

## ***Interactive comment on* “Controls on spatial and temporal variability of streamflow and hydrochemistry in a glacierized catchment” by Michael Engel et al.**

### **Anonymous Referee #1**

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The manuscript of Engel et al., explores the influences of geology and nivo-meteorological parameters on stream hydrochemistry during baseflow and during the spring/summer. They set up a comprehensive field campaign in an alpine watershed for sampling hydrochemistry. An automatic daily sample was taken from the watershed outlet; in addition monthly sampling tackled stream chemistry along two main stream branches, springs, glacial outflow, etc. By this, Engel et al., collected a high-quality spatio-temporal data set in an alpine environment. They used this for an extensive statistical data analysis and found that hydrometric and geochemical dynamics are controlled by meteorology and geological heterogeneity. The approach is derived from a previous publication of the authors in a neighboring watershed (Penna et al.,

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2017), extending the analysis and supplying a novel high-quality data set. The focus on data presentation is one of the current limitations of the manuscript, already somewhat outlined in the introduction, when the authors stated that they want to fill the current research gap in alpine hydrology by “presenting data”. This may be the wrong start for this research paper, as it leads to a case study and simple report style manuscript, I rather expect that a detailed question will be answered or a theory challenged by hypothesis testing. For this – the otherwise very good introduction – may need to pinpoint the research gaps more specifically and could more often summarize how something influences response rather than what influences responses of alpine watersheds (cf. lines 81 ff.). I think this will help to narrow the focus and ease the writing. This is necessary, as I feel that parts of the manuscript are somewhat premature and not fully developed yet. The current focus of the manuscript is too much on the presentation of the data and thus becomes quite a heavy read in some sections (for me), where I felt that the selection of what is important for the understanding of the research gaps and the watershed was left to the reader. A more careful selection of the data and results that are presented in detail is necessary as it will help to streamline the manuscript and better guide the reader, e.g. how far is the presentation of turbidity data relevance for the processes (among other)? The current version seems to present all derived data without carefully considering the why behind the structure of the results and the presentation thereof. This relates to the most major limitation of the work: the lack of a clear story line (already mentioned above). I found some inconsistencies in the manuscript. It starts with the title where it is stated that spatial and temporal variability of streamflow will be assessed, while neither the hypotheses, the research objectives, nor the results come back to this. Therefore I would remove the hydrometric question from the title, especially since only one station was investigated. Next, the conclusion does not clearly link back to the research objectives, and actually cover quite a range of findings from controls on streamflow chemistry to the similarity the chemical composition of glacial melt and outflow from a rock glacier; yet the main finding is rather obvious “hydrometric and geochemical dynamics were controlled by an interplay of meteorolog-

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ical conditions and the geological heterogeneity". Several decades have looked at this (cf. Wolock et al., 1997); the finding is very general, probably applies to nearly every watershed and one does not require such an extensive sampling campaign to be answered. A clearer analysis of the research gap, and a more specific formulation thereof (the statement about the current gaps is rather general 103-106) may help, as a very general question leads to a very general answer, and a rather speculative discussion. This is obviously ok for parts of the paper, but also a sign that the questions asked may not be specific enough for being answered with the existing data set. So I would recommend to analyze the research gap more detailed and formulate objectives/hypothesis to tackling this. From there one can tidy up the results for a better guidance (helpful to the authors and the reader). I am convinced that this is possible considering the detailed and extensive field data sets and the experience of the research group in alpine environments. Last, I felt that quality of writing declined after the introduction, you may have another careful revision before submitting the revised manuscript.

Ref:Wolock, D. M., Fan, J., & Lawrence, G. B. (1997). Effects of basin size on low-flow stream chemistry and subsurface contact time in the Neversink River watershed, New York. *Hydrological Processes*, 11(9), 1273-1286.

Minor comments line 68 "... and topography with drainage ... and catchment shape" maybe delete the first "and" line 103ff, please revise and streamline. Maybe some more detail before this is needed. line 127ff, please also report mean elevation line 134, "current" does this mean 2018? Figure refers to 2006, which is not current. If 2018, why not unify this information with the figure? line 151, change "is" to "are" l155, add "At the catchment outlet" l157, the conversion to discharge is done via a rating curve, not via the salt dilution measurements. Yet, the rating curve is derived from these measurements. l164, suggestion: replace "tracer" with stream chemistry. Chemistry becomes a tracer when you infer processes, flow paths, etc. Otherwise, it is stream chemistry. l165, technically the sampling is not continuous l166, delete "Generally" l168, "respecting its seasonal variation", not sure what this should mean l172, "less than an hour"

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l190ff., needs more detail l198, “before the analysis”, delete “the” l223ff., “Then...” I do not understand this l232, change tracer to hydrochemical l246-256, this is a little awkward and the use of the terms old and new water quite confusing. What you actually do is calculating the discharge for the sub-catchments via the isotopic data and known discharge. So rather avoid the hydrograph separation terminology. l264, “signatures”, “. . .area are” l312, compared to what? l329, maybe l/km<sup>2</sup> to compare the watersheds l430ff., I found this section rather irritating. From my perception daily max temperature, max solar radiation, and the change (at least the decrease) of the snow cover are correlated. So how can you assess their impact in stream chemistry independently? Further, are you not mixing causation and correlation in this section? Hydrochemistry is caused by the amount of snow melt contributing to the streamflow, while you correlate the metrics that will lead to snowmelt with the hydrochemistry. l481ff., what is the link to the hypotheses or research question? l495ff., As connectivity is in the section header, one expects to more clearly link and discuss connectivity here, while the text itself is more about rock weathering etc. What is connected when? l569ff., see comment on l430. l594, are other met-station in the region available. Can one correlate these? The effect of topography is only marginally considered here, contrary to the sub-section’s header l619ff., Why are you not performing a hydrometric data analysis? l721, this is actually something we can say about every catchment without sampling for 2 yrs l739, see comment on l430 l743ff., how? Can you show this or elaborate on this final conclusion. Table1, change “average discharge (median)” to “median discharge” Table2, can you indicate the locations in the map of Figure 1. Figure 1, add locations of table 2., font sizes are different between the subplot and too small Figure 2, please adapt the figures after fig.2 to font size and font type of this figure. Figure 4, adapt color scale of a) b) to the same range for inter-comparison, font size too small Figure 7, 9, too small Figure 10, see comment l.430

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