

## ***Interactive comment on “Reconstructing glacier mass balances in the Central Andes of Chile and Argentina using local and regional hydro-climatic data” by M. H. Masiokas et al.***

**Anonymous Referee #2**

Received and published: 27 October 2015

The authors use Ben Marzeion's minimal model to reconstruct the mass balance of a glacier in the central Andes with the longest record of direct mass balance observations. They show that the model is capable of accurately reconstructing mass balance, and use stream-flow data to extend the modeling to the last 100 years. The paper is well written and the conclusions are generally sound, although I have a concern (see below). The discussion and conclusion sections are slightly repetitive and can be trimmed.

My concern is related to the sensitivity analysis where the mass balance changes are attributed primarily to precipitation forcing. Because the mass balance model is so simple, it is not clear that this experiment is robust. In the case of a full energy balance

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modeling study, there is the potential to examine uncertainties in each of the energy balance terms, and how these might influence the finding. Specifically, if the model sensitivities to temperature and precipitation are incorrect, then the finding might be spurious. Simply showing that the model does a good job of simulating mass balance history is not sufficient, because of the equifinality issues involved. In other words, many different combinations of temperature, precipitation and model parameter choices could produce a similar mass balance reconstruction. Each of these simulations would show a different sensitivity to temperature and precipitation forcing. I suggest that the authors remove or de-emphasize this component.

In more detail, the model captures the melt process by using monthly temperature data \* by a tunable melt factor. Such a model attempts to capture the influence of long-wave radiation, turbulent heat fluxes and albedo within a single term. In reality, a small, high-elevation glacier such as Glaciar Echaurren Norte must have a relatively complicated surface energy balance. I see that for example, penitentes form on its surface, indicating an important role for albedo and turbulent fluxes. Understanding the sensitivity of such a glacier to climate change (rather than reconstructing mass balance), requires something a bit more thorough, e.g. a full-energy balance model and on-glacier observations. See for example Molg et al. 2008. *International Journal of Climatology* 28: 881–892 (2008).

The paper should include a figure that shows the modelled and measured surface mass balance profiles (how  $b$  varies with elevation) so that we can get a sense of how much accumulation and melt actually occurs on Glaciar Echaurren Norte.

Minor comments: Title: 'mass balance' (rather than balances) 4951, Lines 8-11. See above. This finding should be de-emphasised or removed until more complete modelling is carried out. 4952, Line 4. 'touristic' isn't used by native English speakers. Replace. 4954, Lines 1-3. This statement about snow remaining frozen is not supported by data or a reference. It may be correct but it either needs a citation or more speculative language should be used. Lines 16-20. This sentence is too complicated

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and needs to be rewritten. 4955, Line 1. Please provide elevational range of glacier. Lines 20-26. I disagree that this approach provides 'solid evidence' for 'objective testing' of the relative significance of temperature and precipitation on mass balance. See discussion above and revise this text appropriately. 4956, ~ line 5. The paper would benefit from a clear list of objectives. 4957, Line 27. 'Values' of what? 4959, Line 4. Add space 'predictand'. 4966, lines 10-11. A hypothesis can not be 'validated'. Use 'support' instead.

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Interactive comment on The Cryosphere Discuss., 9, 4949, 2015.

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