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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Quantification of runoff generation from a combined glacier and *páramo* catchment within an Ecological Reserve in the Ecuadorian highlands" *by* Verónica Minaya et al.

Anonymous Referee #1

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The paper entitled "Quantification of runoff generation from a combined glacier and paramo catchment within an Ecological Reserve in the Ecuadorian highlands " by Minaya V., Suarez, V.C., Wenninger, J., Mynett, A., aims to identify the various runoff sources in a small mountainous glacierized Andean catchment using environmental tracers (stable isotopes and major ions) and hydrochemical features. This is a good piece of work that intends to answer a present and interesting question in the glacierized catchments in general. The approach is not novel in itself but for this precise catchment this is a new way to quantify the sources of the runoff sources. I think this article needs major revision in order to be published in HESS. Here you will find 4 major comments and some specific comments that should be taken into account for the next

submission.

GENERAL COMMENTS

GC1 : A first problem in this study is the characterization of the different sources of the runoff. Authors identify for instance in the figure 9 "Qprecipitation", "Qglacier", "Qparamo" but they identify also "Springwater" (Figure 7). The typology and the definition of each sources of water have to be clear. Furthermore "Qprecipitation" is not a good term. I understand that the definition is not easy but as the authors wrote, the hydrochemical signature has to be the driver to differentiate the sources. Other studies done in the same catchment prove that water originating from the glacier melting could give springwater, you should consider this point. Can we consider that "Qparamo" is a groundwater? Please respond to this in the article. A strong definition of groundwater has to be done. In order to be more accurate, a good description of the geology and the soil has to be conducted. In the part 4.1.1, a short description of the different samples is done, but for the springwaters more details are needed. How are the springs, in which kind of rocks? Are we sure that each sampling point correspond to one spring? GC2 : A additional table is needed with the details concerning all the samples (location, type of water, main characteristics, etc. . ..). GC3 : The weathering processes are not described in the paper even if some general statements are written. A good description of the geology and the different soils is needed. It would be interesting to give some quantification concerning the residence time of the water: (i) in the soil, (ii) in the fracturated aquifer. Page 16, authors stated that to increase the conductivity the water should be stored for long period of time in rocks but, in fact it depends on the type of the rocks, in evaporitic rocks for instance, the mineralization is very fast. GC4 : The EMMA methodology is briefly described in the section 3.4.3 but its application should be more detailed. Authors explain that they use only the runoff at the outlet, so I deduced that this runoff is QT. In the figure 9 authors stated that the EMMA analysis is done with 2 variables, EC and δ2H. How can we calculate the 3 different terms if one considers all the other unknown factors? What are the different equations composing

the system and how authors solve this equation system?

SPECIFIC COMMENTS Title – The title should be more informative, what is the study period? What methodology is applied ? Which period is studied? Abstract: The altitudinal range of the catchment should be specified. The area of the glaciers should be specified too. Abstract P.1, l.14 - The term “Andean region” is inappropriate as the study is focused only on one study case. Not all the catchments in the Andean region are volcanic. Please be more specific. Abstract P.1, l. 20 – The “dry and wet conditions” have to be defined, it will depend of the considered timescale. If one see the figure 2 at monthly time step, we don’t observe any dry season. P2., l.16 – Write “stable isotopes” instead of “isotopes” P5., l.4 – How be sure that 3 samples are sufficient to characterize the chemical signature of the ice? For me the number of analysis has to be increased, the number of samples is not sufficient enough. Considering basic statistics it is not possible to draw box-plots with only 3 points as samples! P6., l.30 – Once again , 3 samples for Ice and 4 samples for the precipitation are not sufficient to define a strong signal for these water types. P6., l.31: The number of spring water is n=44, could you precise if each point is an individual spring? For that the adding of a new table is necessary (see GC2). P12., l.5-6: : I don’t understand why three (of the four) samples of precipitation water are very far from the GMWL and LMWL curves. I suspect some problem due to evaporation during the sampling and/or during the storage. Please explain why we observe these differences. Why the 3 samples of ice are not located on the LMWL? Please define the acronyms GMWL and LMWL. P14., l.6-9: Please precise the period for the calculations of the different contributions. P14., l.11-17: Idem P15. l.11-12: The two references cited are not relevant because the type of catchment are very different. Please provide other references with catchments that have the same behavior than the catchment of your study (high catchment in volcanic tropical region). P16. L.23 and P17, l.1: The reference Mena (2010) is not freely available, has no DOI and so it should not be cited. Please provide other references. A table is missing with the indication for all the water samples, locations, main characteristics, etc.... Figure 1: The latitude and the longitude have to be added, the sources of data for each map

have to be mentioned. Figure 2: What is the time step for the temperature data? Monthly? If it is the case please indicate “monthly temperature”. If the temperatures are monthly temperatures, it would be better to plot the values with points without a line between them. Figure 3: How is made the separation between the sub-catchment, is it topographic? Which is the DEM (source, resolution) and which methodology has been used to separate each sub-catchment? How to be sure that the springwaters are not superficial rivers (see GC 1)? Some sub-catchments are missing, for example 21, 31, 32. Please add these sub catchments to the figure. Figure 4: The font size is too small. How can you draw box plots for the categories “ice” and “precipitation” with only 3 and 4 values respectively? Concerning the δ18O and δ2H rates, how do you explain the differences between the two categories “Ice” and “Precipitation”? Figure 5: The font size is too small. It should be indicated that the numbers for the X-axis represent the number of the sub-catchment. How many samples are used to draw the different box-plots? The number n of samples has to be specify (may be in the new table). Figure 6: The font size is too small. Figure 7: see comment above (P12l.5-6). Figure 8: Please be more precise and define the three following terms: “pre-event” “event” and “post-event” Figure 9: No mention is done to Qspringwater : why?

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