

Interactive comment on “ENSO influence on surface energy and mass balance at Shallap Glacier, Cordillera Blanca, Peru” by F. Maussion et al.

Anonymous Referee #1

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The authors use a four-year time series of surface mass and energy balance distributed over Shallap glacier in the Cordillera Blanca Peru to study the influence of large-scale atmospheric variables on these terms. Using reanalysis data the derived relationships are then extended back to 1980 to analyze the influence of ENSO on individual fluxes that affect mass and energy balance on this glacier. The results produced by this approach by and large confirm what has already been known from previous studies (enhanced ablation due to higher temperature and reduced snowfall during El Niño periods, with a roughly linear relationship to tropical Pacific SST). The major step forward produced by this paper, however, is on the methodological front, downscaling the large-scale circulation to surface mass and energy balance at the glacier scale in an

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open-source environment, allowing the authors to link these two domains over a longer, 30 year period.

The paper is well written, all steps are clearly documented, and the methods are straightforward and appropriate for the target analysis. I only have a few minor comments that the authors may want to consider when revising their manuscript. I suggest accepting the paper with minor revisions.

Comments/Questions:

- I don't understand why the ENSO definition has to be based on full hydrologic years. After all the analysis was based on monthly time steps, which would have allowed for a much more refined ENSO delineation. Allowing a full year to be counted as El Niño or La Niña year as long as 5 out of 12 consecutive months are above or below the threshold does not seem like a very stringent criterion. Indeed when looking at Figure 2 it looks as if some years, which were essentially neutral years were classified as La Niña. I think the composites of the seasonal cycle associated with the two phases of ENSO shown in Figure 6 would be much cleaner as a result of a better ENSO phase definition.

- The atmospheric circulation in the region undergoes a fundamental seasonal transition from wet to dry periods. I wonder if this does not pose significant restriction on downscaling methodology (i.e. would results be different if separate downscaling algorithms were used for wet, dry and transition seasons?).

- The downscaling model only accounts for local relationships with the large-scale circulation (i.e. the closest reanalysis grid cell). The authors argue that this is justified as it ensures to allow for the local climatic influence and avoids spurious long distance influences that may not be real. I agree that this is a valid argument, but at the same time there are dynamical reasons why the strongest relationship with atmospheric variables may not be located directly overhead. For example correlations with an oscillatory mode will almost never be strongest directly aloft and in fact may be completely missed

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if the location in question is near the node of the oscillation, far removed from the two oscillatory poles. In addition Vuille et al. (2008b) documented that correlation of Cordillera Blanca mass balance with atmospheric temperature is significantly stronger toward the equator than directly overhead (see their Figure 6). Hence I think the down-scaling model could still be improved in future studies by also allowing for more distant influence factors.

Minor edits:

- Table 1: please replace the terms 'longitudinal' and 'latitudinal' wind component with the appropriate meteorological terms: 'zonal' and 'meridional' wind component.

-Figure caption 8. You state that Pacific SST are lagged by three months. I assume this is a typo, since Pacific SST should obviously lead the mass balance series by three months.

Page 3000, line 13 and throughout manuscript: capitalize 'pacific'

Page 3003, line 14: change 'Francou, 2003' to 'Francou et al., 2003'

Page 3019, footnote 3: change 'he' to 'the'

Page 3021, line 1: To my knowledge Salzmann et al (2013) never stated that precipitation is increased in the Cordillera Vilcanota during El Nino periods. Please clarify where they made such a statement or remove this reference.

Page 3021, line 15: change 'specially' to 'especially'

Page 3025, line 22: change 'participated to' to 'participated in'

Page 3028, line 16: Reference 'Francou, 2003': you forgot to list the co-authors of that study.

Page 3028, line 17: 'chacaltaya' should be capitalized.

Page 3028, line 19: 'andes' should be capitalized.

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Interactive comment on The Cryosphere Discuss., 9, 2999, 2015.

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