

Interactive comment on “The spectral signature of cloud spatial structure in shortwave irradiance” by S. Song et al.

Anonymous Referee #2

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Review report on: *The spectral signature of cloud spatial structure in shortwave irradiance* by Song et al.

Overview:

The manuscript discusses the spectral net horizontal photon transport in shortwave irradiance fields. Since 3D radiative effects are often discussed in terms of retrieval uncertainties of cloud properties based on radiance measurements, this paper aims on layer properties that are linked to the energy budget.

The authors clearly motivate the relevance of the problem. 3D radiative transfer simulations were applied to determine the magnitude of 3D radiative effects, and to find a reason for the simulated spectral dependence. They found a correlation between magnitude of net horizontal transport and its spectral slope which is parameterized.

C1

The data set and the radiative transfer model is well described. The structure of the manuscript is mainly straight forward. The extensive summary helps the reader significantly to recapitulates the major findings of the work, since there a lot of information given in the main part of the manuscript.

The manuscript is highly recommended for publication in ACP. Nevertheless, a few minor comments should be addressed first.

General comments:

- 1): There are several places in the manuscript related to radiances instead of irradiances (e.g., p17, l11ff) . For the flow of the paper discussions concerning the relation between H and radiance measurements by satellites should be shifted to the end of the paper.
- 2): It is not completely clear how to use your findings for other users. How can we improve for example layer properties calculations from airborne irradiance measurements with respect to horizontal photon transport?

Specific comments:

- 1): In the last sentence of the abstract the authors mention a companion paper. It is not necessary to refer to this publication in the abstract. Rather the authors should give an example how and where the parametrization can be applied for other users.
- 2): (p3, l7) “can assume similar values as the absorbed irradiance”; Comparing the apparent absorption shown in Fig. 4a (500 nm) and 4b (1600 nm) in Schmidt et al. (2010) I identify the more the same magnitude than similar values. It’s still a variable factor between the numbers. Use “same magnitude” instead “similar values”. In addition, the authors should give reasons for smaller H -values in the NIR.
- 3): (p3,l20ff) The wavelength dependence of horizontal photon transport is mentioned here. Could you give a more detailed literature review on this since it is crucial for the entire manuscript?
- 4): (p4, l2-15) The paragraph is a mixture of outline and outlook (l6-9). Please

C2

strengthened the content. A structure of the paper is already described in the last paragraph of the introduction. Therefore the idea of the paper should be presented before (performing 3D and 1D simulations with a measured cloud data set, identifying H and its spectral behavior, . . .) without prejudging the results.

5): (p5, l18) Eq. (3) states the spectral absorptance. Add here directly, that these layer properties are valid for homogeneous conditions without horizontal photon transport. The reader might be confused otherwise because Eq. (3) contradicts Eq. (1) without this restriction (as noted only on p.6, l5-7).

6): (p8, l8-12) This paragraph gives an outlook. Better put this at the end of the manuscript.

7): (p9, l4-6) As stated by the authors using height-constant effective radii has an effect on the vertical distribution of the phase functions which probably differ from reality. Why does the phase function don't affect the 3D radiative transfer? Changes of the phase function result in changes of the scattering direction. Maybe this is not as relevant as for radiance simulations. Please clarify.

8): (p9, l8) Please define WC .

9): (p9, l17) Please justify the choice of spatial resolution (with respect to typical spatial scales of radiative smoothing).

10): (p11, l16) What will be generalized? The solar position?

11): (p12, l8-11) The enhancement of radiance in the vicinity of clouds is mentioned here. Can you cite also papers dealing with the enhancement of irradiances? Add also the fact that this effect is wavelength-dependent.

12): (p13, l15) Could you insert the linear fit in Fig. 3a?

13): (p13, l24) "pixel-to-pixel radiation exchange" → Please add "horizontal" here. There is of course a vertical exchange of photons.

14): (p18, l16-19) "Eq. (1) suggests. . ." In my opinion these two sentences do not contribute significantly to the context of this section. Referring to transmittance here somehow interrupts the flow of the discussion on spatial aggregation.

15): (p20, l20) Please motivate the restriction of conservative scattering here, other-

C3

wise the missing absorption term might confuse the reader.

16): (Sect. 8, first paragraph) To make sure that the equations are valid only for a specific wavelength range, the index " λ " would be helpful for H , R , T , . . .

17): (p23, l4, l10) If you give numbers here then you have to mention that these numbers are case specific with respect to surface albedo and solar position.

18): (Sect. 9) Be more consistent with using indices for H . For example p.23, l.16: Is it H or H_0 or H_λ which has to be known?

19): (Fig3b) Is there any reason for the increasing scattering of 3D-based $S_0 - H_0$ correlation for negative slopes?

Technical comments:

1): Please remove the footnotes.

2): (all Figs.) Check that symbols have italic format.

3): (p12, l25) Figs. → Fig. 4): (p13, l25) " H " → " H_0 " 5): (p14, l3) " H_λ " → " H_λ " (italic)

Interactive comment on Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2015-911, 2016.

C4