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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Spectral invariant behavior of zenith radiance around cloud edges simulated by radiative transfer" *by* J. C. Chiu et al.

Anonymous Referee #1

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General comments

Two recent papers (Marshak et. al., 2009 and Chiu et. al., 2009, see references in the paper) found from radiance measurements of cloud edges a surprising spectral-invariant relationsship, described in Marshak et. al. (2009). The measured radiance at different wavelengths can be parametrized with a linear relationship using the clear-sky and cloudy radiances, as well as the optical depth of the part of the cloud edge seen by the measuring instrument.

This paper analyzes the relationship with help of numerical simulations. It performs a sensitivity study of the relationship on different aerosols and cloud properties such as e.g. the effective radius and cloud phase, and adresses the question what effect the finite field-of-view of the detector has on the relationship. The paper concludes that

with help of the relationship it is possible to derive cloud properties when looking at the edge of the cloud.

The outcome of the paper is scientifically relevant and will help improve atmospheric retrieval. However, the core part of the paper, the sensitivity study, is based on too strong assumptions and is incomplete.

In particular, the simulations were performed with a Henyey-Greenstein (HG) parametrization of the phase functions for clouds and aerosols. While this approach can be justified when simulating fluxes or heating rates in the atmosphere, it should not be used when calculating radiances, since radiances depend sensitively on the exact form of the phase function. This is especially true in the case of low optical depths, as is the case in this study.

Secondly, the simulations were performed with a 1D radiative transfer solver. However, cloud edges are obviously regions with large horizontal inhomogeneity, and it is quite possible that 3D effects will have an effect on the relationship discussed by the paper.

The possible consequences using these two approximations made by the paper, i.e. using HG phase functions and ignoring 3D effects, are not discussed in the paper. This should be done. Even better would be if the paper would drop these approximations. This should be possible at least for the phase function.

Specific comments

Abstract: In the abstract the relationship is not defined. It would be helpful to explain the relationship in one or two sentences. This would also make the second part of the abstract understandable.

page 9, line 16-24: This paragraph is hard to understand, see also below. The authors should rewrite it.

page 9, line 17: The width of the cloud edge is taken here to be 150m. Can the authors justify this value?

page 9, Eq. 6: The variable "a" is not defined. It is probably not identical to the variable "a" defined in Eq. 3.

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 14557, 2010.