



Atmospheric radiative transfer generalised for use on Earth and other planets: ARTS 2.2

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Microwave and (sub)millimetre-wave frequencies have long been of interest for remote sensing of the Earth and space objects. They suffer less from interference by small particles (dust, clouds), hence penetrate deeper into atmospheres revealing their deeper structures hidden to shorter wavelengths, and possess characteristic line absorption features of many gaseous species, which are of interest for the understanding of atmospheric chemistry and dynamics.

Models simulating radiative transfer and wave propagation (RT/WP) have been developed by many institutions. Most of them are designed for a particular, narrow region of the electromagnetic spectrum, certain instrument types or missions, and specific atmospheric conditions. In particular, they are usually set up for a specific planetary body. This high level of specialisation allows for accurate modelling results. However, it also limits the flexibility of those models and comparability between them.

One of the major differences in radiative transfer modeling in the atmospheres of Earth and other planets arises from the different composition of the atmospheres. When interested in measuring total abundance or even vertical distribution of atmospheric constituents, knowledge of parameters describing spectrally dependent absorption in dependence of atmospheric state is required. When modeling radiative transfer for different planets, the line shapes are often accounted for by scaling the parameters valid for Earth's "air" or by building a spectroscopic catalogue specific to the planet in question and its main atmospheric composition. This strongly limits applicability of these models.

Based on the ARTS model [1], a sophisticated, flexible RT model for Earth atmosphere (3D spherical geometry, diverse absorption models, scattering, polarization, Jacobians), we have developed a toolbox for microwave atmospheric radiative transfer in solar system planets. As part of this, we developed and implemented a more generalized absorption calculation approach that is able to flexibly handle largely different atmospheric compositions. In order to facilitate this approach, we compiled a spectroscopic catalogue for the 0-3 THz spectral range, that reports broadening and shift parameters for individual molecular species. Currently it covers the most abundant species in Earth and its neighboring planets (Venus, Mars, Jupiter). Additionally, a number of features have been added to the model (radio link and cloud radar modes, zeeman splitting, doppler shifts) and a data package contains atmospheric and surface data for Earth and the planets Venus, Mars, and Jupiter has been compiled.

Here, we present the generalized propagation modeling approach and show example results of simulations for different planets underlining the relevance of our approach.

[1] Eriksson, P., et al. (2011): ARTS, the atmospheric radiative transfer simulator, Version 2. JQSRT, 112, doi:10.1016/j.jqsrt.2011.03.001.