LINEARIZED VECTOR SPHERICAL RADIATIVE TRANSFER MODEL MCC++ FOR APPLICATION TO REMOTE SENSING AND MODELING OF SPECTRAL OBSERVATIONS

O.V. Postylyakov
A.M. Obuhov Institute of Atmospheric Physics, RAS, Moscow, Russia, ovp@ifaran.ru

Application of radiative transfer models has shown that optical remote sensing requires extra characteristics of radiance field in addition to the radiance intensity itself. Development of retrieval algorithms, analysis of retrieval errors and simulation of spectral measurements are in need of derivatives of radiance with respect to atmospheric constituents under investigation. These derivatives are called also weighting functions, being used in gas retrieval, or the air mass factors, if are used in the DOAS retrieval algorithms. A radiative model, which solves equation in derivatives of radiance simultaneously with transfer equation in radiance, is termed linearized. Gained experience proved that a simultaneous solution of these equations can be greatly faster than the traditional algorithm of the finite difference approach based on multiple runs of a radiative model with perturbed optical properties.

The presented vector spherical radiative transfer model MCC++ was linearized, that allows calculating derivatives of all elements of the Stokes vector with respect to the volume absorption coefficient and surface properties simultaneously with radiance calculation [1]-[2]. Theory for linearization with respect to volume scattering coeffitient has been developed. 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. 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.

The MCC++ model took part in intercomparisons with other models [3] -[4], including comparison of weighting function calculations, calculations in limb geometry, calculations for twilight for solar zenith angles up to 96 degree. The model has been applied for interpretation of field radiance observations and for solution of inverse problems [5]-[7].

[1] **Postylyakov O.V.** Radiative transfer model for use in inverse problems of atmospheric optics with calculation of weighting functions and air mass factors. *Izvestiya Akademii Nauk, ser. Fizika Atmosfery I Okeana (Atmospheric and Oceanic Physics), 2004, 40, 3, 319-334.*

[2] **Postylyakov O.V.**. Linearized vector radiative transfer model MCC++ for spherical atmosphere. *J. Quant. Spectrosc. Radiat. Transfer*, 2004, a*ccepted*.

[3] **Postylyakov O.V. et al.** A comparison of radiation transfer algorithms for modelling of the zenith sky radiance observations used for determination of stratospheric trace gases and aerosol. *IRS 2000: Current Problems in Atmospheric Radiation,* A. Deepak Publishing, Hampton, Virginia, 2001, 885-888.

[4] **Loughman R.P. et al.** Comparison of radiative transfer models for limb-viewing scattered sunlight measurements. *J. Geophys. Res.,* 2003JD003854R, *2004, accepted.*

[5] **Postylyakov O.V., J. Lenoble, I.V. Mitin.** Effect of polarization on UV sky radiance during twilight. *This issue.*

[6] **Ugolnikov O.S., O.V. Postylyakov, I.A. Maslov.** Observations of the polarization of the twilight sky using wide-angle CDD camera and their modeling. *This issue.*

[7] **Postylyakov O.V., A.S. Elokhov, A.I. Igaev, N.F. Elansky.** Opportunities of TROICA train observations to validate satellite observations. *This issue.*