**The Cryosphere
Discussions**

Interactive comment on "Landsat TM and ETM+ derived snowline altitudes in the Cordillera Huayhuash and Cordillera Raura, Peru, 1986–2005" *by* E. M. McFadden et al.

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Responses to Major Comments: 1. The text has been extensively re-written and short-ened for clarity and conciseness. See more comments below describing the revisions.

2. Although we expect that surface lowering has occurred on these glaciers during the study period, reliable DEMs are very difficult to acquire in this region. We therefore chose the available DEM with the most reliable elevations, as outlined in our methods section. If ASTER DEMs were available for our entire time series, we would utilize those DEMs in order to account for surface lowering. We have now made specific note that we do not consider surface changes in our SLAs. We do not attempt to estimate

errors in our data due to possible surface lowering since we do not have quantitative data necessary to make such estimates.

3. The standard deviations presented in the text reflect transverse changes in snow-line elevation for each individual glacier. These standard deviations do not include the effects of other sources of error such as uncertainty due to snow cover, differences in seasonality, and surface elevation changes relative to the 2004 DEM, as now men-tioned in the text in section 2.5.

4. The purpose of the study was to determine if the methods described in the text can be used to determine SLA/ELA changes in this remote region. Although the data are temporally limited, we believe they indicate SLA change has occurred in this region and must be investigated in more detail, with more complete spatial and temporal data coverage.

5. Efforts were made to ensure minimal snow cover was evident in any of the selected images. Additionally, images used in this study were compiled prior to 2008. Available Landsat imagery was limited at the time, restricting the time series presented in the article.

6. The software used for our statistical computations reports very small p-scores as p=0.000. Due to the confusing nature of reporting p-scores in this manner, the text has been changed to $p < 0.001$, reflecting the statistical significance of the p-score. Assumptions necessary to perform the statistical analysis have been presented in the text. The methods employed with the stated assumptions are valid for the given amount of data. 7. Our climate interpretation of our data has been extensively reworded to reflect the uncertainty in our interpretations of SLA data significance. We note the commenter's suggestion to use reanalysis data, however, our spatial scales are quite small for reanalysis data and it regions with incredibly rugged, steep topography which would most likely result in reanalysis data that do not reasonably reflect local conditions in this remote area. Additionally, reanalysis models for these particular ranges would

have no climatological data to validate the models, adding to possible inaccuracies in our study region.

Minor Comments: 1. These two sentences are saying two slightly different things. The first sentence basically states that SLAs≈ELAs. The second sentence says dry season SLAs can be used to track annual ELAs. The wording has been changed slightly to shorten the sentences although their overall content is maintained.

2. This sentence has been removed because we do not attempt to extrapolate our findings into the future.

3. The final sentences of this paragraph have been re-written with consideration to the commenter's suggestions.

4. Although we did not use the SRTM DEM patched with the GTOPO30 data, it is part of the DEM manipulation we had to employ to create a useful DEM for this region. We note the commenter's statement about the GTOPO30 data, but we will keep the sentence describing its use in the paper.

5. We have included a statement on 1938 describing the exact meaning of the standard deviations we discuss throughout the text. We also make note of other sources of error not included in the standard deviation. That standard deviation is a measure of the elevation range of each SLA, not a measure of error from uncertainties due to snow cover, seasonality, or changes in surface elevation throughout the time series. We acknowledge in revisions that these errors may be 10s of meters, but they are not quantified in the text.

6. This sentence has been revised. Since it describes part of the statistical methods we used in the study, it has not been totally removed.

7. We assumed a normal distribution for the SLAs based on the assumption that underlying controls of SLA variability (like slope, hypsometry, etc) should appear as random variability when looking at all the glaciers within the range. In the absence of more

thorough data on each glacier based on ground-truth measurements, we cannot either validate or refute if our assumptions are applicable.

8. This paragraph has been removed and some of its content has been incorporated into the following paragraph.

9. The interpretation of SLA change in the presence of large standard deviations has been changed throughout the text.

10. This sentence was incorrectly modified and has been corrected.

11. We note the suggestion and have changed our wording.

12. This sentence was incorrectly modified and has been corrected.

13. The p-scores have been re-written as p<0.001 for clarification. As mentioned elsewhere, the standard deviations do not include all error sources, which is now additionally mentioned in this section.

14. This sentence has been reworded.

15. We note the commenter's suggestions and have reworded this page. The purpose of the ΔT section is to determine if the methods used in this paper derive results that are comparable to those found through different methodology.

16. This paragraph has been removed during revision.

17. This paragraph has been removed during revision.

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Interactive comment on The Cryosphere Discuss., 4, 1931, 2010.