Review from Kimberly Casey

(Original comments are in black standard font, our replies are in blue and the proposed modifications in the manuscript are highlighted in **bold**. The line number refers to the lines of the discussion paper. See attached for a document including all the revised figures.)

General Comments and Suggestions for the Authors:

The manuscripts presents a novel MODIS satellite data analysis of seasonal changes of surface albedo and annual mass balance for two Himalayan glaciers. The authors compare in situ albedo measurements to two variations of MODIS satellite based albedo retrievals. Satellite albedo data is then compared to glacier equilibrium line altitude measurements to inspect annual mass balance. The albedo records of the satellite data are used to calculate mass balance at two Himalayan glaciers for a period of 6 and 11 years based on available satellite data.

The study is focused and addresses an important aspect of glaciologic analysis in difficult to access terrain. Data used in generating the results are well documented. The manuscript may benefit from slight structural changes, for example, providing increased presentation of spatial and temporal data source discrepancies and methods in addressing these discrepancies earlier in the text (i.e. place section 5.1 discussion earlier in presentation of methods/results). The manuscript is generally diverse in including relevant heritage citations. Some areas of the manuscript could be improved with greater depth of citations (see point 1 below for request to add citation for supraglacial debris models). The manuscript would be strengthened by revising discussion and conclusion text to reiterate the value of seasonal analysis as clearly emphasized in the introductory sections.

Thanks for your review. We addressed your comments below.

Specific Scientific Concerns:

1) In the introduction, supraglacial debris glaciologic models are missing from the text. Suggestion to add reference to such studies (e.g. Nicholson and Benn, JG, 2006; Foster et al., JG, 2012; Fyffe et al., JG, 2014) and revise paragraph appropriately to include consideration of supraglacial debris glaciologic models.

We added a sentence in the introduction to include debris-covered glaciers that are numerous in the Himalayas, and in turn require specific melt models (see below). We included the suggested references in our reference list but we replaced Foster et al. (2012) by Lejeune et al. (2013) who specifically deal with a Himalayan glacier (Changri Nup) not far from Mera Glacier.

“Glaciological field data remain sparse in the Himalayas (e.g., Bolch et al., 2012; Vincent et al., 2013). **Debris-covered glaciers are also common (e.g., Scherler et al., 2011) and require specific melt models able to assess melting beneath the supraglacial debris (e.g., Nicholson and Benn, 2006, Lejeune et al., 2013, Fyffe et al., 2014).**” P3439-L 15

Additional references added in the revised manuscript:

Fyffe, C. L., T. D. Reid, B. W. Brock, M. P. Kirkbride, G. Diolaiuti, C. Smiraglia and F. Diotri: A distributed energy-balance melt model of an Alpine debris-covered glacier, J. Glaciol., 60(221), 587-202, doi: 10.3189/2014JoG13J148, 2014.

Lejeune, Y., J. M. Bertrand, P. Wagnon & S. Morin, A physically based model for the year-round energy and mass balance of debris-covered glaciers, J. Glaciol, *5*9(214), doi: 10.3189/2013JoG12J149, 327-344, 2013.

Nicholson L and Benn DI (2006) Calculating ice melt beneath a debris layer using meteorological data. J. Glaciol., 52(178), 463–470, doi: 10.3189/172756506781828584

Scherler, D., Bookhagen, B., and Strecker, M. R.: Spatially variable response of Himalayan glaciers to climate change affected by debris cover, Nature Geoscience, 4, 156–159, doi:10.1038/ngeo1068, 2011.

2) Suggestion to add another sentence or two regarding the MODIS snow product used in the study (e.g. similar to the detail provided in section 3.2.2. for the MCD43A3 products).

This is done in the new manuscript. "**The daily albedo is calculated from the daily MODIS reflectances corrected from the atmospheric effects (MODIS/Terra Surface Reflectance Daily L2G Global 500m SIN Grid; MOD09GHK). The adjustment of snow and ice anisotropic scattering effects is done using a DIScrete Ordinates Radiative Transfer model (DISORT).**" P 3444-L 14

3) Suggestion to add a sentence on how the glacier masks initially described in section 3.3, Page 3445,lines 13-17, compare to glacier outlines available from the Randolph Glacier Inventory (http://www.glims.org/RGI/).

See figure R1 and figure R2 below for the comparison. We added the following sentence: **"These masks were manually defined using SPOT5 (2.5m resolution) and Pléiades (1m resolution) orthoimages acquired on 21 September 2005 and 25 November 2012, respectively. They slightly differ from the glacier outlines of the Randolph Glacier Inventory (Pfeffer et al., 2014) but are believed to be more accurate because they have been determined based on visual inspection of high resolution images and field expertise." P 3445-L 17**

Additional reference added in the revised manuscript:

Pfeffer, W. T., Arendt, A. A., Bliss, A., Bolch, T., Cogley, J. G.,Gardner, A. S., Hagen, J.-O., Hock, R., Kaser, G., Kienholz, C.,Miles, E. S., Moholdt, G., Mölg, N., Paul, F., Radic, V., Rastner, P., Raup, B. H., Rich, J., and Sharp, M. J.: The Randolph GlacierInventory: a globally complete inventory of glaciers, Journal ofGlaciology, 60, 537–552, doi:10.3189/2014JoG13J176,2014.

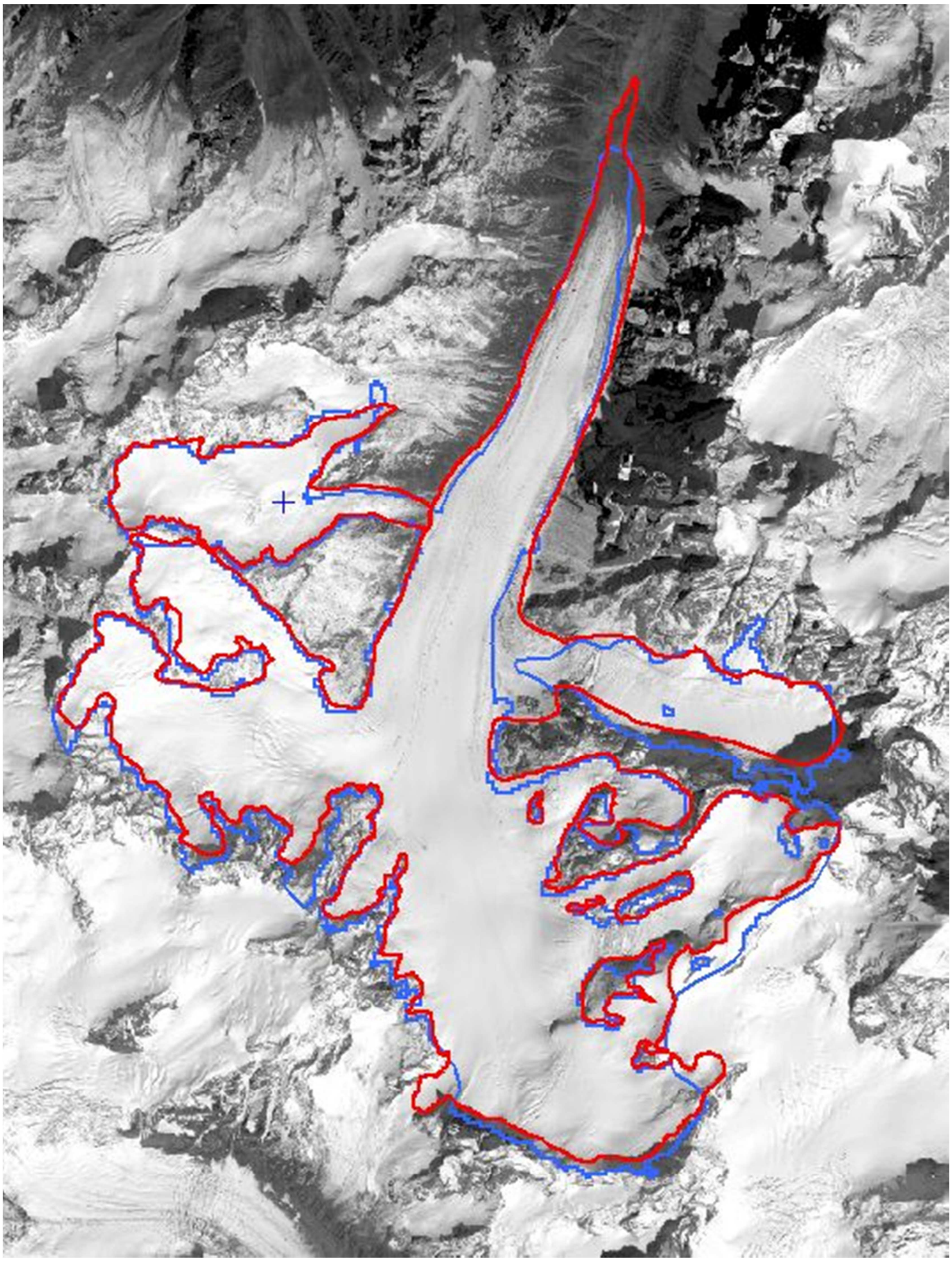

Figure R1: RGI outline (blue) and Wagnon et al. (2007) (red) outline for Chhota Shigri Glacier

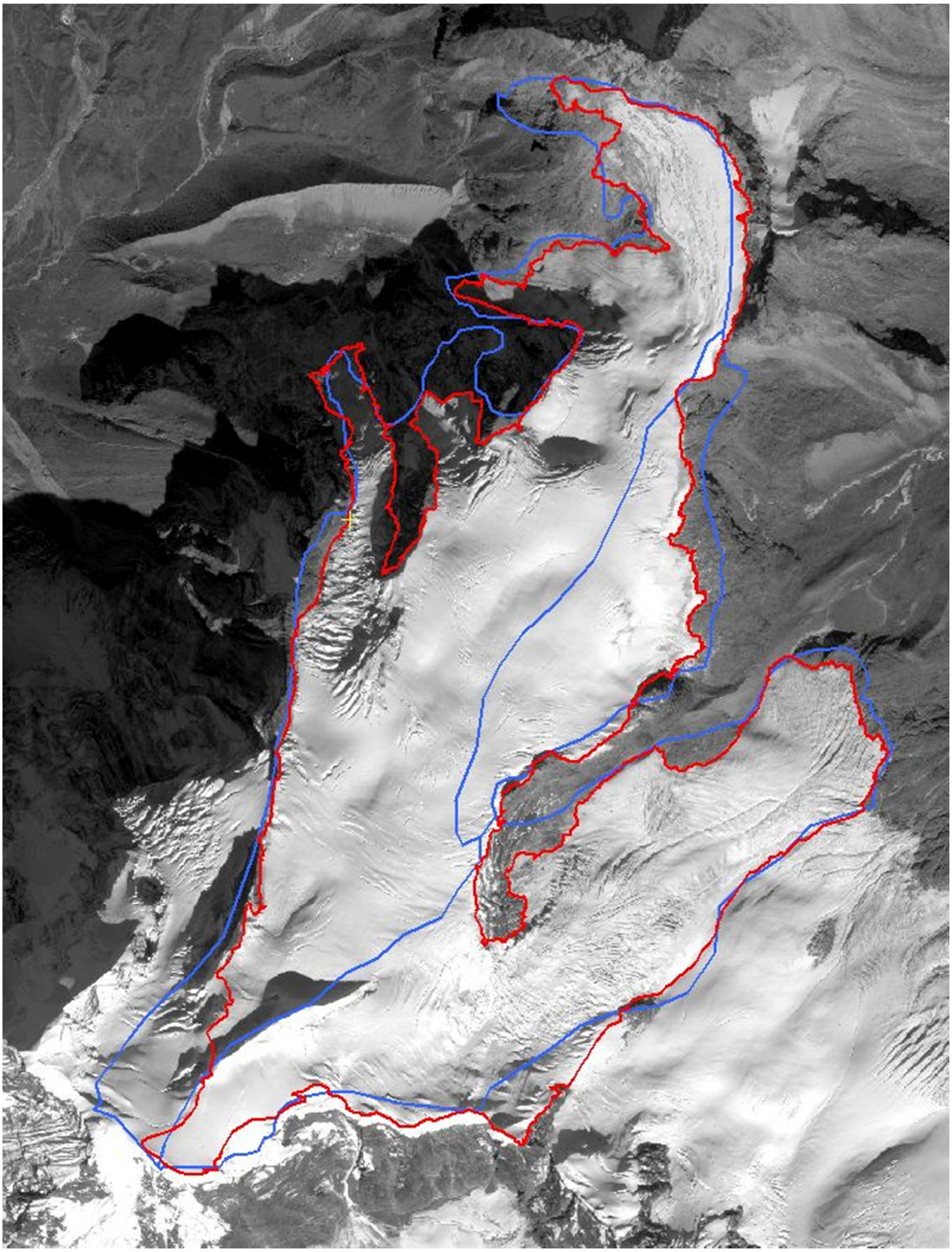

Figure R2: RGI outline (blue) and Wagnon et al. (2013) (red) outline for Mera Glacier

4) In Section 4.1.1. regarding the results of comparing the albedo values, the spatial and temporal resolution discrepancies are not discussed. How does the study deal with the in situ synoptic, assumed point measurements related to the albedo measured vs. the satellite albedo retrievals?

What is the temporal difference of in situ albedo measurements used vs. the MODIS satellite values? (e.g. AWS data collected every 20 minutes compared to one MODIS swath based calculation?) A portion of this is discussed in section 5.1, consider restructuring manuscript toinclude spatial/temporal comparison methodology earlier, e.g. section 4.1.1 or earlier.

These points are now highlighted in the beginning of section 4.1.1 by these sentences: "**While ground-based and satellite-retrieved measurements of albedo are not directly comparable, as their spatial and temporal resolutions differ, they will be coherent in time. Indeed, the albedo measured from the AWS comes from a 80 m²surface whereas the albedo derived from satellite has been calculated over a 62 500 or 250 000 m² surface. Additionally, the AWS albedo is averaged over a two-hour time span centered on the satellite passing time.**" P 3446-L 11

Also - - why is there a different value for MODIS MODImLab albedo measurements compared to MODIS MOD10 measurements? Why are less than half of the scenes calculated for MODImLab vs. MOD10? If this detail is present in the manuscript - consider relocating or reiterating in data or analysis description text.

The numbers of images are different for MOD10 and MODImLab for two reasons:

- MODImLab data were also filtered with the sensor zenith angle (in the revised version of the manuscript we processed additional MOD09 products to filter the MOD10 products –see the answer to the second reviewer on this point below)
- the cloud masks are different for the two products (it is more conservative for MODImLab, explaining why fewer MODImLab images are accepted).

We modified the Fig. 5 caption: "**Please note that the number of MOD10 and MODImLab images is different because the two dataset are filtered with different cloud detection algorithms.**"

How are the conclusions drawn for MODImLab being generally "more reliable" than MOD10? Perhaps this diction is a bit strong for the limited study over two sites. Suggestion to constrain projections to the context of this study.

This conclusioncomes from the estimated bias and RMSE of the AWS measurements vs. satellite measurements. We modified it to stress the fact that it is true only in the context of this study: "**In conclusion, MODImLab and MOD10 retrievals seem to have the same quality in the context of this study. Nevertheless, given the higher spatial resolution of MODImLab and the ability of its cloud detection algorithm to better detect clouds, we choose to mostly rely on MODImLab products for our analyses.** " P3447-L3

5) In section 5.1, suggestion to add specifications as to why each method corresponds to the area listed (e.g. AWS sensor at XX height above the surface, 250 m pixel resolution used in MODImLab calculations, 500 m pixel resolution used in MOD10A1).

This is done in the revised manuscript. **"**The satellite retrieval is a quantity integrated over 62 500m^2 for MODImLab **(= 250 m x 250 m, approximately one pixel area**) and 250 000m² for MOD10 product**(= 500 m x 500m, approximately one pixel area**), while the AWS sensor's footprint is approximately 80m^2 **(99% of the radiation reaching the sensor come from a 10*h diameter disc, where h = 1m is the sensor height above the surface).”**P 3452-L 11 to 13

Technical Corrections:

Page 3438, Line 8: Correct abbreviation for MODIS is Moderate Resolution Imaging Spectrometer.

This is changed in the new manuscript.

Page 3440, Line 23: Correct abbreviation for MODIS is Moderate Resolution Imaging Spectrometer.

This is changed in the new manuscript.

Page 3444, Line 12: Correct NSIDC listing from 'Centre' to 'Center'.

This is changed in the new manuscript.

Page 3448, Line 26: Consider clarifying sentence with regards to glacier not being optically apparent from spaceborne satellite remote sensing. E.g. the glacier could be measured via active remote sensing measurements.

The beginning of the new sentence is: ‘**The glacier surface is seldom apparent from space in visible and near infrared channels during summer time,**’ P 34448-L26

Page 3449, Lines 4-5: Clarify which glacier is being discussed in this sentence and following paragraph.

Mera Glacier is being discussed in this paragraph. This is added to the new manuscript.

Page 3452, Lines 1-4: Suggestion to reword sentence for clarity.

The new sentence is: ‘**However, the uncertainties on mass balance values retrieved with the albedo method are large, and some retrieved mass balance values are estimated from albedo values out-of-calibration range (years 2000–2001 and 2006–2007). This is likely to lead to a questionable mass balance average.**’ P3452-L1 to L4

Page 3455, Line 8: Suggestion to add full reference glacier names rather than abbreviations.

This is changed in the new manuscript. « Two of their studied glaciers **(Naimona’nyi and East Rongbuk glaciers)** exhibit an albedo cycle with a phase opposition compared to the others » P3455-L8

Review from Thomas Painter

This paper presents remote sensing retrievals coupled with in situ measurements and modeling for Himalayan glaciers toward accessing a remotely sensed proxy for glaciermass balance. The motivation for such an effort is strong given that we have veryscarce quantitative knowledge of glacier mass balance and the controls on glaciermass balance in the Himalaya.

For the most part, the paper is well written and well reasoned. In general, caveats areprovided in appropriate places with regards to in situ and remotely sensed observations.The goals are stated clearly in the introduction and followed well.However, there some confusing points that are rather critical that should be addressedbefore publication and one in particular related to the selection of pixels on Mera Glacier for calculating the “mean albedo of the glacier”.

I wish that there was a button between Minor Revisions and Major Revisions – in generalI think the paper contributes well and is generally sound, but the issues discussedbelow I think need to be addressed and I would like to iterate on making sure they areclarified.

Thanks for this in-depth review. We would be pleased to iterate to make sure we clarified the points you mentioned.

Introduction and 3.3 Glacier Masks The paper speaks frequently to the importance ofthe average albedo of a whole glacier surface. “The ELA, and thus the annual minimumalbedo averaged on the whole glacier (AMAAG), is strongly correlated with the annualglacier mass balance : : :.”

In Figure 2, it is indicated that reasonably nearly all of the glacier is sampled for the AMAAG for the Chhota Shigri Glacier. However, in Figure 3 for Mera Glacier, a minorityof the glacier is sampled. This is problematic for two main reasons – (1) it is inconsistentwith the defined parameter AMAAG and (2) the selected pixels do not span the knownELA for all years. (1) is obvious in that only pixels that reach up to ~5550 m elevationare sampled whereas the glacier runs up to 6420 m – this breaks the defined metric. It is of course impossible with the coarse pixels of MODIS to sample the whole glacier, but in this case, an enormous percent of the whole glacier is lost from the analysis. In the case of ELA (2), a paper in this journal last year shows that the ELA for Mera Glacier ranges from 5340 m (2010-2011) to > 6000 m. By the background presented in the present paper, it is indicated that the ELA is ~5550m. So, this indicates that you are only sampling the ablation zone.

By contrast, there are 89 pixels used for Chhota Shigri Glacier, that appear to cover the whole glacier, consistent with the definition of the AMAAG.

I understand the issues related to cloud cover that are expressed in 3.3 Glacier Masks. However, the statement about monsoonal snow cover and trimming out those pixels seems to exclude the reality of that being a period of accumulation and its impact on albedo – which are in fact influential. In the end, the analysis appears to be inconsistent between Chhota Shigri and Mera glaciers – one is AMAAG and the other is “average albedo for a proper subset of the glacier that is mostly lower than the known ELA range”.

While I am not enthused with the idea of suggesting a complete reanalysis with more pixels, it does seem that consistency with the AMAAG definition would be appropriate and would also lend confidence in the broader application of the AMAAG to other glaciers of the Himalaya. Please speak to this in reply so that we might understand how the inconsistency is OK.

Thanks for pointing out this inconsistency; we agree that we need to clarify it both in the mask description section and in the discussion. We therefore chose to include in the revised manuscript other results obtained on Mera Glacier while working with a mask more consistent with the AMAAG definition. We also stress again in the discussion that the method did not give reliable results for Mera Glacier. We made the following modifications in the manuscript:

- in section 3.3: "To tackle this issue **we defined two separate masks for Mera Glacier to conduct a parallel analysis. On one hand, mask 1 (red line in Fig. 3) includes the whole glacier (44 pixels). On the other hand, we retained only the 16 pixels corresponding to elevations lower than the ELA_0 (5550 m a.s.l.) for mask 2 (black line in Fig. 3).** Moreover, calculating the albedo on a small part of the glacier **(for mask 2)** increases the availability of good quality images." P 3446 – L3
- in section 4.3, we make it clear that the seasonal cycle is calculated on the lower part of Mera Glacier only: "the cycle observed for the lower part of Mera Glacier**(mask 2)** exhibits a less pronounced seasonality **compared with Chhota Shigri**" P 3448-L25
- in section 4.4: "**When albedo is averaged over the entire glacier (Mask 1), no significant relation is found between AMAAG and B_a (Fig. 9 b). However, when averaged over the ablation area (Mask 2), the minimum albedo is highly correlated with B_a (determination coefficient of 0.75; n=6 years; significant at 95% confidence with a Student test, Fig.9 c). Consequently for the rest of the study, we will use mask 2 to average albedo over the ablation area only, and therefore AMAAG refers to "annual minimum albedo averaged over the glacier ablation zone".**" P 3450-L23
- We replaced the discussion paragraph on the masks (P 3454-L18 to 28), by a revised paragraph, inserted earlier in the discussion "**First, the choice of pixels included in Mera Glacier mask is questionable. In our case selecting only the lower part of the glacier lead to a strong improvement in the correlation between B_a and AMAAG (Fig. 9b and c). This approach is only suitable for glaciers where ELA_0 is known. As mask 2 includes only pixels located below the ELA_0 (Fig. 3), the mean albedo cannot be related to ELA detection in the cases when ELA is above ELA_0 (i.e. negative B_a observed for years 2008-2009, 2009-2010 and 2011-2012."**
- We modified Fig. 3 to show the two different masks used for Mera Glacier. We also modified Fig. 9 to add a third panel showing the relation between AMAAG calculated with mask 1.

3.1 Field data The paper indicates that at Mera Peak, the inferred clear sky, broadband atmospheric transmissivity is 0.99. This is excessive given scale height of about 8.5km and your measurements are at 5.4 km. Most likely there is a strong contribution of irradiance from snow-covered terrain scattered radiation and/or a tilted up-looking pyranometer. This is not crucial to the outcome of this paper – it is simply the metricused to select when albedos are reasonable to use. However, it is erroneous andshould be at least commented on and the reasonable plane parallel value given for Mera elevation and atmosphere. With the SBDART model, I arrived at an atmospheric transmissivity of 0.89 in the liberal case defined below: â˘A ´c wavelength range: 0.28 to 2.8 micrometers â˘A ´c sub-Arctic winter atmos: column water vapor 0.418 g/cm2 â˘A ´c substrate albedo: 0.85 â˘A ´c solar zenith angle: 5 deg (summer solstice) â˘A´c elevation: 6 km. Even when I open it up to the elevation of the summit of Everest, I get just shy of 0.91. Of course SBDART is not perfect, but I doubt that it has that magnitude an error given.

Thanks for making the computation. The field inferred transmissivity is only a way to filter the field data. We agree that such a high atmospheric transmissivity is unrealistic, and is most probably due to reflections on the surrounding slopes. For clarification, we added the following sentence in section3.1: "**The very high clear-sky χ estimated above Mera Glacier is not realistic. It is probably due to reflections on surrounding snowy slopes and/or tilting of the sensor which artificially increase the incoming shortwave radiation measured by the AWS.**" P 3444 – L4

4.1.1 Comparison with field measurements This section is puzzling in light of Figure 5. The paper states that RMSE for MODImLab and MOD10 for albedo were 0.067 and 0.071, respectively. Looking at the data in Figure 5, unless there is an enormous number of data points atop one another very near the 1:1 line, it appears impossible for the RMSEs to be as low as stated. Can you please clarify this as it seems unlikely– but without the data, we cannot say for sure.

Thanks for finding the mistake. The standard errors were reported in the text instead of the RMSE, the latter being 0.10 for MODImLab data and 0.08 for MOD10 data. This is changed in the new manuscript and the subsequent figures.

Likewise, the average albedo errors are reported as 0.03 and 0.18. Given the large overestimates at lower AWS albedos and large underestimates at higher AWS albedos,these numbers are not that informative. Instead, please report the mean absoluteerrors.

This is done in the new manuscript. "**The mean absolute errors are 0.10 for MODImLab and 0.16 for MOD10 data.**" P 3447 – L3

In Figure 5, why, if the MODImLab acquisitions are a subset of the MOD10A1, arethere not AWS albedos below 0.6 in the MOD10A1 comparison? Perhaps I did notunderstand the separation of MODImLab and MOD10A1 acquisitions.

MODImLab acquisitions are not a subset of MOD10A1; they are calculated from L1 data (see table 1). The two datasets are filtered with their own cloud masks (and the solar angle for MODImLab data). As MODImLab cloud mask is more conservative than MOD35 product (see figure 6), it excludes more images. We added the following sentence in Fig. 5 caption: **"Note that the number of MOD10 and MODImLab images is different because the two dataset are filtered with different cloud detection algorithms."**

4.2 Multi-annual trend of albedo signal: In Figure 7, the albedos for the highest pixel are plotted. Albedos in excess of 0.9 appear and likewise, albedos lower than 0.2 appear. These are not physically realistic in the former case and less likely in the latter case (lower) given that these are the highest pixels respectively (although with the domain on Mera being in the ablation zone, it is possible to be that low). I wonder if the data show this because you include MODIS albedos for acquisitions when the sensor zenith angles are large. This forces erroneous irradiance calculations in the MODIS processing and also the pixels are severely mixed. Please analyze the sensitivity to sensor zenith angle, a product that is available. Note the discussion in Dozier et al (2008) regarding sensor zenith angle and the impact on ground instantaneous field of view.

We agree that MOD10A1 often gives unrealistic values for albedo retrieval, this can be either due to non-detected cloudy pixels or to images acquired with a high sensor zenith angle. Unfortunately the solar and sensor angles are not easily accessible (because they are only available in MOD09GA products). Consequently in the revised manuscript, we downloaded and processed additional MOD09GA, and filtered the MOD10A1 by keeping only the images acquired with a sensor zenith angle lower than 40 degrees. This has the following consequences:

- we modified the albedo products descriptions and added these two sentences: "**Through additional processing of MOD09 products, we filtered the albedo products to keep only those calculated from images acquired with a sensor zenith angle lower than 40 degrees, as recommended in Dozier et al. (2008).**" P 3444-L16 and "**We filtered the albedo products to keep only those calculated from images acquired with a sensor zenith angle lower than 40 degrees.**"P3445-L9
- It changed also the analysis we conducted for the field data validation (Fig. 5 now modified). It greatly improved the correlation between field measured albedo and satellite retrieved albedo (old R^2 = 0.38, new R^2 = 0.57, old RMSE = 0.11, new RMSE = 0.08).
- It changed slightly the values calculated from the pluri-annual trend regression, and lead to a slightly more robust pluri-annual trend. In the table R1 below we report the old and new values:

Table R1: Values of various parameters of the linear fit performed to study the albedo pluri-annual trend with MOD10. "Old" refers to the values obtained without zenith angle filtering of the MOD10 and "new" accounts for the filtered values.

	Old R^2	New R^2	Old slope value	New slope value
Chhota Shigri	0.001	0.0001	0.0013	0.00043
Mera	0.003	0.016	-0.0025	-0.0036

Thus, despite the filter applied to the sensor zenith angle, the conclusions from this part are not very different and did not lead to significant changes in the manuscript.

Additional reference added in the revised manuscript:

Dozier, J., T. H. Painter, K. Rittger, and J. Frew (2008), Time-space continuity of daily maps of fractional snow cover and albedo from MODIS, Advances in Water Resources, 31,

1515–1526, doi: 10.1016/j.advwatres.2008.08.011.

Please indicate the significance of the linear trends presented (+0.0013 and -0.0025yr-1, respectively). Provide 95% confidence intervals.

This is done in the revised Fig. 7. "The linear trends are $\mathbf{+4.3\cdot10^{-4} \pm 7\cdot10^{-5}}$ and $\mathbf{-3.6\cdot10^{-3} \pm 3\cdot10^{-5}}$ yr^{-1}, respectively" P3448-L6

4.3 Seasonal variations of albedo You linearly interpolated between the dates w information. Not much of a way to get around it without fabricating data of course, butplease speak to why and how this is likely erroneous, and give a feeling for how much impact there is (e.g. albedo may be elevated but irradiances are lower). Also, please indicate from the in situ measurements what the cloud cover probabilities are for diurnal and then seasonal and how the diurnal probabilities relative to the instantaneous MODIS acquisitions are influencing your results.

We agree that linear interpolation can be misleading, and it is only a mean to allow comparison. We added the following sentence in section 4.3: **"Although such a linear interpolation may sometimes hide unobserved changes in albedo, we believe that the seasonal cycle is well captured on Chhota Shigri Glacier where observations are numerous. On the other hand, for Mera Glacier, the cycle presented in Fig. 8 has to be considered with caution." (P 3448 – L19).** It is not possible to calculate the seasonal probabilities for cloud coverage above the glaciers as the AWS data covers only short periods. Nevertheless, we plotted the cloudy days on figure 4 to give a feeling of this probability over the periods for which we have data. We added in figure 4 caption: "**Note the difference in x-axis scale.The vertical grey lines show the days detected as cloudy, using a threshold on incoming irradiance (see text for details).**"

Figure 1 What is the source of the map of glacierized areas? RGI? MODICE? Please include in caption.

The source is Randolph Glacier Inventory. The Fig. 1 caption is now: "The glacierized areas **(from Randolph Glacier Inventory version 3.2, Pfeffer et al, (2014))** are in blue and the two studied glaciers are represented by red dots."

Figure 2 Several pixels in the 5 October 2004 albedo retrieval are between 0.95 and1.0 – this is physically unrealistic. Please determine the source of error and correct.

Thanks for noticing these values. It appears that some images with an important snow coverage (high albedo over the whole glacier) exhibit albedo above 0.95 for the upper pixels. These pixels are located in steep parts of the glacier. And these unrealistic albedo values are probably due to inaccuracy of the geometric corrections (slope + multiple reflections on the surrounding slopes). After checking carefully the whole season, these unrealistic values appear only when the glacier is fully snow covered and therefore has no influence on the results of this study, as we are mostly interested in the cases where the albedo is low. We changed figure 2 by an image acquired on 7 September 2001 which is more representative of the albedo maps used in this study. The new Fig. 2 caption is: "Example of an albedo map retrieved by MODImLab over Chhota Shigri Glacier on **7 September 2001 05:50:00** (UTC)."

Figure 4 Again, there appears to be a problem with the atmospheric transmissivity calculation – in particular it appears that the measured irradiances are too high.

This point is now discussed in the new manuscript (section 3.1). See the answer to your comment above.

Figure 5 Again, please look at these scatterplots in light of the reported RMSE of 0.06and 0.07 – looks to be markedly erroneous but perhaps there are a lot of points on topof each other near the 1:1 line.

This is corrected in the new figure.

Figure 7 I was surprised to see so many more acquisitions for Mera than for Chhota Shigri given the statements about cloud climatology for Mera and why you selected a smaller area for the average albedo for Mera. It also seems inconsistent with thetemporal densities expressed in Figure 8.

We plotted only the MOD10 albedo of the upper pixel for each glacier. We highly suspect that a lot of the albedo values retrieved during the summer periods for Mera Glacier, and the winter period for Chhota Shigri Glacier, are calculated in cloudy sky conditions. According to the test we performed (see figure 6), MOD35 cloud mask product misses a high percentage of clouds. We added this sentence in the Fig. 7 caption "**Note that many data points acquired during monsoon time above Mera Glacier, or during winter time above Chhota Shigri Glacier, probably correspond to undetected cloudy pixels.**"

Figure 9 Please plot confidence intervals around the Chhota Shigri and Mera fits and give the uncertainty in the slope. Speak to the fact that there can be large variation in the minimum mean albedo during ablation season when annual mass balance is near 0 to slightly positive. Please note in the caption the differences in the y-axes between Chhota Shigri and Mera.

This is done in the new figure 9. We added this sentence at the end of the 4.4 section: "**It is also noteworthy that the AMAAG values are scattered when B_a is 0 or slightly positive for Chhota Shigri Glacier.**" (P3450-L8) We added this sentence in the caption: "**Note that the scales are different on the two figures.** "

Figure 10 It is surprising that there is such a small uncertainty in 2003 and 2004 at Mera given the paucity of observations and the large uncertainties in the regression for Mera shown in Figure 9.

The uncertainty is calculated from the Monte-Carlo simulation (figure 11). As the year 2003 and 2004 fall in the middle of the calibration interval, the uncertainty on the albedo retrieval is low for these years.

References: Dozier, J., T. H. Painter, K. Rittger, and J. Frew (2008), Time-space continuity of daily maps of fractional snow cover and albedo from MODIS, Advances in Water Resources„ doi: 10.1016/j.advwatres.2008.08.011.