

Atmos. Meas. Tech. Discuss., referee comment RC2  
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## Review of amt-2021-143

Anonymous Referee #2

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Referee comment on "Cloud-probability-based estimation of black-sky surface albedo from AVHRR data" by Terhikki Manninen et al., Atmos. Meas. Tech. Discuss.,  
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### General Comments

This paper presents a statistical method of calculating temporally averaged black-sky surface albedo from measurements made by a satellite imaging radiometer - in this case AVHRR. The unique aspect of the method presented is that it includes measurements effected by partial cloud-cover, using a cloud-probability (CP) product (essentially the Bayesian probability that a given observed pixel is, or is not, cloudy) to correct the albedo derived from top-of-atmosphere observations with a given CP threshold. The method is presented as an improvement on previous albedo retrieval schemes which rely on binary cloudy-clear masks. The authors provide a derivation of the equations used to make this correction, with a description of the assumptions and limitations of the method, before presenting results of the algorithm applied over a small range of stations which provide in-situ surface albedo observations.

The work presented is interesting, especially as the method is being operationally applied to calculate surface albedo in the new CLARA-A3 AVHRR products produced by the CM-SAF, and the derivation and analysis seem sound. The paper draws heavily on work done previously by the lead author (Manninen et al. 2004) and represents the (long-awaited, one imagines) practical realisation of that more theoretical analysis. Thus, as an improvement and application of an existing approach, which is being applied to a large data record, I feel it is worthy of publication. However, the paper itself could do with some improvement. My biggest complaint is the paper lacks a clear description of its structure - there is a brief (3 sentence) overview of what the paper covers, but without an existing knowledge of the analysis undertaken by the authors, I felt lost for much of the paper. The authors have a tendency to provide a series of related, but not directly connected statements, which makes following the thread challenging. Thus, I would recommend that the introduction is extended, or an introductory section is added to the methods (section 3), to include a overview of the algorithm which clearly lays-out the steps involved and the final product - maybe a flow diagram would help.

One specific omission in the paper is that no indication of which wavelength(s) the albedo

is being derived for. I presume it is one or more of the AVHRR visible/near-IR bands. Please include this information in the paper.

### **Specific corrections and suggestions**

Abstract: The abstract doesn't scan well and should be revised. For example the basic purpose of the paper should be stated in the very first sentence, so the abstract should start with something like (as an example): "This paper describes a new method for cloud-correcting observations of black-sky surface albedo derived using the Advanced Very High Resolution Radiometer (AVHRR)."

Pg.1, Ln.20: Again, these introductory sentences don't scan well and come across as a series of dis-connected sentences. For example, I would suggest re-structuring the first few sentences like so: "The surface albedo is a key indicator of climate change (GCOS, 2016) and is continuously and accurately measured across contrasting climatic zones by the Baseline Surface Radiation Network (BSRN), operated by the World Climate Research Programme (WCRP). However, satellite remote sensing is required to augment these regional measurements with global estimates of surface albedo".

Pg.2, Ln.11: I'm not sure what is meant by the sentence "However, for the really large deviations also other cloudy vs clear non-separability issues become important"

Pg.2, Ln.13-15: I would suggest replacing the last two sentences of this paragraph with something more succinct. For example: "Using such data would introduce errors on the order of 100% on derived surface albedo, with potentially much higher errors occurring in cases with the combination of snow, complex terrain and low sun elevation, which are common in Northern Europe for example."

Pg.2, Ln.19-21: A couple of points here. Firstly, the sentence needs restructuring, I would suggest something like: "Thus, across a 0.25 x 0.25 degree grid-box over one month, the slowly varying surface albedo would be expected to dominate the broadband albedo distribution observed by non-cloud masked AVHRR data". The second question is, why would you expect the albedo distribution to be dominated by the surface contribution, even though the cloud albedo is more variable? Surely this would be rather dependent on how much, and just how variable, the cloud cover was for the region and period in question?

Pg.2, Ln.32: Replace "surrounding area, an important" with "surrounding area, which is an important".

Section 3.1.1 I feel this section would benefit from restructuring. As it stands, it reads like a series of seemingly unconnected statements. For example, Pg.5 starts with a description of the distribution of cloud fraction and then suddenly switches to the diurnal variation of surface black-sky albedo, before switching again to seasonal and monthly variation of surface albedo. A simple introductory statement laying out what albedo components are to be discussed and why at the start of the section is required - something along the lines of what appears starting at Pg.6, Ln.5, for example.

Pg.5, Ln.9: Replace "like ceilometer observations show" with "as is shown by ceilometer observations, for example"

Pg.5, Ln.12: I'm not sure how Figure 1 could be described as resembling a U-curve. If this

is not an error, more explanation is needed.

Pg.5, Ln.17/18: Remove "also".

Pg.11, Ln.7: Remove comma after "shown".

Pg.11, Ln.27: "high" rather than "highest".

Pg.12, Ln.1: Replace "zenith angle so that" with "zenith angle such that".

Pg.12, Ln.7: Remove "per pass".

Pg.12, Ln.10: "also provides" rather than "provides also".

Pg.13, Ln.9: Remove comma after "show".

Figure.3: These plots do not effectively convey the distribution of the points plotted, beyond showing they are concentrated in the bottom left corner. I would suggest a density plot (where the data-space is divided into a regular grid and the number of points in each bin is shown by a colour gradient).

Figure.4: I assume the top-left panel should be labelled "Desert Rock", rather than "Payerne"? Also, I don't think it is necessary to show the full range of albedo for each panel - the distributions would be clearer if the x-axis was limited to the range of albedo observed at each station.

Figure.5: See figure.4.

Figure.6: I would suggest that this plot be regenerated to show the distributions of CP values flagged as cloudy or clear relative to the total number of observations of at each CP value (so that the sum of the red and blue lines is always 1). This would convey the the distributions in a more intuitive way and remove the need to include the dotted "cloud-fraction" line.