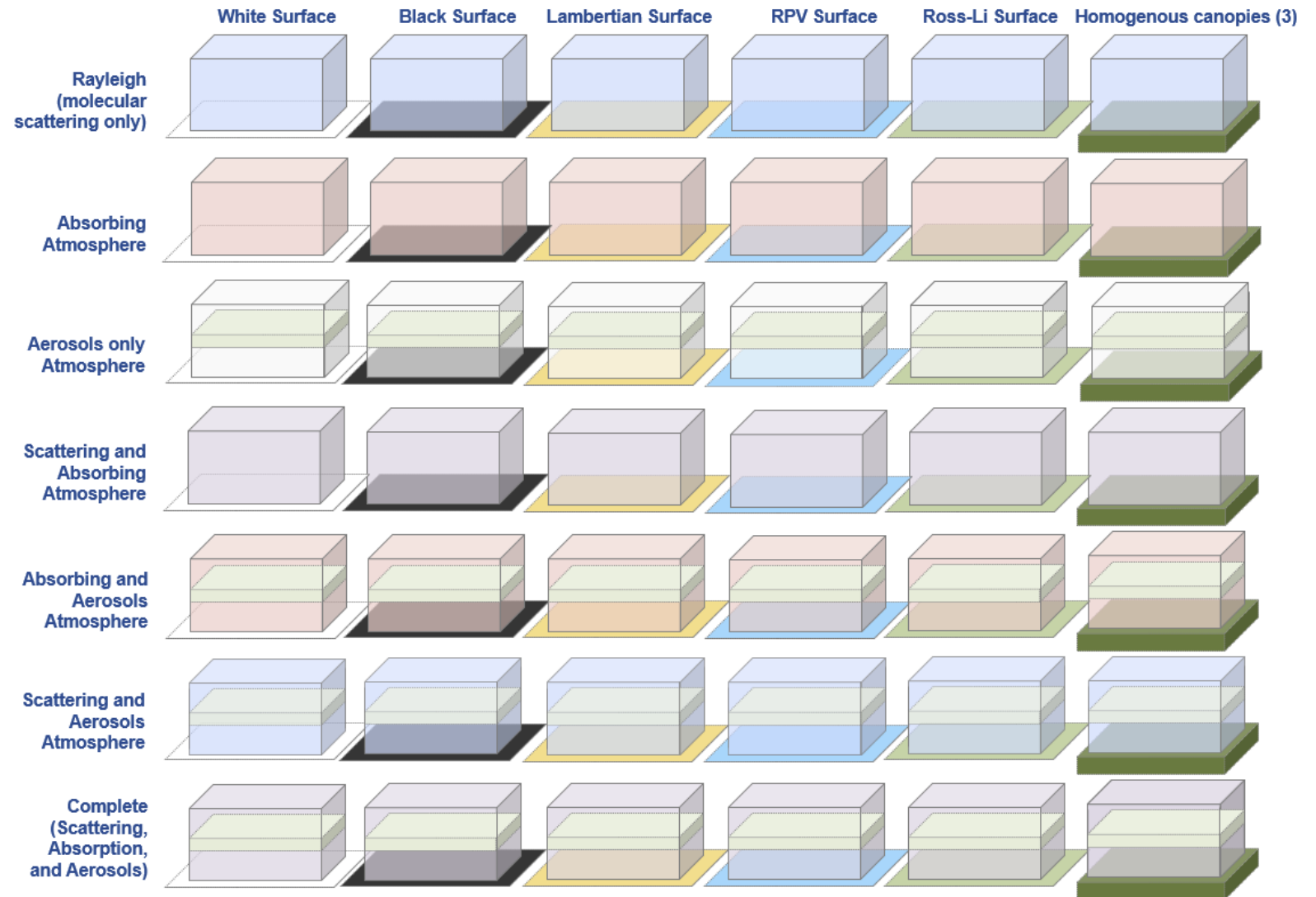


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# Scenarios

7 Atmospheres families

## Surfaces: 5 parametric + 3 abstract canopies



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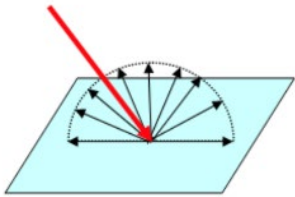
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# Surfaces

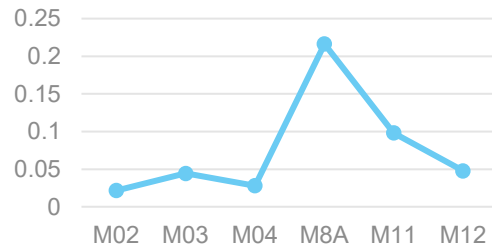


Purist corner  $R = 0.0$

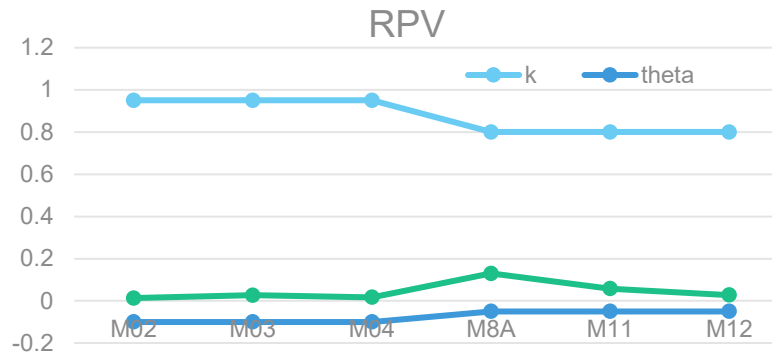
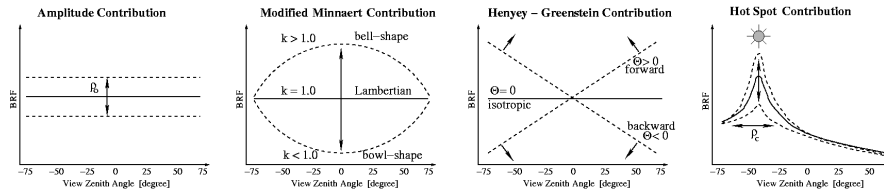
$R = 1.0$



reflectance



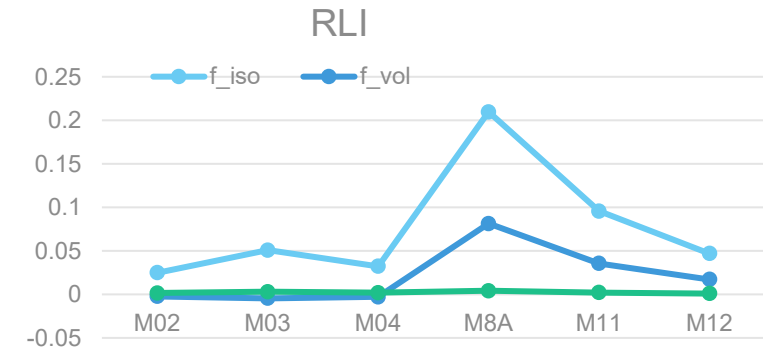
RPV model with 3 parameters:  $\rho_0, k, \theta$



$$\rho(z_0, \mu_i, \mu_r, d\phi; \rho_0, \Theta, k, \rho_c) = \rho_0 \cdot M(k) \cdot F_{HG}(\Theta) \cdot H(\rho_c)$$

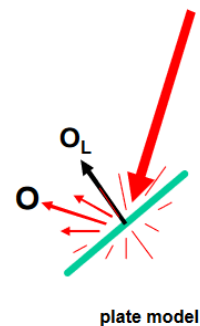
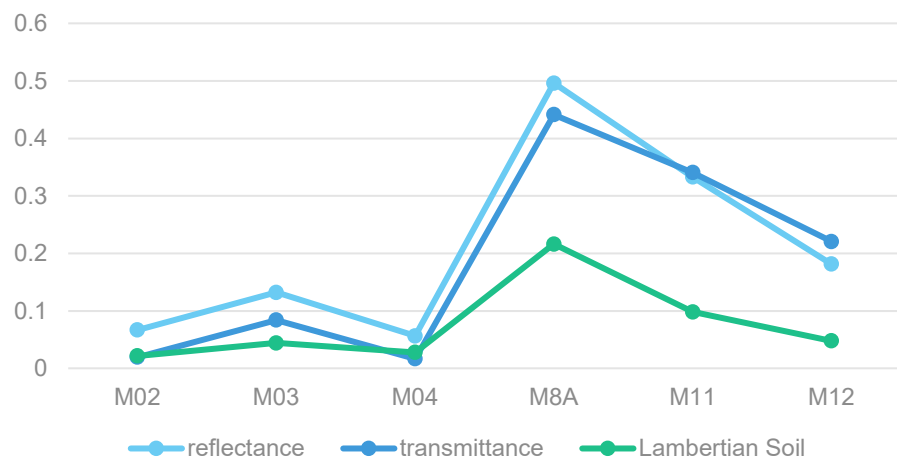
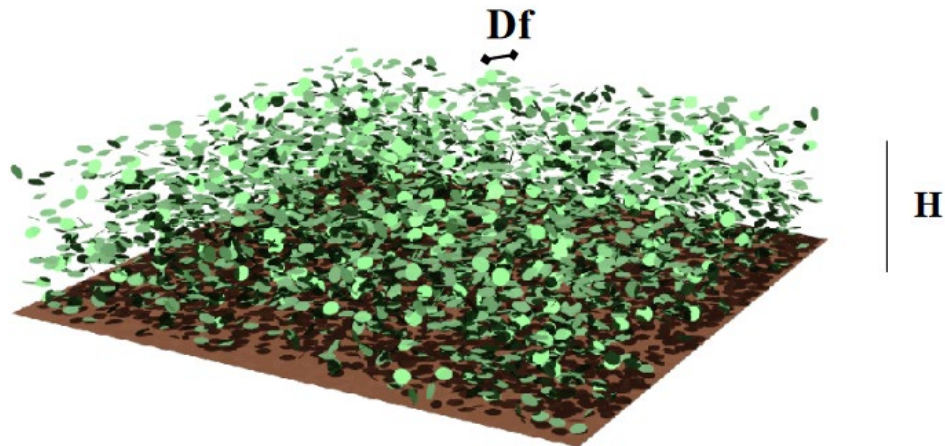
$$= \rho_0 \frac{(\mu_i \mu_r)^{k-1}}{(\mu_i + \mu_r)^{1-k}} \frac{1 - \Theta^2}{(1 + \Theta^2 + 2\Theta \cos g)^{1.5}} \left( 1 + \frac{1 - \rho_c}{1 + G} \right)$$

Ross thick and Li sparse kernels combinations:  $f_{iso}, f_{vol}, f_{geo}$



$$\rho(\theta_i, \theta_r, d\phi) = f_{iso} K_{iso} + f_{vol} K_{vol} + f_{geo} K_{geo}$$

# Surfaces



## 3 homogeneous abstract canopies

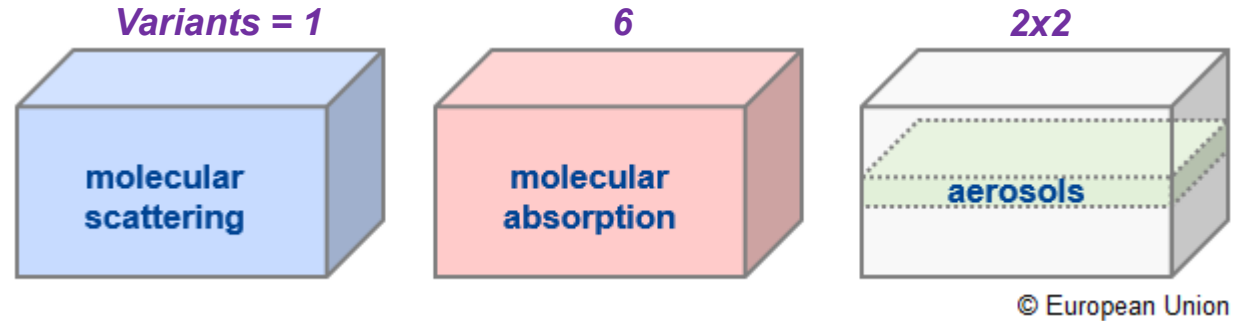
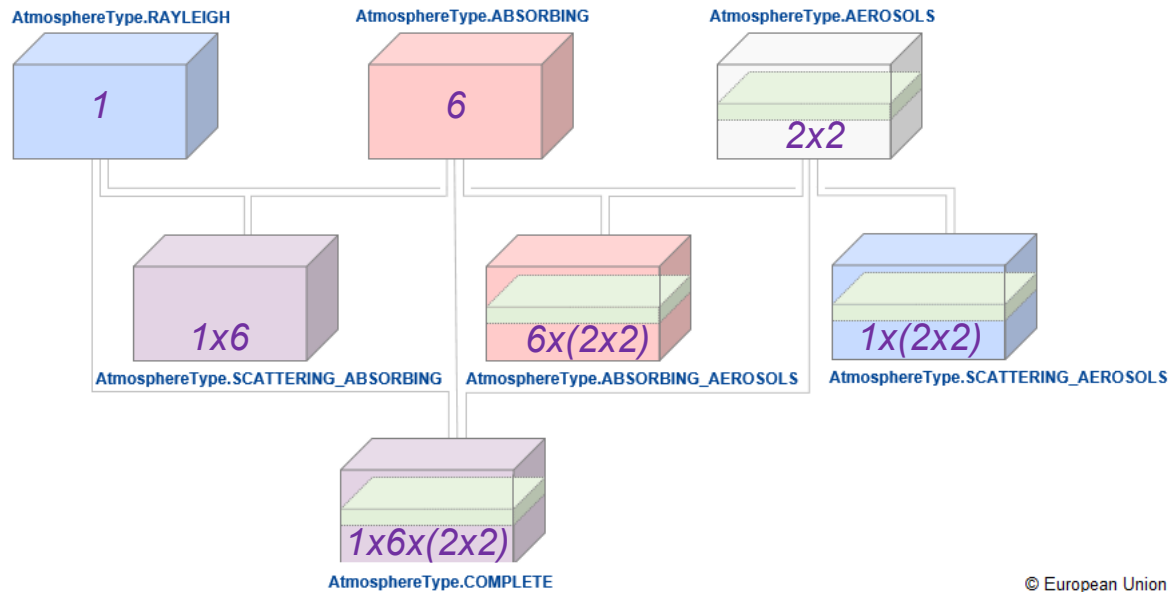
Scene dimension	25 x 25 x 2.1 m
Leaf center (Xmin, Ymin, Zmin)	-12.500, -12.500, 0.100 m
Leaf center (Xmax, Ymax, Zmax)	-12.500, -12.500, 2.100 m
Scatterer Radius	0.05 m
Leaf area index	3 m <sup>2</sup> /m <sup>2</sup>
Height of canopy	2 m
Number of leaves	238732
Planophile LAD (HOM25_LAM)	$\mu=2.531 \nu=1.096$
Erectophile LAD (HOM35_LAM)	$\mu=1.096 \nu=2.531$
Uniform LAD (HOM45_LAM)	$\mu=1.0 \nu=1.0$

Common properties



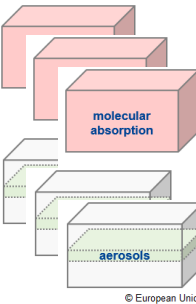
# Atmospheres

Three main elements are combined to create **seven** atmosphere families as shown in the diagram below



As the three main elements are further characterized by specific properties such as:

- 6 different combinations of the columnar concentrations of **water vapor** and **ozone**
- **Continental** and **Oceanic** aerosol models
- AOD550 low (0.2) and high (0.6)

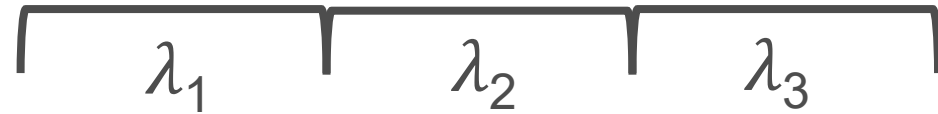


A total of **69 atm. variants** are defined in **RAMI4ATM**.

Some of them are used only

# Participation

## RTM users versus expert mode



Radiative transfer equation (RTE) is strictly valid only for monochromatic intervals.

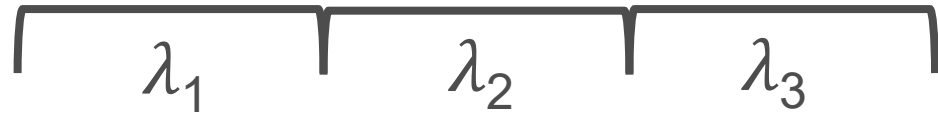
For practical reasons, RTE is solved in spectral intervals when simulating satellite bands.

One homogeneous atmospheric layer

# Participation

## RTM users versus expert mode

One spectral band



Molecular absorption (lines)  
Molecular scattering (Rayleigh)  
Scattering/absorption by aerosols

Advanced coupled surface-atmosphere RTMs combine all the radiative processes in each atmospheric layer and in each spectral interval for the **users**.

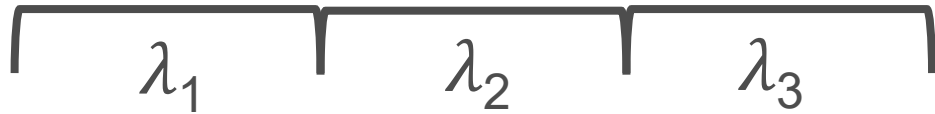
RAMI4ATM primarily targets these users.

One homogeneous atmospheric layer

# Participation

## RTM users versus expert mode

One spectral band



Molecular absorption (lines)  
Molecular scattering (Rayleigh)  
Scattering/absorption by aerosols

One homogeneous atmospheric layer

RTM developers can participate. Single scattering albedo and phase function of each layer and spectral interval is however not provided. Provided information is:

- Aerosol micro-physical properties
- Aerosol vertical concentration
- Molecular concentration

# Participation

<https://rami-benchmark.jrc.ec.europa.eu/>

EU Login



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About the European Commission > RAMI > Homepage

## RAMI Homepage

RAdition transfer Model Intercomparison

Home

Past phases ▾

The new RAMI V

The new RAMI4ATM

Guidance ▾

How to participate

News and events

April 2022 RAMI4ATM

[Launch of the RAMI4ATM phase](#)

October 2020 RAMI V

[Launch of the 5th RAMI phase](#)

2009/2015 RAMI IV

2008/2009 RAMI4PILPS

This is the official site of the RAdition transfer Model Intercomparison (**RAMI**) initiative. RAMI proposes a mechanism to benchmark models designed to simulate the transfer of radiation at or near the Earth's terrestrial surface, i.e., in plant canopies and over soil surfaces.

As an open-access, on-going activity, RAMI operates in successive phases each one aiming at re-assessing the capability, performance and agreement of the latest generation of radiation transfer (**RT**) models. This in turn, will lead to model enhancements and further developments that benefit the RT modelling community.

**RAMI-V** maintains the abstract and actual scene definition of [RAMI-IV](#) phase. Additionally, two actual scenes, defined through a semi-parametric (Savanna) and an



# Participation



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Search

About the European Commission > RAMI > Phase: RAMI4ATM

## The new RAMI4ATM

2022 - on going

Home Past phases The new RAMI V The new RAMI4ATM Scenario Measurements Guidance

Description

Scenario Combinations

Experiments

Output Filename and Formats

JSON file to setup RAMI4ATM experiments

RAMI On-line Format Checker

RAMI On-line Model Submission

References

Download

Acknowledgments



Compared to previous RAMI benchmarks, the major difference radiative effects occurring between the surface and the simulated Sentinel-2A/MSI spectral bands has been chosen for that it support the simulation of radiative processes at the surface coupling between the two.

Over the past decades, many radiative transfer models have been used for Observation for e.g., vicarious calibration, lookup table generation and analyses. Many of these models have been extensively tested in ideal conditions but so far, no long-term systematic comparisons have been made when they are used to simulate typical Earth Observation applications by remote sensing sensors. The uncertainties of these models have not been clearly assessed. This new phase is oriented toward the support of calibration and validation of radiative transfer models for the simulation of satellite observations in the visible, near and shortwave infrared spectral

About the European Commission > RAMI > Phase RAMI4ATM: RAMI On-line Model Submission (ROMS)

## RAMI On-line Model Submission (ROMS)

RAMI4ATM phase

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This table is showing the last 100 successfully submitted testcases. To visit the entire table, [click here](#). You are advised to check the **logfile** each time you submit new data, especially for new archives: this file informs you of any problems with results submission.

All form fields identified by \* are required.

### Model

New model

Allowed chars: [a-z, 0-9, -]  
(min: 3, max: 20 chars)

eradiate

### Additional information

Description\* (min: 3, max: 500 chars)

Copernicus Community model

Reference\* (min: 3, max: 500 chars)

Add reference if exists ...

Note

Developer or user

Register a Model

### Submission files

The maximum size of an uploaded file is 2Mb.  
Allowed extensions are: mes, zip, tgz, tar, bz2.

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