ELS-XV-2015 Abstracts
ELS-XV-2015-166
Electromagnetic & Light Scattering XV 2015, Leipzig

Discrete Ordinates vs Successive Orders: what method to choose?

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Given different atmospheric conditions, some methods of solution of the radiative transfer (RT) equation achieve the same accuracy faster than the others. In this talk, we discuss two known methods, the discrete ordinates (DO) and the successive orders of scattering (SO). Both use the same approach for integration over angles (analytically over azimuth and numerically over zenith). The major difference between the two comes from integration of the RT equation over optical thickness (OT). We propose an idea of a hybrid RT code based on the two methods and discuss a criterion for selection one or the other.
The method of DO replaces the RT equation with a system of linear differential equations, one equation per ordinate. The system is integrated over OT analytically. A special time consuming factorization of the system matrix, the singular value decomposition (SVD), is involved. The SVD is applied to each optical layer, i.e. layer with optical parameters different from its neighbors. Thus the run-time of the method grows linearly with the number of layers. Optimized library is highly desirable to speed-up the SVD but it makes the RT code less portable. Thus the DO scheme is preferable for cases with a few (1-3) optical layers.
On the contrary, the SO scheme employs numerical integration of the RT equation over OT. The number of optical layers is practically unimportant. But the total OT is crucial. The method is known to exponentially slowdown with OT and becomes practically useless for OT > 5. Thus the SO scheme is suitable for scenarios with complicated extinction height profile and low total OT.
This simple analysis naturally leads to an idea of using these two methods jointly in order to cover lots of possible atmospheric conditions without compromising speed and accuracy. The hybrid RT code will select what method to choose automatically based on the given (retrieved) OT.
In this talk, we discuss two our vector (polarized) RT codes. Several scenarios with different OTs and number of layers are analyzed to formulate the criterion of selection. The first RT code, IPOL (Intensity and POLarization), uses the DO scheme. The second one is the SO code SORD (Successive ORDers). Recent intercomparison of vector RT codes proved high accuracy of the code IPOL in all test cases (http://www.meteo.physik.uni-muenchen.de/∼iprt). The code SORD has been intensively tested against IPOL and the results published in literature. Both codes are publicly available from ftp://climate1.gsfc.nasa.gov/skorkin/IPOL/ and ../skorkin/SORD, respectively.