Hydrol. Earth Syst. Sci. Discuss., 9, C6004–C6011, 2012
www.hydrol-earth-syst-sci-discuss.net/9/C6004/2012/

Hydrology and Earth System Sciences Discussions

Interactive comment on "Stable water isotope variation in a Central Andean watershed dominated by glacier- and snowmelt" *by* N. Ohlanders et al.

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Received and published: 21 December 2012

General comment.

This paper aims to identify and quantify the different sources of runoff in a glacierized catchment by means of a tracer-based experimental approach. The topic is of sure interest for readers of this journal due to the importance of glaciers and snow bodies as water resources in mountain regions, particularly vulnerable in the actual framework of global warming. Water stable isotopes represent effective tools for the investigations of spatial sources to streamflow and for the analysis of the temporal dynamics of water

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components in the hydrological. Indeed, the paper relies on a good isotopic database that has been well exploited in order to achieve the foreseen goals and, in my opinion, it deserves to be published on HESS. In general, I agree with the two previous reviewers on the strong and weak points of this paper. I add some points. Overall, the manuscript is well organized and logically structured. The introduction is sufficiently documented and the objective concisely stated. However, the manuscript shows a lack of clarity when presenting, especially in graphical forms, the results. More specific and minor comments are given below. In the end, I recommend to significantly revise the manuscript in order to improve the quality of presentation, making it suitable for publication.

Specific comments. (The first number refers to the page number, the second one(s) to the page line(s))

12232, 12-18. So the two processes are balanced? It is important to clarify this since it's the basis of the working hypothesis.

12233. As pointed out by one of the reviewer, there are many acronyms that are quite difficult to remember well and this make difficult to follow the explanations. A Table presenting the meaning of the used acronyms would be helpful here.

12237, 15-23. Please, specify the manufacturer of the laser spectroscope or, at least, the underlying technology (OA-ICOS or CRSD). More recent references that have tested this relatively new technology and defined it as suitable for hydrological studies could be cited here (they are listed below). Moreover, it seems to me that there is a contrasting precision in the analysis of the 10 replicates: 1.1 per mil is just a little higher than the typical instrumental precision for such devices for hydrogen and, on the contrary, 0.1 per mil for oxygen is quite good. I understand that the authors did not analyses the samples themselves but since they often used deuterium in the plots and results, it would be interesting to know if the used spectroscope showed a high variability for this isotope. Furthermore, the measurement accuracy (i.e., the vicinity

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of a measure to its “true” value) is reported but references or information about how the accuracy was assessed are missing (e., g., comparison between laser-based and mass spectrometry-based measurements. . .). Finally, since the instrumental precision is better described by one digit for hydrogen and two digits for oxygen, I suggest to present these values in this way, consistently throughout the paper.

12239, 14-17. Here the possible influence of rain-on-snow events should be introduced and shortly commented.

12241, 26. Yes, the samples in Fig. 6 are close to the Chilean Meteoric Water Line but they rarely fall just on it, plotting usually above it. This is much more evident for samples displayed in Fig. 7. Thus, I wonder if the CMWL is really representative of the precipitation occurring in the study area. Is it possible that, given its vicinity with the Argentinian border, other MWLs would be closer to the analyzed samples? In case, the GNIP database (http://www-naweb.iaea.org/napc/ih/IHS_resources_gnip.html) could be searched. Or are there any possible factors related to the departure of all samples from the CMWL? In the two Figures, I suggest to indicate the R2 and the equation of the linear interpolator to assess the departure or vicinity to the MWL (either Chilean, Global or another one, possibly more representative).

12245, 19-12246, 5. The process of the daily variability is well described and interpreted. However, I wonder whether it is possible to derive a generalized behavior of daily variability, since only one event (as long as I understand) was measured and reported. Are data from any other events available?

12246, 15-16. This is really interesting. Was the composition of groundwater experimentally demonstrated? If so, where are the data the authors refer to?

12247, equations 1 and 2. The approach is really interesting. Were these equations derived by the authors or they have been already used? If so, please, give references. Moreover, I wonder which is the “correct” value of delta 2H stream to insert in the equation since the isotopic composition of the stream is very variable during the day

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(see Fig. 9). I think this is a very critical issue that has the potential to significantly affect the results and should be discussed in the revised version of the manuscript.

12248, Section 3.6. I think that the results presented here about the glacier melt and snowmelt contribution are very interesting and potentially significant for other glacierized catchments in South America (and not only). However, the authors should notice more markedly that such results are mainly indicative, since they are based on different scenarios (Table 3). In this context, I cannot totally understand how the authors derived the values reported in Table 4 and I cannot see how they can be so "highly confident" (12248, 14) about these results. Therefore, I suggest to explain this fundamental part better. Moreover, the obtained results and values of glacier contribution should also be compared to some additional recent studies, whose references are provided below.

Minor comments. (The first number refers to the page number, the second one(s) to the page line(s))

12228, 14. Is it necessary to mention "La Nina" in the abstract, without reminding what it refers to?

12228, 18-19. These two lines are not as immediately understandable as sentences in the abstract should be.

12228, 21. I don't like the term "discharge evolution" so much and I suggest to use "discharge variability" or "discharge patterns" instead. The same holds for 12229, 23.

12229, 27-28. The sentence needs to be fixed.

12230, 7. Change "H2O" into "water".

12230, 9. Change "in" into "of".

12230, 18. Remove "this".

12230, 25. The concept of "pre-event water" and "old water" is analogous. Please, arrange the sentence accordingly.

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12231, 19-21. It is not immediately clear why snowmelt isotopic composition should increase over time quasi-linearly. Please, explain better and give references.

12231, 21. Add an “s” to “occur”

12231, 28. Add “with elevation” after “of precipitation”

12233, 2-3. I suggest to change the sentence as follows “to estimate the contribution of the main water sources in major periods. . .”

12233, 21. Change “much more” into “most”

12234, 25; 12235, 8 and other parts in the manuscript. Please, decide whether to use “data” as a singular or plural term and adopt this criterion consistently throughout the paper.

12234, 26. Add “DGA” after “Direccion General de Aguas”

12234, 27. Where is the Riecillos station in the map? Similarly, in the following lines, where are the Portillo and Hornitos stations?

12235, 10. What does “n.d.” stand for?

12236, 6. Delete “C. Grazis and X. Feng (personal communication, 2011)” since there is a corresponding published reference.

12238, 7. Change “yr” into “years”

12239, 20. -121 per mil is not “highly enriched”! Perhaps, it’s slightly relatively enriched compared to other water sources (e.g., -134 per mil of snow at mid-altitudes)

12239, 24. Change “collected along an altitude gradient plotted against altitude.” into “as function of altitude”.

12240, 7. Is it possible to indicate also the average depletion gradient in terms of delta per mil/100 m?

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12240, 15 and 22. Change “demonstrates” into “show”

12241, 25-26. Give the equation (here and/or in Fig. 6) and a reference of the CMWL, that, if I’m correct, should have lower values of slope and intercept compared to the GMWL.

12242, 20. Define what “SCA” stands for.

122244, 24. Change “varied” into “variable”

122244, 24. Specify “vertical” lines

12245, 14. “Line 7” should be “line 8”

12245, 16. Change “precip” into “precipitation”

12247, 21. “higher” means “enriched”?

Additional references.

Brown L., Hannah D.M., Milner A. M., Soulsby C., Hodson A.J., Brewer M. J., 2006. Water source dynamics in a glacierized alpine river basin (Taillon-Gabietous, French Pyrenees). Water Resources Research, VOL. 42, W08404, doi:10.1029/2005WR004268, 2006

Huss M., 2011. Present and future contribution of glacier storage change to runoff from macroscale drainage basins in Europe. Water Resour. Res., 47, W07511.

Jeelani G., Feddema J. J., van der Veen C.J., Stearns L., 2012. Role of snow and glacier melt in controlling river hydrology in Liddar watershed (western Himalaya) under current and future climate. Water Resources Research, VOL. 48, W12508, doi:10.1029/2011WR011590, 201

Penna D., Stenni B., Šanda M., Wrede S., Bogaard T.A., Gobbi A., Borga M., Fisher B.M.C., Bonazza M., 2010. On the reproducibility and repeatability of laser absorption spectroscopy measurements for ïĄď2H and ïĄď18O isotopic analysis. Hydrology

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Viviroli D., Archer D. R., Buytaert W., Fowler G., Greenwood G. B., Hamlet A. F., Huang Y., Koboltschnig G., Litaor M. I., López-Moreno J. I., Lorentz S., Schädler B., Schreier H., Schwaiger K., Vuille M., Woods R., 2011. Climate change and mountain water resources: overview and recommendations for research, management and policy. Hydrol. Earth Syst. Sci., 15, 471–504

Tables and Figures. Overall, Tables and, most of all, some Figures, should be really improved. Since HESS is an online journal only, I suggest using the color in the plots, that help to better distinguish between different variables.

Table 2. Not clear. What do 10/8 and 4/8mean? Put standard deviation in brackets. Why is it important to compute the d18O/d2H ratio? Please, explain and/or refer to the text.

Figure 1. Panel b is a little confused. Make the map bigger. Does “gauge” mean “rain gauge”? Please specify. Where are Riecillos and the other stations?

Figure 2. “masl” must be “m a.s.l.”

Figure 3. I suggest to write the label on the y-axis as ”specific runoff (m/yr)” and the label on the x-axis as ”snow water equivalent (m/yr). Add R2. Make the dots bigger.

Figure 4. Highlight better the wet and the dry years. The Table is hardly readable.

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Figure 5. Add the values of R2.

Figure 6. Give equation of CMWL. See comment above on the representativeness of the CMWL. Add R2 and equation of the interpolating line.

Figure 7. If available, add two variables: temperature and discharge. This way it is possible to assess the relation between temperature, isotopic composition of streamflow, melt. Add R2 and equation of the interpolating line.

Figure 8. The Figure, very important for the final results, is really confused and deserves to be significantly improved. Color could help. Some issues: why the rain is represented by an arrow pointing upward and snow by an arrow pointing downward? The caption mentions precipitation but I cannot find it. The legend referring to the hatched area is not immediately understandable.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 12227, 2012.