Radiative transfer modeling activities in FMI Atmospheric Radiation group

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The radiative transfer (RT) modeling activities in the FMI Atmospheric Radiation group are related to the atmospheric radiative transfer. We model the RT of light from ultraviolet (UV) to shortwave infrared. Our focus is on the atmospheric aerosols and UV radiation. The RT models are mostly used in the development of satellite retrieval algorithms that are inverse algorithms that are used to estimate the atmospheric properties given the satellite observed top-of-atmosphere radiances. There is a long experience, starting from 2007, to develop algorithms to retrieve aerosol properties (e.g. aerosol optical depth, AOD) using measurements from dual view instruments of ATSR-2, AATSR and SLSTR, earliest measurements starting from 1995. Currently, our algorithms are also adapted within the ESA FLuorescence Explorer mission (FLEX), planned to be launched in 2024. We are also starting a project to provide the official EUMETSAT aerosol product.

The FLEX work from our part is concentrated on the atmospheric correction which is a demanding task as the fluorescence signal is very small when compared to other TOA contributions. The correction for atmospheric aerosols and water vapor is to be carried out utilizing instruments (SLSTR, OLCI) on-board the Sentinel-3B satellite. The aerosol correction will be done with our ATSR-2/AATSR/SLSTR algorithm, but the radiative transfer requirements are quite different as the fluorescence instrument will be a very high-resolution spectrometer sensing in the Oxygen A and B regions.

One recent activity, in which RT modeling has been utilized, has been aerosol retrieval development work applied algorithm for the Moderate Resolution Imaging Spectroradiometer (MODIS) measurements (Lipponen et al. 2018) in collaboration with NASA. Due to high computational costs of RT models, typically a pre-computed lookup-table-interpolation based RT models are used in these aerosol retrieval algorithms. Recently related to the aerosol retrieval algorithm development, we have also started to develop computationally efficient but accurate surrogate RT models based on, for example, neural networks.

FMI has taken the leading role in the research, development and processing of satellite-UV and has been the only institute hosting the currently operational algorithms for many years. To support this development work, extensive experience in RT modeling (particularly focusing on UV wavelength range) has been gained.

For our applications we have mostly applied the following RT models:
LibRadtran http://www.libradtran.org/
DAK (Doubling-Adding KNMI)
MODTRAN (MODerate resolution atmospheric TRANsmission)