Geophysical Research Abstracts,
Vol. 10, EGU2008-A-10399, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-10399
EGU General Assembly 2008

The influence of vertical edges of a cloud on light absorption, reflectance, transmittance and radiative balance

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A 1-D plane-parallel vertically inhomogeneous cloud model is usually used for the calculation of light absorptance, reflectance and transmittance in a cloudy atmosphere. Such a model is adequate only in the case if physical properties of a light scattering medium do not vary in the horizontal direction and horizontal radiation transport can be neglected. However, this effect can not be neglected in broken cloud conditions and the 3-D radiative transfer model must be used in such cases.

A corresponding 3-D model being based upon an approximation of the radiation transport equation (RTE) via grid schemes of the discrete ordinate method is included into the code RADUGAP-5.2 developed by authors. The systems of algebraic equations approximating RTE are solved via the successive-orders-of-scattering technique. In general case these systems are very large. Therefore, we use multi-processor computations to find grid solutions.

We consider an isolated homogeneous cloud cube in a clear atmosphere under arbitrary position of the sun. Spatial distributions of radiation fluxes within the cloud at different heights and also around the cloud edges are found. Spatial distributions of reflectance and transmittance on top and bottom boundary of the atmosphere are calculated too. Influence of vertical cloud edges on these distributions are studied.

It is shown that horizontal radiation fluxes at different heights of the cloud lead to

large variation of absorptance, reflectance and transmittance in vicinity of vertical cloud boundaries. For an optically thick cloud this influence is not essential within the cloud far from vertical cloud edges and there is an inner sub-region of the cloud where 1-D parallel layer model can be used for the light absorptance, reflectance and transmittance calculations. For an optically thin cloud, influences of cloud edges is significant within the whole cloud. The results of work can be used to asses the accuracy of modern aerosol and cloud satellite retrievals in the vicinity of cloud edges.