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Interactive comment on "APOLLO_NG – a probabilistic interpretation of the APOLLO legacy for AVHRR heritage channels" *by* L. Klüser et al.

Anonymous Referee #3

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In this paper the authors discuss modifications/improvements made to the APOLLO cloud detection and cloud property retrieval system. The new system, referred to as APOLLO_NG (APOLLO_NextGeneration) uses an adjustable probabilistic based cloud detection scheme which is effectively an extension of the binary system used in the original APOLLO. In the new system the cloud detection results in a probability rather than a binary yes/no as in the old system. In addition to cloud detection, APOLLO retrieves cloud properties including optical thickness, effective radius, cloud top temperature and cloud water path. Improvements in the retrieval of these parameters are discussed including how determination of their standard deviation allows retrieving their

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associated uncertainties.

Although the paper should be published, as it is being used in several applications, I can only recommend it for publishing until after major changes.

The paper is missing a discussion of the problem, in particular, the reason for extending APOLLO to a probabilistic method, and a review of the literature related to this problem. In addition, a review of other cloud detection methods and retrieval methods and how they compare to APOLLO should be included. It is obvious that extending APOLLO to support any instrument with the “heritage channels” and moving to a full Nakajima and King (1990) style retrieval are both improvements but a more thorough discussion of the merits of the probabilistic cloud detection approach should be included. The adjustability from “clear confident” to “cloud confident” is mentioned but are there more benefits, and how does the probabilistic approach fit into the users needs? Examples of the probabilistic method and its advantage in practice should also be presented. The figures show examples of results but do not convey the value of the probabilistic approach. Perhaps a more quantitative analysis with figures should be provided.

Some of the English especially in the cloud detection test descriptions is difficult to understand. The author’s use of “respective” is incorrect in many cases. Commas tend to be missing or used where they should not be.

Below I present two lists of issues that can be located to a particular part of the paper given by page number and line number. The first list presents science/technical issues and the second list presents grammatical/wording issues.

Science/technical issues:

4415, 18: What are “solar radiation issues”. This should be explained.

4415, 27: These are not necessarily “obvious”. This should be explained.

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Interactive Comment

4416, 04: Three things in this paragraph: (1) The required channel wavelengths should be listed. (2) The text in parentheses makes it seem like the instrument must provide both 1.6 and 3.9 μm channels when it really should only have to provide one. (3) The AVHRR channel switching should be explained: why and how it happens. (4) The AVHRR channel numbering should be explained completely. What are channels 2, 3 and 4?

4419, 05: Is there logic to make sure that a singularity does not arise here when $x_{\text{cld}} = x_{\text{bg}}$?

4429, 03: In this paragraph the authors discuss the use of the two-stream approximation to the radiative transfer equation including solar and thermal sources given by Coakley and Chýlek (1975). It is suggested that the AVHRR instrument noise and broad spectral response functions will contribute more uncertainty than the two-stream approximation therefore justifying its use.

There are two major issues involving the assumption made about the two-stream approximation and the particular formulation used:

1. The authors have stated that generalising APOLLO to work with any instrument with heritage channels is one of the significant improvements in APOLLO_NG. Is the assumption about the two-stream approximation still valid with well calibrated instruments with much narrower spectral response functions such as AATSR? If it is then this should be shown quantitatively by comparing two-stream results with n-stream results from an RT solver such as DISORT for a range of cloud states.
2. Coakley and Chýlek (1975) show that their formulation of the two-stream approximation has good accuracy for optically thin atmospheres but is not appropriate for clouds. From Coakley and Chýlek (1975): "Of course, the fact that the accuracy of these models suffers greatly when the optical depth of the medium becomes large implies that they will be inadequate for the

description of the scattering due to clouds". The authors should explain this significant discrepancy.

4429, 05: The paragraph suggests that water vapour absorption above the cloud is the only other atmospheric component besides the cloud itself that is affecting the radiative transfer. Is this accurate? What about absorption by other gases and absorption below the cloud. What about molecular scattering? If these are not required then this should be shown quantitatively. Also, the source of meteorological profiles required to compute gas concentrations, gas extinction coefficients and thermal emission should be given.

4429, 05: Nothing is discussed abut how the affects of the surface are included in the RT solution. Is the surface assumed to be Lambertian? If so, what is the source of the albedo value used?

4430, 26: Size distribution must be assumed for this calculation. It should be described.

4433, 02: In this case $Q_\mathrm{e} = 2$ is an approximation. A better statement is that for drops large compared to the wavelength $Q_\mathrm{e} \to 2$.

4436, 19: Concerning "clearly out weighs": This claim needs to be shown quantitatively.

Grammatical/wording issues:

4414, 13: "allows to retrieving" should be "allows retrieving".

4414, 24: "from on NOAA-18" should be "from NOAA-18".

4415, 27: Awkwardly worded sentence.

4416, 08: "consequently also the" should be "consequently the".

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4417, 15: "Although it seems not to be straightforward" is awkward.

4419, 19: There should be a comma after the equation.

4420, 03: There should be a comma after the equation.

4420, 25: Hinf should be H_{inf}.

4421, 05: There should be a period after the equation.

4422, 10: "Infrared Gross temperature test (IGT)" should be "Infrared Gross Temperature (IGT) test".

4423, 01: "values then a" should be "values than a".

4423, 16: There should be a period after the equation.

4423, 19: The equation number is a percent sign.

4423, 23: Should reference some original spatial coherence test papers.

4424, 09: There should be a comma after the equation.

4424, 16: Missing a period at the end of the sentence in this line.

4426, 14: There should be a period after the equation.

4427, 09: $\cos(\Theta v)$ should be $\cos(\Theta_{\text{v}})$.

4427, 14: There should be a period after the equation.

4427, 18: Awkwardly worded sentence.

4431, 21: There should be a comma after the equation.

4432, 23: There should be a period after the equation.

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References

James A. Coakley, Jr. and Peter Chýlek. The two-stream methods in radiative transfer: Including the angle of the incident radiation. *J Atmos Sci*, 32:409–418, February 1975.

Teruyuki Nakajima and Michael D. King. Determination of the optical thickness and effective radius of clouds from reflected solar radiation measurements. part i: Theory. *J Atmos Sci*, 47(15):1878–1893, August 1990. doi: 10.1175/1520-0469(1990)047<1878:DOTOTA>2.0.CO;2.

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 4413, 2015.