Author response to comment on « Monitoring spatial and temporal variations of surface albedo on Saint Sorlin Glacier (French Alps) using terrestrial photography" by M. Dumont et al.

Response to comment of Anonymous Referee #1

Discussion points

a) p. 291, lines 14 onwards. Satellite albedo retrieval algorithms are already available and a range of albedo 'products' are available for, e.g. MODIS. Surely, the advantage of your technique is that is overcomes some of the limitations of satellite measurements: e.g. photographic spatial resolutions more suited to small glaciers and provide much better temporal resolution (especially at locations which are frequently obscured by cloud).

Thanks for this remark. Nevertheless, as far as we know, MODIS albedo products currently available have low temporal and spatial resolution. In addition, they are often validated on rather flat areas. Our method, with accurate topographic and anisotropy corrections, applied to MODIS reflectance, will probably allow retrieval of broadband albedo on highly rugged topography at 250 m resolution. Consequently, we propose to add the following sentence p. 291 line 14 :"Indeed, currently available MODIS albedo product have often large spatial and temporal resolution (Dozier et al., 2009). The method presented in the study, thanks to accurate topographic and anisotropy corrections, will probably allow retrieval of broadband albedo on highly rugged topography applied to MODIS reflectance".

b) In the conclusion you should point out that albedo cannot be retrieved from your method under cloudy conditions, but albedo is known to vary significantly with varying cloud cover and these effects would need to be parameterized in a model.

Thank you for pointing this out. Consequently, we propose to add a new sentence in the paragraph p291, Line 10:" Indeed, the method described in this study allows retrieving of broadband albedo under clear sky conditions. Nevertheless, albedo varies significantly with cloud cover (Gardner and Sharp, 2010). Consequently, the effect of cloud cover will need to be parameterized in the solar irradiance model to be taken into account in the retrieval method and to allow retrieval of broadband albedo under cloudy conditions."

c) Presumably, the range of zenith angles under which albedo was measured is quite small (summer season on a temperate glacier, within a few hours of solar noon). How might the results vary at larger zenith angles and how applicable could the method be to polar glaciers where solar zenith angles are greater?

Actually, the range of illumination zenith angle is quite large over the glacier due to different slopes and aspects. It varies from 20 to 80 degrees. As for the reference measurements, due to the different times of the day chosen (9.00, 12.00 and 15.00), the illumination zenith angle varies from 25 to 65 degrees. Consequently the method might be easily extended over polar glaciers. The limit of it, is certainly the anisotropy correction. The measurements used to derive the anisotropy factor have maximum illumination zenith angle of 60 degrees and maximum observing zenith angle of 70 degrees. In addition, at these grazing angles, the anisotropy factor is far from unity and then the anisotropy correction step might be crucial (Dumont et al., 2010).

Consequently we add page 291, line 10, the following sentences : « The range of albedo reference measurement illumination zenith angles is quite large (25 to 65 degrees). Thus, the

method can also be easily applied to polar glaciers. Probably the anisotropy correction at larger zenith angles will be a crucial point. For illumination zenith angles larger than 65 degrees, the anisotropy factor used in this study for correction might need further improvements. »

Clarifications Order of figures:
Fig. 4 is introduced in the text before Fig. 3 (p. 284) so the order of these two figures should be reversed.
The order of these two figures has been reversed (p. 284 line 16 and p. 284 line 21).

p. 278, Measurements of reference albedo section. Under what conditions were suitable photographs retrieved? Are these limited to clear sky conditions, or is a partly cloudy sky acceptable. Also, what is the range of solar zenith angles for the albedo reference data?

The photographs were selected only for clear sky conditions while no cloud or cloud shadows visible on the glacier (see p. 278, lines 18 to 21). The range of solar zenith angles (effective i.e. taking into account the local slope below the measurement device) for the albedo reference data is 25 to 65 degrees (see also discussion point c)).
Consequently, we propose to add a sentence p. 278 line 16: "The albedo reference data selected for estimation of the method accuracy have illumination zenith angles varying from 25 to 65 degrees."

p. 288, first paragraph, if the AWS was located at the equilibrium line then surely the transient snowline (boundary between ice and snow) would have been located well downglacier from this location at this relatively early stage of the ablation season. Or do you mean that the AWS corresponded with the position of the transient snowline on 3rd July?
Thank you for noticing this imprecision. In this paragraph, we mean that the AWS was located at the position of the transient snowline on 3rd July.
Consequently, we propose to replace line 4-7 by "The glacier was visited on 3rd July and the AWS was located exactly at the position of the transient snowline. The latter line is the boundary between remaining snow and ice."

Typographical and grammatical errors
p. 272 Line 3, glaciers. Line 5, replace 'leading variable' with 'most important variables'.
Done
Lines 20-21, final sentence overcomplicates things, you simply mean that the melt rate is sensitive to meteorological conditions – but this is obvious.
Line 20-21. Final sentence will be removed
p.273 Line 1, replace 'becomes' with 'is'.
Done
Line 12, 'frozen surfaces' but temperate glaciers often have liquid water present at the surface.
Done
Line 18, replace 'proved' with 'has proven'.
Done
Line 26, replace 'showed' with 'shown'.
Done