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Linearized vector radiative transfer model MCC++ for a spherical atmosphere

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Abstract

Application of radiative transfer models has shown that optical remote sensing requires extra characteristics of radiance field in addition to the radiance intensity itself. Simulation of spectral measurements, analysis of retrieval errors and development of retrieval algorithms are in need of derivatives of radiance with respect to atmospheric constituents under investigation. The presented vector spherical radiative transfer model MCC++ was linearized, which allows the calculation of derivatives of all elements of the Stokes vector with respect to the volume absorption coefficient simultaneously with radiance calculation. The model MCC++ employs Monte Carlo algorithm for radiative transfer simulation and takes into account aerosol and molecular scattering, gas and aerosol absorption, and Lambertian surface albedo. The model treats a spherically symmetrical atmosphere. Relation of the estimated derivatives with other forms of radiance derivatives: the weighting functions used in gas retrieval and the air mass factors used in the DOAS retrieval algorithms, is obtained. Validation of the model against other radiative models is overviewed. The computing time of the intensity for the MCC++ model is about that for radiative models treating sphericity of the atmosphere approximately and is significantly shorter than that for the full spherical models used in the comparisons. The simultaneous calculation of all derivatives (i.e. with respect to absorption in all model atmosphere layers) and the intensity is only 1.2–2 times longer than the calculation of the intensity only.

Keywords: Radiative transfer; Polarization; Derivatives; Weighting functions; Air mass factors; Remote sensing; Inverse problems; Retrieval algorithms

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