Detailed point-by-point list of answers to the reviewers´ comments:

Anonymus Referee #1:

Received and published: 11 January 2017

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.

We thank the referee for the valuable comments. Hereby we present a point-by-point reply to the referee´s questions and comments.

GENERAL COMMENTS

1) **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.**

   The first approach during the analysis was a characterization of the main runoff sources being surface, spring, precipitation and ice as indicated in Section 3.2.1. However, based on the large variation of chemical components and stable isotopes of surface water and springwater, a separate analysis was performed. Surface water samples were analyzed related to catchment and subcatchments and springwater samples were analyzed per geological background. The latter was not included in the manuscript but based on the comments from the referees, it will be included in this improved version. The results from the surface water samples showed two distinctive groups: surface water coming from the melting of the glacier (subcatchment 23) and surface water that comes from the páramo-vegetated areas (subcatchments 41,42,43,5,6,7,8,9) as stated on pg 10 lines 8-14. In this regard, only the results from the surface water were taken into account further for the hydrograph separation analysis; since one of our objectives was to quantify the water coming from the two sources being páramo and glacier during dry and wet conditions.

2) **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.

Thanks for your comment, we have changed Qprecipitation for Qevent, which reflects exactly a distinctive component within the hydrograph separation during a rainfall event. Regarding the water originating from the glacier melting, in the Discussion section pg 15 lines 12-14, we discussed that the results from some outliers in the springwater group are a clear evidence of the meltwater resurgence from the glacier as also confirmed in other studies like Cauvy-Fraunié et al (2013). The large variations and high values of the chemical components and stable isotopes of the springwater samples suggest that some runoff could originate from deeper sources, from fissures and fractures in the bedrock. However, as stated in pg 15 lines 14-16: "*Unfortunately, it is very difficult to crosscheck the water chemistry with the water signatures from the isotopes since they could be altered as a consequence of the strong influence of bedrock substrates, altitude and manifold underground processes (Nelson et al., 2011)*". We cannot state that Qparamo (now Qevent) is entirely groundwater since it represents a mix of surface water, shallow subsurface flow and at some extent even deeper groundwater flow that comes to the surface via fissures and fractures of the bedrock. In this regard, a specific and strong analysis of groundwater should be done as further research and to complement this current study. We have added a statement in Section 5.2 to state what Qparamo (now Qevent) represents: "*The contribution from the paramo is a result from the mixing between surface runoff, soil water, shallow surface flow and groundwater as evidenced in other small head watersheds (Marechal et al., 2013)*".

3) **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?**

The authors intention was to make a simplification of the work done by focusing in the quantification and further analysis of the water coming from the glacier and paramo subcatchments. However, we agreed with the referee in the sense that the description of the geology together with the analysis of the springwater will clarify some of the results that might be incomplete. We have added in Section 2:

"*Geology*

The geology of the catchment has a wide detritic range that holds a variety of volcanic deposits from previous eruptions (Figure 1d), the last significant eruption occurred nearly 1000 years ago based on stratigraphic studies (Hall et al., 2012). The peak is slightly flat; it presumes that the crater is glacier filling. Although there is no volcanic activity or hot fumeroles lately, there are reports of SO_2 gas in higher elevations (Hall et al., 2012). Most of the stratigraphy is composed by dark layers of ash and andesite scoria, which is product of the fall of eruptive clouds with intercalations of fluvial deposits (Hall et al., 2012).

The geology as shown in figure 1d is composed, next to the glacier cover, of morraines, glacial-fluvial sediments, tillites, volcanic rocks and Lahar rojo. The morraines are deposited debris that form along the glacier from the receding of the glacier. These areas are characterized by lagune formations which intercept meltwater. The pleistocene lavas formation are older volcanic pyroclastic deposits which are composed of andesite rocks containing plagioclase, amphibole and feldspar minerals. The Hialina Lava is formed also of andesite content. However, this is a younger formation with olivine, plagioclase and quartz, arranged in a matrix formed by volcanic glass (Alvarado, 2009). The Lahar Rojo is a sequence of red volcanic lava deposits along the Antisana river. Its pyroclastic material when mixed with water became red indicating several volcanic eruptions during the Holocene.

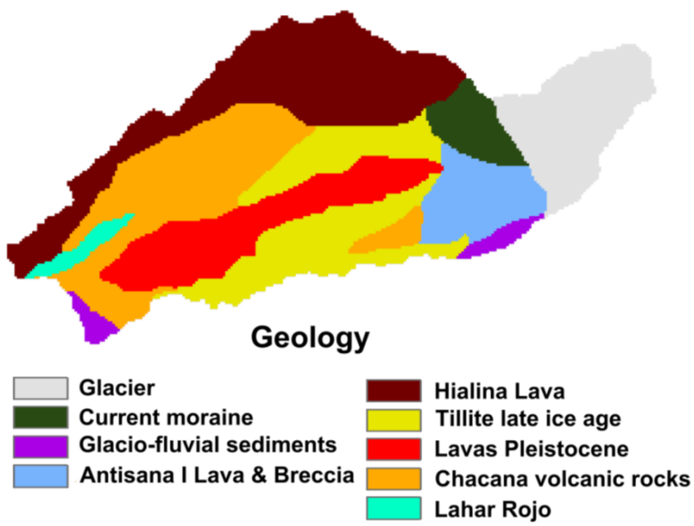

Figure 1d Geology of the catchment the Los Crespos - Humboldt, Antisana icecap - Ecuador (original source from Hall et al (2012))

In addition we have added in Section 4.1:

"*Spring water*

Spring water characteristics were based on the geological formation from which they originate (refer to Figure 1d). Spring water samples that come from the Lahar Rojo formation were significantly higher in most of the major ions and EC concentrations (Figure 7). The rest of the geological formations showed different concentration ranges; however, they could not be tested for significance due to the lack of samples for specific major cations.

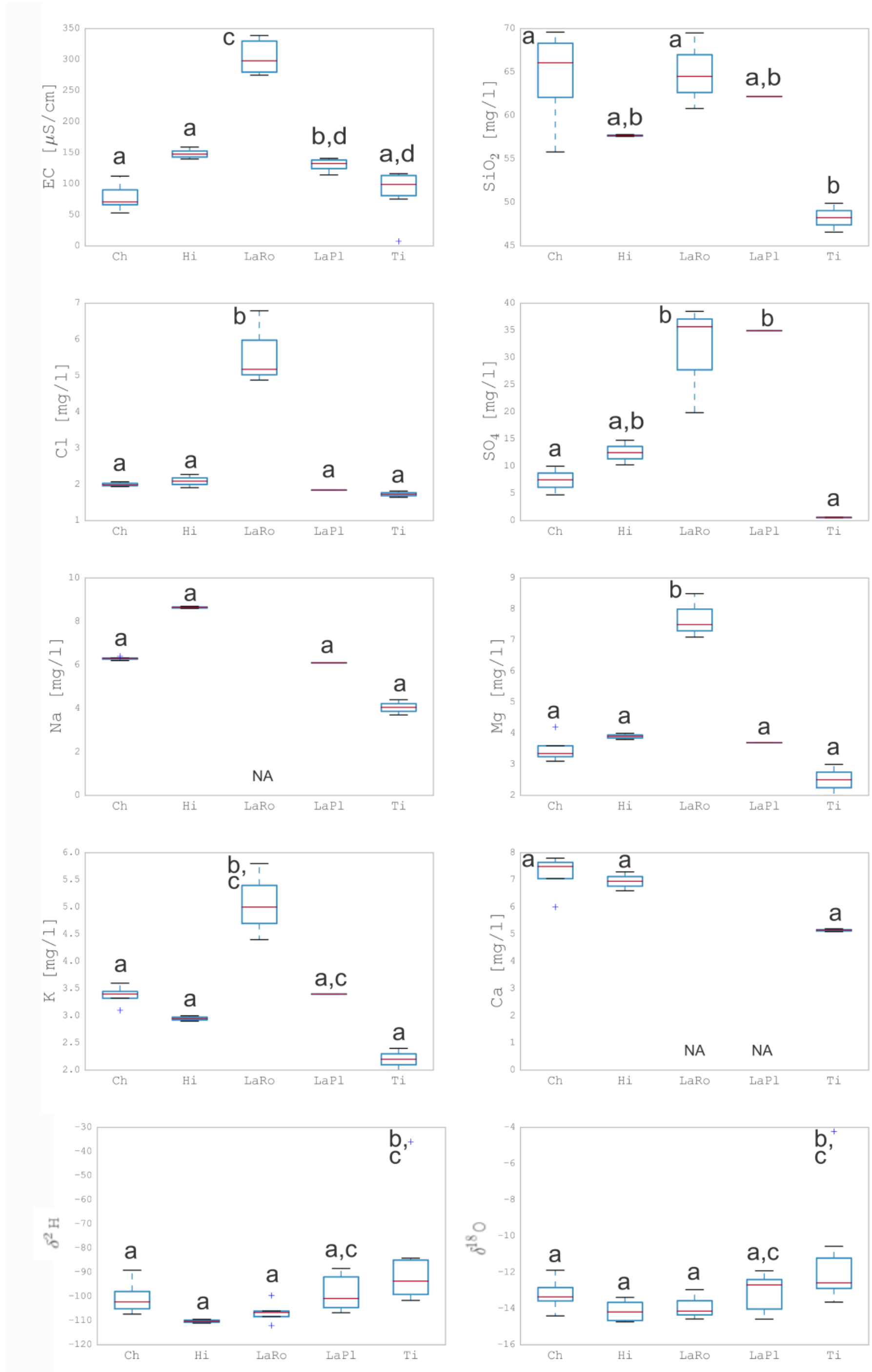

Figure 7 Chemical components and stable isotopes of spring water samples within the Los Crespos-Humboldt basin, analyzed per geological background (Ch = Chacana volcanic rocks, Hi = Hialina lava, LaRo = Lahar Rojo, LaPl = Lavas Pleistocene, Ti = Tillite late ice age). Lowercase letters indicate significant differences among geological background (P ≤ 0.05), according to Tukey's test."

In Section 5.1:

"*In a more comprehensive analysis, most of the spring water samples showed silica concentrations of 55 to 70 mg/l; while the samples that correspond to the type of geology Tillita showed concentrations between 45 and 50 mg/l. In most of the cases the latter type of geology consists of impermeable tough layers that have a shallow water table (Cuesta et al., 2013) and thus could easily get in contact with the subsurface flow and experience a dilution effect. The comparatively higher concentrations in the cations (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}) in spring water showed similar characteristics to silica. Hence these cations should be considered as indicators for water from deeper soil layers in study areas comparable to this one. These results strengthen the assumption that most of the spring water comes from a groundwater source; nevertheless the discrimination among groundwater, shallow and deeper subsurface flows are subjects of further analysis which lies outside the scope of this study.*"

In references:

Alvarado, C.: Caracterización hidrogeológica de ls vertientes occidentales del volcán Antisana como parte de los estudios de los glaciares y páramos frente al cambio climático (Unpublished dissertation), Thesis. Escuela de Ingeniería en Geología, Universidad Central del Ecuador, Quito, 2009.

4) **GC2 : A additional table is needed with the details concerning all the samples (location, type of water, main characteristics, etc. . ..).**

Thanks for the suggestion. We have added a table in the Annex section with all the details of the samples collected during our field campaign. Annex is included at the end of this response letter.

5) **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**

We have included a description of the geology in section 2 (also please see reply of comment #3). A brief description of the soils is given in pg 2 lines 44-52. In the discussion, we have included the following section regarding the weathering processes:

"*Catchment geology and weathering processes*

The chemical signature observed in the surface water samples is in accordance with the geology of the area. Surface water samples obtained near the glacier and morraines formations (upper section of catchment 2) show low electrical conductivities (mean of 7.5 µS/cm) and silica concentrations (mean 9 mg/l), as well as other ions (Figure 5). Catchment 1, where the Hialiana lava formation is dominant, shows higher electrical conductivities (mean:

149 µS/cm) and silica concentrations (mean: 48 mg/l). The Hialiana lava formation is dominant in catchment 1. These area is rich in olivine, plagioclase and quartz. Although quartz are highly resistant to weathering processes, olivines are known for decomposing faster (Goldich, 1938; Appelo & Postma, 2005). The weathering of these minerals results in increased contents of silica, bicarbonates, and cations in the water. Sodium is also derived from weathering of plagioclase materials. Catchment 1 contains the highest sodium concentrations (mean: 7.5 mg/l) as shown in Figure 5. The Pleistocene lavas are dominant in catchment 4. These are characteristic for also their high silica content (mean: 52 mg/l), but as opposed to the Hialina lava, they contain lower sodium concentrations (mean: 4 mg/l). Magnesium is evidence of weathering of pyroxenes and amphiboles. Catchment 4 displays a wider range of magnesium concentrations from 1.4 to 5.7 mg/l. For both catchments 1 and 4, calcium is known to be released with the weathering of amphiboles and pyroxenes. These weathering processes may also result in the precipitation of carbonates and clay minerals. Surface water samples from the Lahar Rojo formation did not show the high ionic content expected as observed in the groundwater samples. Figure 7 (in this authors' response) shows the high concentrations observed in the Lahar Rojo section. The high clay content in this formation explains the high observed ionic content found in the groundwater samples. In catchments 5,6,7,8,9, the dominant formations are glacial fluvial sediments, tillites, lava and breccia. These sediment deposits have lower electrical conductivities thus lower ionic content, but a wide range in silica concentrations. Their low ionic content is explained by the source of these materials which comes from the glacial debris."

In References:

Appelo, C. A. J. and Postma, D.: Silicate Weathering. Geochemistry, Groundwater and Pollution, Second Edition, pp. 375-414, Taylor & Francis, 2005.

Goldich, S. S.: A Study in Rock-Weathering The Journal of Geology, 46, 17-58, 1938.

No site-specific information/studies were found regarding the residence time of the water in the soil or in the fractured aquifer.

6) **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 C2 the system and how authors solve this equation system?**

Indeed, we used only the runoff at the outlet. We have updated Line 13 on page 6: *"Isotope and hydrochemical data were combined with discharge data taken at the outlet of the basin to perform three-component hydrograph separations based on steady state mass balance equations......"*

For the End Member Mixing Analysis, mixing diagrams with combinations of EC (µS/cm), SiO_2 (mg/L), Cl (mg/L), SO_4 (mg/L), Na (mg/L), Mg (mg/L), K (mg/L), Ca (mg/L), δ^2H (‰ VSMOW), $\delta^{18}O$ (‰ VSMOW) were created first. In addition, these parameters were plotted against discharge to observe the dilution bevaviour and hysteresis. Then a principal component analysis was carried out on the mentioned parameters indicating that two principal components explained 90% of the data variability leading to a three component hydrograph separation.

SPECIFIC COMMENTS

7) **Title – The title should be more informative, what is the study period? What methodology is applied ? Which period is studied?**

We have added some informative details in the title that reflect the work done: "*Quantification of runoff generation from a combined glacier and paramo catchment during dry and wet conditions using environmental isotopes within the Antisana Ecological Reserve in the Ecuadorian highlands*"

8) **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.**

Thanks for your comment, we have included the catchment elevation range in the Abstract section line 17: "*This study focuses on data collection and experimental investigations in a small catchment (15.2 km^2) that ranges between 4000 to 5700 m a.s.l. within the Antisana Ecological Reserve in the Ecuadorian Andean Region. It consist of 2.3 km^2 glaciers, 10.3 km^2 páramo grasslands and 2.6 km^2 moraines.*"

Pg1 line 14 has been updated: "*However, not all runoff processes are well-understood in the Andean Region due to the high spatial variability of precipitation. Particularly in the northern Ecuador, young volcanic ash soil properties, soil moisture dynamics and other local factors such as vegetation interception and high radiation might influence the hydrological behaviour.*"

Pg1 line 20 has been updated: "*.... in order to determine their respective contribution during dry and wet conditions. Dry conditions defined as periods in which precipitation was absent for at least three consecutive days and wet conditions during rainfall events.*"

9) **If one see the figure 2 at monthly time step, we don't observe any dry season.**

We agree that the Figure 2 does not show a clear and defined dry season. The catchment is characterized for having precipitation throughout the year therefore the Figure shows period of less precipitation. As indicated in pg 3 line 11-12: There are two main sources of precipitation: those influenced by the air masses from the Amazon region and those influenced by the inter-Andean valley regime (Vuille et al., 2000).

10) **P2., l.16 – Write “stable isotopes” instead of “isotopes”**
    Pg2 line 16 updated.

11) **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.**
    Thanks for your comment. The amount of data is a limitation to make a complete analysis and chemical signature characterization of ice. We agree that we cannot draw strong conclusions on the chemical signature of ice based on a very small dataset. In this regard, the results were only used to have a first overview of the chemical components and stable isotopes comparing four different runoff sources being ice, precipitation, surface water and springwater. In a later stage we analyzed further only the surface water and springwater samples that have a larger number of samples.

12) **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.**
    As explained in the previous comment. We are aware of the limitation of our sampling points for ice, hence it was not used for further analysis on the quantification of the runoff coming from *páramo* and glacier subcatchments. In case of precipitation, the four samples correspond to the same rainfall event that was chosen for the End-member analysis and hydrograph separation. The amount of samples are limited to the amount of rainfall during the event.
    We have updated Figure 4 and replaced the box-plots for other type of plot showing only the distribution of samples and their mean.

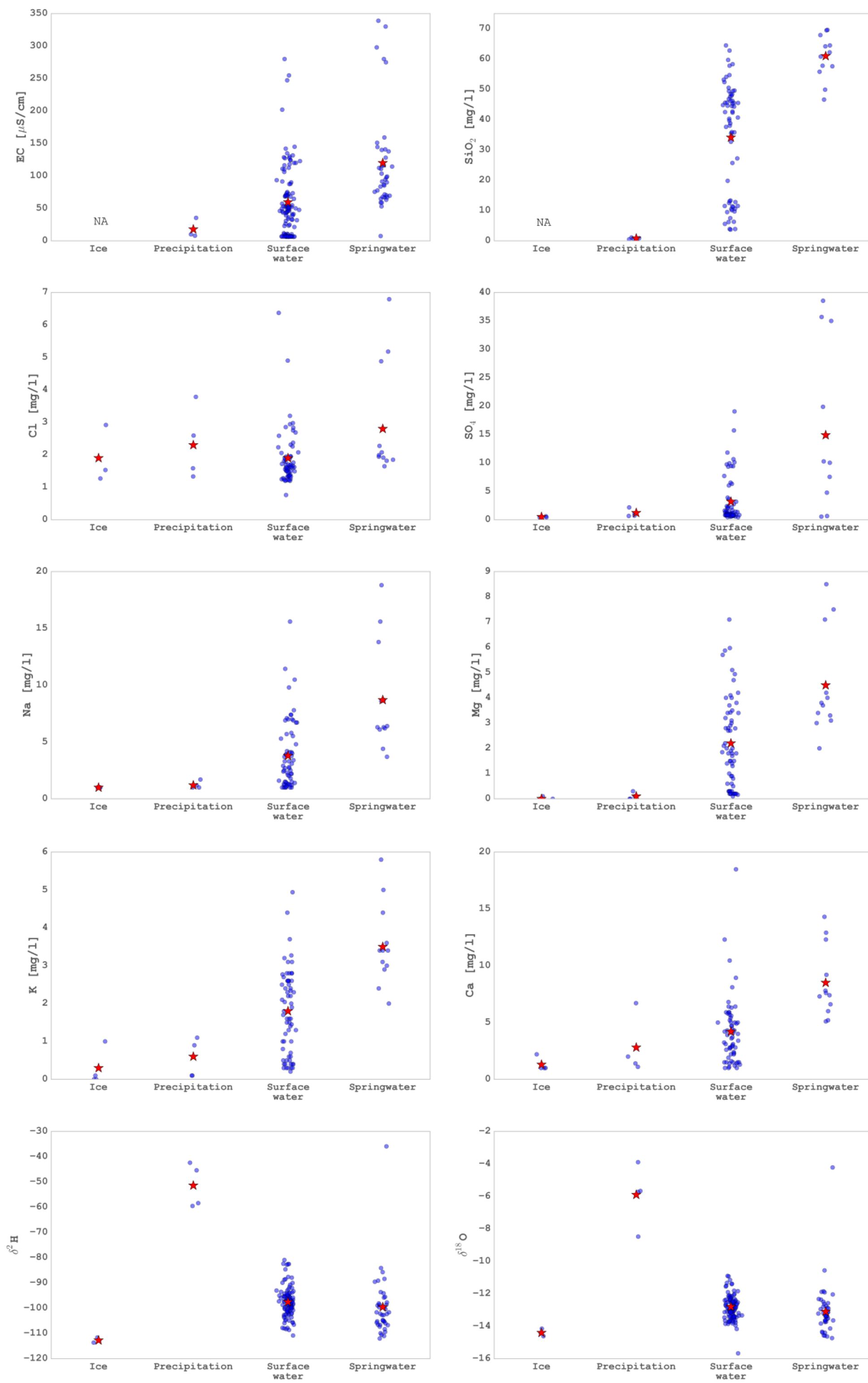

Figure 4. Chemical components and stable isotopes of water samples within the Los Crespos-Humboldt basin of different runoff sources (Ice, Precipitation, Surface and Spring water). The blue dots represent the samples and the red star the mean values. NA= samples are not available.

13) 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).

Indeed the number of samples correspond to an individual spring which are detailed in the Annex section. Please check table at the end of this letter.

14) 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.

During the analysis, these precipitation samples for stable isotopes also called our attention since they are deviated from the LMWL and GMWL slopes. It's unlikely that the main reason is due to evaporation during sampling and storing since we followed strictly the procedure of the IAEA as indicated in pg5 lines 18-19. Therefore, we hypothesize that the distance of the precipitation samples to the LMWL and GMWL lines might indicate other secondary evaporation processes that occur when raindrops fall in a warm atmosphere.

These is suggested by the values of deuterium excess less than 10‰ in all precipitation samples. The event was not a heavy rain and therefore the raindrops are slightly more enriched.

We have included a small statement about our possible explanation. However, an in-depth and further analysis are not within the scope of this study. It will definitely need a robust number of samples to draw strong conclusions. Pg 16 Line 16: *"The isotopic composition of rainfall and their relative distance to the GWML propose a possible evaporation effect. The first raindrops are usually more isotopically enriched (Gat & Carmi, 1970). For the specific case of precipitation, further research on rainfall events at this location should be done to check for possible re-evaporation processes and contributions of different water vapor sources that might occur taking into account inter and intra event variability in the hydrological process."*

In References:

Gat, J. R. and Carmi, I.: Evolution of the isotopic composition of atmospheric waters in the Mediterranean Sea area, Journal of Geophys. Res., 96, 13179-13188, 1970.

15) Why the 3 samples of ice are not located on the LMWL? Please define the acronyms GMWL and LMWL.

The relative distance of the samples of ice to the LMWL and GMWL curves are most likely due to evaporative losses during the melting. The vials available for sampling were not adequate for ice. They were completely full during sampling but unfortunately the time between the sampling and the storage was long and led to evaporation processes and isotopic fractionation during melting as seen by the excess of headspace within the vial.

Regarding the acronyms, thanks for the observation. We have defined the acronyms that were missed in Figure 7, as follows:

"Figure 7. Stable isotope compositions of precipitation, surface water, spring, ice, storm runoff. Global Meteoric Water Line (GMWL): $\partial^2 H = 8.13 \times \partial^{18} O + 10.8$ ‰ (Source: Rozanski et al.,

1993). Local Mean Water Line (LMWL) for Izobamba: $\partial^2 H = 8.1 \times \partial^{18} O + 12.8$ *‰ (Source: IAEA, 2016)"*

16) P14., l.6-9: Please precise the period for the calculations of the different contributions.

We have updated the statement with the sampling period on Pg 14 line6: *"Thus, EC values and stable isotopes were used to estimate the contribution of water from the glacier component, which was of 21% for EC, 14% for* δ^2H *and 15% for* $\delta^{18}O$ *during the sampling campaign on July 4 - 7, 2017."*

In addition, we have added this information in Section 3.1 so it is clear that the period is different for dry and wet conditions, pg4 line 8: *"Isotopic and hydrochemical samples were collected in a sampling campaign carried out in July 2014. For dry conditions July 4-7 and for wet conditions July 14-15."*

17) 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).

Thanks for the observation. We have deleted the statement to avoid a misunderstanding.

18) 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.

The reference Mena (2010) is an unpublished thesis available at the University digital library. We have updated the reference to:

Mena, S. P.: Evolución de la dinámica de los escurrimientos en zonas de alta montaña: caso del Volcán Antisana (Unpublished dissertation), Thesis, Facultad de Ingeniería Civil y Ambiental, Escuela Politécnica Nacional, Quito - Ecuador. Retrieved from: http://bibdigital.epn.edu.ec/handle/15000/2503, 2010.

19) A table is missing with the indication for all the water samples, locations, main characteristics, etc. . ..

It has been included in the Annex section as advised in the referee's GC 2 (Comment No.4).

20) Figure 1: The latitude and the longitude have to be added, the sources of data for each map have to be mentioned.

Thanks for the comment. We have added the coordinates to the main map and added the sources of data for each one.

21) 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.

Indeed, the values for temperature are average monthly maximum and average monthly minimum temperature. We have updated the Figure 2 accordingly.

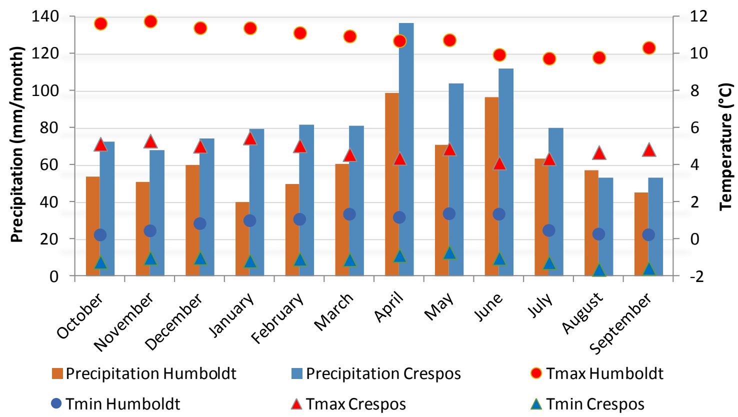

Figure 2. Average monthly precipitation, maximum and minimum average monthly temperatures at Humboldt and Crespos weather stations from 2000 to 2011.

22) 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?

We used a GIS-based subcatchment division approach to delineate the subcatchments for our study. We have updated the text in the manuscript on Pg 4 line 6: *"The DEM has a resolution of 20 x 20m and it was obtained from the contour line from the Ecuadorian Military Geographical Institute (IGM) scale 1:50000. The stream network was based on 'hydrological approach' as defined by Mark (1984) (Lo & Yeung, 2007) and later verified during ground-truthing recording GPS point measurements and field observations. Subcatchment delineation used the multiple flow direction model (Tarboton, 1997) and the eight-direction method (D8) introduced by O'Callaghan amd Mark (1984).*

In references:

Lo, C. P. and Yeung, A. K. W. (Eds.): Concept and techniques in geographic information systems, Second Edition. Prentice Hall, 2007.

Mark, D. M.: Automated detection of drainage networks from digital elevation models, Cartographica, 21, 168-178, 1984.

O' Callaghan, J. F. and Mark, D. M.: The extraction of drainage networks from digital elevation data, Comput. Vis. Graph. Image Process, 28, 328-344, 1984.

Tarboton, D. G.: A new method for the determination of flow directions and upslope areas in grid digital elevation models Water Resour. Res. , 33, 309–319, 1997.

23) How to be sure that the springwaters are not superficial rivers (see GC 1)?

One of the limitations of this study is that it was not possible to clearly identify the source of the springwater. As explained in GC 1 (Comment #2) the springwater could come from a shallow subsurface flow or from a deeper groundwater flow that comes to the surface via fissures and fractures of the rock. Springwater samples were tested for significant difference based on their geological background (please refer to the reply on Comment #3).

24) **Some sub-catchments are missing, for example 21, 31, 32. Please add these sub catchments to the figure.**

Those numbers were left out due to the lack of space. We have updated the Figure to include them.

25) **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?**

We have improved the font size of all figures. Regarding the boxplots for the categories "ice" and "precipitation" please refer to the explanation given above in Comment # 12.

26) **Concerning the δ18O and δ2H rates, how do you explain the differences between the two categories "Ice" and "Precipitation"?**

The difference has to do with the fractionation of isotopes. Precipitation has a "heavier isotopic signature" than ice because the heavy molecules are the ones that fall during a rainfall event while for ice and glacier is the lightest. The isotopic signature for the ice is influenced by several aspects, mainly the primary isotopic composition of water at its formation, and the isotopic fractionation during freezing, melting and sublimation processes.

27) **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).**

Yes, the number of samples are specified in the new table (Annex section). All figures have been improved.

28) **Figure 6: The font size is too small.**

Thanks for your comment. We have updated all the Figures to be clearer.

29) **Figure 7: see comment above (P12l.5-6).**

The deviation of the precipitation and ice samples from the GMWL and LMWL curves were explained above in the reply to comment # 14 and 15.

30) **Figure 8: Please be more precise and define the three following terms: "pre-event" "event" and "post-event"**

Thanks for the observation. We have updated the definition of those three terms in section 3.2.2 on Pg 5 line 15: *"Surface water samples at the outlet were collected with a resolution of 15-20 min at three different phases: 1) Pre-event, which are water samples taken before the peak of the rainfall event (n=3), 2) Event, samples taken during the rainfall event (n=13), and 3) Post-event, which are samples taken after the peak of the rainfall event (n=10)."*

31) **Figure 9: No mention is done to Qspringwater : why?**

Please refer to the reply on Comment #1.

Annex

Table A-1. Location of the water samples taken from four different runoff source (Ice, Prec = precipitation, SW = springwater and Surf = surface water) and main characteristics and chemical concentrations (EC = electrical conductivity [µS/cm], SiO_2 [mg/l], Cl^- [mg/l], SO_4^{2-} [mg/l], Na^+ [m/l], Mg^{2+} [mg/l], K^+ [mg/l], Ca^{2+} [mg/l], δ^2H [‰],$\delta^{18}O$ [‰]) taken during July 2014. The UTM coordinates (WGS84) of the area are Zone 17M North and East, Dist = distance to the outlet, Subcat = subcatchment, Cat = catchment and Geol = geological background (Ch = Chacana volcanic rocks, Hi = Hialina lava, LaRo = Lahar Rojo, Lapl = Lavas Pleistocene, Ti = Tillite late ice age). NA = samples are not available.

ID	Source	N (m)	E (m)	Elev.	Dist.	EC	SiO_2	Cl^-	SO_4^{2-}	Na^+	Mg^{2+}	K^+	Ca^{2+}	δ^2H	$\delta^{18}O$	Subcat.	Cat.	Geol.
10	Ice	9945370	816341	4736	7300	NA	NA	2.9	0.6	1.0	0.1	1.0	2.2	-112.8	-14.4	23	2	-
20	Ice	9945370	816341	4736	7300	NA	NA	1.3	0.4	1.0	0.0	0.1	1.0	-111.6	-14.2	23	2	-
30	Ice	9945370	816341	4736	7300	NA	NA	1.5	0.4	1.0	0.0	0.0	1.0	-113.6	-14.6	23	2	-
P_01	Prec	9943248	810185	4060	1	NA	0.7	3.8	2.2	1.7	0.3	1.1	6.7	-59.5	-8.5	1	1	-
P_02	Prec	9943248	810185	4060	1	7.9	0.9	1.3	0.7	1.0	0.0	0.1	1.4	-45.4	-5.7	1	1	-
P_03	Prec	9943248	810185	4060	1	10.0	1.1	1.6	0.7	1.0	0.0	0.1	1.1	-42.4	-3.9	1	1	-
P_04	Prec	9943248	810185	4060	1	35.4	0.5	2.6	1.1	1.2	0.1	0.9	2.0	-58.4	-5.7	1	1	-
T_S1_01	SW	9943424	810258	4047	320	144.5	57.8	1.9	10.3	8.7	4.0	3.0	7.3	-111.0	-13.4	1	1	Hi
T_S1_20	SW	9943451	812460	4166	2850	70.0	NA	NA	NA	NA	NA	NA	NA	-89.1	-11.9	7	5	Ch
T_S1_26	SW	9943471	813147	4206	3600	116.2	NA	NA	NA	NA	NA	NA	NA	-85.7	-11.9	9	5	Ti
T_S1_22	SW	9943489	812029	4135	2500	NA	NA	NA	NA	NA	NA	NA	NA	-98.9	-12.4	7	5	LaPl
T_S1_25	SW	9943502	812928	4191	3370	NA	NA	NA	NA	NA	NA	NA	NA	-90.4	-12.7	9	5	LaPl
T_S1_21	SW	9943521	812319	4146	2800	116.3	NA	NA	NA	NA	NA	NA	NA	-99.6	-13.6	7	5	Ti
T_S1_16	SW	9943524	811802	4127	3670	NA	NA	NA	NA	NA	NA	NA	NA	-89.5	-11.9	5	5	LaPl
T_S1_15	SW	9943526	811662	4122	3675	140.9	NA	NA	NA	NA	NA	NA	NA	-105.2	-14.4	5	5	LaPl
T_S1_14	SW	9943543	811655	4121	2100	137.7	NA	NA	NA	NA	NA	NA	NA	-106.7	-14.6	5	5	LaPl
T_S1_17	SW	9943547	812001	4134	2540	94.5	55.8	NA	NA	6.3	4.2	3.1	6.0	-105.3	-13.5	6	5	Ch
T_S1_09	SW	9943576	811372	4109	2020	114.4	NA	NA	NA	NA	NA	NA	NA	-88.4	-12.5	5	5	LaPl
T_S1_06	SW	9943599	811130	4114	1550	275.0	69.5	6.8	19.9	13.8	7.5	5.8	14.3	-99.6	-13.6	31	3	LaRo
T_S1_02	SW	9943639	810532	4077	817	159.2	NA	NA	NA	NA	NA	NA	NA	-109.4	-14.6	1	1	Hi
T_S1_03	SW	9943708	810640	4079	1005	140.0	NA	NA	NA	NA	NA	NA	NA	-109.9	-14.7	1	1	Hi
T_S1_13	SW	9943739	810657	4083	1050	151.0	57.6	2.3	14.8	8.6	3.8	2.9	6.6	-110.5	-13.7	1	1	Hi

ID	Source	N (m)	E (m)	Elev.	Dist.	EC	SiO_2	Cl^-	SO_4^{2-}	Na^+	Mg^{2+}	K^+	Ca^{2+}	δ^2H	$\delta^{18}O$	Subcat.	Cat.	Geol.
T_S1_04	SW	9943741	810709	4080	1113	330.0	NA	NA	NA	NA	NA	NA	NA	-106.0	-14.1	1	1	LaRo
T_S1_29	SW	9943790	814275	4325	4850	86.6	49.9	NA	NA	NA	NA	NA	NA	-98.6	-13.1	9	5	Ti
T_S1_12	SW	9943797	810758	4083	1100	339.0	NA	NA	NA	NA	NA	NA	NA	-112.0	-13.0	1	1	LaRo
T_S1_27	SW	9943812	814257	4316	4780	99.1	NA	1.8	0.7	3.7	3.0	2.4	5.1	-101.6	-12.6	9	5	Ti
T_S1_28	SW	9943825	814281	4319	4800	110.8	46.6	NA	NA	NA	NA	NA	NA	-93.6	-12.6	9	5	Ti
T_S1_05	SW	9943878	811156	4100	1455	280.0	64.5	4.9	35.7	15.6	7.1	4.4	12.3	-106.6	-14.6	22	2	LaRo
T_S1_31	SW	9943930	814545	4341	5015	NA	NA	1.5	1.4	NA	NA	NA	NA	-94.9	-11.6	9	5	Ti
T_S1_32	SW	9943934	814574	4345	5060	59.0	NA	NA	NA	NA	NA	NA	NA	-95.8	-12.3	9	5	Ch
T_S1_30	SW	9943935	814517	4334	4975	77.7	NA	NA	NA	NA	NA	NA	NA	-101.6	-13.1	9	5	Ch
T_S1_33	SW	9943973	814685	4354	5170	58.8	NA	NA	NA	NA	NA	NA	NA	-94.1	-12.8	9	5	Ch
T_S1_11	SW	9943975	811328	4103	1790	298.0	60.8	5.2	38.5	18.8	8.5	5.0	12.9	-108.3	-14.3	22	2	LaRo
T_S1_34	SW	9943985	814740	4356	5200	67.0	NA	NA	NA	NA	NA	NA	NA	-98.6	-12.9	9	5	Ch
T_S1_35	SW	9944017	814842	4369	5400	64.7	NA	NA	NA	NA	NA	NA	NA	-97.7	-13.2	9	5	Ch
S1_49	SW	9944045	813496	4246	4150	75.5	NA	1.6	0.5	4.4	2.0	2.0	5.2	-84.1	-10.6	8	5	Ti
T_S1_36	SW	9944054	814937	4382	5450	53.1	NA	NA	NA	NA	NA	NA	NA	-100.4	-12.8	9	5	Ch
T_S3_14	SW	9944054	811454	4110	1950	NA	66.1	NA	NA	NA	NA	NA	NA	-105.5	-14.6	22	2	Ch
T_S1_37	SW	9944066	814948	4386	5475	67.8	NA	NA	NA	NA	NA	NA	NA	-105.2	-13.7	9	5	Ch
T_S3_13	SW	9944099	811526	4113	2100	NA	NA	NA	NA	NA	NA	NA	NA	-107.2	-14.8	22	2	Ch
T_S1_38	SW	9944100	815040	4389	5530	69.5	NA	NA	NA	NA	NA	NA	NA	-98.1	-14.4	9	5	Ch
T_S3_12	SW	9944108	811526	4113	2170	112.3	NA	NA	NA	NA	NA	NA	NA	NA	NA	22	2	Ch
T_S3_11	SW	9944111	811570	4117	5980	103.5	NA	NA	NA	NA	NA	NA	NA	-102.2	-13.4	22	2	Ch
T_S3_10	SW	9944237	811748	4129	2370	91.5	64.2	2.1	10.0	6.4	3.3	3.4	7.4	-106.5	-13.4	22	2	Ch
T_S3_09	SW	9944239	811757	4129	4920	83.6	NA	NA	NA	NA	NA	NA	NA	-107.3	-13.2	22	2	Ch
T_S3_02	SW	9944265	812357	4179	7100	63.2	NA	NA	NA	NA	NA	NA	NA	-105.7	-13.4	41	4	Ch
T_S3_01	SW	9944332	812494	4190	6750	71.5	NA	NA	NA	NA	NA	NA	NA	-104.7	-13.6	41	4	Ch
T_S3_08	SW	9944362	811920	4149	2590	97.6	NA	NA	NA	NA	NA	NA	NA	-102.3	-13.8	22	2	Ch
T_S3_04	SW	9944462	812125	4171	3800	85.2	67.9	1.9	4.8	6.2	3.4	3.6	7.8	-104.9	-13.7	22	2	Ch
T_S3_03	SW	9944477	812033	4159	2550	90.1	69.6	2.0	7.5	6.3	3.1	3.4	7.6	-102.7	-13.4	22	2	Ch
T_S3_05	SW	9944521	812189	4176	3900	128.1	62.2	1.8	35.0	6.1	3.7	3.4	9.2	-102.7	-12.9	22	2	LaPl
T_S3_06	SW	9944576	812602	4209	2550	67.1	NA	NA	NA	NA	NA	NA	NA	-95.5	-12.0	22	2	Ch
T_S3_07	SW	9944602	813584	4274	2900	7.4	NA	NA	NA	NA	NA	NA	NA	-35.9	-4.2	22	2	Ti

ID	Source	N (m)	E (m)	Elev.	Dist.	EC	SiO_2	Cl^-	SO_4^{2-}	Na^+	Mg^{2+}	K^+	Ca^{2+}	δ^2H	$\delta^{18}O$	Subcat.	Cat.	Geol.
S1_01	Surf	9943252	810178	4044	100	127.2	44.8	2.6	9.4	7.0	4.0	2.4	5.9	-98.3	-13.1	1	1	-
S1_02	Surf	9943306	810262	4046	200	122.8	NA	NA	NA	NA	NA	NA	NA	-101.3	-12.1	1	1	-
S1_03	Surf	9943396	810158	4047	300	124.4	45.5	2.3	7.7	7.4	4.1	2.6	6.4	-101.7	-12.0	1	1	-
S1_04	Surf	9943443	810304	4053	400	112.5	NA	NA	NA	NA	NA	NA	NA	-98.7	-12.1	1	1	-
S1_25	Surf	9943452	812467	4166	2950	36.3	NA	NA	NA	NA	NA	NA	NA	-95.6	-13.2	7	5	-
S1_05	Surf	9943467	810390	4066	500	116.3	44.5	2.7	9.7	7.1	3.8	2.5	5.9	-98.6	-11.9	1	1	-
T_S1_10	Surf	9943470	811664	4122	2240	72.0	38.0	2.2	2.1	2.5	2.2	1.5	3.6	-98.6	-12.6	7	5	-
S1_27	Surf	9943471	812000	4133	2480	45.4	NA	NA	NA	NA	NA	NA	NA	-97.5	-12.5	7	5	-
S1_24	Surf	9943477	812678	4179	3200	59.7	42.5	1.6	0.5	3.4	2.8	2.4	4.7	-82.5	-10.9	8	5	-
S1_28	Surf	9943478	812864	4187	3300	57.2	37.6	1.7	0.9	2.4	1.5	1.6	3.0	-96.6	-13.4	9	5	-
S1_29	Surf	9943481	813062	4200	3500	54.7	NA	NA	NA	NA	NA	NA	NA	-95.3	-13.4	9	5	-
S1_06	Surf	9943505	810474	4076	600	110.9	NA	NA	NA	NA	NA	NA	NA	-98.3	-12.2	1	1	-
S1_26	Surf	9943507	812253	4143	2750	43.7	40.3	1.6	0.8	2.0	1.5	1.3	3.1	-98.2	-12.5	7	5	-
T_S1_19	Surf	9943514	812666	4179	2700	68.2	NA	NA	NA	NA	NA	NA	NA	-82.5	-10.9	8	5	-
S1_18	Surf	9943529	811891	4129	2500	48.9	NA	NA	NA	NA	NA	NA	NA	-104.5	-13.9	6	5	-
S1_07	Surf	9943548	810515	4078	700	124.5	46.2	2.7	9.9	7.8	4.2	2.8	6.3	-100.0	-12.5	1	1	-
S1_16	Surf	9943548	811455	4112	2190	127.7	NA	NA	NA	NA	NA	NA	NA	-102.4	-14.2	5	5	-
B_1	Surf	9943548	811455	4116	1850	128.7	38.8	2.4	6.3	5.5	2.8	2.0	5.1	NA	NA	31	3	-
S1_19	Surf	9943557	812079	4139	2700	47.7	48.5	1.8	1.2	3.9	1.7	2.2	4.1	-108.6	-13.8	6	5	-
S1_17	Surf	9943558	811675	4122	2300	52.9	45.6	1.9	1.4	4.1	2.1	2.1	3.9	-102.3	-13.5	6	5	-
A_1	Surf	9943562	811460	4116	2000	254.8	57.8	6.4	15.7	10.5	6.0	4.9	18.5	NA	NA	32	3	-
S1_23	Surf	9943566	812862	4189	3400	50.1	NA	NA	NA	NA	NA	NA	NA	-82.8	-11.5	8	5	-
S1_30	Surf	9943569	813246	4214	3700	54.2	35.5	1.3	1.1	2.7	1.9	1.8	4.2	-96.8	-13.5	9	5	-
S1_08	Surf	9943621	810526	4078	800	117.9	NA	NA	NA	NA	NA	NA	NA	-99.1	-12.5	1	1	-
T_S1_23	Surf	9943624	812177	4149	2670	44.1	NA	NA	NA	NA	NA	NA	NA	-107.8	-13.7	6	5	-
S1_15	Surf	9943630	811327	4107	1900	106.1	45.6	2.3	6.0	5.7	3.4	2.3	5.0	-99.8	-13.3	5	5	-
T_S1_24	Surf	9943638	812201	4155	2680	43.5	47.5	1.9	1.3	2.8	1.3	1.6	2.8	-108.3	-13.6	6	5	-
S1_22	Surf	9943661	813059	4204	3600	47.3	44.3	1.5	0.4	4.2	2.9	2.8	5.8	-84.6	-11.2	8	5	-
S1_31	Surf	9943669	813421	4230	3900	52.3	NA	NA	NA	NA	NA	NA	NA	-95.3	-13.1	9	5	-
3_2C	Surf	9943673	811237	4103	1620	142.0	42.3	1.8	3.9	6.7	3.4	2.3	5.4	NA	NA	31	3	-
S3_17	Surf	9943675	811337	4108	2020	75.2	NA	NA	NA	NA	NA	NA	NA	-103.1	-12.4	41	4	-

ID	Source	N (m)	E (m)	Elev.	Dist.	EC	SiO_2	Cl^-	SO_4^{2-}	Na^+	Mg^{2+}	K^+	Ca^{2+}	δ^2H	$\delta^{18}O$	Subcat.	Cat.	Geol.
S1_32	Surf	9943689	813619	4244	4100	52.8	35.8	1.5	1.0	2.9	1.8	1.9	4.1	-99.2	-13.0	9	5	-
S1_09	Surf	9943690	810581	4078	900	120.0	45.5	2.8	10.1	7.0	3.5	2.6	5.6	-100.4	-12.4	1	1	-
T_S1_08	Surf	9943703	811488	4116	1120	93.5	49.4	1.5	2.4	4.8	3.0	2.5	4.7	-98.9	-13.4	41	4	-
S1_10	Surf	9943706	810637	4079	1000	130.0	NA	NA	NA	NA	NA	NA	NA	-99.5	-13.3	1	1	-
S3_16	Surf	9943711	811540	4119	950	69.1	50.5	1.7	2.4	5.3	2.8	2.8	5.0	-103.2	-12.7	41	4	-
C_1	Surf	9943717	811140	4114	1840	131.6	39.7	2.9	9.3	3.8	1.9	1.5	3.2	NA	NA	31	3	-
S1_14	Surf	9943724	811178	4100	1500	144.9	42.7	3.2	6.5	6.7	3.4	2.3	8.1	-101.9	-13.5	31	3	-
S3_15	Surf	9943733	811602	4123	1220	90.1	49.6	1.6	0.6	6.9	5.7	3.7	6.8	-92.0	-11.4	41	4	-
S1_11	Surf	9943735	810706	4082	1100	110.0	45.3	2.9	9.5	6.9	3.7	2.6	5.9	-101.0	-12.2	1	1	-
S1_12	Surf	9943746	810801	4088	1200	120.0	NA	NA	NA	NA	NA	NA	NA	-99.6	-13.1	1	1	-
S1_33	Surf	9943756	813817	4259	4300	52.0	NA	NA	NA	NA	NA	NA	NA	-98.7	-12.8	9	5	-
S1_13	Surf	9943767	810978	4092	1300	134.9	46.8	3.0	10.7	7.4	4.0	2.7	6.4	-102.6	-13.4	1	1	-
21_1_2C	Surf	9943783	811014	4094	1345	247.2	59.7	1.5	19.1	11.4	5.9	3.3	10.5	NA	NA	21	2	-
S1_34	Surf	9943790	914018	4281	4500	49.1	34.5	1.9	2.2	2.2	1.4	1.5	2.9	-105.9	-13.7	9	5	-
S1_35	Surf	9943814	814221	4314	4700	50.6	NA	NA	NA	NA	NA	NA	NA	-101.4	-12.8	9	5	-
S1_21	Surf	9943817	813187	4225	3800	46.3	NA	NA	NA	NA	NA	NA	NA	-82.4	-11.4	8	5	-
S3_14	Surf	9943854	811772	4133	1545	91.5	NA	NA	NA	NA	NA	NA	NA	-95.4	-11.8	41	4	-
S1_36	Surf	9943871	814412	4324	4900	53.3	35.9	1.4	0.7	2.5	1.5	1.6	3.4	-103.6	-13.1	9	5	-
22_1_2C	Surf	9943878	811156	4050	1445	280.0	64.5	4.9	NA	15.6	7.1	4.4	12.3	NA	NA	22	2	-
21_2_2C	Surf	9943894	811126	4100	1420	202.0	47.9	0.8	11.8	9.8	4.9	2.8	8.9	NA	NA	21	2	-
S2_28	Surf	9943926	811107	4101	1500	11.8	10.6	1.3	0.8	1.0	0.3	0.4	1.2	-89.9	-12.5	23	2	-
S1_20	Surf	9943934	813378	4236	4000	42.5	40.7	1.6	0.5	3.3	2.0	2.2	4.4	-80.9	-11.3	8	5	-
S1_37	Surf	9943957	814637	4347	5100	49.9	NA	NA	NA	NA	NA	NA	NA	-99.5	-13.4	9	5	-
S1_38	Surf	9944019	814821	4365	5300	49.0	32.7	1.6	1.3	1.5	0.9	1.0	3.7	-96.7	-13.7	9	5	-
S3_13	Surf	9944046	811889	4146	1990	87.7	52.4	1.6	0.9	5.8	4.7	3.2	5.7	-95.0	-11.8	41	4	-
S1_39	Surf	9944090	815015	4386	5500	46.1	NA	NA	NA	NA	NA	NA	NA	-96.0	-13.5	9	5	-
S2_29	Surf	9944102	811177	4127	1700	9.4	10.5	1.6	1.0	1.3	0.3	0.5	1.5	-90.0	-12.4	23	2	-
S3_12	Surf	9944139	812070	4161	2190	71.3	NA	NA	NA	NA	NA	NA	NA	-104.9	-13.2	41	4	-
S1_40	Surf	9944153	815208	4410	5700	41.1	27.2	1.4	1.6	1.5	1.0	1.0	2.6	-96.5	-13.7	9	5	-
S3_11	Surf	9944207	812233	4172	2370	73.4	49.5	1.9	0.6	3.9	2.7	3.1	5.0	-98.4	-12.3	41	4	-
S2_27	Surf	9944207	811300	4138	1900	10.2	NA	NA	NA	NA	NA	NA	NA	-91.5	-12.3	23	2	-

ID	Source	N (m)	E (m)	Elev.	Dist.	EC	SiO_2	Cl^-	SO_4^{2-}	Na^+	Mg^{2+}	K^+	Ca^{2+}	δ^2H	$\delta^{18}O$	Subcat.	Cat.	Geol.
S1_41	Surf	9944209	815393	4431	5900	33.9	NA	NA	NA	NA	NA	NA	NA	-99.8	-13.1	9	5	-
S1_46	Surf	9944216	816351	4596	7000	23.5	11.4	2.1	3.2	1.2	0.5	0.7	2.3	-100.8	-13.7	9	5	-
S1_45	Surf	9944223	816189	4567	6800	24.8	NA	NA	NA	NA	NA	NA	NA	-99.8	-12.5	9	5	-
S1_44	Surf	9944233	816003	4538	6600	26.5	12.5	2.1	2.7	1.3	0.6	0.8	2.4	-96.8	-13.0	9	5	-
S1_47	Surf	9944273	816511	4634	7200	22.9	NA	NA	NA	NA	NA	NA	NA	-98.9	-13.4	9	5	-
S1_42	Surf	9944323	815567	4462	6100	32.5	19.8	1.3	2.0	1.4	0.8	1.0	2.7	-97.7	-13.9	9	5	-
S3_08	Surf	9944327	812892	4221	7000	41.0	NA	NA	NA	NA	NA	NA	NA	-95.5	-11.6	41	4	-
T_S1_39	Surf	9944328	815945	4522	6550	39.2	25.7	NA	NA	2.2	0.9	1.3	2.8	-108.0	-13.7	9	5	-
S3_09	Surf	9944331	812703	4207	6600	39.2	48.4	1.7	1.1	2.7	1.4	1.7	2.2	-100.3	-12.3	41	4	-
S3_10	Surf	9944331	812495	4190	7300	70.5	NA	NA	NA	NA	NA	NA	NA	-102.5	-13.2	41	4	-
S1_43	Surf	9944356	815746	4492	6300	31.8	NA	NA	NA	NA	NA	NA	NA	-97.3	-13.7	9	5	-
S1_48	Surf	9944382	816692	4673	7400	21.3	7.5	1.4	3.6	1.0	0.6	0.6	3.1	-100.9	-12.8	9	5	-
S2_26	Surf	9944402	811469	4148	2100	10.3	6.2	1.3	1.0	1.8	0.3	0.6	1.9	-90.7	-12.4	23	2	-
S3_07	Surf	9944403	813078	4236	3700	55.4	46.2	1.9	1.3	2.1	1.8	1.2	2.2	-100.6	-12.2	41	4	-
S3_06	Surf	9944505	813280	4257	3900	64.7	NA	NA	NA	NA	NA	NA	NA	-101.4	-12.9	43	4	-
S3_18	Surf	9944534	813410	4268	4030	55.1	44.6	1.6	0.6	3.3	3.2	2.0	4.3	-92.4	-12.1	42	4	-
S3_19	Surf	9944594	813565	4286	4230	32.9	NA	NA	NA	NA	NA	NA	NA	-99.7	-13.1	42	4	-
S2_25	Surf	9944600	811518	4157	2300	10.8	NA	NA	NA	NA	NA	NA	NA	-88.7	-12.3	23	2	-
S3_20	Surf	9944666	813704	4297	4430	51.2	62.8	2.0	1.2	4.1	1.8	2.8	4.3	-97.0	-15.7	42	4	-
S3_01	Surf	9944677	813367	4281	4100	68.7	54.1	1.6	1.7	2.3	2.7	1.4	2.8	-105.6	-12.9	43	4	-
S3_21	Surf	9944713	813880	4314	4630	30.7	NA	NA	NA	NA	NA	NA	NA	-103.7	-12.7	42	4	-
S3_02	Surf	9944766	813536	4303	4300	73.8	NA	NA	NA	NA	NA	NA	NA	-104.8	-12.9	43	4	-
S2_24	Surf	9944809	811679	4170	2500	9.8	11.5	1.5	0.9	1.4	0.2	0.4	1.1	-87.9	-12.7	23	2	-
S3_22	Surf	9944829	814097	4343	4830	45.8	53.2	1.8	1.6	4.0	2.0	2.6	4.9	-110.8	-14.0	42	4	-
S3_03	Surf	9944918	813657	4317	4500	69.5	58.3	1.7	1.4	3.7	3.1	2.6	4.0	-105.7	-13.3	43	4	-
S2_23	Surf	9944947	811791	4179	2700	9.5	NA	NA	NA	NA	NA	NA	NA	-88.5	-12.9	23	2	-
S2_01	Surf	9945081	811901	4188	2900	7.6	12.8	1.2	0.8	1.0	0.3	0.3	1.5	-93.0	-13.0	23	2	-
S3_04	Surf	9945090	813820	4341	4700	68.2	NA	NA	NA	NA	NA	NA	NA	-107.8	-13.8	43	4	-
S2_02	Surf	9945155	812102	4208	3100	6.6	NA	NA	NA	NA	NA	NA	NA	-93.5	-13.0	23	2	-
S3_05	Surf	9945164	813983	4370	4900	87.4	54.7	1.7	0.9	3.1	5.1	3.1	5.2	-106.5	-13.5	43	4	-
S2_03	Surf	9945262	812266	4232	3300	6.7	11.2	1.3	0.9	1.2	0.2	0.4	1.4	-95.2	-12.9	23	2	-

ID	Source	N (m)	E (m)	Elev.	Dist.	EC	SiO_2	Cl^-	SO_4^{2-}	Na^+	Mg^{2+}	K^+	Ca^{2+}	δ^2H	$\delta^{18}O$	Subcat.	Cat.	Geol.
Lake	Surf	9945276	815577	4664	7050	6.6	3.9	1.2	0.7	1.6	0.2	0.5	1.0	-87.6	-12.6	23	2	-
S2_22	Surf	9945276	815578	4664	7050	6.6	3.9	1.4	0.8	1.0	0.2	0.3	1.0	NA	NA	23	2	-
S2_21	Surf	9945331	815528	4650	6900	6.3	3.7	1.7	0.8	NA	NA	NA	NA	-94.9	-13.4	23	2	-
S2_04	Surf	9945351	812415	4237	3500	6.7	NA	NA	NA	NA	NA	NA	NA	-94.1	-12.9	23	2	-
S2_05	Surf	9945411	812613	4260	3700	6.5	13.3	1.2	0.8	1.2	0.2	0.3	1.5	-94.2	-12.8	23	2	-
S2_20	Surf	9945449	815378	4597	6700	6.4	NA	NA	NA	NA	NA	NA	NA	-95.5	-13.4	23	2	-
S2_15	Surf	9945503	814384	4431	5700	6.9	5.6	1.2	0.8	1.3	0.3	0.4	1.5	-97.4	-13.1	23	2	-
S2_19	Surf	9945504	815186	4552	6500	6.4	9.7	1.6	0.8	1.0	0.2	0.2	1.0	-93.0	-13.4	23	2	-
S2_17	Surf	9945509	814813	4489	6100	6.6	6.3	1.2	0.8	1.0	0.2	0.3	1.5	-97.2	-12.9	23	2	-
S2_14	Surf	9945510	814192	4413	5500	6.9	NA	NA	NA	NA	NA	NA	NA	-96.9	-13.2	23	2	-
S2_18	Surf	9945524	814995	4521	6300	7.5	NA	NA	NA	NA	NA	NA	NA	-95.8	-12.8	23	2	-
S2_06	Surf	9945534	812806	4275	3900	6.5	NA	NA	NA	NA	NA	NA	NA	-95.0	-12.7	23	2	-
S2_16	Surf	9945534	814618	4460	5900	6.7	NA	NA	NA	NA	NA	NA	NA	-96.6	-12.9	23	2	-
S2_07	Surf	9945599	813004	4294	4100	6.5	10.1	1.5	0.8	1.5	0.2	0.5	1.6	-96.0	-12.6	23	2	-
S2_13	Surf	9945612	813989	4397	5300	6.9	9.5	1.2	0.8	1.2	0.2	0.4	1.4	-97.2	-13.1	23	2	-
S2_12	Surf	9945716	813831	4370	5100	7.0	NA	NA	NA	NA	NA	NA	NA	-94.0	-12.4	23	2	-
S2_08	Surf	9945758	813117	4303	4300	6.4	NA	NA	NA	NA	NA	NA	NA	-94.0	-12.6	23	2	-
S2_11	Surf	9945769	813624	4353	4900	6.9	13.1	1.2	0.8	NA	NA	NA	NA	-94.6	-12.5	23	2	-
S2_10	Surf	9945858	813448	4338	4700	6.7	NA	NA	NA	NA	NA	NA	NA	-93.3	-12.4	23	2	-
S2_09	Surf	9945899	813229	4320	4500	6.5	11.5	1.3	0.8	1.1	0.1	0.3	1.3	-93.8	-12.5	23	2	-

Table A2. Statistical summary of the chemical components and stable istopes of water samples within the Los Crespos-Humboldt basin.

	EC	SiO_2	Cl^-	SO_4^{2-}	Na^+	Mg^{2+}	K^+	Ca^{2+}	δ^2H	$\delta^{18}O$
Ice (n=3)										
mean	-	-	1.9	0.5	1.0	0.0	0.3	1.3	-112.7	-14.4
std	-	-	0.9	0.1	0.0	0.1	0.5	0.6	1.0	0.2
min	-	-	1.3	0.4	1.0	0.0	0.0	1.0	-113.6	-14.6
max	-	-	2.9	0.6	1.0	0.1	1.0	2.2	-111.6	-14.2
Precipitation (n=4)										
mean	17.8	0.8	2.3	1.2	1.2	0.1	0.6	2.8	-51.4	-5.9
std	15.3	0.3	1.1	0.7	0.3	0.1	0.5	2.6	8.8	1.9
min	7.9	0.5	1.3	0.7	1.0	0.0	0.1	1.1	-59.5	-8.5
max	35.4	1.1	3.8	2.2	1.7	0.3	1.1	6.7	-42.4	-3.9
Springwater (n=46)										
mean	119.9	61.0	2.8	14.9	8.7	4.5	3.5	8.5	-99.5	-13.1
std	77.7	7.2	1.7	14.2	4.8	2.1	1.1	3.1	12.0	1.6
min	7.4	46.6	1.5	0.5	3.7	2.0	2.0	5.1	-112.0	-14.8
max	339.0	69.6	6.8	38.5	18.8	8.5	5.8	14.3	-35.9	-4.2
Surface water (n=113)										
mean	59.6	34.1	1.9	3.2	3.8	2.2	1.8	4.2	-97.5	-12.8
std	53.9	18.2	0.9	4.1	3.0	1.8	1.1	2.9	6.0	0.7
min	6.3	3.7	0.8	0.4	1.0	0.1	0.2	1.0	-110.8	-15.7
max	280.0	64.5	6.4	19.1	15.6	7.1	4.9	18.5	-80.9	-10.9