Matrix exponential in C/C++ version of vector radiative transfer code IPOL

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In 2015, our Fortran 90/95 radiative transfer (RT) code IPOL for simulation of multiple scattering of Intensity and POLarization of the monochromatic solar radiation in a plane-parallel atmosphere confirmed high accuracy in a comprehensive polarized (vector) RT codes intercomparison [1]. Since then, we have used IPOL to account for the effect of polarization of light in the Multi-Angle Implementation of Atmospheric Correction (MAIAC) algorithm [2]. However, IPOL requires further development: speed-up due to neglect of tiny circular polarization in Earth atmosphere, and translation into C/C++ for natural integration with MAIAC.

Similar to RT code Pstar [3], IPOL combines the discrete ordinates and matrix-operator methods. Evaluation of the matrix exponential using eigendecomposition is a key and, arguably, the most time consuming part. The eigendecomposition represents a matrix using its eigenvalues and eigenvectors. In the new C/C++ version of IPOL, we use only left eigenvectors to evaluate the matrix exponential. This is contrary to a common practice of using the right eigenvectors to evaluate the matrix exponential and the left eigenvectors to avoid the inversion of the matrix of the right ones [3,4].

Recently, we published our approach with independently reproducible test cases in JQSRT [5]. In this talk, besides theoretical background and numerical examples, we will discuss the use of object-oriented programming with GNU Scientific Library (GSL) [6] in computationally intensive software, which the RT code is.

References

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