Review of: "Modeling energy and mass balance of Shallap Glacier, Peru"

Overall Evaluation:

The manuscript documents an energy and mass balance study of a tropical glacier in the Cordillera Blanca of Peru. The authors apply a distributed energy balance melt model to the glacier, tuning the model using an array of ablation stakes distributed in the ablation zone of the glacier. The study finds that the glacier had a negative mass balance in the 2006-2007 mass balance year, and a positive mass balance in the 2007-2008 mass balance year. Like other tropical glaciers in the region the largest source of melt energy for the glacier is net shortwave radiation. Unlike other studied glaciers in the region Shallap Glacier demonstrates little seasonal variation in ablation.

The manuscript is well written and organized. The research presented is original and of a quality well suited for *The Cryosphere*. I recommend that the manuscript be accepted for publication with minor revisions.

General Comments:

The Monte-Carlo method used in this study to tune the distributed energy balance model is an innovative approach to bypass the large data requirements of this class of melt models. However, the approach – as applied in this study – does not leave an independent source of validation data. The cross-validation method used to evaluate the transferability of the model gives some confidence in the validity of the model, but pro-glacier stream-flow data or comparison to photographs of snowline position could have improved the confidence in the conclusions of this study. This lack of validation data is not unique to this study and I appreciate that the authors only have the data that was collected during field campaigns. I would, however, like to see an acknowledgement of this lack of independent validation data in discussion section of the paper.

Otherwise I have not found a flaw in the general scientific methods used in this study.

To make the manuscript more self-contained I suggest that a brief summary of the temperature transfer function and meteorological instruments be included in the methods section, instead of referring readers to Gurgiser et al. (2013).

The manuscript has a large number of figures for a paper of this length (17!). I believe that many of these figures can be deleted without harming the presentation of the study results. In particular I would delete figures Figures 6, 9, 10, A1, and A3. Figures 9 and 10 are in particular incomprehensible. There is simply too much information in these figures to extract useful information from them.

Why are some figures in an appendix when references are made to them in the main text of the paper?

I do not understand how the error ranges are being computed for the values given in the abstract and Table 1. Table 1 refers the reader to a section 2.3, a section that does not exist.

Specific Comments:

Page 4016 line 14: ~2 ± 0.68 m w.e. is strange notation. The error range seems overly precise for a value that is approximately 2.

Page 4018 line 15: This sentence is too long and would benefit from being re-written for clarity.

Page 4022 line 20: The symbol S↓ is used here, while SWin is used in the rest of the text.

Equation 4: I think p1-21 is typo.

Equations 4-6: np, ni, and ny would be clearer as n_p, n_i, and n_y

Page 4028 lines 13-16: Figure six is probably superfluous, simply stating the r and p values in this paragraph is sufficient.

Page 4028 line 15: "so" could be replaced with "therefore".

Page 4028 line 20 and 21: the adverb "slightly" is unnecessary.

Section 3.2: In high latitude distributed energy balance model studies (e.g. MacDougall and Flowers (2011)) the ELA varies across the surface of the glacier due to topographic shading. Is this not so here due to the high elevation angle of the sun in the tropics? Or does the glacier have little topographic shading?

Page 4031 line 24: How can the ground heat flux always be negative? Unless the glacier is warming up (non-temperate), however, it is stated that the glacier is assumed to be at freezing point below your 14 layer ice heat flow model component?

Table A1: It is difficult to tell where one parameter description ends and another begins. Maybe you should treat the descriptions as sentences beginning with a capital letter and ending with a period.

Figures: Labeled ticks should all have the same precision. That is 0, 0.5, 1.0, 1.5 not 0, 0.5, 1, 1.5

Figure 4: The dates are difficult to read. Maybe you should use a dash or backslash instead of a period.

Figure 7: Please include North arrows on these maps. Labeling the year in panels a. and b. would also help with clarity.

Overall this paper is scientifically solid, well written, and adds to our knowledge of an understudied region.

Sincerely:
-Andrew MacDougall