

## ***Interactive comment on “Assessing high altitude glacier volume change and remaining thickness using cost-efficient scientific techniques: the case of Nevado Coropuna (Peru)” by P. Peduzzi et al.***

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Received and published: 19 January 2010

As stated in your disclaimer you did not take into consideration the comments made by previous reviewers, nor on answers and related documents posted by the authors in addressing the reviewer's comments. This is therefore a third reviewing of the initial paper. As such, most of your general comments were already highlighted by previous reviewers, thus already addressed and corrected. However, your specific comments are very valuable. We addressed and corrected all of them (see below for details).

Regarding the general comments: Most of the general comments were already made by the other reviewers. We acknowledged them. We corrected the structure of the

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paper, we asked a native English person to review our article for the language. The figures were completely remade in order to gain in clarity.

On the following comment: "Although the authors state their method is an improvement on (Racoviteanu et al.2007) . . . It is clear that on the glaciated area the errors in the ASTER DEM data are large. The authors of this paper have failed to address this issue adequately."

Answer: We did solve the issue of error on ASTER DEM, as we end up not using it! Instead, we used the DEM from the ESA/ERS radar sensor. This new DEM (based on 1997 images) was ordered specifically for our research to SARMAP. We never stated that our method was an improvement of Racoviteanu 2007. It couldn't be as we undertook this research in 2004, and presented our results in December 2005 to COPASA and GTZ who commissioned this study. This was hence done 2 years before the publication of Racoviteanu 2007. Incidentally we used similar, but not exactly the same method and more importantly we tested it on 8 different DEM, including this new 1997 radar DEM. We encountered similar issues, but we solved them differently. We do find the same result, i.e. about 5 m reduction between SRTM and 1955 topographic map. We also discover that ASTER DEM had a wide range of error and was therefore less reliable. But having seen this, we ordered a DEM based on ESA/ERS sensor. So finally, our analysis is based on Map 1955, SRTM and ERS radar DEM 1997. In addition, we add an estimation of modelling the remaining volume and mapped the area reduction as well as volume changes.

Regarding the specific comments:

"Page 835: Why have all of the NASA DEMs been included in a table with a statement that they are not being used?" Answer, we acquired them all, this also shows the availability of all DEM. For our purpose we then select the one that we thought were of better quality. We also acquired a new DEM, which was produced for our purpose (see DEM ESA/ERS 1997). On elevation accuracy, this was included in the table in the

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document attached to our final comments."

"Page 832 line 23 Over what period? Sentence is not specific enough." Answer: Corrected with "the period 1990/91 and 2003/04 as compared with 1960/61 to 1989/90"

"Page 833 lines 7-9 Maybe "In the Andes, ... an acute retreat of glaciers, ... from 725 km<sup>2</sup> to 600 km<sup>2</sup> from 1970 to 1996 in Cordillera Blanca, Peru (Silverio and Jaquet, 2005)." Note the change of spelling to Cordillera, I think this is right." Answer: OK, changes made.

"Page 833 Lines 11-12. Maybe it should be ""Cooperacion Peruano Alemana Para la" and "(COPASA)"" Answer: OK, changes made. Cooperación Peruana Alemana de Seguridad Alimentaria

"Page 833 line 21 Maybe "surface area"?" Answer: Yes, change made.

"Page 834 line 8 your geographical coordinate format is unclear" Answer: 15.546 S, 72.660 W

"Page 834 line 18 "today, Digital Elevation Models (DEMs)" the word 'height' is not needed as it is covered by the word 'elevation'" Answer: spelling mistake, corrected as: 8 Digital Elevation Models (DEM) from different years and periods were considered.

"Page 834 line 19 You do not need to say it was generated by Walter Silvero because he is one of the authors on the paper." Answer: already corrected.

"Page 834 Do you mean you digitised the elevation contours from the map of 1955? Isoline is too general and can mean lines joining equal points of many different quantities." If so what map? Where is the reference to it? What is the estimated accuracy of this technique (and the original map)? Answer: changed by altitude isoline. Topographic map 1955, 1:100 000. +/- 50m

"Page 835 line 8 "longer" not necessarily "better"" Answer: OK, Changed for "longer"

"Page 835 line 12 Which DEM?" Answer: taking GPS points for the adjustment of the

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## DEMs

"Page 835 lines 18-20 An electronic device? You mean the actual unit? You do not need to say it included this or batteries it is sufficient to say you used an "xxxradar with 100 MHz shielded antennas." You do not need to say you buried it every day so that you didn't have to carry it. " Answer: Already removed

"Section 2.3.1 What did you actually use the laptops for in the field? You have a lot of detail about hard drives etc. which people may find useful if they haven't worked at high altitude before." Answer: laptops were used for managing the GPR unit and recording data. We thought to include how we manage to work with regular laptop at high altitude. As you say some people might find this useful if they cannot afford a Husky computer.

"Page 836 line 4. It was not set to emit at 438 MHz, as you show in Table 2 that was the sampling frequency" Answer: Corrected

"Page 836 Eq. 1 is wrong it should be  $2l = CT$ . Although this error has not affected their calculation which is correct" Answer: Corrected

"Page 843 The last paragraph of the conclusions is poor and could be cut entirely" Answer: Done

"Figure 1: A general location map showing where this place is in the Andes would be useful, either as a separate figure or an insert. " Answer: OK, a locator map was inserted.

"The figure caption offers very little explanation of what is in it. What are the contours? What separation? What are the different colours of the dots? Are the dots representing places where coordinates were measured by GPS? Some of this may be in the text but it is really needed in the figure caption so it is possible to know what you are looking at." Answer: Figure 1 was completely remade.

"Figure 3: Caption "Example of an interpreted profile..." Because of your interpretation

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line it is not at all clear in this figure that you have a bedrock reflector." Answer: We surely have, but without interpretation line, it is not obvious for the reader.

"Figure 5: No distance scale" Answer: This was already corrected

"Figure 7: Inadequate caption, what does grey represent? It needs to be stated in the caption not just in the text" Answer: This was already corrected

Thank you very much for your detailed review of our article.

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Interactive comment on The Cryosphere Discuss., 3, 831, 2009.