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The Cryosphere Discussions

Interactive comment on "Glacier changes in the Pascua-Lama region, Chilean Andes (29° S): recent mass-balance and 50-year surface-area variations" *by* A. Rabatel et al.

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Rabatel et al., (2010) examine recent glacier areal extent change and mass balance in a previously poorly documented region of the Andes. The glaciers here survive in a climate setting that maybe somewhat unique and documenting their response to long term climate change and annual climate change is quite valuable. The valuable and unique information is the specific field data on glacier mass balance. To better leverage the valuable observations into robust reported results I suggest four key changes. A greater focus on the actual field data with respect to penitents, winter accumulation, actual mapped glacier margins and a reduced focus on the PDO discussion which

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relies largely on a separate data set and is an insufficient data set to yield statistically meaningful results at this point.

1) An increased focus on penitent distribution. One of the key aspects of the mass balance of the glaciers is the extent and size of the penitents. This papers goal is not to document their formation or the associated energy balance. However, particular attention needs to be paid to their distribution and their relation to ablation. Winkler et al., (2009: http://www.the-cryosphere.net/3/21/2009/tc-3-21-2009.pdf) should be consulted in this discussion.

2317-12: Need to include the percent coverage of penitents on the four glaciers from Figure 3.

2317-23: The penitents height ablation comparison should be included as a figure. A separate paper on the surface energy balance (SEB) is likely forthcoming, but this still is a key observation even without the full energy balance explanation of formation.

2318-7: Why fewer penitents on the Guanaco? Penitents preferentially develop in glacier regions where the SEB is not homogenized by wind, is there more of a persistent downslope or overall surface wind on Guanaco versus the glacierets?

2314-23: Diurnal fusion?

2) Winter precipitation is noted as a more important variable than ablation. Winter accumulation distribution is nowhere documented.

Table 1: Indicates 32 stakes emplaced on the four key ice bodies in Figure 3. Nowhere is there a map showing their distribution on any of the ice bodies.

2316-3: There is no indication of the seasonal cycle or the variability of accumulation from stake to stake. If winter balance is to be shown to be the key variable, then a key focus must be the details on how much snow accumulates and where and how long it tends to persist. At what point in the ablation season is the snowcover lost during low accumulation years.

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2316-6: It is noted that the Guanaco tends to either be fully snow covered or mostly bare at the end of the ablation season. What is the accumulation difference and distribution near the beginning of the ablation season. This should be discussed in terms of AAR. Of more importance is the accumulation for the various years of high AAR and low AAR.

2316-11: Given that normal concepts of ELA ablation season and accumulation zone do not apply, it is even more important to report directly in a map figure their distribution on Guanaco at least in 2006 versus a low Bw year.

3) Areal extent changes are quantified, but not well illustrated.

2318-18: It would be quite useful to have detailed follow up to Figure 1 mapping the marginal changes for Guanaco, Toro 1, and Toro 2 possibly. This is typical in any remote sensing analysis of glacier change (Andreasson et al., 2008; http://www.the-cryosphere.net/2/131/2008/tc-2-131-2008.pdf).

4) Focus on PDO is too extensive for the temporally short data set. There is not sufficient examination of the temporal changes in PDO-ENSO relationships. Lacking the spatial analysis of accumulation variation as well inhibits PDO analysis. This section should be shortened to a few sentences.

2319-13: PDO needs a reference for categorization of the current phase being negative. This is not what the creators (JISAO) of this index identify. They note cool period from 1998-2002, warm period from 2003-2008 and a cool period since that makes it impossible to assign a phase change at this point. (http://cses.washington.edu/cig/pnwc/aboutpdo.shtml)

2319-19: The reinforcing nature of PDO and ENSO referred to here, suggest that PDO cannot alone be examined, that it has to be viewed in context of ENSO. Pelto (2008: http://www.the-cryosphere.net/2/13/2008/tc-2-13-2008.pdf) derived a mass balance forecast model for the North Cascades, based on PDO and ENSO indicating

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this reinforcing nature, but also noting that many years one the indexes are at cross purposes. Vuille et al. (2008) discuss this for the Cordillera Blanca. Noting that "The relationship between ENSO and glacier mass balance is therefore characterized by occasional 'break downs', more common since the mid-1970's, when El Niño years with above average mass balance and La Niña events with negative mass balance have been observed."

2308-22: Arid diagonal?

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