

TCD Review

Manuscript: tc-2014-94

Title: Seasonal changes in surface albedo of Himalayan glaciers from MODIS data and links with the annual mass balance

General Comments and Suggestions for the Authors:

The manuscript 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.

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.
- 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).
- 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/>).
- 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 to include spatial/temporal comparison methodology earlier, e.g. section 4.1.1 or earlier.

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.

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.

- 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).

Technical Corrections:

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

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

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

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.

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

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

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