

Review of Wojciechowska et al., 2025.

This paper tests the performance of a simplified calculation of all-sky albedo vs CERES satellite data. The simplified calculation consists of a function or look-up table (LUT) using the MODIS-observed 1x1 degree daily cloud fraction (CF), droplet number (Nd) and Liquid Water Path (LWP) values as inputs. It is constructed using a kernel approach that (presumably – there needs to be more detail on this in the paper) uses several other MODIS variables as inputs along with the CF, Nd and LWP. Using a single (time and global) mean LUT leads to large errors that exhibit a spatial pattern and a dependence on Estimated Inversion Strength (EIS) and Solar Zenith Angle (SZA). Attempts were made to improve the LUT. Correcting for the SZA bias using the single global mean LUT had only a small impact. However, moving to using a separate time-averaged LUTs for each 1x1 gridbox led to significant improvements leaving only small errors. This suggests that regional information (in addition to the CF, Nd and LWP values) is needed for an accurate estimate of albedo.

The paper describes a potentially very useful simplified way to calculate albedo quickly and easily based on only 3 cloud variables. I recommend its publication after the changes below are made – mostly clarifications of the methods and some extra description.

General and line-by-line comments

It is interesting that there is no need for separate seasonal/time-varying LUTs – one time-mean LUT for the whole data period for each location seems sufficient to get low errors. It might be worth commenting on this a little more.

Is there an advantage to using the LUTs vs using the kernel method directly? Especially if there is a need to have a separate LUT for each grid-box requiring a fairly large array to be stored? If we knew what is required by the kernel method then this might be clearer to the reader – presumably it requires lots of extra variables (see comments later)?

Line 94 - How much does the filtering by ice cloud fraction restrict the altitude of the clouds studied? It would be useful to show this somewhere. E.g., are you just looking at low-altitude clouds after the filtering?

Line 96 – it would be useful to reiterate that this is 1x1 degree data. E.g., “The daily gridded 1x1 degree data...”.

Line 98 – “For each bin, the average albedo (α_{avg}) was then calculated as a multi-year mean value of all pixels across the globe that fall into the same bin of CF, LWP, and Nd.”

- It's not clear from the methods section how you calculate the albedo of the pixel using CF, LWP and Nd. Presumably, it is as mentioned on line 62 (“Using a joint-histogram/kernel approach from Gryspeerdt et al. (2019),”)? But this should be described in the methods section too. Some details on how the method works should be provided too.
- Otherwise one might think that you could use the bin-centre values to calculate albedos for each bin using the kernel method without having to do it for every datapoint and then averaging? But I think this comes from the lack of explanation

about the kernel method. Presumably the kernel method requires more information so that this is not possible? It would be good to talk about that a little.

- It would also be good to say that the average albedo values for each bin are the ones that could form the “look-up table” that might enable rapid albedo calculations based on just CF, Nd and LWP, which would be a lot easier than doing radiative calculations and (presumably) easier than doing the kernel calculation. And then that this approach needs to be tested against CERES (following onto the next sentence). This would be useful to the reader because it is reiterating the aim of the paper, but at the point in the text where you have explained the approach.
- The word “pixel” here is a bit confusing too – “1x1 degree daily datapoints” would be clearer.
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Line 132: “Underestimates of $\Delta \alpha < -0.02$ are particularly frequent around 40° latitude in both hemispheres,”

- It looks to me like the frequencies are high at latitudes greater than 40° deg?

Line 140: “as suggested by the faint diagonal lines visible in Figure 4b.”

- I can’t really see any faint diagonal lines? I can see some straight lines that look like artefacts, though.

Line 160: “which in Figure 4a appear predominantly brighter than other cloud scenes with similar CF-LWP-Nd characteristics”

- Could be worded better. Fig. 4a more suggests that they “are observed by CERES to be brighter than calculated from the CF-LWP-Nd values using the kernel approach”, or similar.

Line 175: “This explains the significant number of strong underestimates also visible in Figure 3.”

- It might also suggest why there are underestimates at high latitudes in Fig. 4a.

Line 190: “Secondly, in order to ensure that the number of bins (50) was sufficient to reflect the characteristic U-shaped distribution of cloud fraction (with very small or nearly complete cloud cover occurring most frequently, while intermediate values appear relatively rarely), an alternative estimation was also performed using a much larger number of bins - 1000 (modification no. II).”

- Presumably, this is separate to modification no. I? It would be good to make that clear here.

Line 216 – “Figure 7a-b shows the histogram of $\Delta \alpha$ after applying this correction.” – it’s not clear which correction you are referring to here. From the text and table I think that this is just the correction using the mean $\Delta \alpha$ within each SZAmax interval (modification IV) and not also modification III?

Line 232 (and 235) – “These results show that the reconstructed albedo of a scene of clouds based on the mean cloud field properties exhibits systematic biases”

- “based on the mean cloud field properties” is a bit confusing here since you are basing it on the actual CF, LWP and Nd cloud properties - the issue rather seems to be that using a single global mean “look-up table” with mean albedo values for each bin leads to systematic biases?
- Reading on to line 260 makes it clearer what you mean here since you have now explained that there are likely factors other than the cloud properties (CF, Nd and LWP) at play. However, this was not so clear at the start of the section where you should explain the use of the global mean albedo look-up-table (as mentioned in the previous bullet point) and mention that by “mean cloud properties” you mean CF, Nd and LWP only.

Line 268 – “to build a simplified CF-LWP-Nd- α kernel” – not sure if this is a very descriptive way of describing it. “a simplified method to calculate albedo based only on CF, LWP and Nd values” or similar would be better.

Line 268 – “spatial differences in albedo-to-cloud-sensitivity.” This is also not clear – do you mean “spatial differences in the sensitivity of albedo to cloud properties”?

Line 270 – “It was demonstrated that the number of biases in reconstructed albedo can be as high as ~60% of cases, when aiming for the accuracy in estimates (absolute difference between expected for the given CF-LWP-Nd conditions and measured by CERES albedo) at 0.02; which corresponds to about 10% of relative difference (Fig. 3).”

- This would be better as “It was demonstrated that the percentage of datapoints in which the reconstructed albedo biases (relative to the measured CERES albedo) were $> \pm 0.02$ (a relative bias of around $\pm 10\%$) can be as high as ~60% (Fig. 3).”

Line 280 “can be achieved when the average albedo in the given CF-LWP-Nd conditions is calculated at a 1° grid resolution.”

- Would be better as “can be achieved when the average albedo for each CF, LWP and Nd bin is calculated at a 1° grid resolution.”

Line 284: “on a pixel level” – again, better as “at a 1 degree resolution”

Line 286 – “the mean cloud field properties” – again, it would be good to say that you mean CF, Nd and LWP here.

Typos

Line 55; “bins the” -> “bins in the”

Line 90: “explaining” -> “explain”

Line 95: “Resulting subset of cases considered in this study is pictured at Figure 1.” -> “The resulting subset of cases considered in this study is pictured in Figure 1.”

Line 189: “may have an larger influence” -> “may have a larger influence”

Line 272: “showed” -> “shown”.

Line 279: “in attempt” -> “in an attempt”

Line 282: “with modest” -> “with a modest”

Line 283: “showed” -> “shown”

Line 283: “in CF-LWP-Nd- α ” -> “in the CF-LWP-Nd- α ”