The Cryosphere

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Discussions

Interactive comment on "Correction of albedo measurements due to unknown geometry" *by* U. Weiser et al.

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Received and published: 25 June 2015

The paper proposes a method to correct broadband albedo measurements from errors caused by the unknown slope of the underlying surface and the imperfect levelling of the sensor. This problem is common and not often addresses in the literature. This makes the goal of this paper important.

Unfortunately the paper and more specifically the introduction and first subsections of the method are not well written, not rigorous enough and as a consequence subject to mis-interpretation. Many statements lack proper references, are vague or are only valid for a very specific context (e.g. alpine conditions) without this context being explicit. This is incompatible with the international audience of The Cryosphere. The discussion is short and provides too basic information. At last, the terms referring to

optical variables do not follow scientific standards or are not precise enough (in the introduction, this improves in the other sections). Various terms seem to be used for the same meaning (e.g. radiance / irradiance, global / total, directly, . . .) which is confusing.

The description of the direct model and the fitting approach is exhaustive and well-done. The assumptions are also clearly stated. However, the assumption that the (true) albedo of snow surface is constant over the day is overoptimistic. It is well known that snow albedo depends on the solar zenith angle and many studies present this result through analytical derivation, experimental results or numerical computations. The correction proposed by the authors relies on the measured albedo variation as a function of the SZA during the day and is designed to minimize the albedo variations during each day. By doing so, it remove not only the geometrical artifacts (which is good) but also the variations of physical origin (which is bad). It over-corrects the albedo and it is difficult to know if the corrected one is better than the un-corrected one . To solve this major issue, it is suggested to either include theoretical/analytical calculation of snow albedo into the direct model presented in the paper or, at least, show a few computations (or find some data) to evaluate the relative effects of the slope versus "normal" sza dependence and demonstrate the physical variations are second order compared to geometrical artifacts.

As a conclusion, the method presented in this paper may be interesting once the albedo dependence to SZA is taken into account and the text is improved. The following detailed comments should help for a first correction. At last English should be revised .

Detailed comments:

* P2710 L17 "The energy balance of a glacier surface defines the amount of energy available for the ablation processes, once the underlying snow/ice is isothermal". Please clarify isothermal. Do you mean "reach freezing point" ?

* P2710 L20 What is an "isolated area of a glacier" ?

* P2710 L25 "ideally southwards". Specify in which hemisphere

* P2710 L25 it is not clear what "changing conditions" refers to: weather, snow or instrument ?

* P2711 L1 "In the method described in this paper". Give first the objective of the paper. It is not clear at this point that the paper is about a method (introduction must be independent of the abstract).

* P2711 L1 "cosine law" is not clear for most readers, especially when it is used to refer to the error with respect to the ideal cosine law. Give a reference or details and check throughout the paper the use of this term.

* P2711 L3 "Many publications". Give references of several of them.

* P2711 L9 "caused by the specular components of daily albedo". What is "daily" albedo ? Is it the averaged ? Explain also "specular components" (especially the plural).

* P2711 L14. Remove the parenthesis

* P2711 L14 "global radiation". The term global is not clear. Correct throughout the text.

* P2711 L19. References needed.

* P2711 L23 "described problems of albedo" is vague

* P2712 L7 "These results are essential because albedo of a forest is expected to be almost constant, in contrast to snow albedo which changes over time.". It is not clear why the result is essential.

* P2712 L12 "Extinction coefficient" seems to be misused here. Do you mean optical depth ?

* P2712 L19 "on preceding clouded day" → cloudy. Check everywhere.

* P2712 L20. Not sure the reference Weiser, 2012 is perennial and useful for many readers (not in English and no doi). Understanding the text should not depend on it.

* P2712 L20-21. The sentence is difficult to understand. The value +0.15 depends on the solar zenith angle (+other parameters). Precise the conditions (latitude/period of the year or sza).

* P2713 L5. Equations must be ordered (first is (1), second is (2), . . .)

* P2713 L14. References needed.

* P2713 L15. What is "Realistic physical range" ?

* P2713 L18. "the tilts of the sensors increase over time". This statements is not always true. Give references, examples or remove it.

* P2713 L20. "Reasonable" is subjective, remove. Define "diurnal mean albedo"

* P2713 L21. "The method described in the present paper shows how to correct the true albedo with unknown tilts and directions of both the slope and the sensor." → the present paper proposes a method to correct measurements of albedo . . .

* P2713 L23. "the direct incoming radiation being reflected diusely". Do you mean the reflected radiation ?

* P2713 L24. "the slope of the observed apparent diurnal variation of albedo". Which slope ?

* P2714 L17. "For an opening angle of 160 the cosine error" is not clear.

* P2715 L1. "0.5 %". Do you mean 0.5 degrees or 0.5% of something that must be specified in the text?

* P2715 L5. "5%". Where this value comes from ?

* P2715 L10. References needed for BSRN and Suntracker.

* P2715 L18. Remove "described". It is not yet described.

* P2715 L20. The assumption of constant broadband albedo seems not reasonable because snow and probably concrete albedo has a strong dependence to SZA and spectrum of the incident radiance.

* P2717 L5. "As most glaciological measurements " unnecessarily subjective. Rephrase.

* P2719 L13. "On a real measuring site," → in practice

* P2720 L18. Epsilon is not an extinction coefficient. It includes the path length (which is not constant) and should be renamed to avoid confusion.

* P2720 L1. Assumption 3 is very strong! Discussion and evaluation of this effect should be done especially regarding the statement P2716 L18.

* P2720 L3. Reference is needed for the assumption 4

* P2721 L12. Give details on the time resolution and the hours (or sza) used for the fitting.

* P2721 L11 and L19. Is V a atmospheric parameter ? Or is it mainly related to the sensor ?

* P2721 L15. "Radiation model" is not clear. Which equation is it referring to ?

* P2723 L23. I don't understand the sentence with "... where... where..."

* Section 2.3.3 is obscure. E.g. P2723 L5 "factore C should be as constant as possible" and the following sentence: "the constant C" and again at the end of the section "C is as constant as possible".

* P2724 L2. I don't understand "flat" zenith angle.

* P2724 L6. What is "SD" ?

* P2724 L11. Remove the middle equation

* P2724 L14. I don't understand

* P2724 L20. Where are the results/data ?

* P2724 L21. Not sure to understand "weighted".

* P2724 L21. How the range is obtained ? Can it be shown in a figure ? Why is it so large ?

* P2724 L22. This is not shown by the results and should be moved to the discussion (with references).

* P2724 L22. Same question. Why such a ranges ?

* P2725 L24. I don't understand.

* P2725 L25. Remove "Reasonable" and give uncertainty range or other scientific arguments.. As far as I see, the corrected albedo is not more constant than the un-corrected one (please give standard deviation or any statistical metric that can help to give objective arguments). It means the correction is not efficient, can you comment on this ?

*P2726 L13: "acceptable zenith angles" is subjective. Again L14

*P2726 L22: observed albedo ?

* P2727 L2: "directly" is not clear and not used before, which is disturbing.

* P2727 L3: remove "(true)". True albedo is the goal. Estimated or corrected albedo is ok.

*P2727 L25: "flat" is not adequate + I don't understand the end of the sentence.

*P2728 L3: which "direction" ?

*2729 L10: "flat"

*2729 L10: "differences" between what ?

*2729 L20: "flat"

Figures 3 and 5. Instead of using UTC for a specific day and latitude, why not to compute as a function of SZA ? Otherwise, add the relevant information of latitude and day in every figure and in the text.

Figure 4. Can be removed because it is not useful unless angle notations are added.

Figure 5. The colors of the curves should be taken from a circular continuous color scale. South and north facing could be shown with a stronger face (instead of showing the 315 degrees curve with dash).

Figure 6. Title should include "... and compute the net SW radiation"

Figure 7. the albedo labelling on the right y-axis needs to be extended down to 0. Solve the overlap of the date and label on the x-axis... The cyan color should be avoided.

Most figures: Units should be written without slash, use scientific notation.

Interactive comment on The Cryosphere Discuss., 9, 2709, 2015.