

## ***Interactive comment on “Climatic interpretation of the length fluctuations of Glaciar Frías, North Patagonia, Argentina” by P. W. Leclercq et al.***

**Anonymous Referee #2**

Received and published: 13 January 2012

Review of Leclercq et al. “Climatic interpretation of the length fluctuations of Glaciar Frías. . .”

General comments:

This is a very interesting contribution comparing the detailed glacier length reconstruction of Glaciar Frías with the newly developed climate reconstructions by Neukom et al. and Villalba et al. As to my knowledge, this is the first approach using a surface energy and flow-line models to a glacier in South America. The detailed comparison of southern hemispheric glacier length changes and climatic information is novel, too. The knowledge of past glacier behaviour in South America is still sparse as compared to the northern hemisphere and it is therefore welcome to see this detailed climatic interpretation of best-documented Glaciar Frías.

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However, given the quality and uncertainties of the input data, the authors should be more careful in their climatic interpretation of the results and the statements made, also in view of the scope of the journal (it is CP and not TC, with focus on the climatic interpretation and not on the technical description of the glacier model etc.).

First, the uncertainties (regarding input data and model calibration) should be quantified (as good as possible). For instance, I miss a detailed description of the glacier length record and related uncertainties. The glacier reconstruction consists of “only” 6 dots before AD 1900. Is there any information from other glaciers in the area, e.g. for the gaps around 1700 and 1800? This lack of information stands in contrast to the precise statements made in the paper (e.g.,  $dT$  of  $0.7^{\circ}\text{C}$  for the early 19th century, mentioned in the abstract; discrepancies to the independent climate reconstructions). In addition, climate reconstructions by Neukom et al. for comparison with the glacier behaviour are only available for DJF and JJA, but spring and autumn conditions might have substantial influence on the glacier, too. This point must at least be addressed.

Second, the reconstructions starts with the LIA maximum position in 1639. The major glacier advance is therefore not covered by the modelled time period, and I am wondering what this might have for implications for the calibration of the model.

More details are given in the specific comments below. They need to be addressed before publication in CP. Apart from that, the paper is very well written and solid.

Specific comments:

P3653: The title should be more concise, including the time frame (LIA? Holocene?). And, as the title place emphasis on the length fluctuations, the glacier reconstruction should be described more in detail in the paper.

P3654: Line 4: write “AD 1639” Line 13: tree rings are mentioned twice, and indicate what kind of sediments are used (or delete this sentence) Line 17/18: write “observed glacier length changes.” Line 20: write “and to make reliable” Line 22/23: This is not

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only the case of southern South America, but applies to all regions. Maybe remark at this point the importance of South American climate and glacier studies/reconstructions (best information for the southern hemisphere available, inter-hemispheric comparisons possible).

P3655: Line 2: Which are the other climate proxies? Line 4: write "Neukom et al. (2010, 2011)"

P3656: Line 5: delete "thus" Line 10/11: delete "the southern part of" (because the scarcity of historical information applies to the whole Andes) Lines 16-23: This section could be rewritten and made more clear (explain better). In addition, there is a rather abrupt change from the individual case (Glaciar Frías) to this more general section.

P3657: Line 1: write "historical" (note the difference to "historic") Line 1/2: This is not a full sentence. Line 3: Give reference of these records. Line 5: To the accuracy of the existing proxies: it is not clear to me whether you also refer to the accuracy of the glacier record. Line 10: better: "a peak 3448 m high on the" Line 11: this might be misunderstood: one might read that the glacier itself is temperate and not cold. Line 22: write "thinned by"

P3658: Line 4: What do you mean with "field evidence"? Line 5: What do you exactly mean with "historical position"? (Was there only one?). This applies also to line 8 on the following page. Line 6: to the "dendrochronological dating": with trees in-situ or not? Line 7: Please give more information on these "historical sources", and related uncertainties (beyond Table 1). Line 9: You state that the glacier record has been revised: why has it been revised, and what is new? Is it more accurate now? Is there new evidence? Lines 14-16: This is rather interpretation. Line 19: what kind of satellite images? Line 21: "field measurements": do you mean "length measurements"? Line 25: Give more information on this "etching". Line 26: The moraines, how were they dated?

P3659: Line 20: delete "a<sup>-1</sup>" (annual precipitation is always per year) Line 26: write

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out "ELA" here (first appearance of the term)

P3660: Line 19: delete "also" Line 25: reference?

P3662: Lines 14-16: What are the implications of this simplification for the model results? Line 25: additional question: Why have these records not been used by Neukom et al.?

P3664: Lines 23-25: Please better explain the choice of those parameters, and why you choose a comparable climate as in maritime Norway. Line 25: The reference to Table 2 should be placed in the beginning of the Section.

P3666: It would be helpful to add a list of the variables of Section 3.2, too. Or shorten the Section and give a more qualitative description of the model, including how the glacier length is addressed.

P3669: Line 9: delete "a<sup>-1</sup>" Line 14: Here, a remark on the response time of the glacier could be given. Line 27: better write "highly maritime" Line 28: But there are large differences between summer and winter. Line 29: Correct the English.

P3670: Line 4: Please indicate what concept of "response time" you are referring to.

P3672: Line 11: give reference Line 28: error/uncertainties of the dating of the moraines?

P3673: Line 1: write "1970s"

P3673/3674: To the explanation of the differences: How are the results influenced by spring and/or autumn conditions? What is the uncertainty of the glacier reconstruction? Might there also be an effect of changing ice dynamics during the Little Ice Age (model calibration)? These are crucial questions to be carefully addressed. Note also that the modelling results show discrepancies to both the Neukom et al. and Villalba et al. reconstructions.

P3675: Line 16: explanation for this striking difference?

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P3676: Lines 6-19: This paragraph needs to be shortened and constrained to the facts. E.g., the first sentences can be omitted. Line 3676: write "IPCC A1B scenario"

P3677: Line 8: "dramatic" is not an appropriate word here: do you mean that the retreat is unprecedented (e.g. during the Holocene)?

P3677ff In general: the Conclusions should be more precise (shorter and more concise).

P3678: Line 3: write "sensitive to temperature" Line 8/9: This is vague. Line 22: The information on stable North Patagonian climate comes very abrupt here (Reference?). Address this earlier in the paper. Line 28: Do you mean climate proxies?

P3679: Line 1: better write "represent", otherwise reconstructions reconstruct... Line 4: Which reconstructions do you mean here? Line 12: Why are there no mass balance measurements? This might be beyond the frame of the presented paper, but I still want to raise the question.

P3681: Line 24: Intended journal? Line 33: "Storglaciären"

P3682: Line 11: "Briksdalsbreen"

P3687: Fig. 1.: Name "Monte Tronador" in the map to the left.

P3688: Fig. 2.: elevation distribution from 2009?

P3690: Fig. 4.: Give time period for which steady-state is calculated (1980-2009?).

P3694: Fig. 8.: "Measured glacier length...": Do you mean "reconstructed"? Maybe use two colour for glacier measurements (sensu stricto) and reconstructed frontal positions.

Technical comments:

Use consistent spelling throughout the paper:

ice-cores vs. ice cores

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long-term vs. long term

high-resolution vs. high resolution

Sect. vs. Section

north-east vs. north east

"1950s" instead of "1950's" etc.

mass-balance vs. mass balance

flowline vs. flow line vs. flow-line

Glaciar Frías vs. Frías glacier

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Interactive comment on Clim. Past Discuss., 7, 3653, 2011.

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