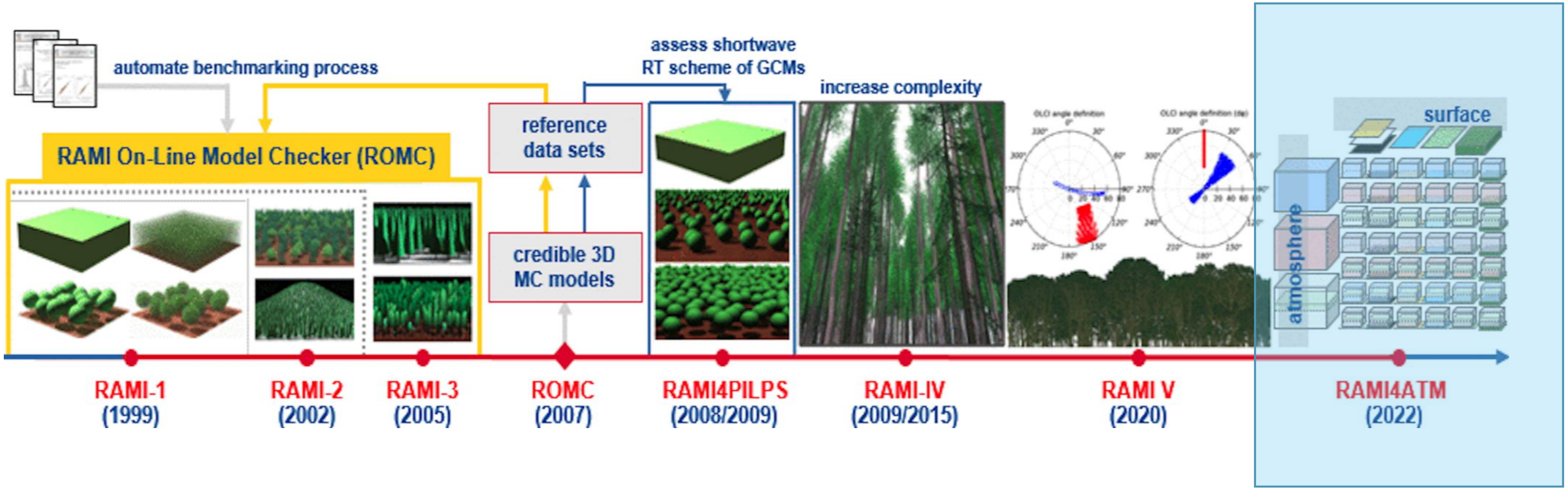
RAMI4ATM: Preliminary Results We are still in feedback phase

Nadine Gobron, Monica Robustelli & Christian Lanconelli

RAMI Workshop 2023

European Commission

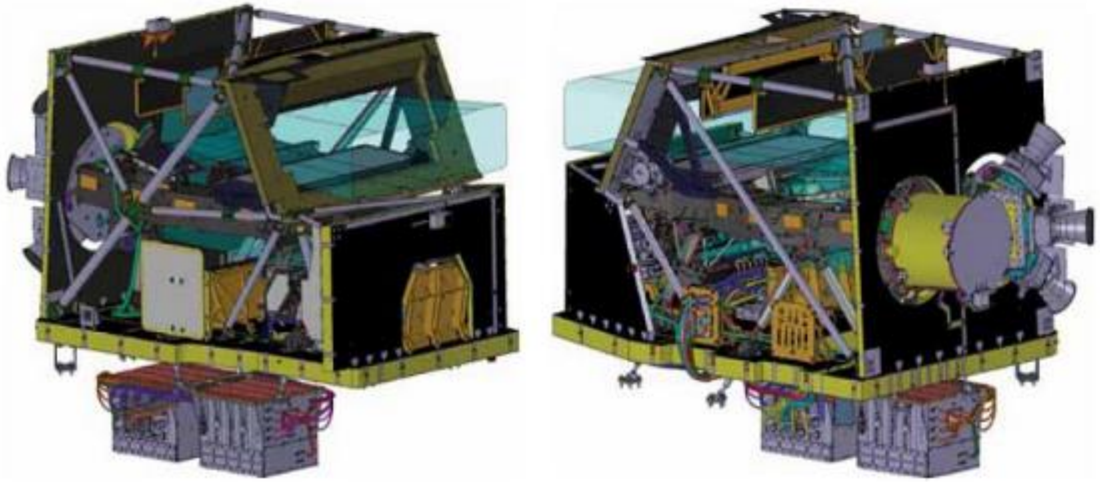
Radiation Transfer Model Intercomparison



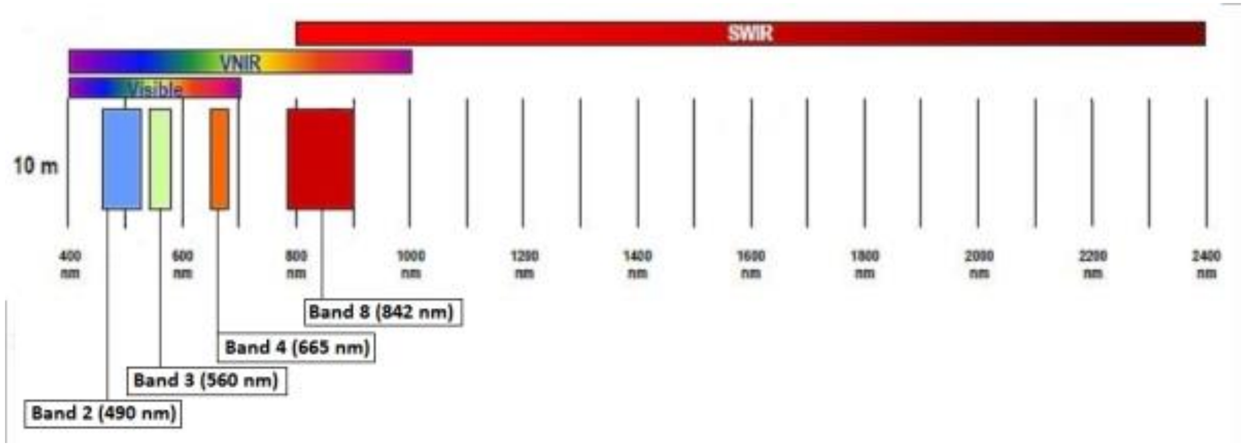
https://rami-benchmark.jrc.ec.europa.eu/

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

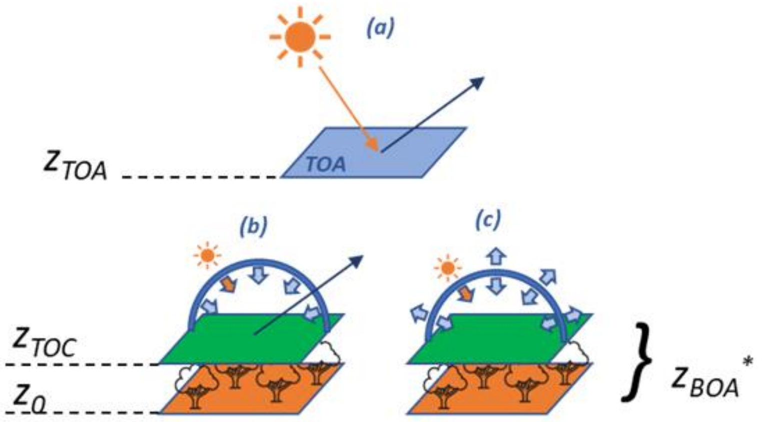


MultiSpectral Instrument (Airbus Defence and Space) source: sentinels.copernicus.eu

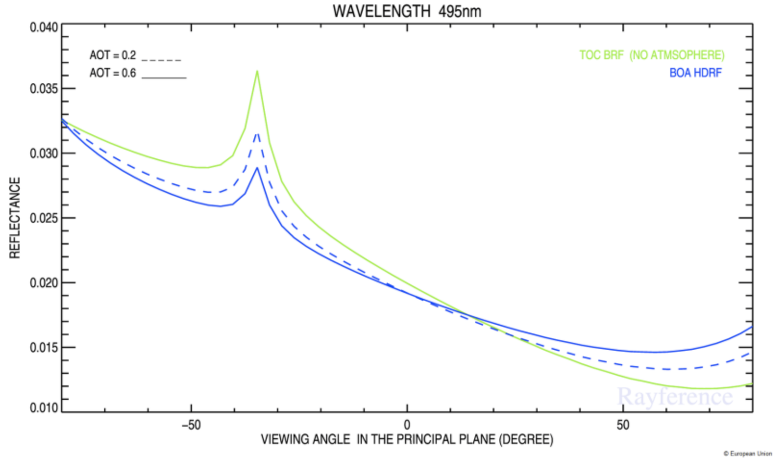


Measurements

<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



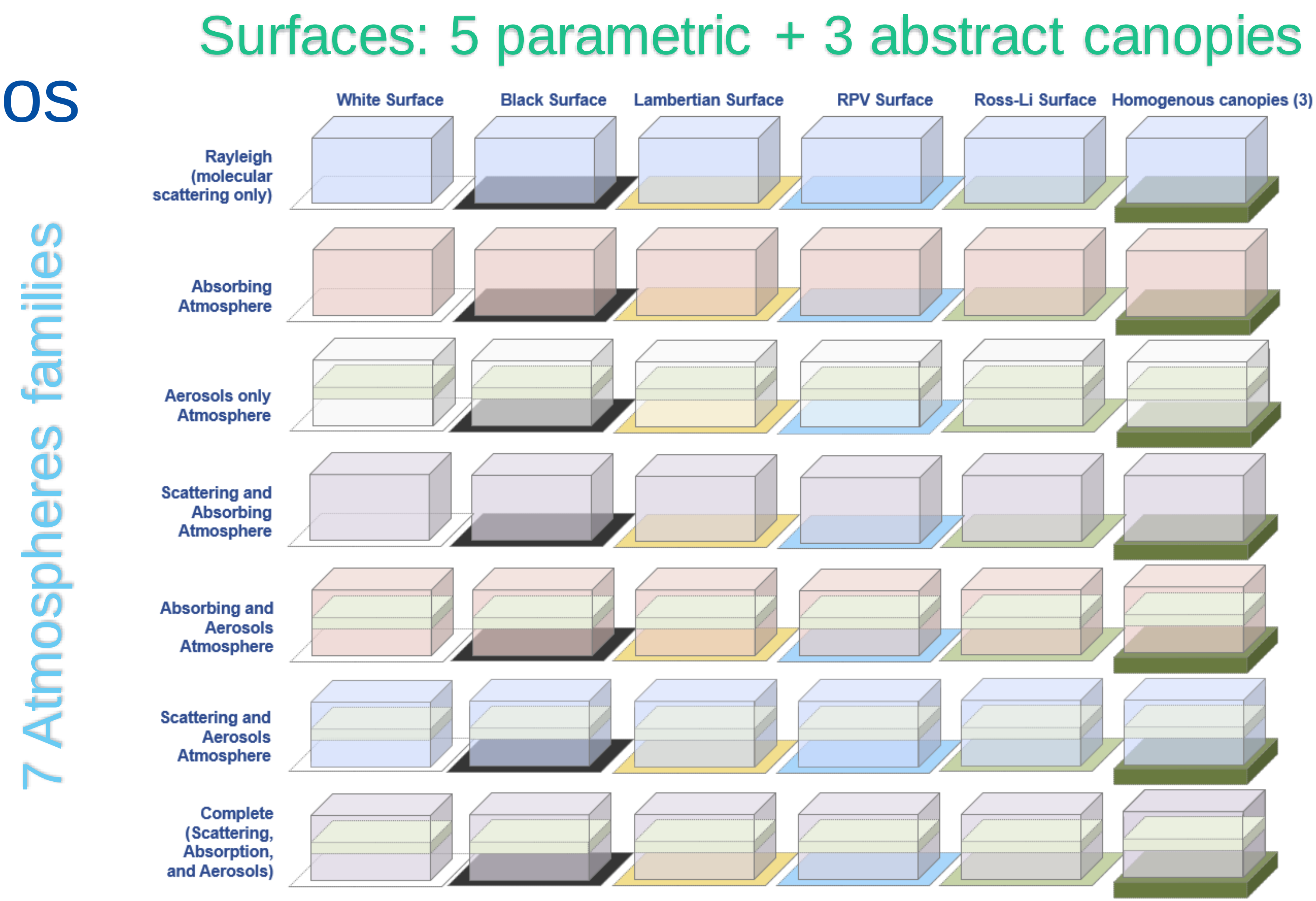
© European Union



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

European Commission

Scenarios



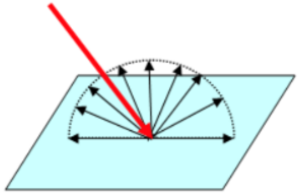
https://rami-benchmark.jrc.ec.europa.eu/

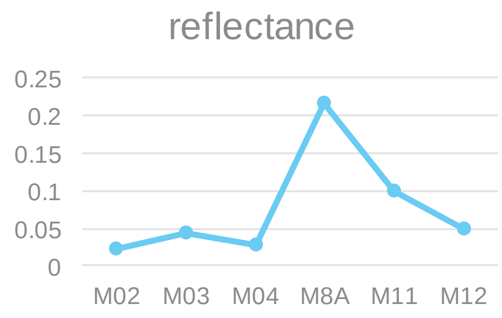
Surfaces

Lambertian

Purist corner $R = 0.0$

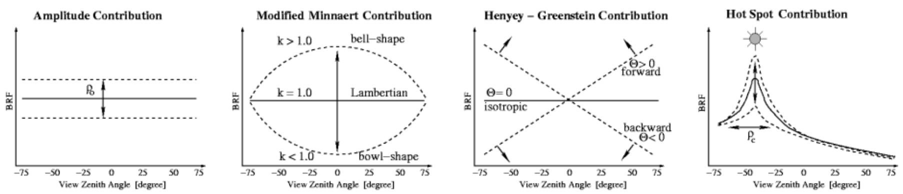
$R = 1.0$

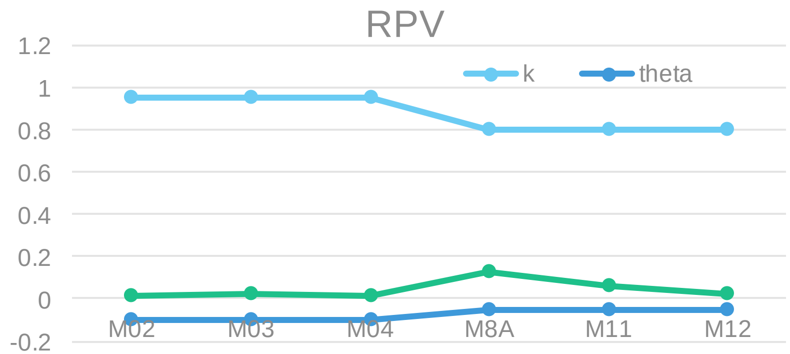




RPV

RPV model with 3 parameters: ρ_0, k, θ



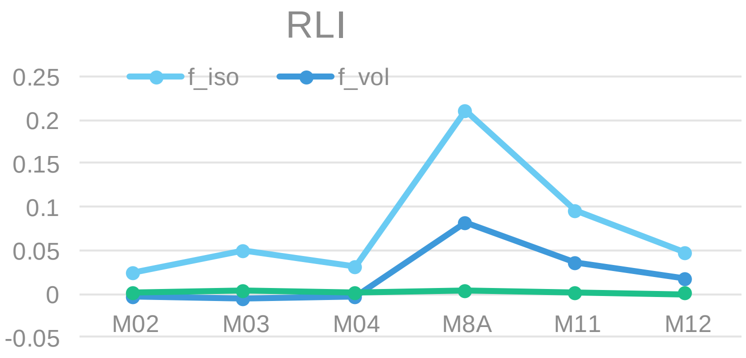


$$\rho(z_0, \mu_i, \mu_r, d\phi; \rho_0, \Theta, k, \rho_c) = \rho_0 \cdot M(k) \cdot F_{HG}(\Theta) \cdot H(\rho_c)$$

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

RLI

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

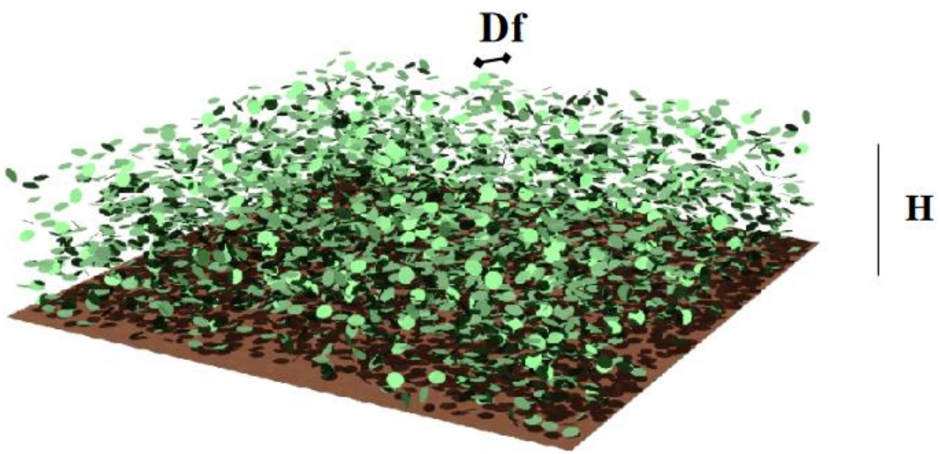


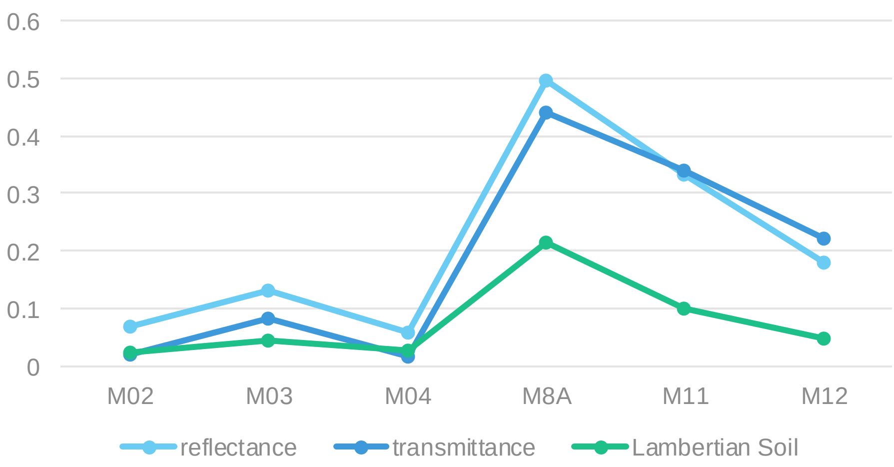
$$\rho(\theta_i, \theta_r, d\phi) = f_{iso} K_{iso} + f_{vol} K_{vol} + f_{geo} K_{geo}$$

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

Surfaces

3 homogeneous abstract canopies





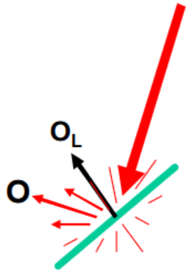


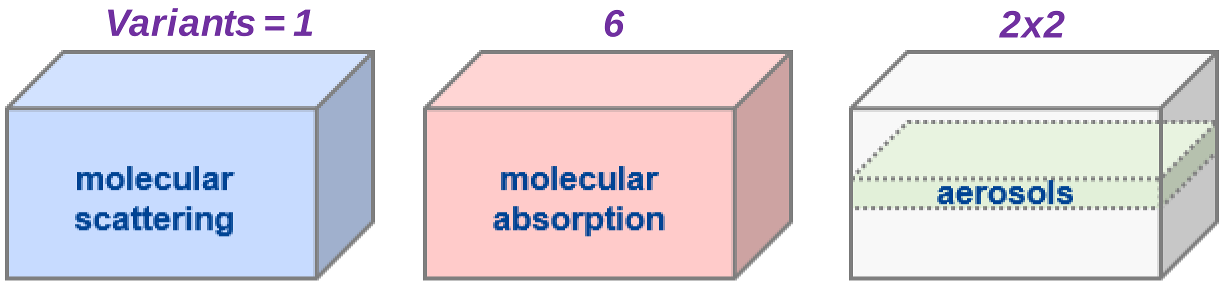
plate model

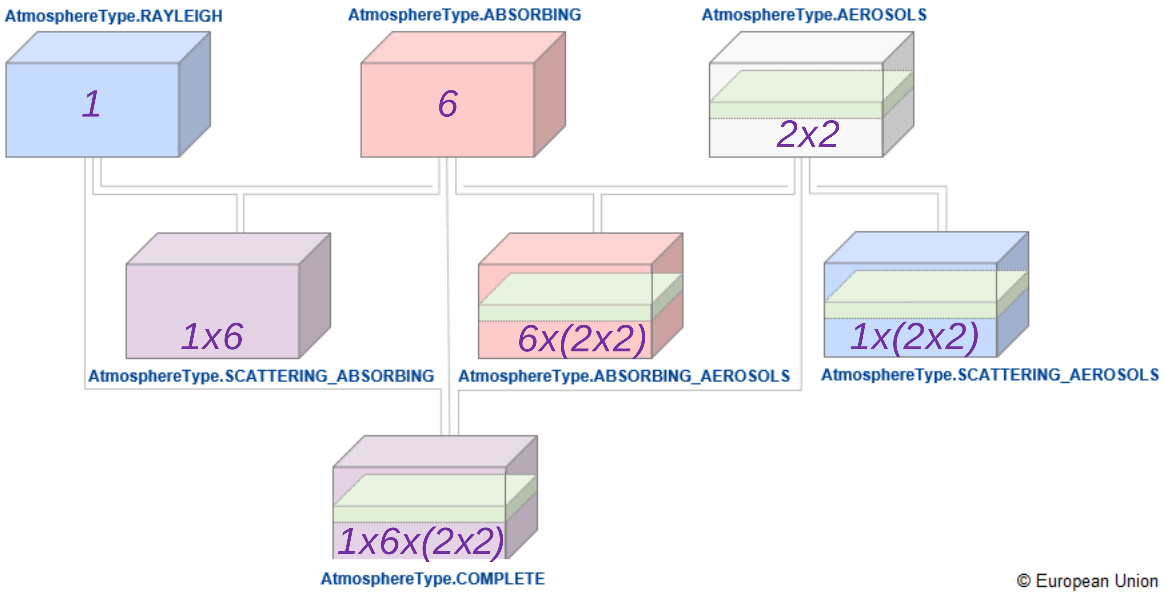
Common properties

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

Atmospheres

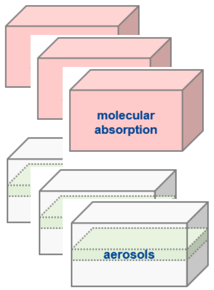
Three main elements are combined to create **seven** atmosphere families as shown in the diagram below





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 <u>69 atm. variants</u> are defined in RAMI4ATM.
Some of them are used only

European Commission

RAMI4ATM models/inst = 16

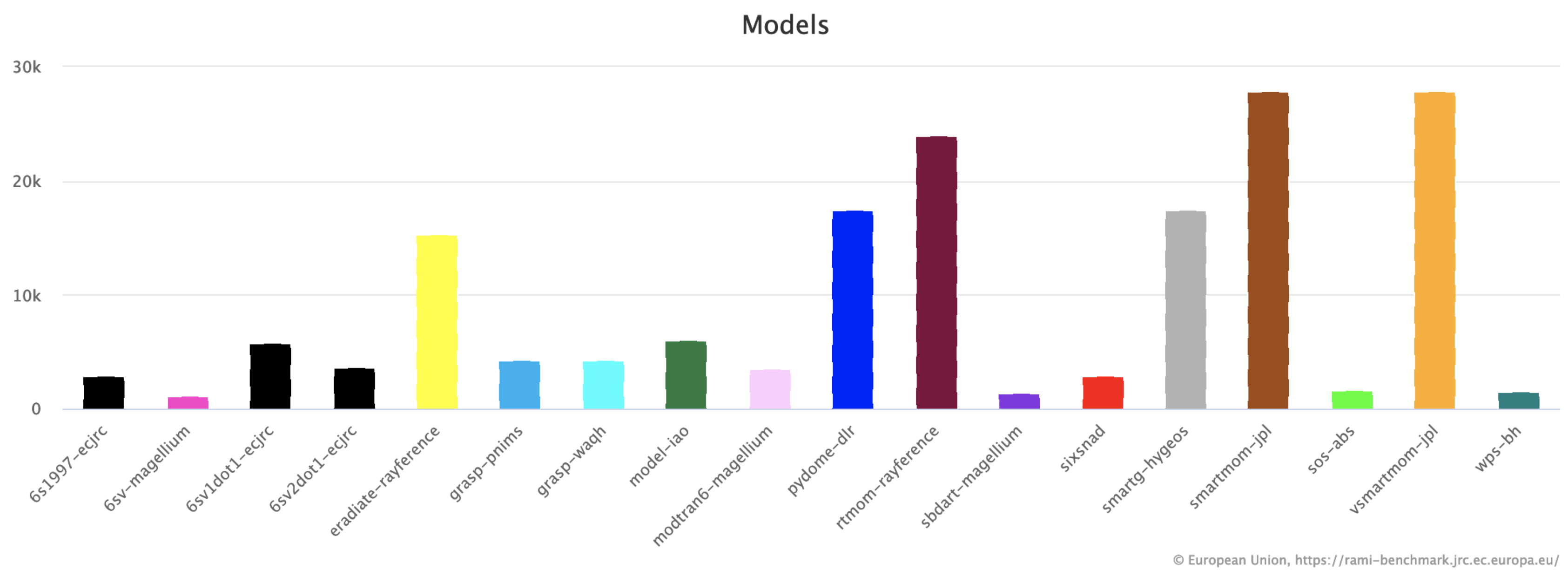
Model	#	Institution	Participants	Reference
6sv	*Second Simulation of the Satellite Signal in the Solar Spectrum v2.1*	Magellium	Jorge VICENT SERVERA	*S.Y. Kotchenova et al. (2008), J. Vicent et al. (2020)*
modtran6	*MODerate resolution atmospheric TRANsmission*			*A. Berk et al. (2014), L. Guanter et al. (2009)*
sbdart	*Santa Barbara DISORT Atmospheric Radiative Transfer*			*P. Ricchiazzi et al. (1998), J. Vicent et al. (2020)*
6sv2.1	*6SV v2.1 (2014)*	*EC-JRC*	Christian LANCONELLI	*S.Y. Kotchenova et al. (2008)*
sixsnad	*Modified 6SV, RT coupled model used for ESA*		Nadine GOBRON	*S.Y. Kotchenova et al. (2008); Gobron et al. (1997)*
eradiate	*A cal/val-oriented 3D radiative transfer model*	RAYFERENCE	Nicolas Misk	*Reference: https://www.eradiate.eu*
rtmom	***R**adiative **T**ransfer **M**atrix **O**perator **M**ethod*			*Y. Govaerts (2006)*
pnims	***P**olarized radiance **I**mproved **M**ultiple and **S**ingle scattering (PnIMS)*	GRASP	Masahiro Momoi	*Lenoble et al. (2007) Momoi et al. (2022) Nakajima and Tanaka (1988)*
waqh	*Waquet and Herman radiance correction*			*Lenoble et al. (2007), Waquet and Herman (2019)*
model-iao	*Model of V.E. Zuev Institute of Atmospheric Optics SB RAS*	IAO	Zhuravleva Tatiana	*T. Zhuravleva (2008), T. Zhuravleva and I. Nasrtdinov (2018)*
smartg	*Speed-Up Monte Carlo Advanced Radiative Transfer using GPU*	HYGEOS	Mustapha MOULANA	*Ramon et al. (2019)*
smartmom	*Simulated measurement of the atmosphere using radiative transfer based on the Matrix Operator Method*	JPL	Sanghavi Suniti	*Sanghavi, S., et al. (2013)*
vsmartmom	*Vectorized Simulated measurement of the atmosphere using radiative transfer based on the Matrix Operator Method*			*Sanghavi, S., et al. (2014)*
sos-abs	*Successive Orders of Scattering code including gas absorption*	CS Group	Stéphan Gwendoline	*J. Lenoble, et al. (2007)*
pydome	*python library for radiative transfer computations*	DLR	Dmitry Efremenko	*A. Doicu and T. Trautmann (2009)*
wps	*Weighted Photon Spread*	Beihang University	Feng Zhao	*Zhao et al. (2022, 2015)*

Participation

- https://rami-benchmark.jrc.ec.europa.eu/_www/RAMI4ATM/stats/SshowStats.php

Results submission progress on RAMI4ATM

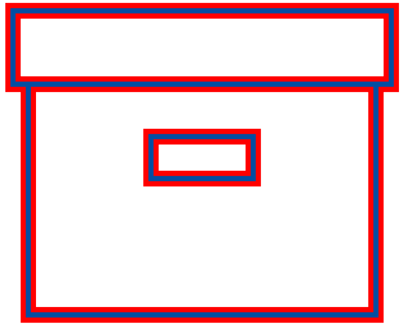
Graphical representation of progress on RAMI4ATM phase submissions.



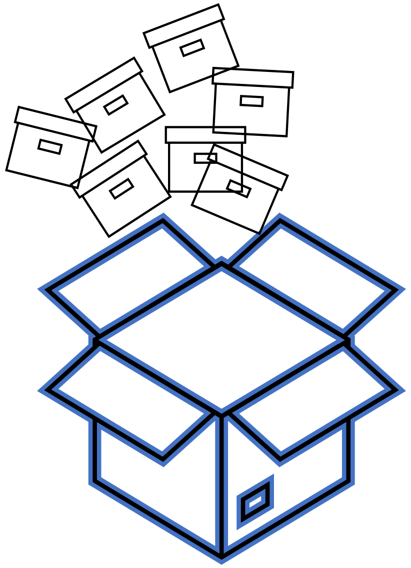
☐ Axis Y Logarithmic scale

European Commission

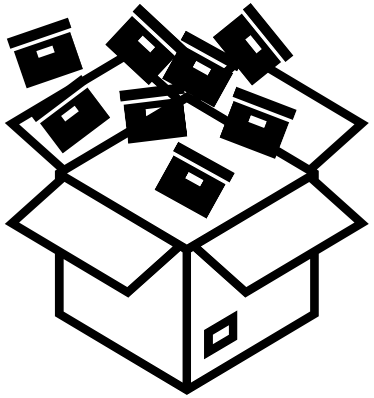
Preliminary Results (feedback phase)



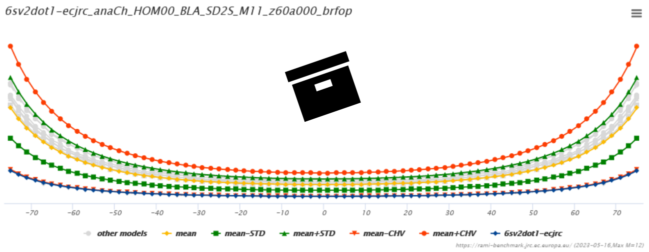
Lev0
Meas vs Surface



Lev1
Meas vs Atmosphere



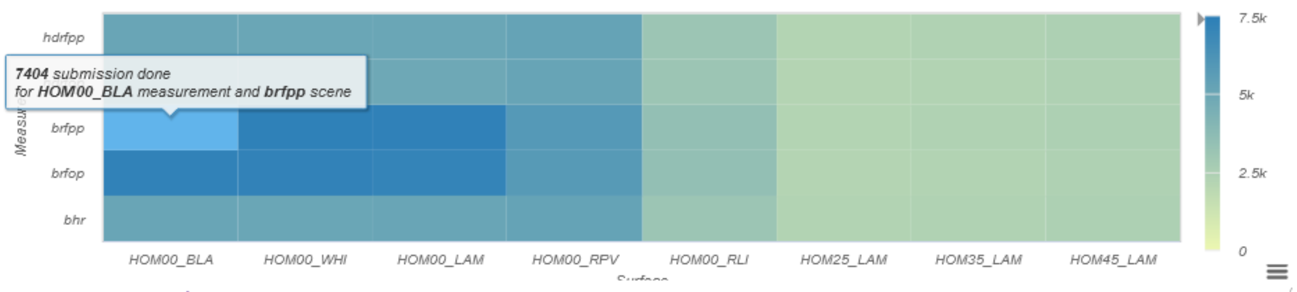
Lev2
Geom vs Band



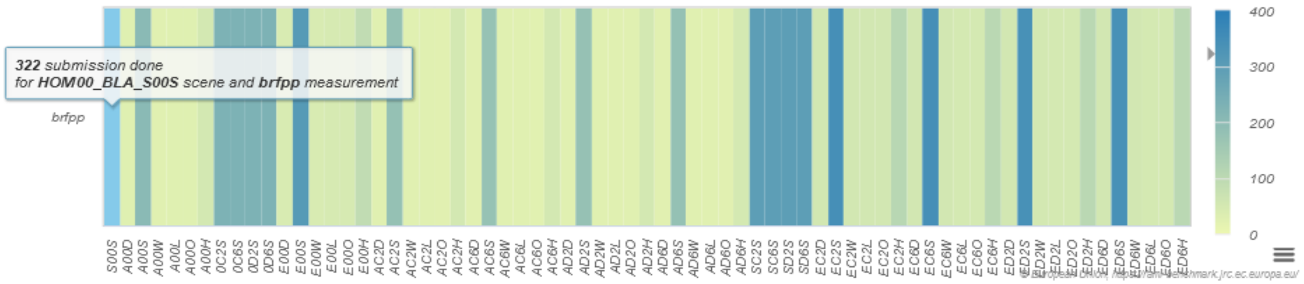
https://rami-benchmark.jrc.ec.europa.eu/_www/RAMI4ATMresults/RAMI4ATMresults_showHM.php

Overall Number of Submission

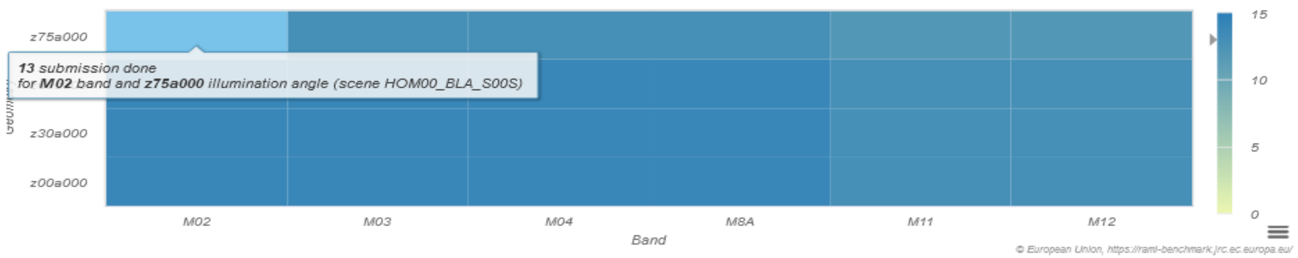
Model: **All models**

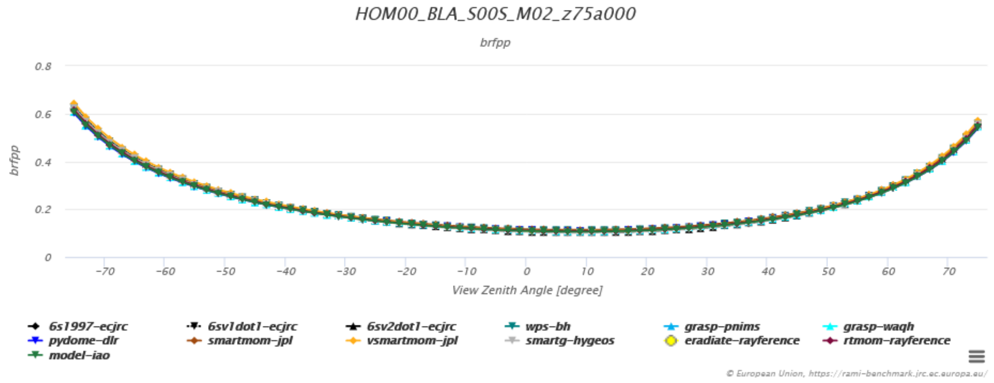


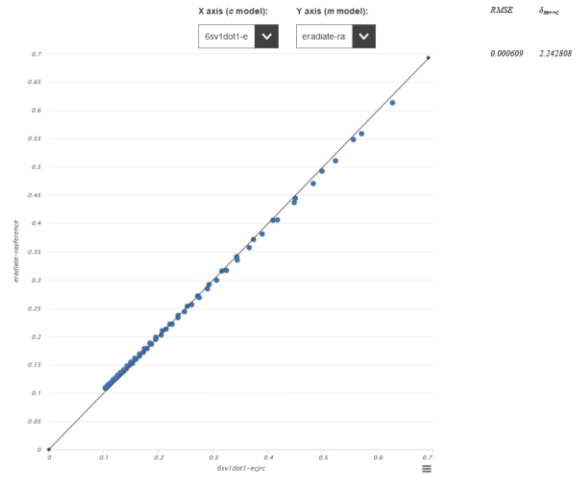
Scene: **HOM00_BLA**



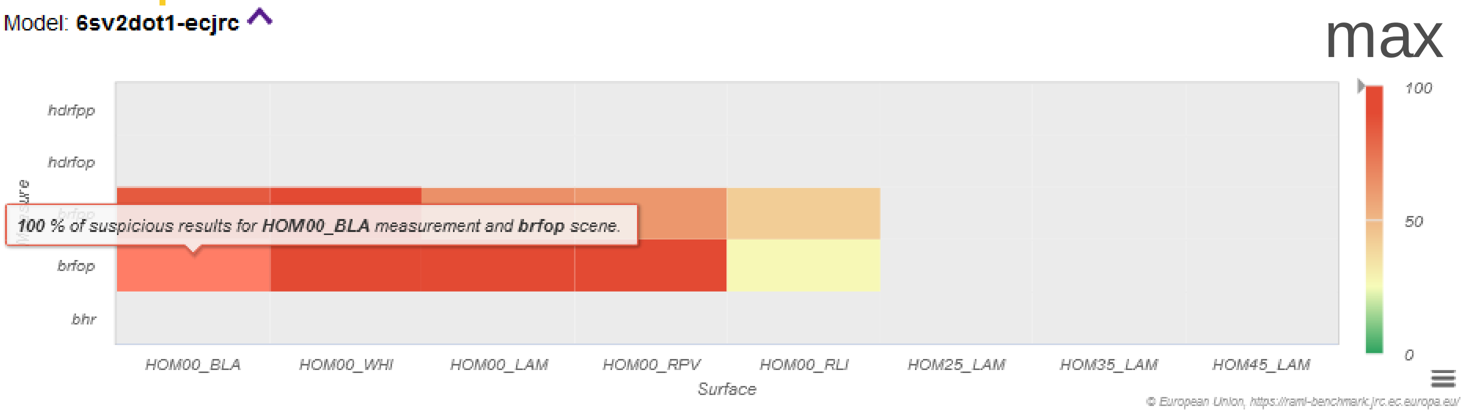
Scene: **HOM00_BLA_S00S**

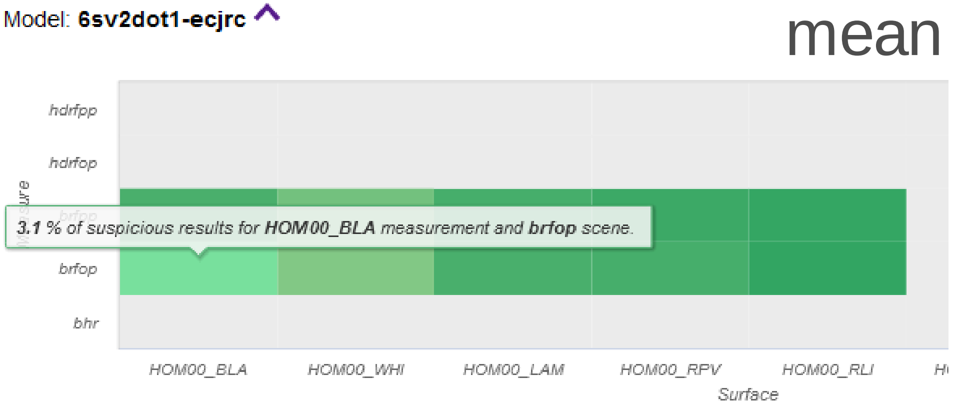


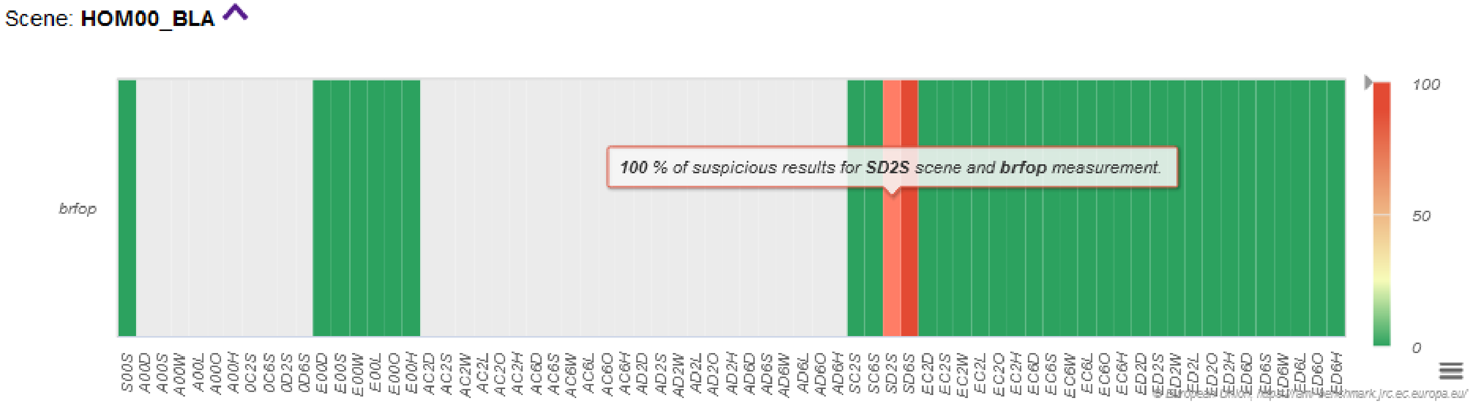


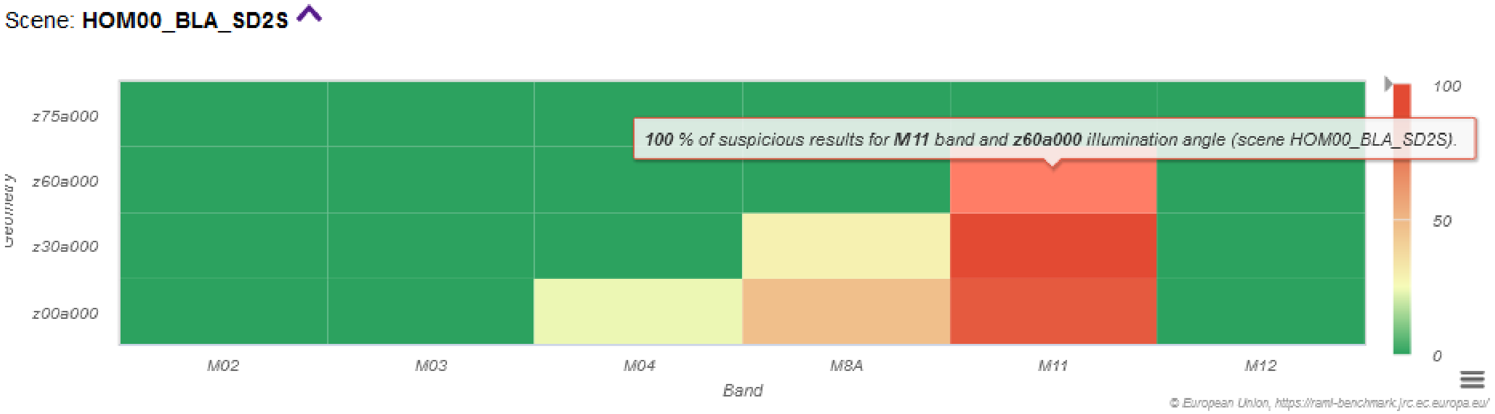


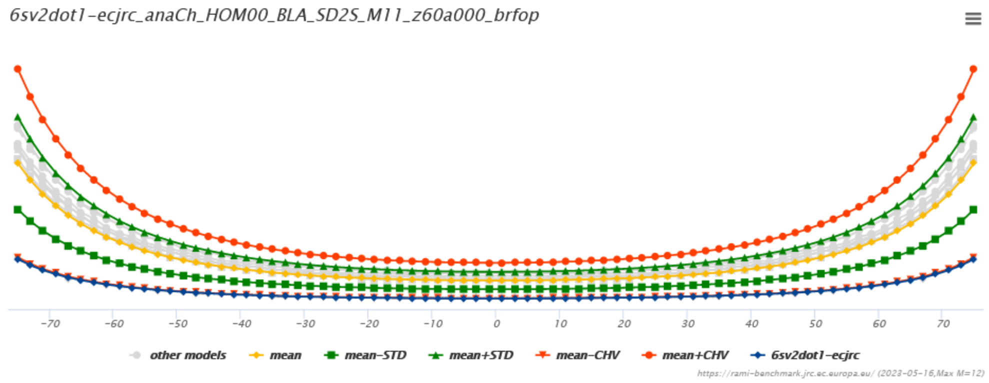
Outlier fraction: max and mean











Mean and Max, … and the Purist Corner

Results

Please, select all fields *

Criteria: *

Outlier fraction: mean

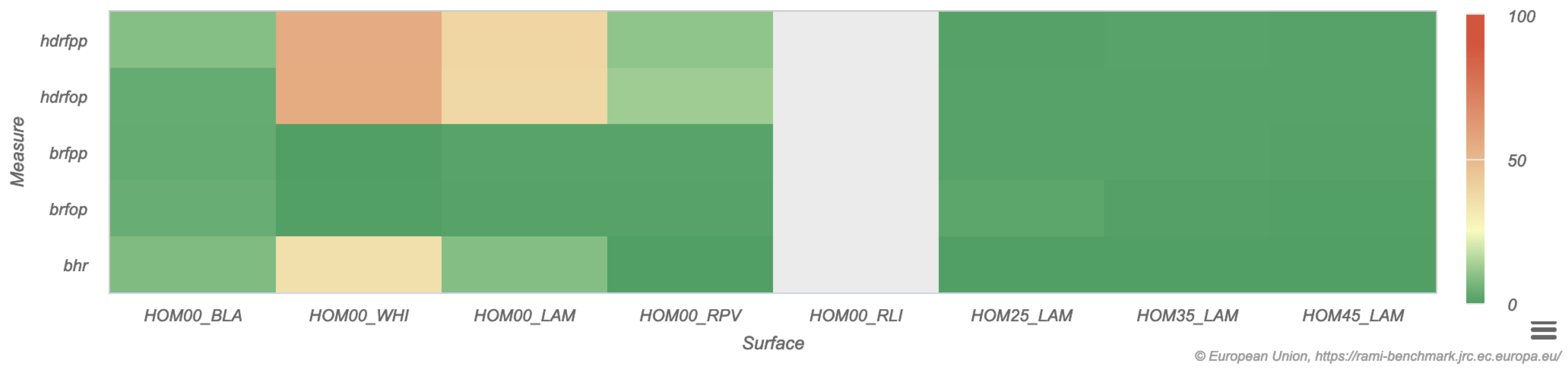
Model: *

eradiate-rayference

Version: *

Last (2023-05-16)

Model: **eradiate-rayference**



European Commission

Mean and Max, … and the Purist Corner

Results

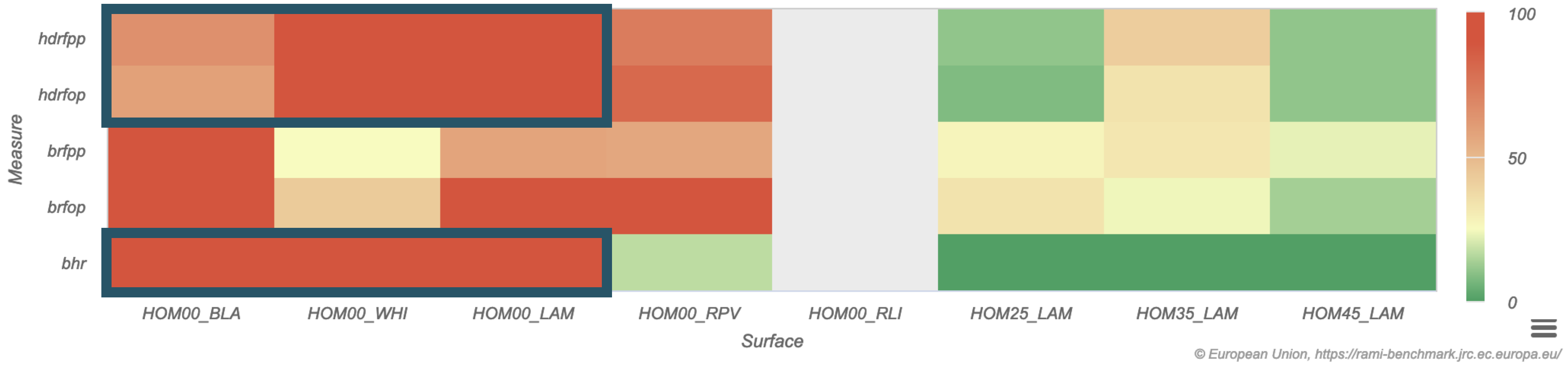
Please, select all fields *

Criteria: *
Outlier fraction: max

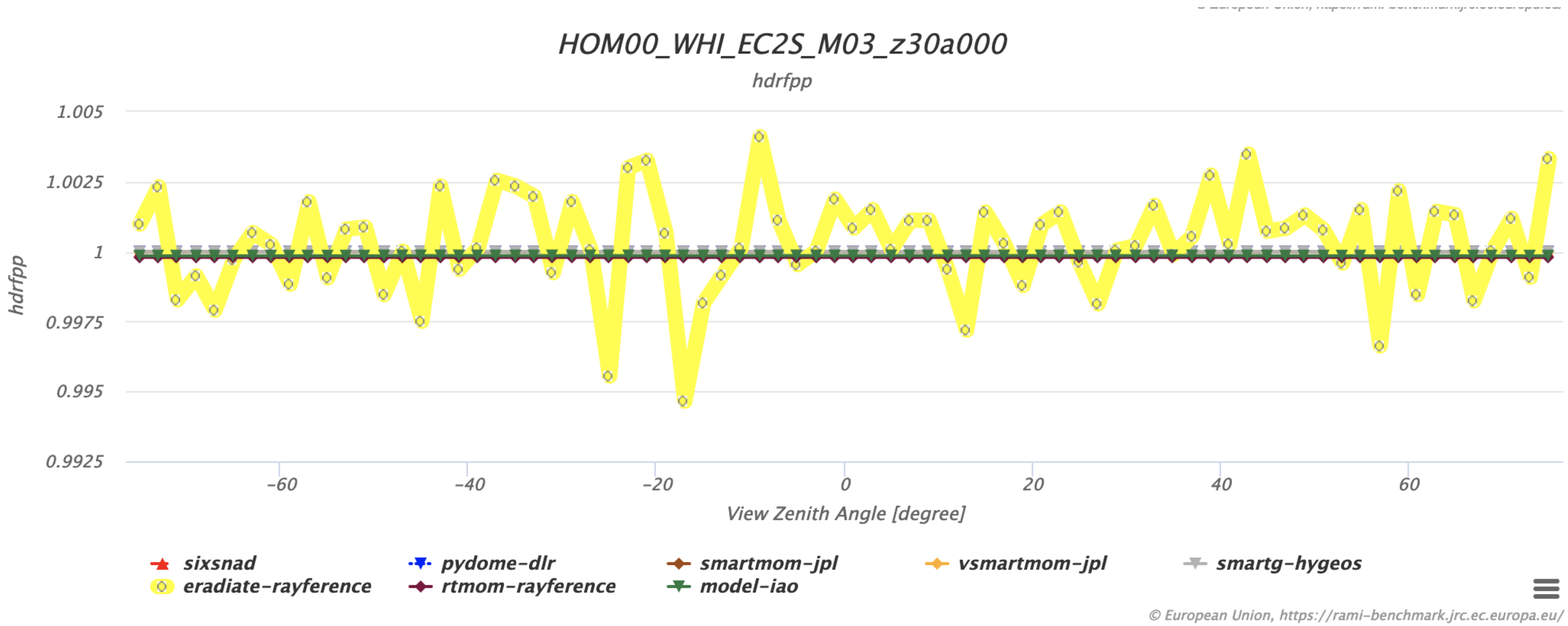
Model: *
eradiate-rayference

Version: *
Last (2023-05-16)

Model: **eradiate-rayference**



Mean and Max, … and the Purist Corner



European Commission

Final Remarks

- 16 models from 10 participants
- Feedback Phase currently on going
- Max/Mean % outliers heatmap issued. Max value seems especially useful to catch problems in the sea of simulations
- User already started fixing issues. Recommend to use the "Bookmark" feature to track your navigation across issues.
- Purist corner simulations (BOA: hdrf, bhr for Lambertian surfaces) will be used as a QC tool more than model intercomparison.
- Reference model identification on going but rather promising for many scenarios. Reference set may change depending on Atmospheric complexity.

Copernicus
#EUSpace
08 June 2023
COPERNICUS:
A EUROPEAN
SUCCESS STORY
IN SPACE
25TH ANNIVERSARY
OF COPERNICUS
sweden
2023.eu
Rymdstyrelsen
esa

Keep in touch

EU Science Hub: ec.europa.eu/jrc

@EU_ScienceHub

EU Science Hub – Joint Research Centre

EU Science, Research and Innovation

Eu Science Hub

Thank you

European Commission