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Accurate and fast radiative transfer packages for spherical atmosphere

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In order to produce realistic radiative transfer simulation in planetary spherical atmosphere, such as twilight observation of from surface or limb observation from satellite, we have built two reliable numerical models. The first model is Monte-Carlo simulation working in full 3D spherical atmosphere, which provides the most accurate simulation results, serving as testing base for any other models. This Monte-Carlo code has passes accuracy tests including comparison with Chandrasekhar analytic solutions, comparison with single scattering solutions in spherical geometry and other presented tests. Because Monte-Carlo code is limited in calculation speed, a second model has also been built to run 1000 times faster. This second model is based largely on the Spherical Harmonic Discrete Ordinate method (Evans 1998), but is modified to take into account the 3D spherical effects and realistic solar input boundary condition, as well as high asymmetry parameter phase-function treatment (Hu et al., 2000). It has passed accuracy test against Monte-Carlo simulation results for a range of representative planetary atmospheres (Earth, Mars, Titan), with gases, aerosol and cloud layers.

The two models have been applied in simulation of telescopic view of Titan backscattering image and terrestrial and Martian cloud observation at sunrise/sunset by ODS (Optical Depth Sensor) instrument.

We have made available on the internet some representative simulations by Monte-Carlo code for researchers who are interested in validating their radiative transfer codes in spherical geometry. The second model is available for download as package in Mathematica environment (Wolfram 1999). Reference

Evans, K. F., 1998, The Spherical Harmonics Discrete Ordinate Method for Three-

Dimensional Atmospheric Radiative Transfer, Journal of the Atmospheric Science, 55, 429-446.

Hu, Y.-X., et al., 2000, Delta-Fit: A fast and accurate treatment of particle scattering phase functions with weighted singular-value decomposition least-squares fitting, Journal of Quantitative Spectroscopy & Radiative Transfer, 65, 681-690.

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