Comparison of atmospheric radiative transfer model simulations with the ALG toolbox

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Résumé

Atmospheric radiative transfer models (RTMs) are physically-based computer models that numerically describe the absorption, emission, and scattering processesof the electromagnetic radiation as it passes through the Earth atmosphere. These models help scientists in understanding the radiation processes occurring in the Earth's atmosphere and are widely used in Earth observation scientific and technological applications, such as (i) satellite mission design, (ii) atmospheric chemistry, (iii) meteorology and climatology, (iv) atmospheric correction, and (v) atmospheric physics . Over time and through continuous improvements, these models have increased in realism from simple semiparametric equations towards advanced RTMs that allow for explicit 3D representations of complex interactions in the atmosphere.

Given the wide use of atmospheric RTMs in remote sensing, their comparison is one of the main tasks used in order to determine their performance and to identify the characteristics that differ between models. The process of comparing various atmospheric RTMs can be a tedious task that requires good knowledge of the model inputs/outputs and the generation of large databases of consistent simulations. Indeed, the evolution of RTMs towards more advanced models has resulted in an increase in complexity and interpretability of these models, which bears implications for practical implementation of intercomparison studies. To overcome this limitation, graphical user interfaces (GUIs) have been developed to facilitate RTM use and execution. A few examples of these GUIs can be found for 6SV, MODTRAN, or libRadtran. These well-documented tools allow complete access to all functionalities and configuration parameters of the models they were designed for, including user support and continuous updates. However, each of these GUIs are customized for their specific RTM; and none can be used to define and run simulations for multiple RTMs in a consistent manner. In addition, they are not designed to easily precompute large databases, which are important due to the high computational burden of performing statistical analysis or running these models in a pixel-per-pixel basis. Altogether, these GUIs are not fully offering practical solutions for the implementation of atmospheric RTMs in Earth observation applications and, in particular, for model intercomparison. Users of atmospheric RTMs are therefore obliged to develop their own specific scripts to create datasets, which are typically (1) limited to a handful input variables and (2) hardly extensible to other RTMs.

In an attempt to facilitate the consistent simulation of databases for a wide range of atmospheric RTMs, we developed the *Atmospheric Look-up table Generator* (ALG). ALG is a MATLAB-compiled software package that allows generating look-up tables (LUTs) based on a suite of atmospheric RTMs. Namely, a LUT consists of a collection of input atmospheric

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conditions and corresponding generated RTM spectral outputs. ALG provides consistent and intuitive user interaction for defining model configuration and running and storing RTM data for any spectral configuration in the optical domain. The main objectives of this presentation is to (1) describe the ALG tool from a functional and software design perspective to give an overview of the implemented features and generated LUT data; and (2) perform a comparison study between the models implemented in ALG: MODTRAN (v5 and v6), 6SV v2.1, libRadtran v2.0.3, ARTDECO, and SBDART.