MGELLIUM | UNIV. OF VALENCIA

USING THE ALG TOOLBOX FOR RAMI4ATM

LESSONS LEARNED, SUGGESTIONS AND FUTURE DEVELOPMENTS

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RAMI4ATM

INTRODUCTION

Benchmarking and comparison of coupled surface–atmosphere radiative transfer models (RTM) for remote sensing applications (vicarious cal., atm. correction)

Expected outcomes

- RTM cross-comparison over a variety of ideal atmospheric scenarios (gas absorption, Rayleigh and Mie scattering)
- To inform users on the performance of the participating RTMs and their differences
- To help developers improve their models
- Build community consensus on the radiative transfer simulation below and above the Earth's atmosphere

Our contribution and objectives

- To provide a software tool (ALG) to streamline RTM configuration, execution and to harmonize inputs/outputs
- To validate the developed tool with other simulations from RAMI4ATM participants
- To contribute to RAMI4ATM with several RTMs

COMPLEXITY OF RTM COMPARISON

1

Difficult to use

Hard entry level. Extense user manuals. Each RTM works differently. No common graphical user interfaces.

2

Consistency of inputs and outputs

Each RTM uses their own inputs and definitions. Lack of harmonization in inputs and outputs (format, content, units).

3

Graphical User Interfaces

Existing tools are customized for only one RTM, and none is designed to generate databases for a variety of models.

4

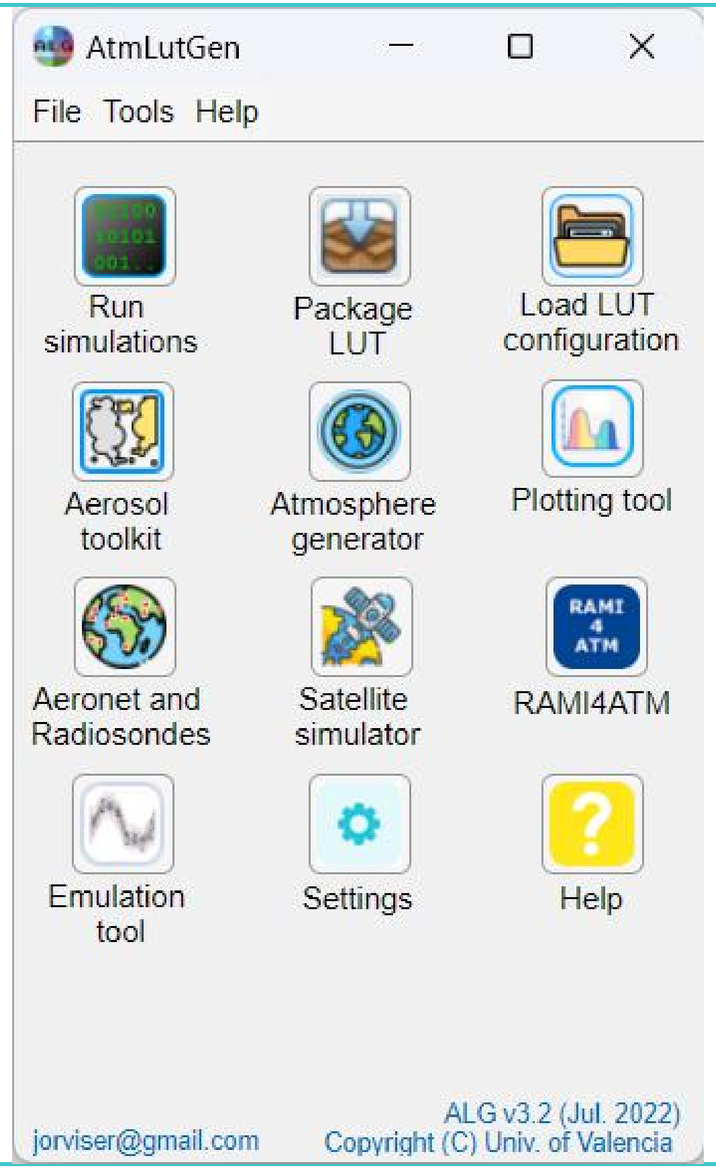
Generation of databases

Simulation of large databases require development of specific scripts. No harmonization of database format.

WHAT IS ALG?

ATMOSPHERIC LOOK-UP TABLE GENERATOR (ALG)

ALG is a software tool that facilitates generating large databases for a variety of atmospheric RTMs. ALG allows consistent and intuitive user interaction to enable configuration and execution of model simulations, storing RTM data for any spectral configuration in the optical domain.



ALG IN A NUTSHELL

MAIN SOFTWARE FEATURES

Configure, run and store your RTM simulations for later use in analysis and applications

Access a broad range of public data repositories to define new aerosols and atmospheres

Download and visualize Aeronet and Wyoming radiosondes data

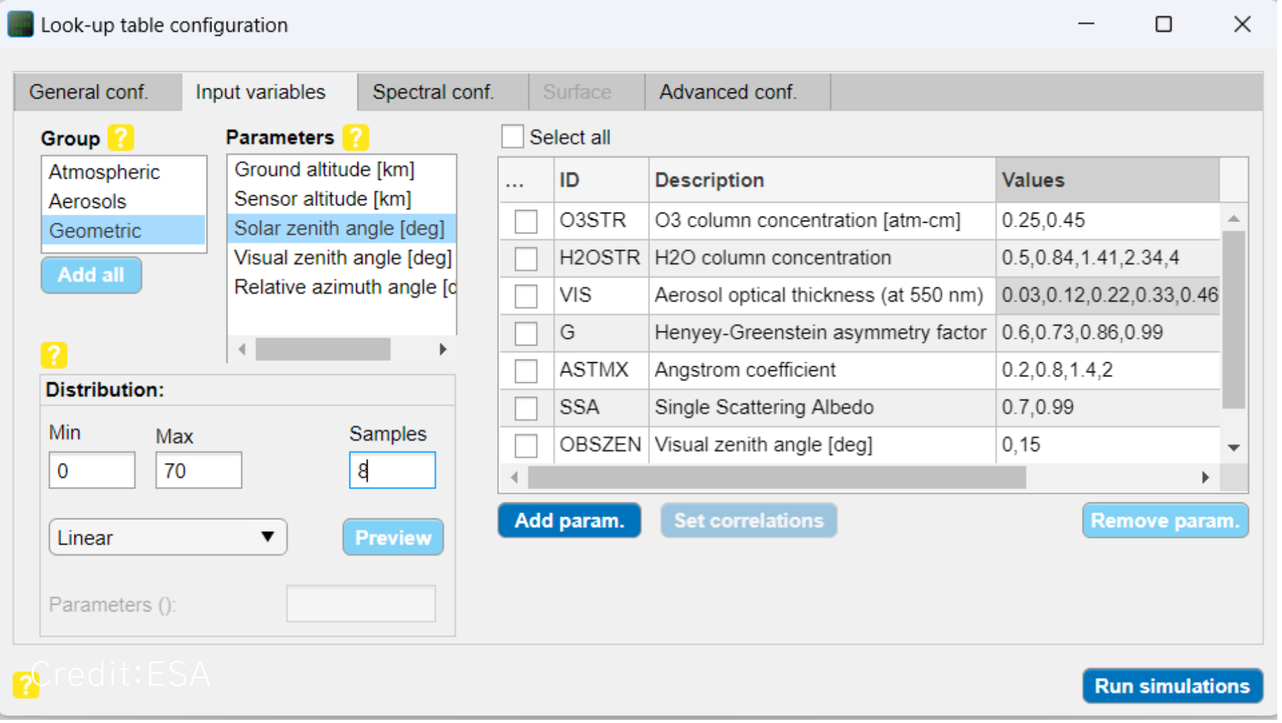
Explore atmospheric data such as RTM outputs, atmospheric profiles, Aeronet data,...

Feeling lost? Find all information in a friendly user manual, reference publications and tutorials

Emulator tool, satellite (scene) simulator tool and RAMI4ATM processing

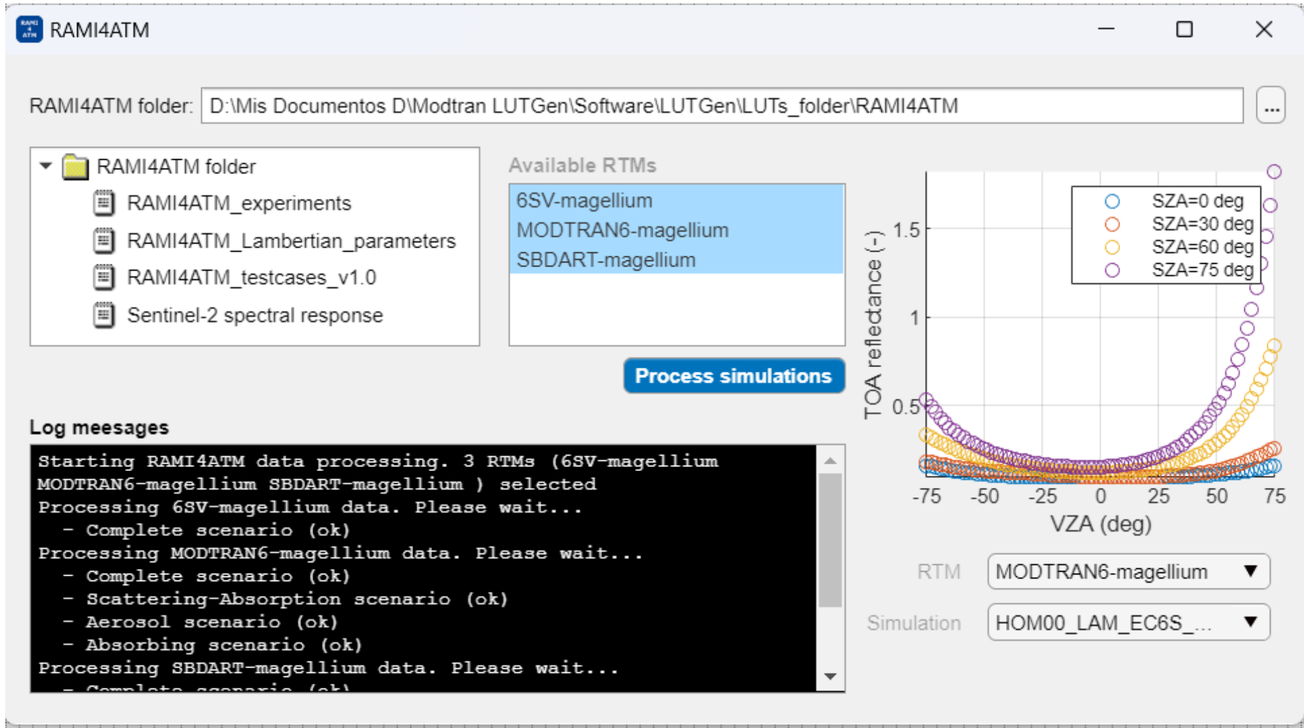
CONFIG. OF RTM SIMULATIONS

Common graphical user interface for all RTMs with harmonized input/output definition. Access to user-defined atmospheric profiles and aerosol models.
Several options for data point distribution (grid vs pseudo-random, correlations, statistical distribution)



RAMI4ATM TOOL

Automatic processor of RTM simulations for RAMI4ATM (scenarios and measurements, file naming & format...) and visualization of data



SELECTED ATMOSPHERIC RTM

MODTRAN

www.modtran.spectral.com
Based on the DISORT solver and a modelization of gas absorptions by the k-correlation method.
Spectral range and resolution: UV to TIR at 0.1 cm-1

6SV

salsa.umd.edu/6spage.html
Based on the SOS solver with polarization and decoupled scattering and absorption.
Spectral range and resolution: VIS to SWIR at 2.5 nm

SBDART

github.com/paulricchiazzi/SBDART
Designed for the simulation of plane-parallel radiative transfer for satellite remote sensing and atmospheric energy budget studies.

Not selected

ARTDECO (LOA)
libRadtran (LMU)

In the pipeline

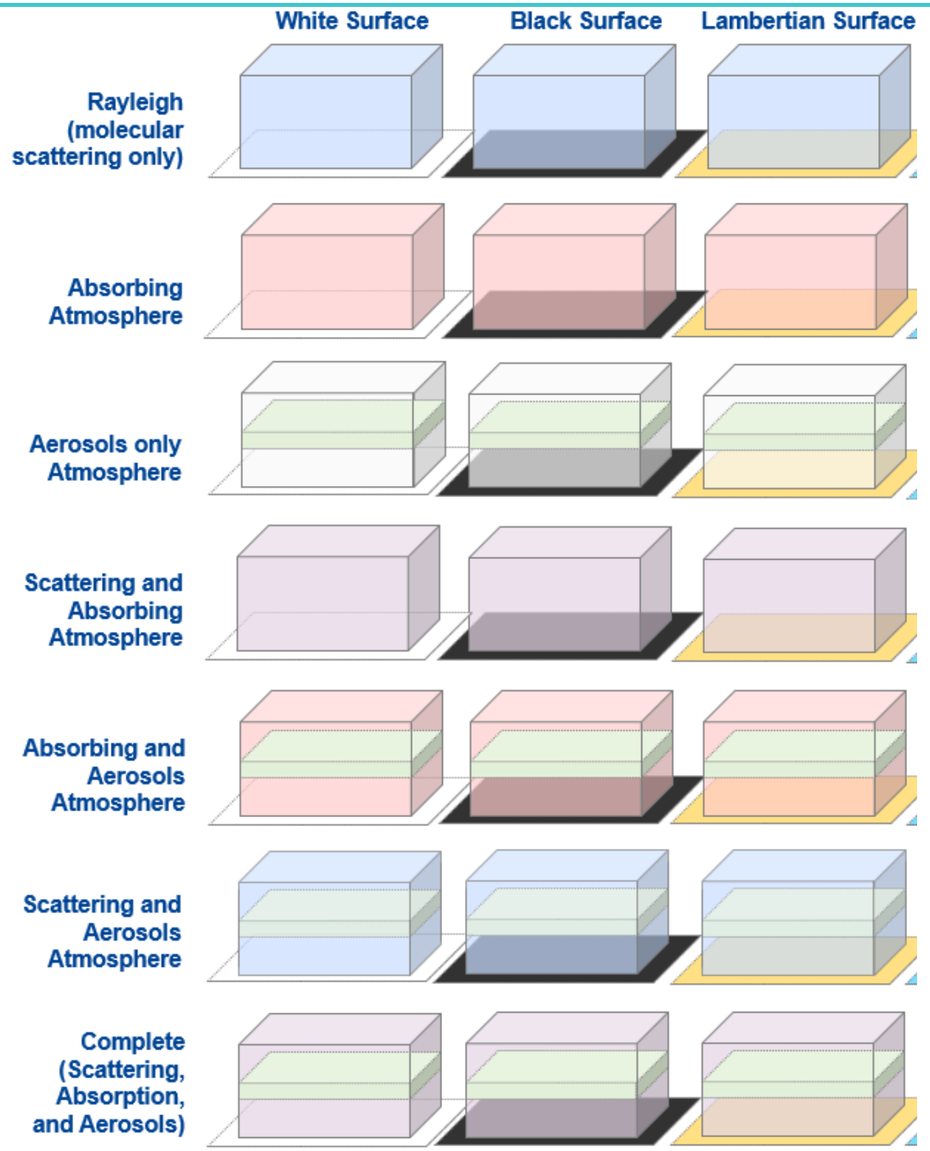
PYDOME (DLR)
SCIATRAN (IUP Bremen)
SOS-ABS (CNES/LOA/CS)
SMART-G (HYGEOS)
DISAMAR (KNMI)...

RAN SIMULATIONS

SCENARIOS AND MEASUREMENTS

- All atmospheric types (when possible):
  - Some RTM don't allow certain atmospheres (e.g. MODTRAN scattering+absorbing wo/ Rayleigh), unless finely tuned configuration or code modified
- Only LAM, BLA, WHI surfaces at top-of-atmosphere:
  - ALG calculates atmospheric transfer functions at high spectral resolution
  - Coupled atmosphere-surface (TOA radiance) simulation and spectral convolution as post-processing steps:

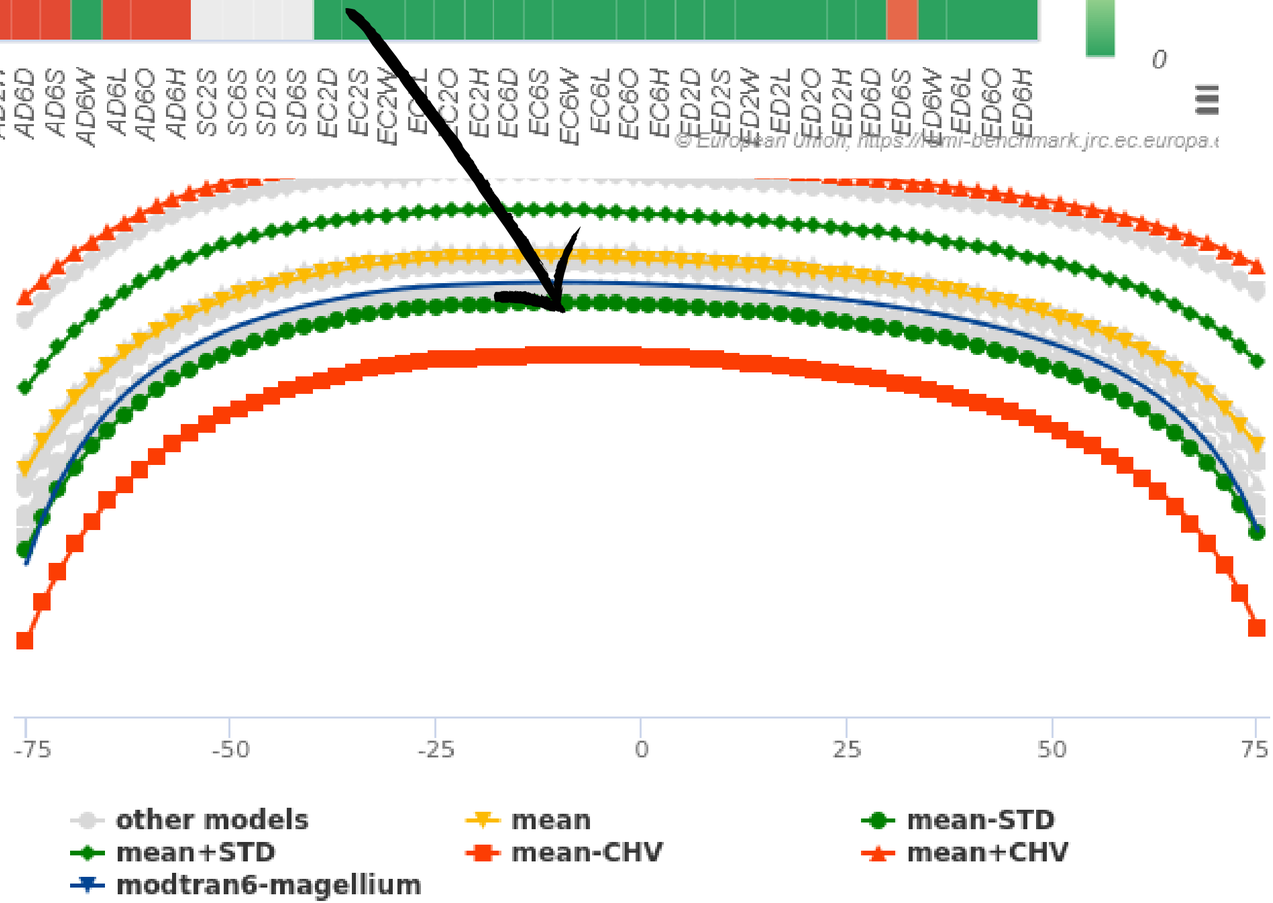
$$L_{TOA} = L_0 + \frac{I_s T^{\downarrow} T^{\uparrow} \rho}{\pi(1-S\rho)}$$



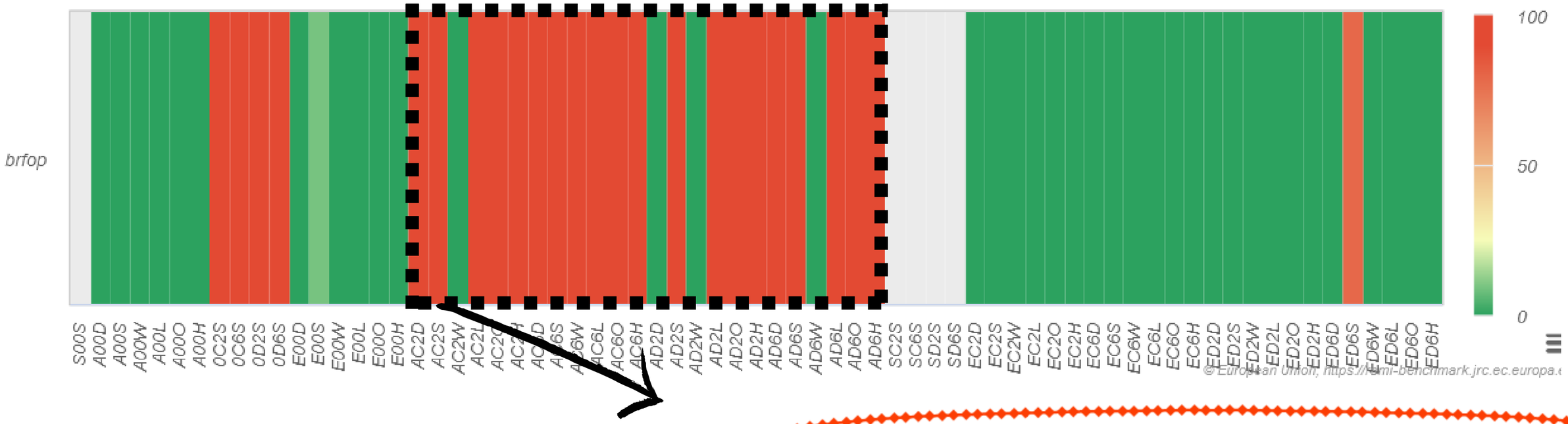
cene: **HOM00_WHI** MODTRAN6 - brfop

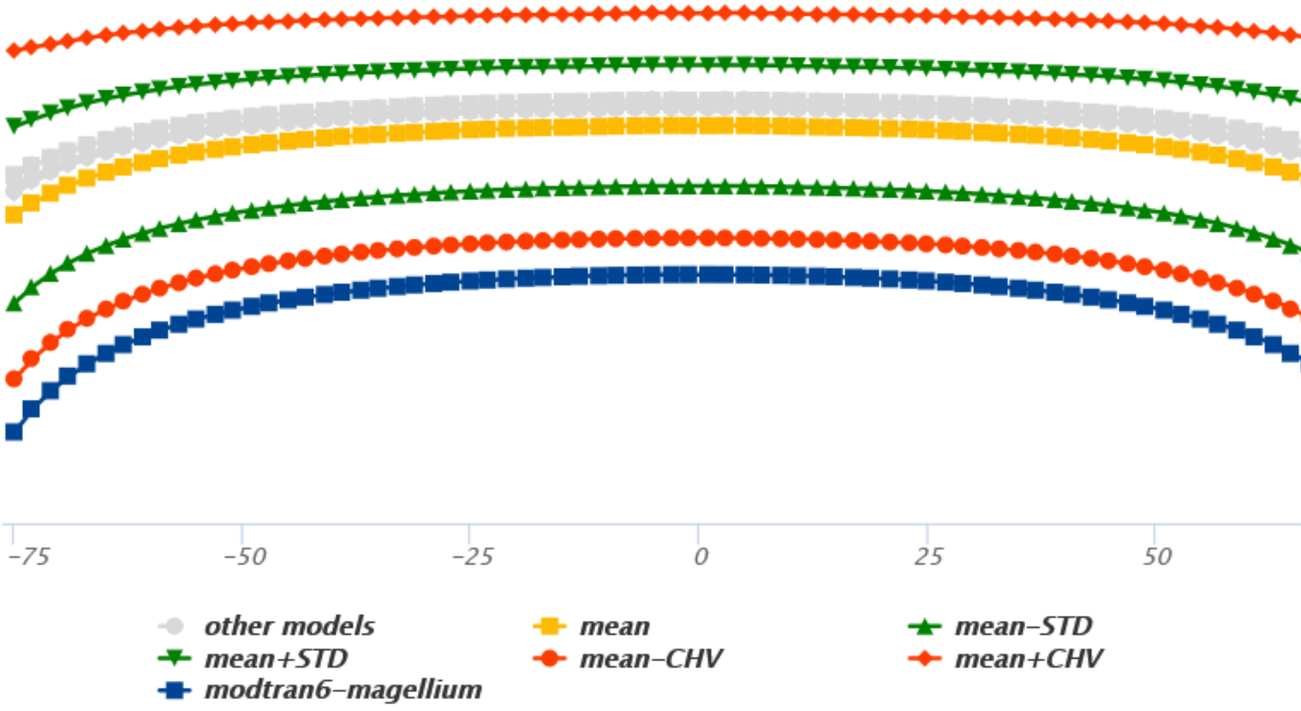
COMPLETE STANDARD SIMULATION

Standard simulation E2CS shows good agreement between MODTRAN6 simulations and the models ensemble. Higher deviations at high VZA (issues with the pseudo-spherical simulation?)



cene: **HOM00_WHI** MODTRAN6 - brfop

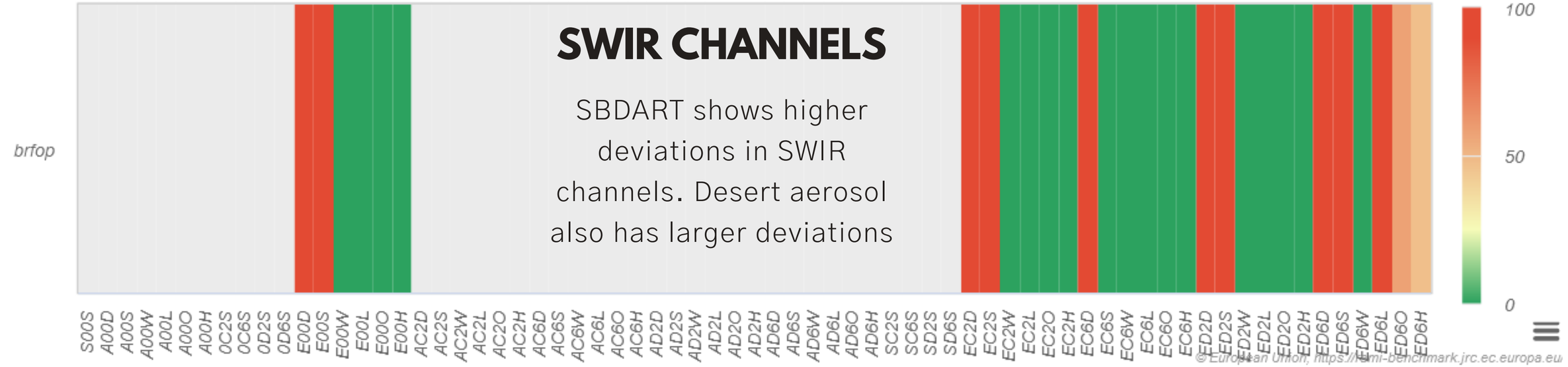




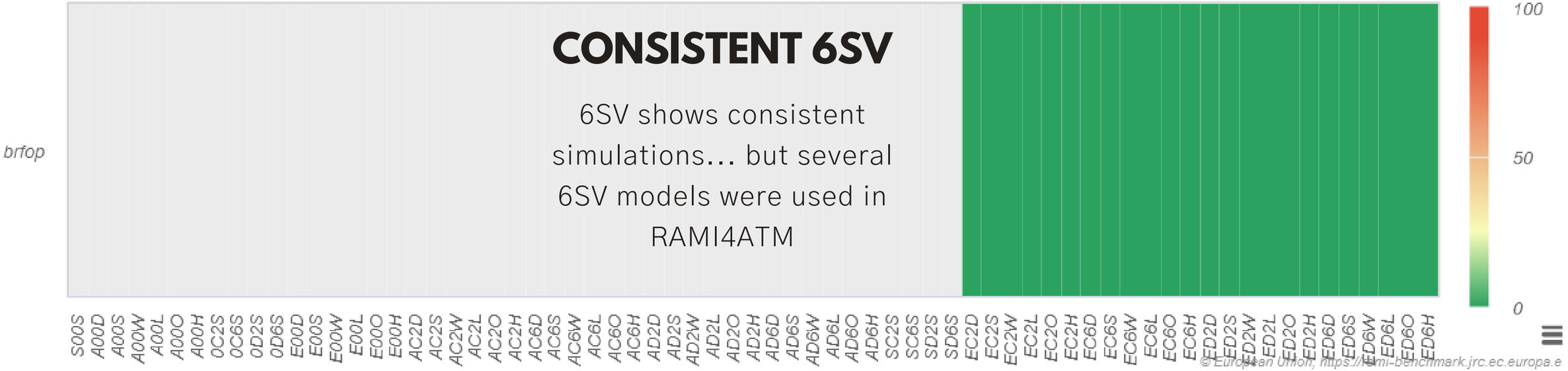
ABSORPTION+SCATTERING

MODTRAN6 simulations deviate from model enseble. Indeed, MODTRAN6 does not allow (at least at user level) removing Rayleigh absorption

Scene: **HOM00_WHI** SBDART - brfop



Scene: **HOM00_WHI** 6SV - brfop



LESSONS LEARNED

1

Identified bugs

Several bugs were identified, and corrected, in the RAMI4ATM tool. E.g.

- Rayleigh scattering included in absorption-only atmosphere
- Wavelength range wrongly defined
- Exchanged low/high H2O values

2

Better RTM understanding

Understanding of RTM limitations at user-level (e.g. Rayleigh simulation, gas absorption only...) and capabilities (e.g. user-defined aerosols)

3

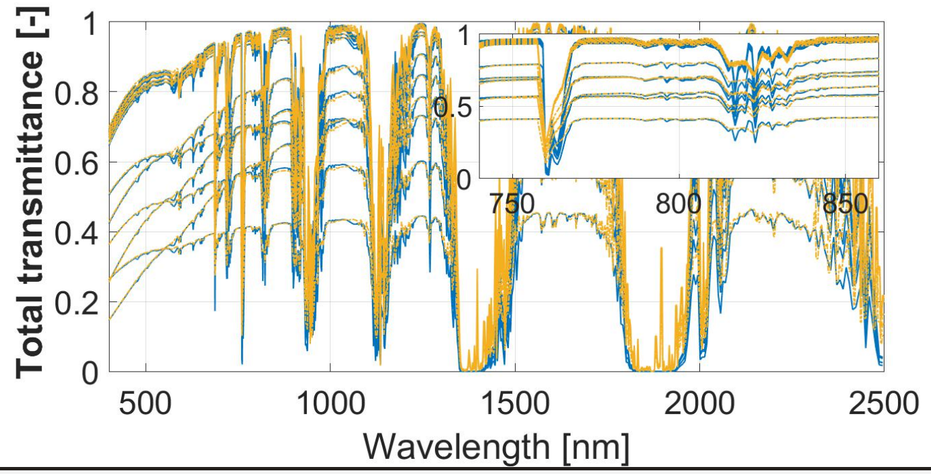
Harmonization and automatization

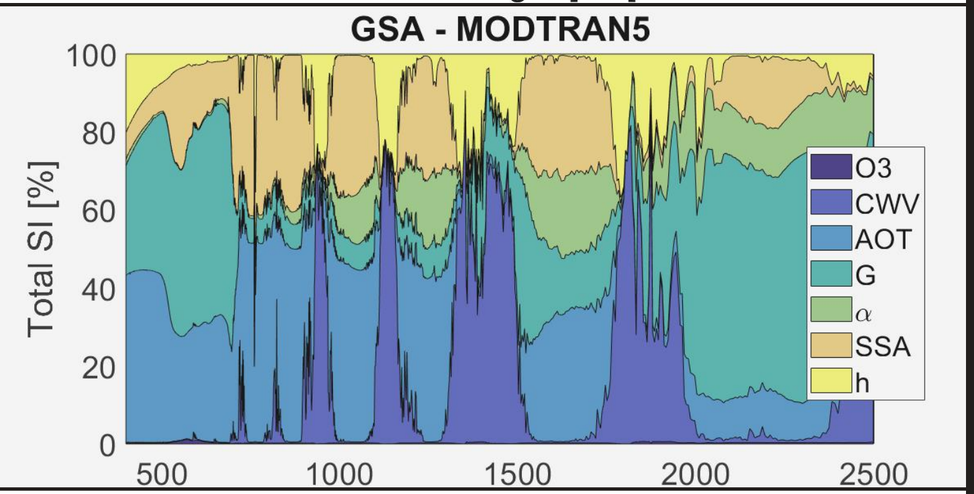
RTM simulations were harmonized in terms of inputs and outputs. Data generation and processing was fully automatized. The whole process facilitates model intercomparison

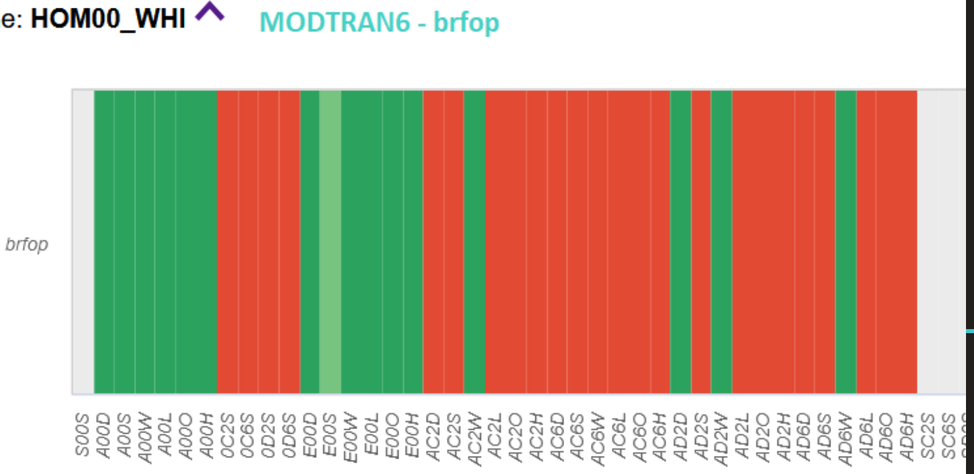
4

Participation in RAMI4ATM

First time to participate in RAMI. Understanding of concepts. Finding the information in the website. Use of ROMS and file checker...





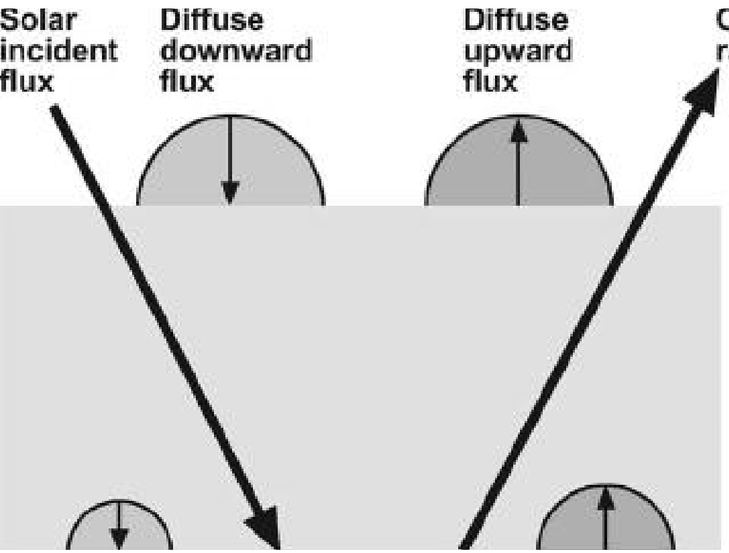


Suggestions

FOR FUTURE RAMI4ATM ACTIVITIES

- Go hyperspectral (e.g. CHIME, FLEX) or RTM native spectral resolution grid (e.g. 1cm−1)
- Analysis of atmospheric transfer functions instead of atmosphere−surface coupling
- Statistical analysis over a large enemble of simulations (e.g. global sensitivity analysis)
- Simplify spectral resampling (averages vs convolution by spectral response)
- Provide a tutorial of ROMS and Preliminary Results site

FUTURE WORK



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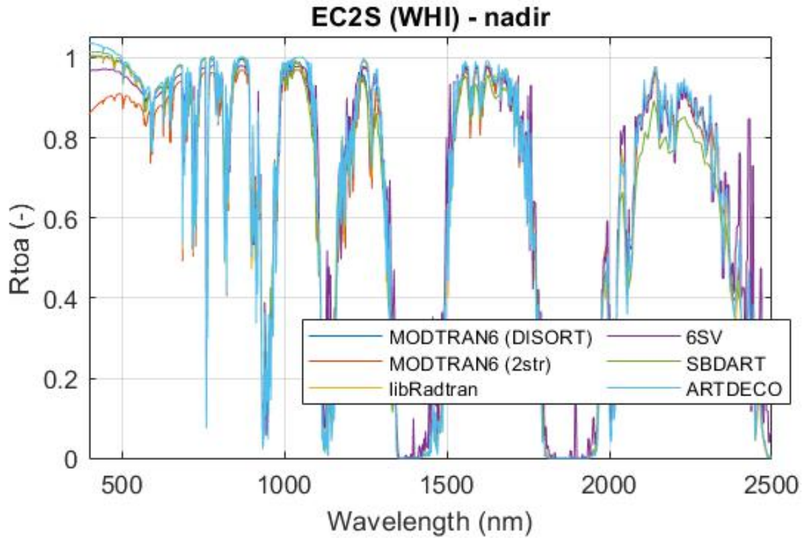

Including BRDF

BRDF surface types (RPV, RLI, HOM25,..) were not simulated since ALG does not yet includes BRDF configuration.

We could rely on the 4-streams approx. (Verhoef et al. 2007) to couple surface hemispheric/directional reflectance with atmospheric transfer functions.

From .json to .mes

Currently, several LUTs were generated and post-processed with RAMI4ATM tool.

Automatization would be possible by reading .json files to configure RTM simulation and generate the associated .mes files.

More models and better configuration

More RTMs (libRadtran, ARTDECO) could be included in future phases, as well as various solvers and RTM configuration (e.g. spectral resolution, sphericity...).

From model user to expert user (i.e. user aerosol optical properties)

WANNA KNOW MORE?

Visit us at:

www.artmotoolbox.com

Contact us:

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- www.linkedin.com/in/jorviser

References

J. Vicent et al.: Comparative analysis of atmospheric radiative transfer models using the Atmospheric Look-up table Generator (ALG) toolbox (version 2.0), Geosci. Model Dev., 13, 1945–1957, https://doi.org/10.5194/gmd-13-1945-2020, 2020.