HARMONIZATION AND COMPARISON **OF ATMOSPHERIC RADIATIVE TRANSFER MODELS WITH THE** ALG TOOLBOX

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Atmospheric radiative transfer models (RTMs)

OBJECTIVE

Our objective is to provide a user-friendly software tool that streamlines workflows and standardizes RTM inputs and outputs. Our tool seamlessly interfaces with external atmospheric data sources (CAMS, OPAC, Aeronet...) and is designed to be modular and expandable to integrate new atmospheric RTM. With our tool, users can effortlessly leverage a wide range of atmospheric RTMs while ensuring harmonization of data sets for remote sensing applications.

IMPLEMENTED MODELS

- MODTRAN
- 6SV
- libRadtran
- SBDART
- ARTDECO
- salsa.umd.edu/6spage.html libradtran.org github.com/paulricchiazzi/SBDART icare.univ-lille.fr/artdeco/

modtran.spectral.com

and others in the pipeline (SCIATRAN, DISAMAR, pyDOME...)

HARMONIZATION

Althrough all RTM solve the radiative transfer equation, their interfaces differ in content, definition and format. ALG serves as a wrapper to write RTM input files and read their outputs in a harmonized manner.

Inputs

Commonly used units, definitions (e.g. AOT vs visibility, optical properties) and conventions.

Outputs

Use of transfer functions (transmittance, path radiance, spherical albedo) for scene simulation and atmospheric correction, and TOA radiance spectra. Units are standardized.

Format

RTM native outputs are read and stored in a netcdf (.nc) file with intuitive and documented interfaces.

Dataset/ description	Format
LUT output data Stored LUT output data, consisting of atmospheric transfer functions as obtained by the executed RTM.	name="LUTdata" type=DOUBLE units=(various) dims=[n_funcs*n_wvl n_comb]
Solar Irradiance Extraterrestrial solar irradiance used in the simulation. Notice that I0 is the same for all the nodes in the LUT.	name="I0" type=DOUBLE units=mW·m-2·nm-1 dims=[n_wvI]
LUT header Matrix containing the values of the input variables at each combination in the LUT.The "units" attribute consists on a string of comma- separated units (e.g., 'unit1,unit2,').	name="LUTheader" type=DOUBLE units=(various) dims=[n_param n_comb]
SZA Values of the Solar Zenith Angle for each of node in the LUT.	name="SZA" type=DOUBLE units=deg dims=[n_comb]
Wavelengths Values values at which the output atmospheric transfer functions are calculated.	name="wvl" type=DOUBLE units=nm dims=[n_wvl]
Static parameters Values of the fixed parameters in the LUT. Each parameter is stored in a subset with the corresponding variable name variable name.	name="static/varname" type=DOUBLE units=(various) dims=[1]

Remove paran

Run simulations

Values

0.25,0.45

0.2,0.8,1.4,2

0.7,0.99

0,15

0.5,0.84,1.41,2.34,4

are a critical tools in remote sensing applications, facilitating instrument design, data processing algorithms, and satellite Cal/Val activities. However, the diverse and complex nature of available RTMs presents a significant challenge to standardizing data processing schemes and harmonizing CalVal procedures.

LEARN MORE AT...

www.artmotoolbox.com

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



CURRENT PROJECTS

- FLEX and CHIME end-to-end simulators | ESA/ESTEC
- Generic Simulator of Optical Satellites(GSOOS) | ESA/ESTEC
- FLEX Level-2 Study ESA/ESTEC
- ACIX-III Land ESA/NASA
- RAMI4ATM | EC
- SMAC | CNES
- VICALOPS | ESA/ESTEC

PLANNED UPDATES

- Satellite simulator tool: simulation of satellite data for testing & validation of atmospheric correction algorithms.
- HITRAN API interface for simulating transmittance spectra.
- Physics-aware emulation of atmospheric RTM data.

RTM COMPARISON

ALG was used to compare various atmospheric RTM. Overall, it was found that ALG facilitates the simulation of physically comparable datasets from a variery of RTM. Figures show global sensitivity analysis, hyperspectral model comparison, and preliminary RAMI4ATM results as illustrative examples.

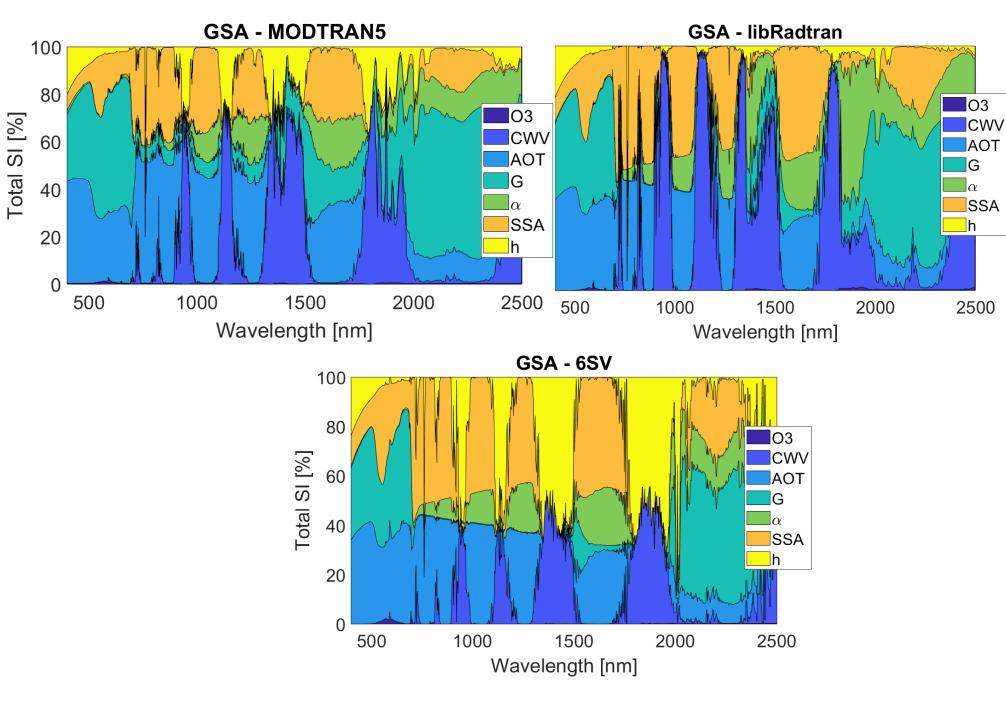


Fig 1. MODTRAN5, libRadtran, and 6SV Global Sensitivity Analysis (GSA) of main atmospheric properties at TOA radiance.

🝓 AtmLutGen Look-up table configuration File Tools Help Advanced conf. General conf. Input variables Spectral conf. Select all Group Parameters Atmospheric Ground altitude [km] ID Description Sensor altitude [km] Aerosols O3STR O3 column concentration [atm-cm] Geometric Solar zenith angle [deg Visual zenith angle [deg] Load LUT Package Add all Run Relative azimuth angle [Aerosol optical thickness (at 550 nm) 0.03,0.12,0.22,0.33,0.46 configuration simulations LUT Henyey-Greenstein asymmetry factor 0.6,0.73,0.86,0.99 Angstrom coefficient 4 Distribution Single Scattering Albedo Samples OBSZEN Visual zenith angle [deg] 0 Plotting tool Atmosphere Aerosol 8 70 toolkit generator Add param. Linear **(**?; X RAMI 4 ATM Parameters (Satellite RAMI4ATM Aeronet and Radiosondes simulator ? Palan ٥.

Aerosol toolkit and **Atmosphere generator**

RAMI4ATM tool

visualize simulations.

User can define their own aerosol models based on micro-physics, optical properties or mixtures, allowing to interface aerosol databases (Aeronet, OPAC, CAMS). Similarly, the Atmosphere generator tool allows users to import and edit verticial profiles from repositories (CAMS, NCEP, NWP-SAF)

Simulations set-up window

Common interface to streamline model simulations. Selection of input variables values (and distribution), spectral configuration, surface conditions and advanced settings.

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Aerosol Tookit (ATK)						_	
lect RTM:							
xSV 🔻	Aerosol name: CAI	MS_OM					
rosol model names:	Select all					Save	
AMS_BC	Rmin,Rmax:	0.0050	20.0000	NaN	NaN	NaN	
AMS_OM	Rmean,Sigma,%:	0.4710	2.5100	0.1124	NaN	NaN	
AMS_SU er_comp	n_r	1.5300	1.5300	1.5300	1.5300	1.5300	
er_test	n_i	0.0080	0.0080	0.0080	0.0080	0.0080	
	Rmean,Sigma,%:	0.0212	2.2400	0.8409	NaN	NaN	
	n_r	1.5300	1.5300	1.5300	1.5300	1.5300	
	n_i	0.0050	0.0050	0.0050	0.0050	0.0050	
+	Rmean,Sigma,%:	0.0118	2.0000	0.0467	NaN	NaN •	•
	Aerosol model: Mul	timodal (log-nor					

S Aeronet and Radiosondes tool		- 0	×
File Plot Settings Help			
Data source: Aeronet	Processing level: 1.5		
Start date:	End date:	Download data	
09-May-2023 🔻	mm/dd/yyyy 👻	Selected stations	

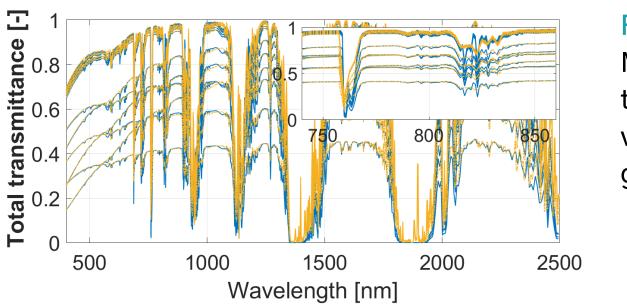


Fig 2. Comparison of MODTRAN5 and libRadtran total transmittance for various atmospheric and geometric conditions.

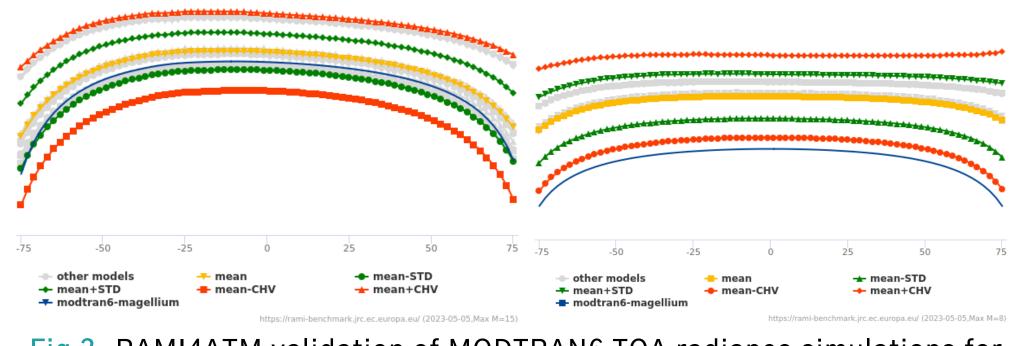
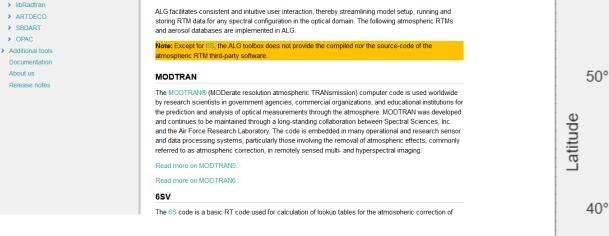


Fig 3. RAMI4ATM validation of MODTRAN6 TOA radiance simulations for complete scenario (E2CS, left) and absorption only scenario (A2CS, right). Absorption scenario indicates deviations since Rayleigh absorption was included in MODTRAN6 simulation.



ssing of optical Earth observation data. They provide meaningful links between radiometry and nospheric composition for applications, such as atmospheric correction, aerosol radiative forcing, a uality, synthetic scene generation and numerical assimulation and weather forecasting amo

Help

ALG v3.2 (Apr. 2023)

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Access to the key tools within ALG

aerosols & atmospheric toolkit,

Search Documentatio

hird-party Software (RTM

ric Radiative Transfer models (RTMs) have become i

simulation configuration,

User manual

Emulation

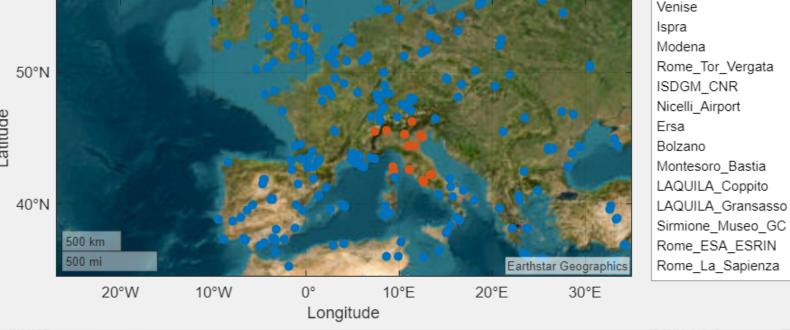
tool

(RTM

Main window

Aeronet, emulation...

Step-by-step procedures for using ALG software, with tutorials for practical examples. The user manual gives support for also RTM installation, description of the main RTM variables, and links to external scientific literature.



Aeronet and Radiosondes tool

Graphical access for downloading Aeronet and Wyoming radiosondes data from various stations and dates. Plotting tools and calculation of statistical information (probabilty distribution, correlations).

