**Hydrology and Earth System Sciences Discussions**

# *Interactive comment on* "Snow glacier melt estimation in tropical Andean glaciers using Artificial Neural Networks" *by* V. Moya Quiroga et al.

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Dear editor and reviewers,

We value the comments and suggestions received greatly, as they pointed out a number of issues to be addresses, in order to improve the article. In this new version, we think we included all the suggestions from the reviewers.

Thank you very much for your kind consideration.

Answers:

This final version of the article not only developed artificial neural networks (ANN), but also multiple linear regression (MLR) and then made a comparison between them. Besides, the development of the ANN and MLR models and the data used was performed in a more clear procedure; first models for the energy fluxes that are not measured directly, i.e., long wave radiation and turbulent fluxes, then models for the whole energy balance and the energy available for melting.

The ANN and MLR models were developed with data from Zongo (in the outer tropics) and then verified against measured data from Antizana glacier (in the inner tropics). Antizana glacier has temperature and relative humidity higher than the limits of the Zongo data. Such verification allowed to analyse the errors of applying the model to data outside the limits of the training set. In order to deal with the limitation of the limits of the training data, two approaches were considered and compared. A prior log normalization of the data as suggested by Hiettarachi, and including. Finally, the models were validated against measured data from the Alpine glaciers Argentiere and Saint-Sorlin

The total snow glacier melt was estimated not only with the ANN and MLR models, but also with the enhanced temperature index model from Pelliccioti et al., (2005). Then, a comparison was done between the SGM estimated by the ANN, the MLR and the enhanced temperature model. Besides, the analysis of Condorir was improved by including more data up to August 2012.. The SGM estimation included a sensibility analysis considering different melting threshold temperatures.

Additional annexes are included with the MLR models and the compiled ANN model for their use with WEKA.

Comments:

Reviewer 1 comment 1. Page 5 lines 15-30.

Reviewer 1 comment2 Page 4 lines 24-26 Page 13 lines 3-15 Page 11 lines 3-6

Reviewer 1 comment 3 SGM was estimated also with the enhanced temperature method from Pelliccioti. Then, a comparisson was made between results from ANN, MLR and temperature model.

Reviewer 1 comment 4 Page 10 lines 1-6 Turbulent fluxes were improved by considering atmospheric stability correction The IRD report by Perroy et al., was removed

Reviewer 1 comment 5 In this version we the analysis and errors of applying the model to data outside the training set limits. Besides, we tested two approaches to overcome such limitation: Including the data outside the limits, hence increasing the knowledge domain; and a prior logarithmic transformation

Minor comments The initial statement was removed The statements ablut calibration and uncertainty were removed. Additional and redundant figure were removed. Besides, Results section was changed, as the new version included an improved analysis comparing different approaches and using data from different locations.

Reviewer 2 comment 1a. Page 7 lines 25-30 and page 7 lines 1-8 includes the considerations about the training period data.

Reviewer 2 comment 1b The model estimates the energy available for melt end the melting rates per unit of area. Thus, for bigger areas is just multiply by the total area. The main concern when applying ti bigger areas, is to consider the spatial variation of the input data.

Reviewer 2 comment 1c The new version includes additional comparisson using data from Antizana glacier (inner tropics) and the Alpine glaciers Argentiere and Saint-Sorlin The new version includes a sensibility analysis considering different melting threshold temperatures

Reviewer 2 comment 2 The new version includes comparison with estimations using MLR and an enhanced temperature method.

Reviewer 2 minor comments The reference of Perroy et al., was removed, as the

new verification method did not use such data. The term undeveloped country was replaced by developing country A sensibility analysis was performed considering different melting threshold temperatures. Besides, references to uncertainty and further research were removed, since they would deviate from the objective of the present paper.

Please also note the supplement to this comment:
http://www.hydrol-earth-syst-sci-discuss.net/9/C6459/2013/hessd-9-C6459-2013-supplement.zip

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 9455, 2012.