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The Radiation Transfer Model Intercomparison for Atmosphere: RAMI4ATM Initiative

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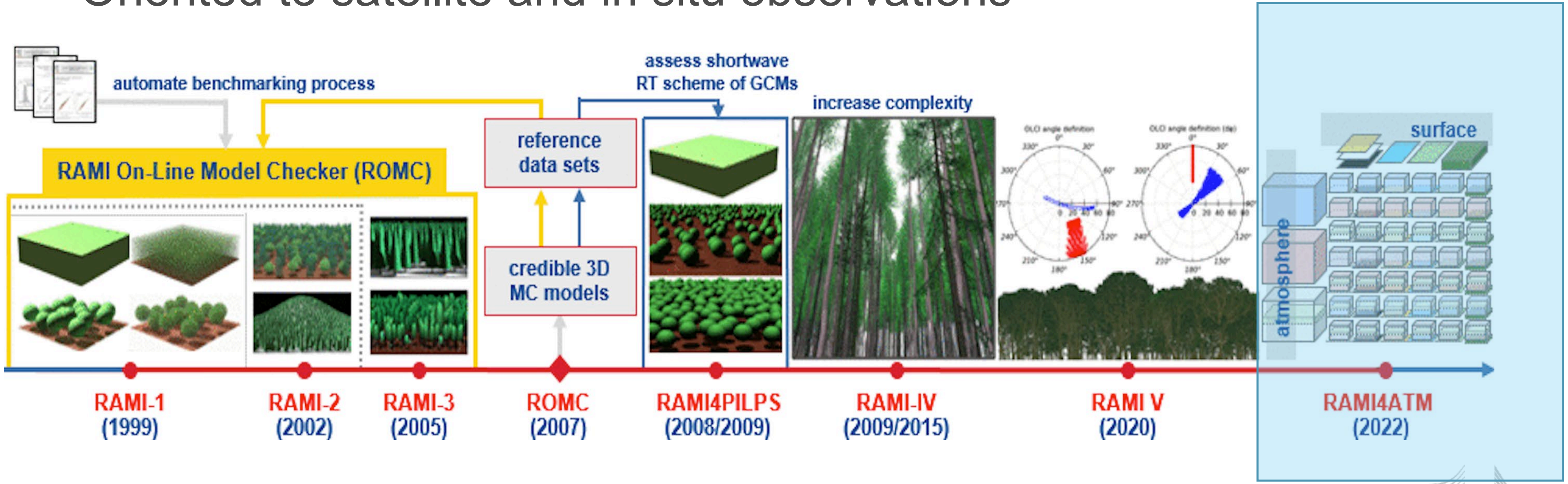
Joint Research Centre

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

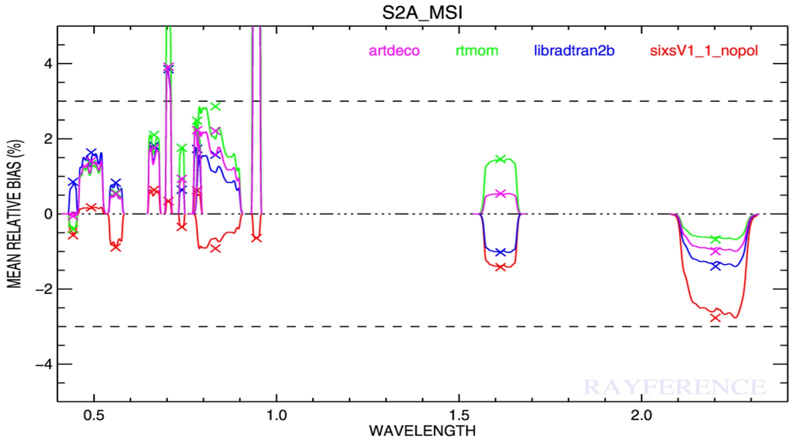


https://rami-benchmark.jrc.ec.europa.eu/

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**.

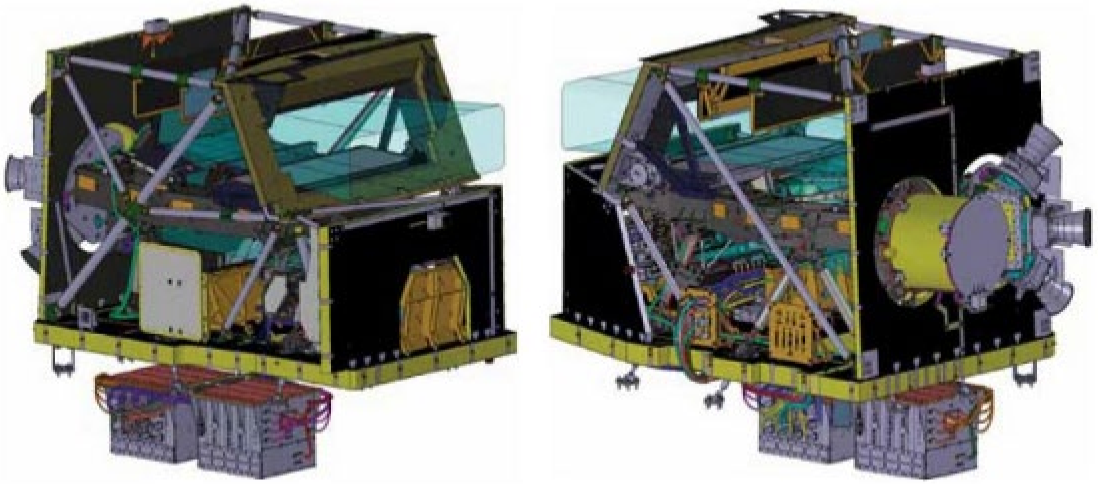
April 2022 - September 2022 — **Active submission period**

January 2023 — **On-line results**

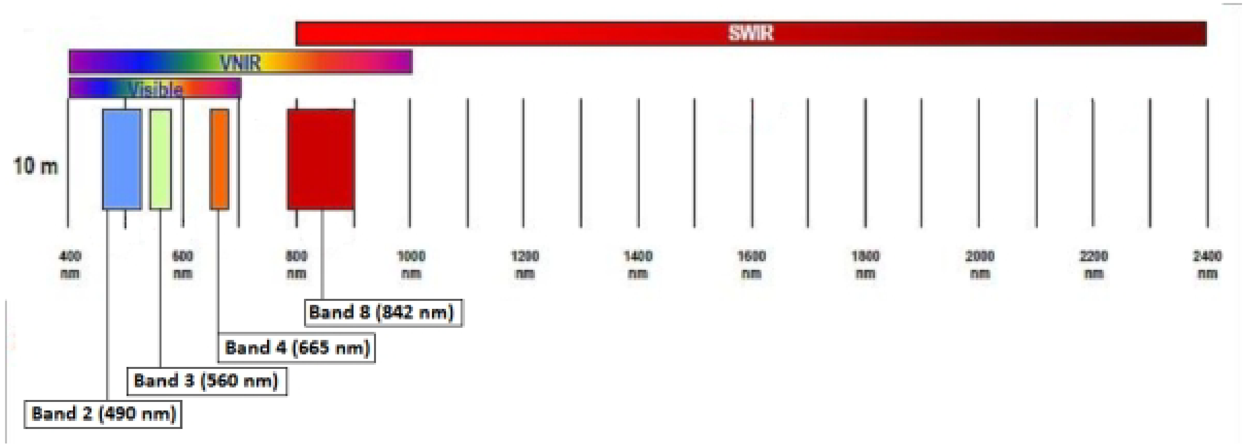
https://rami-benchmark.jrc.ec.europa.eu/

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

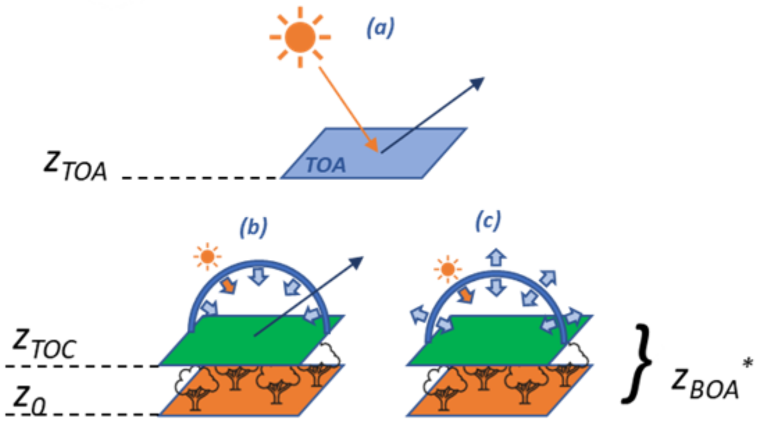


MultiSpectral Instrument (Airbus Defence and Space) source: sentinels.copernicus.eu



Measurements

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



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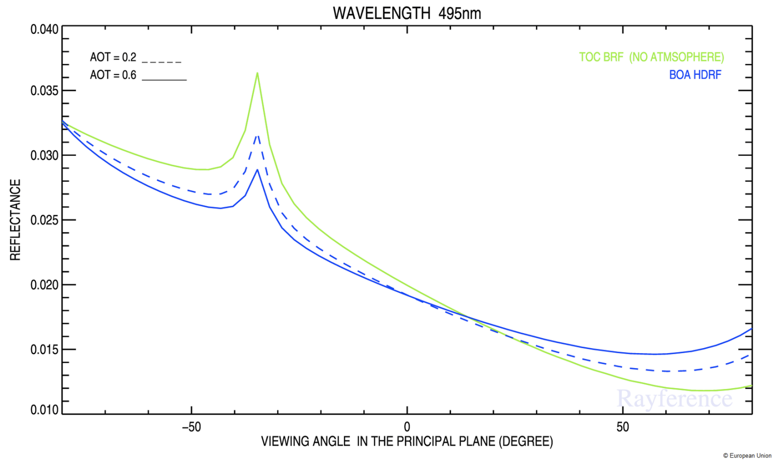

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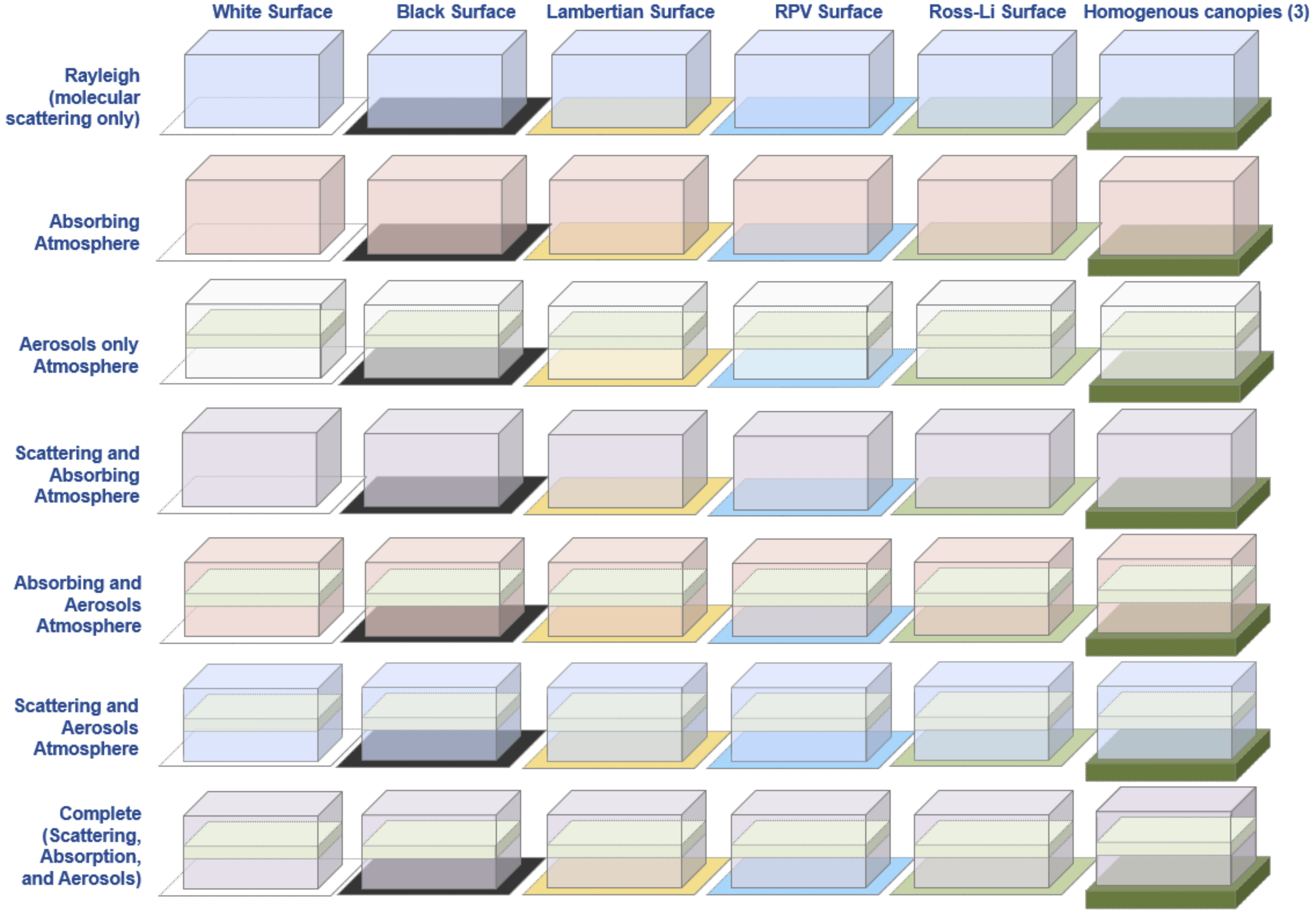
Scenarios

Surfaces: 5 parametric + 3 abstract canopies

7 Atmospheres families



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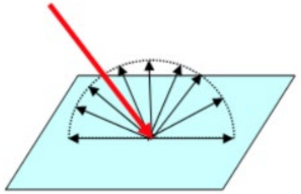
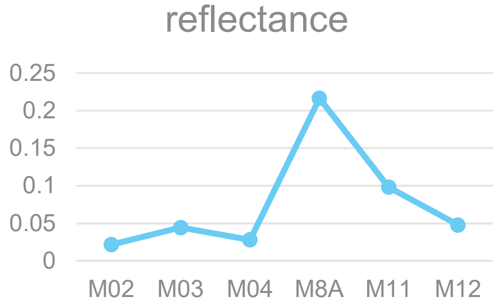
Surfaces

Lambertian

Purist corner $R = 0.0$

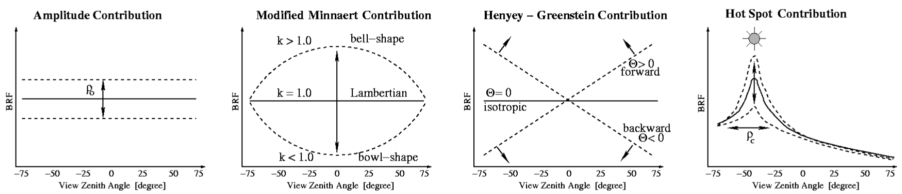
$R = 1.0$

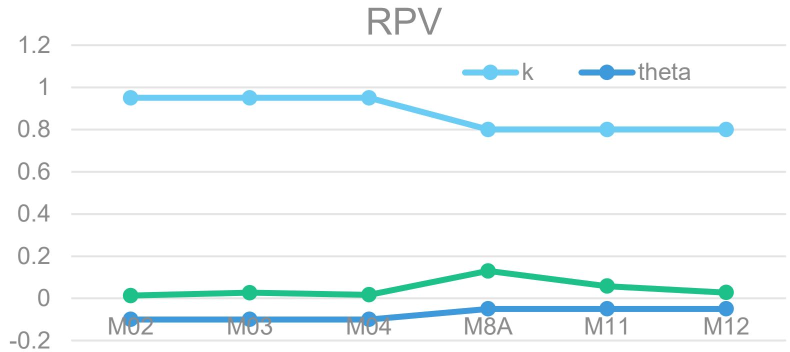




RPV

RPV model with 3 parameters: ρ_0, k, θ



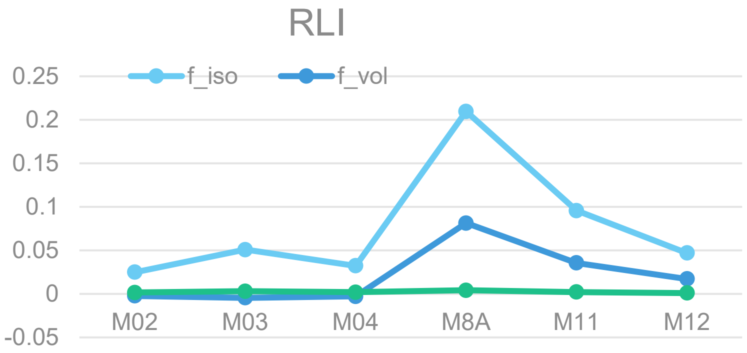


$$\rho(z_0, \mu_i, \mu_r, d\phi; \rho_0, \Theta, k, \rho_c) = \rho_0 \cdot M(k) \cdot F_{HG}(\Theta) \cdot H(\rho_c)$$

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

RLI

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



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

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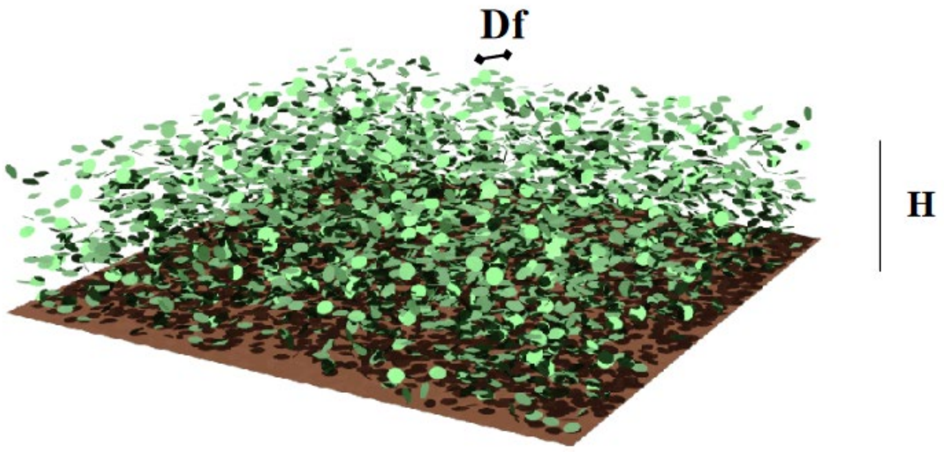
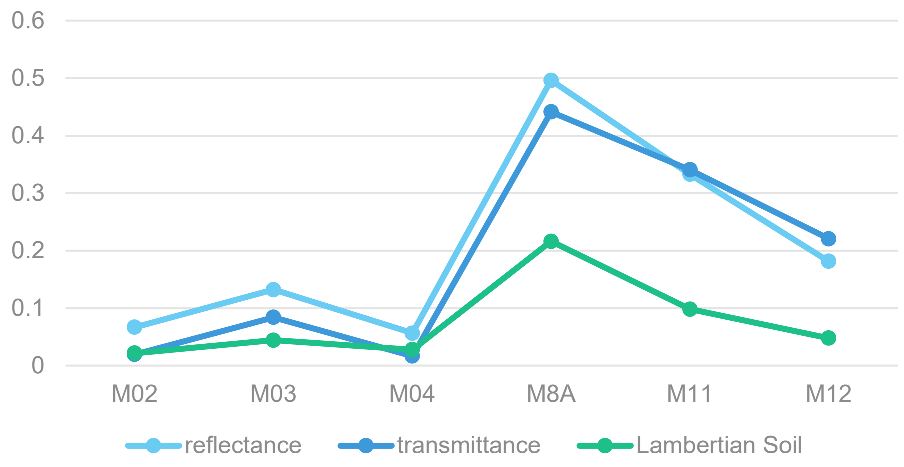
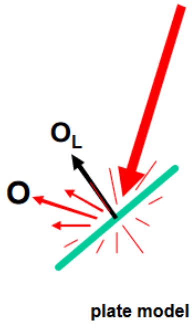
Surfaces







3 homogeneous abstract canopies

Common properties

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^2/m^2
Height of canopy	2 m
Number of leaves	238732
Planophile LAD (HOM25_LAM)	μ=2.531 ν=1.096
Erectophile LAD (HOM35_LAM)	μ=1.096 ν=2.531
Uniform LAD (HOM45_LAM)	μ=1.0 ν=1.0

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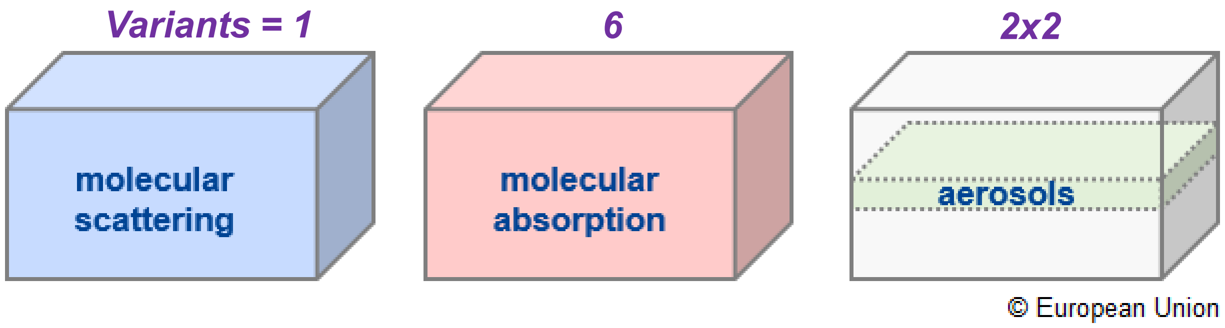
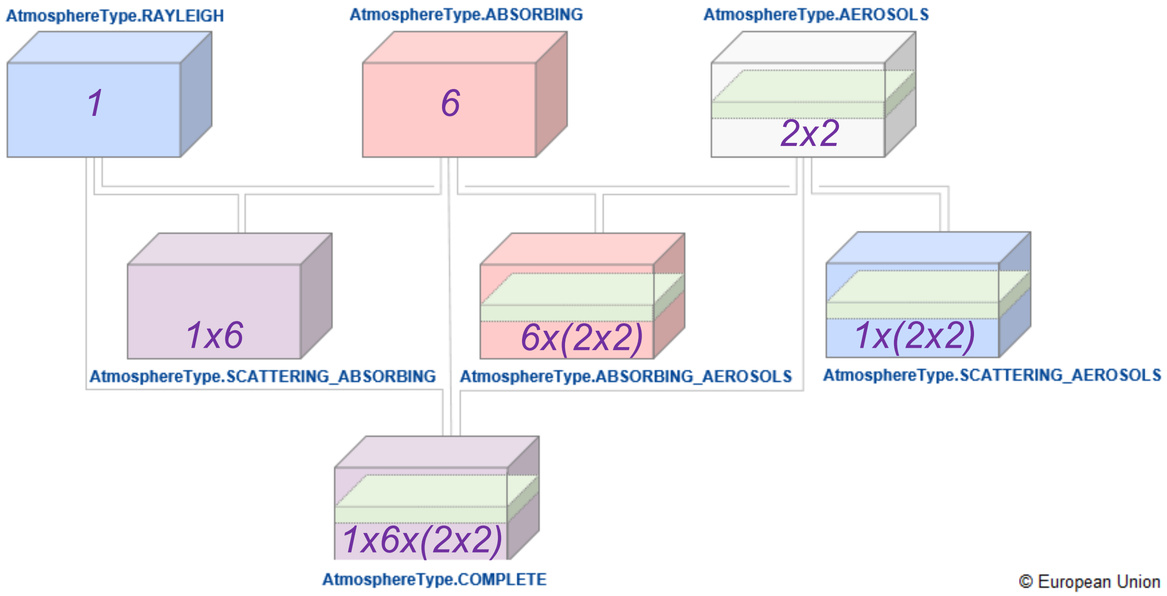
Atmospheres

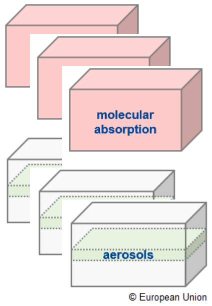
Three main elements are combined to create **seven** atmosphere families as shown in the diagram below





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

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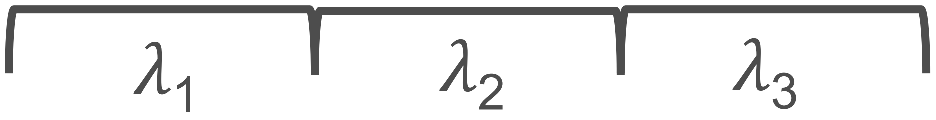
Participation
RTM users versus expert mode



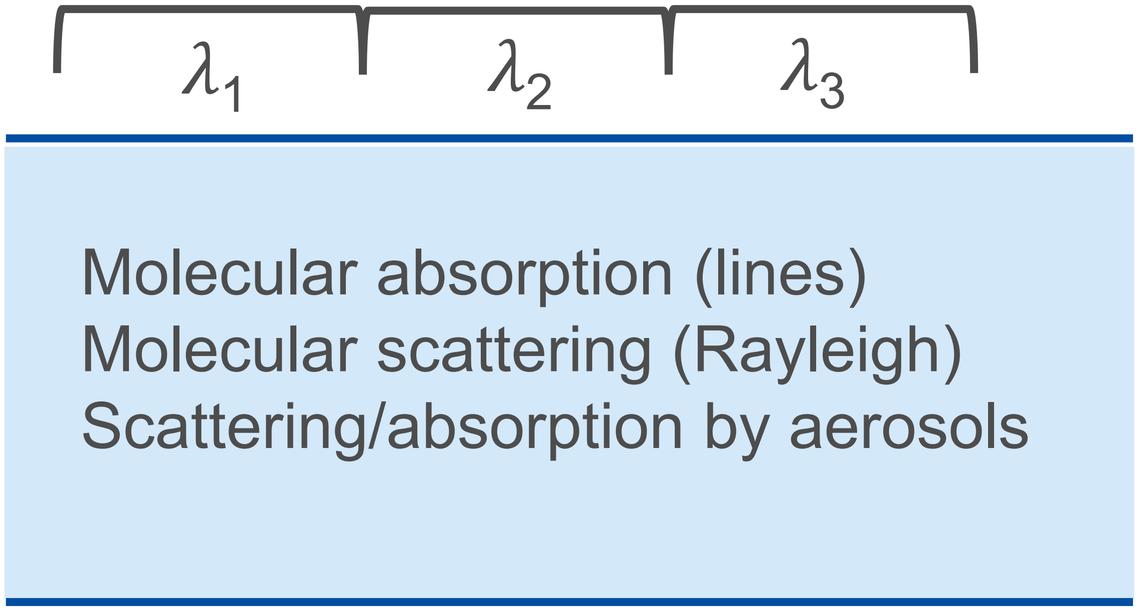
One homogeneous atmospheric layer

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

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

Participation
RTM users versus expert mode

One spectral band



One homogeneous atmospheric layer

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.

Participation
RTM users versus expert mode

One spectral band

λ_1 λ_2 λ_3

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

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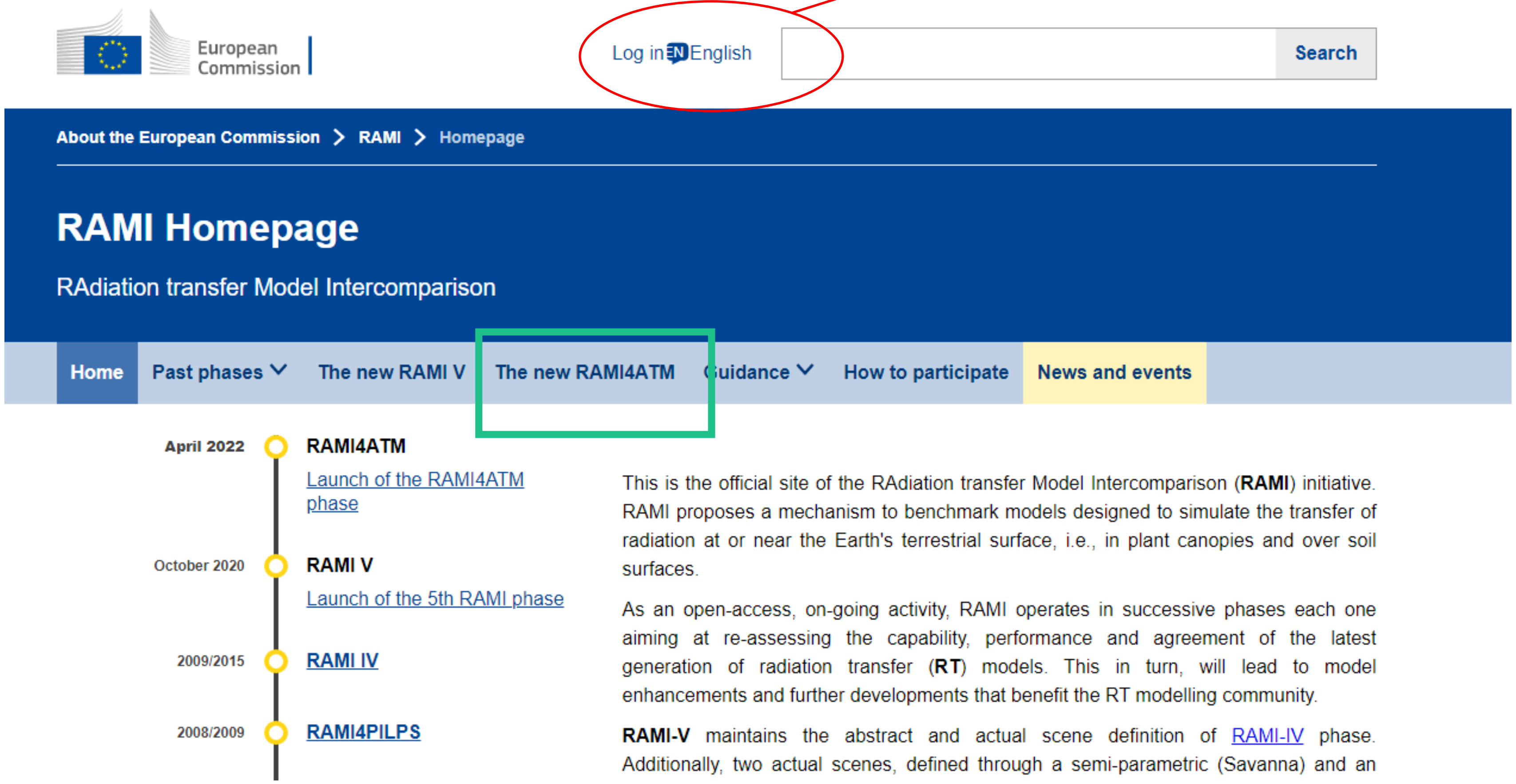
EU Login



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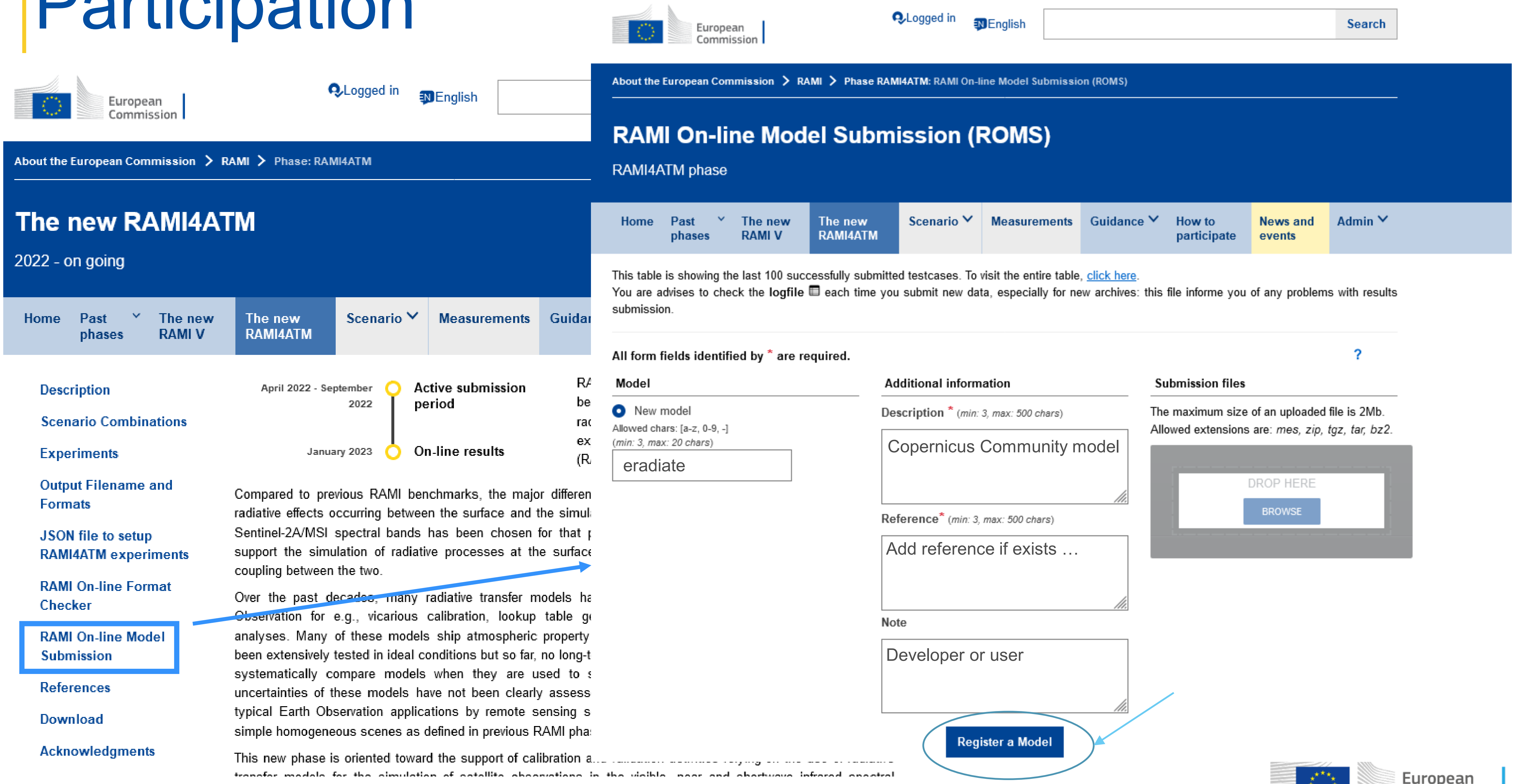
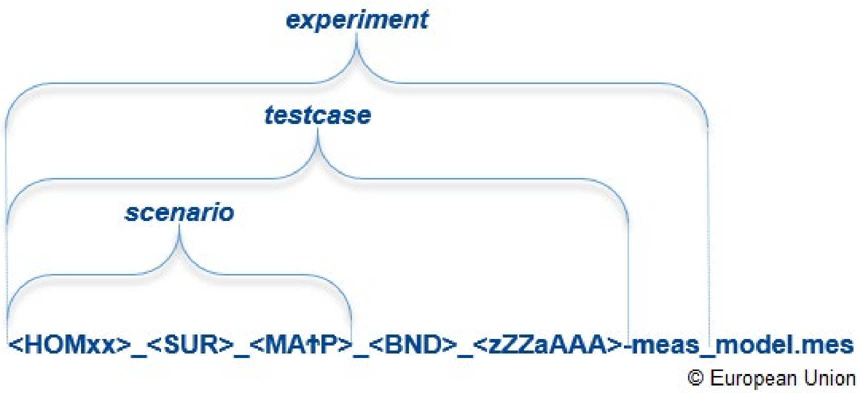
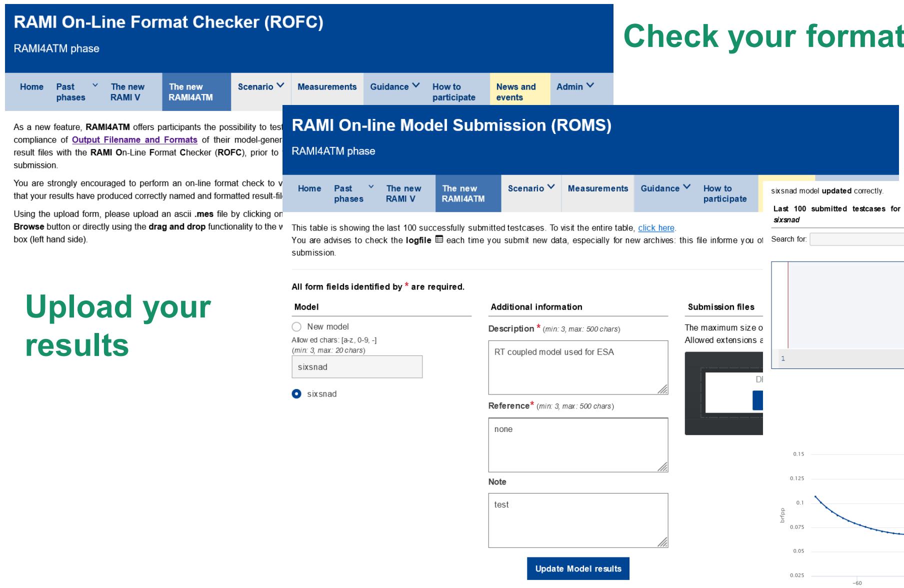
Participation



Practical Information





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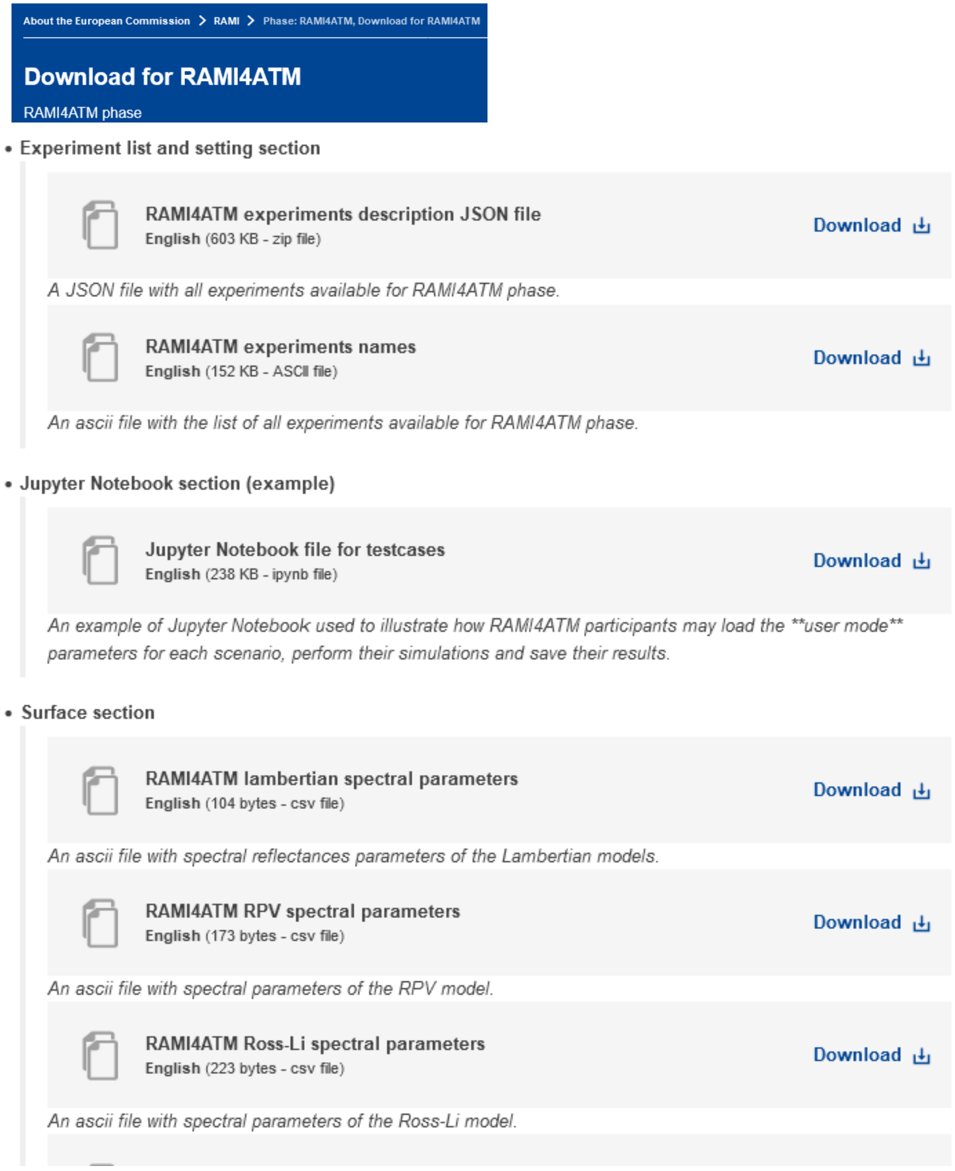
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RAMI4ATM phase

- Experiment list and setting section
  - **RAMI4ATM experiments description JSON file** English (603 KB - zip file) Download
    A JSON file with all experiments available for RAMI4ATM phase.
  - **RAMI4ATM experiments names** English (152 KB - ASCII file) Download
    An ascii file with the list of all experiments available for RAMI4ATM phase.
- Jupyter Notebook section (example)
  - **Jupyter Notebook file for testcases** English (238 KB - ipynb file) Download
    *An example of Jupyter Notebook used to illustrate how RAMI4ATM participants may load the **user mode** parameters for each scenario, perform their simulations and save their results.*
- Surface section
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    An ascii file with spectral reflectances parameters of the Lambertian models.
  - **RAMI4ATM RPV spectral parameters** English (173 bytes - csv file) Download
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  - **RAMI4ATM Ross-Li spectral parameters** English (223 bytes - csv file) Download
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Thank you

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