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An Automated Radiative Transfer Models Operator (ARTMO) toolbox for automated retrieval of biophysical parameters through model inversion

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The aim of this study was to develop a flexible canopy radiative transfer toolbox for better understanding the interactions between solar radiation in the visible and near-infrared (VNIR) spectral range and terrestrial vegetation. In particular, the toolbox is designed for easy generation of leaf and canopy spectra through forward modeling and retrieval of biophysical parameters through model inversion of the simulated datasets against actual measured datasets.
Radiative transfer (RT) modeling plays a key role for earth observation (EO) because it is needed to design EO instruments and to develop and test inversion algorithms. In the scientific community a number of often highly specialized leaf and canopy RT models has been developed, each of which emanates from a different set of original requirements. During the development of RT models a tradeoff has to be made between the invertibility and accuracy of the model, leading to large diversity of models with varying degrees in complexity. Currently there exists no user friendly toolbox which brings these models together.
The RT model toolbox developed in this study, hereafter referred to as ARTMO toolbox, aimed to implement the necessary models and features required for terrestrial EO applications in a graphical user interface (GUI). The toolbox, developed in Matlab, allows the user: i) to choose between various leaf-level and canopy-level RT models, ii) to choose between spectral band settings of various air- and spaceborne sensors, iii) to simulate and store a massive amount of spectra based on a look up table (LUT) approach in a spectral database, iv) to plot simulated spectra of multiple models and compare with measured spectra, and finally, v) given several cost options and accuracy estimates, to run model inversion against airborne or spaceborne images.
Particularly, the difficulty of dealing with land cover heterogeneity within an image has been tackled in the toolbox. Although model inversion is regarded as a physically-sound approach to yield biophysical parameters from EO data, in order to be sufficiently representative, model parameterization is typically set to one explicit land cover type (e.g. crops, forest). Nevertheless, landscapes are often fragmented, consisting of multiple land cover types. ARTMO offers the flexibility to assign specific model settings to each predefined land cover type. This implies that model inversion can be automatically adjusted depending on the land cover type, i.e. with respect to the chosen model (e.g. 1D vs. 3D model), plant geometry and optical properties of leafs, woody elements and soil. Currently, ARTMO includes the leaf models PROSPECT-4 and PROSPECT-5 and the canopy models 4SAIL and FLIGHT. Efforts are underway to implement more models. In this work results of forward simulations and model inversion will be presented for airborne (CASI) and spaceborne (CHRIS) images.