# ARTDECO
# Atmospheric Radiative Transfer Database for Earth and Climate Observation

*Dubuisson[1] P.,* ***L. C.-Labonnote[1]****, J. Riedi[1], M. Compiègne[2], V. Winiarek[3]*

Contact: Philippe.dubuisson@univ-lille1.fr

*[1]LOA, Laboratoire d'Optique Atmosphérique, Université de Lille, 59655 Villeneuve d'Ascq Cedex, France.*

*[2]HYGEOS, Euratechnologies, 165 Avenue de Bretagne, 59000 LILLE, France.*

*[3]AERIS / ICARE Data and Services Center, Université Lille, 59655 Villeneuve d'Ascq Cedex, France.*

## Objectives:

ARTDECO ('Atmospheric Radiative Transfer Database for Earth and Climate Observation') is a numerical tool that gathers models and data for the 1D simulation of Earth atmosphere radiances (total and polarized) and fluxes as observed with passive sensors (narrow and wide band models) from the UV to thermal IR range (0.2 – 50 µm). It is developed / maintained at the Laboratoire d'Optique Atmosphérique (LOA) and distributed by the data and services center AERIS/ICARE (University Lille), and funded by the TOSCA program of the French space agency (CNES). In ARTDECO, users can either access a library for the scene or use their own description through ASCII input files. Optical properties for aerosols and clouds can be computed. Then, the user can choose among available models to solve the radiative transfer equation and to compute radiative quantities corresponding to the scene. ARTDECO is thus a flexible tool for remote sensing or radiative forcing applications, such as sensitivity studies, development and optimization of retrieval algorithms, evaluate the performances of future instruments, etc.

The main objectives of ARTDECO are to provide:

1. a general documentation about the codes and data;
2. codes and data available via a web interface;
3. reference codes for radiative transfer calculations from UV to infrared in absorbing and scattering atmospheres for remote sensing and radiative forcing applications;
4. optical properties databases for aerosols and clouds (liquid or ice clouds);
5. inputs data to simulate the satellite signal as seen by the main current satellite sensors (POLDER, MODIS, SEVIRI, IIR, etc.).

## Main characteristics of the ARTDECO package:

**Atmosphere definition:** plane parallel approximation (1D)
- Pressure, temperature and gas concentration vertical profiles
- AFGL & Mc Clatchey profiles
- User-defined profile

**Spectral range:**
- From UV to infrared: 0.2 to 50 µm
- Solar spectrum: Kurucz high resolution spectrum

**Surface:**
- Lambertian spectral albedo for various surfaces
- Cox & Munk ocean surface BRDF/BPDF
- "Ross–Li"&"Rahman–Pinty–Verstraete" with hot-spot land surface BRDF
- "Maignan & Bréon" land surface BPDF

**Particle optical properties:**
- Refractive index for liquid and ice water and for aerosol material (OPAC database, λ= 0.25 – 40 µm)
- Microphysical properties definition for water clouds (Stephens, OPAC), for aerosols (OPAC) and for cirrus clouds (Baum et al., POLDER/PARASOL model)
- Mie spherical particles for clouds and aerosols
- Henyey-Greenstein approximation
- Ray tracing for hexagonal crystals: pristine (PHM), rough (RHM) monocrystal particles or monocrystal particles with inclusions (IHM)

**Gaseous absorption:**
- k-distribution coefficients for absorption lines : $H_2O$, $CO_2$, $O_3$, $O_2$, $N_2O$, CO, $CH_4$, $N_2$
- Continuum absorption: $H_2O$, $CO_2$, $O_3$, $N_2$

**Radiative transfer (1D):**
- DISORT2.1 discrete ordinate (I, thermal), Stamnes et al., 1988
- adding-doubling (I Q U V), de Haan et al.,1987
- Monte-Carlo (I Q U V) , from LOA
- Single scattering approximation (I Q U V)

**Truncation of phase function:**
- δ−Potter, δ-M or δ−fit methods

**Intensity correction for first order scattering (TMS)**
- Nakajima & Tanaka (1988)

**Spectral response of the sensor**
- For various satellite sensors: MODIS, POLDER, IIR, SEVIRI, etc.

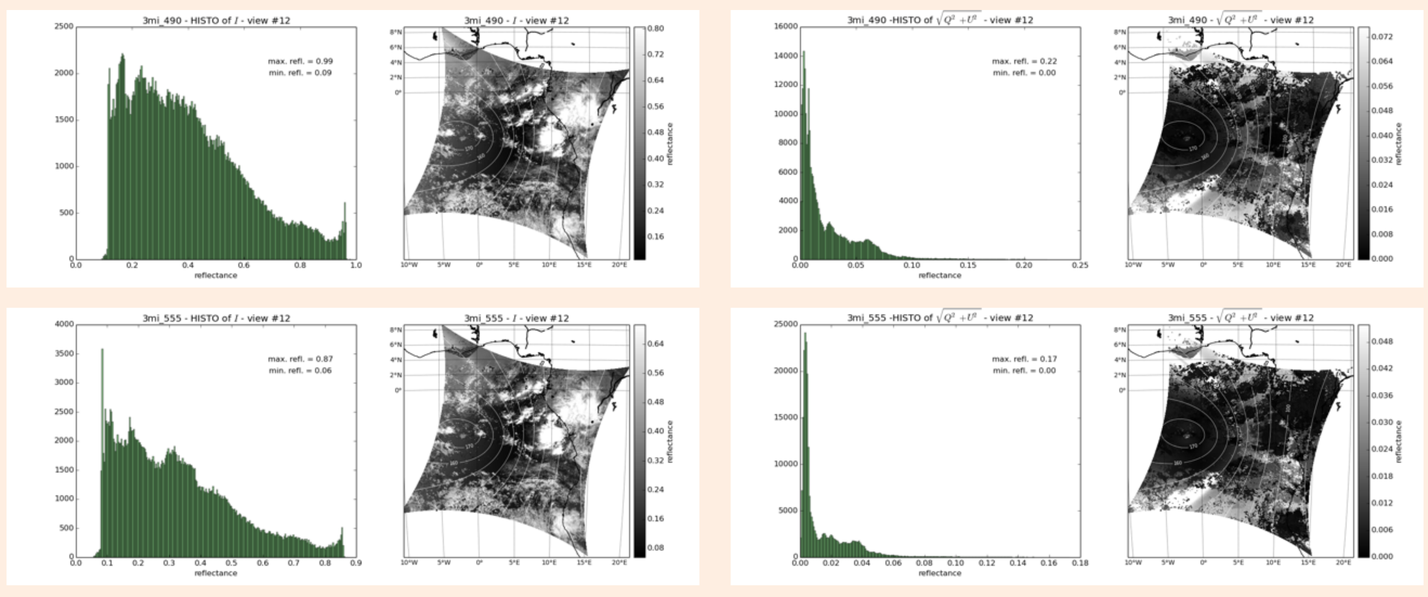
**Radiative quantities:**
- Radiance ($W.m^{-2}.sr^{-1}$) and flux ($W.m^{-2}$)
- At Top-Of-Atmosphere, surface or any atmospheric level
- For any viewing geometry typical for 1D atmospheric observations
- At a given wavelength or for a specified spectral resolution (from 10 to 400 $cm^{-1}$)
- For the solar and infrared spectrum (0.2 to 50 µm)

## Example of application :

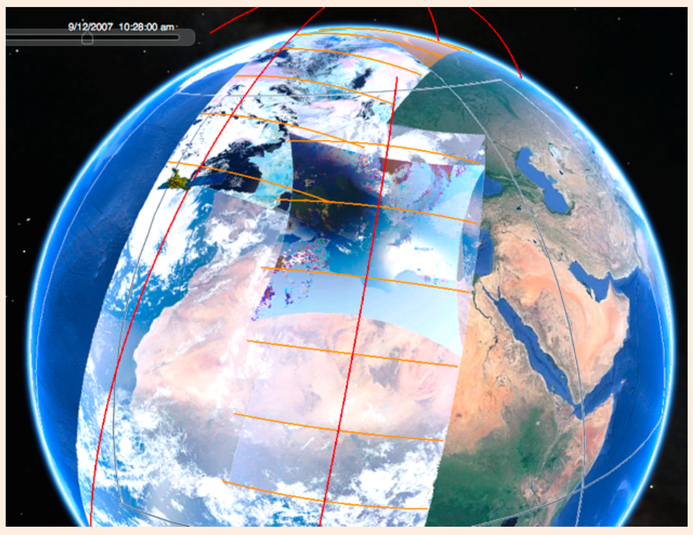
Simulations of synthetic images (total and polarized radiances) have been performed with ARTDECO for the 3MI instrument (Multi-Viewing, Multi-Channel, Multi-Polarization Imager), on the future EPS-SG payload, using a realistic dataset of atmospheric properties (pressure, temperature, gases, clouds and aerosols) and instrumental characteristics (orbital parameters, spectral configuration).

A full orbit propagation has been performed based on orbital parameters provided by EUMETSAT. Geolocation and sampling geometries have served as input to radiative transfer code in which surface and atmosphere (clouds, aerosols, gas) have been realistically described, based on ancillary information (among which AVHRR products for clouds, MACC reanalysis for aerosols, ECMWF reanalysis for atmospheric state, MODIS albedo climatology). The simulated TOA radiances have been generated at level 1b, equivalent to the calibrated and geolocated measurements of the 3MI instrument.

*This study has been realized as a part of the EUMETSAT project EUM/CO/13/4600001231/TMa*




*Examples of histograms and synthetic images for the total (left column) and polarized (right column) radiances of the 3MI channels at 490 (top) and 555 nm (bottom).*




*Example of simulated radiances along the orbit of the future 3MI instrument*

**Conclusions:** The ARTDECO package is available at AERIS/ICARE data and services center.
URL : http://www.icare.univ-lille1.fr/projects/artdeco
Contact : contact@icare.univ-lille1.fr

**Acknowledgements:**
Authors would like to thank the French space agency, "Centre National d'Etudes Spatiales" (CNES), for ARTDECO financial support (TOSCA program)