RC1: 'Comment on egusphere-2024-927', Anonymous Referee #1, 13 Jun 2024

General Comments:

The authors present an interesting study of the Canfinal Rock Glacier in the Swiss Alps. They investigate the factors that have contributed to the rock glacier's flow and how the rock glacier contributes to spring flow during different times of year. The study was interesting, novel and I appreciate the use of multiple methods/lines of evidence to characterize the hydrological dynamics.

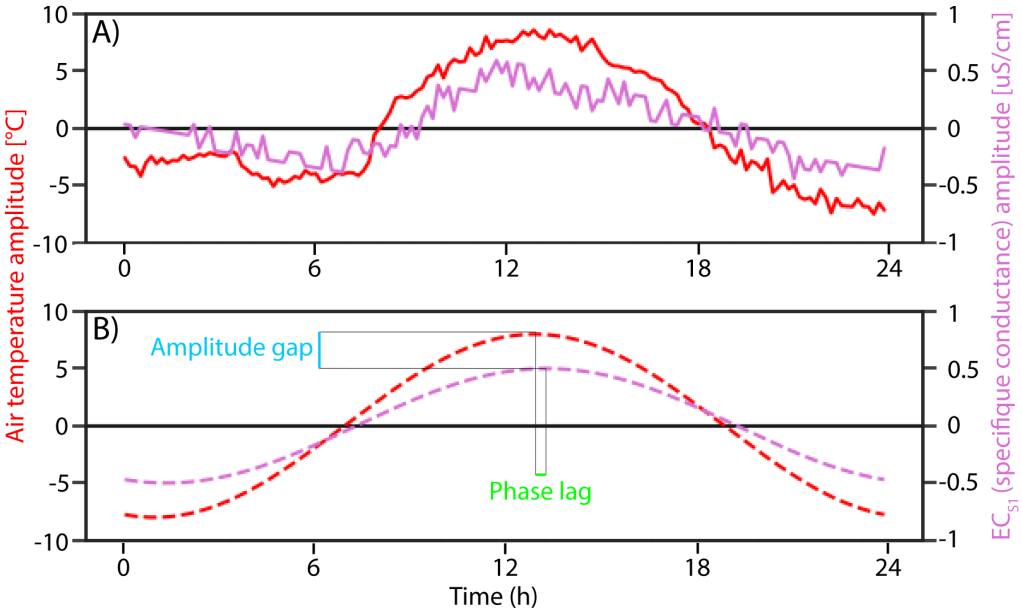
Author response (AR): Thank you for your positive feedback on the novelty of this work and for the constructive suggestions. We will address each of the comments.

My suggestions for improvement mostly focus on increasing context and detail in places. For the hydrochemistry results, more graphical representation of the hydrochemical signatures of different sample types and locations is needed. They are currently presented in PCA form in Figure 6 but the different waters (springs, streams, etc.) are not differentiated. Were any samples taken from the well? That would be interesting to see in comparison to the other samples. Consider adding an additional panel to Figure 6 to show EC versus some other ion with the sample types coloured or shaped by water type (spring, groundwater, stream, etc.) or location. Or else in panel B, you could make the points different shapes for different types of samples (although that may get too busy and be less clear). That way, the reader can easily see how the different samples and presumed end members relate to each other.

AR: Thank you for the insightful suggestions to improve the clarity and detail of the hydrochemistry results. We will enhance the graphical representation of the hydrochemical signatures in the future manuscript. We will make sure to update the Figures to differentiate the different water types (springs, streams, groundwater) by using distinct colours or shapes. We will also consider adding additional figures with scatter plots showing the relationship between the ions and electrical conductivities. Unfortunately, the wells are currently grouted, and the groundwater cannot be accessed for sampling.

In general, some additional explanation of the frequency-domain analysis methods and results would be helpful for readers who are not particularly familiar with these techniques. Around line 133, a conceptual statement about how the time-domain analysis is going to be interpreted would improve clarity. Consider adding a diagram to help clarify the phase shifting described on lines 148-150. In the results, the frequency-domain analysis results are not always intuitive, so some additional contextualization in text or annotation of the plots would likely help readers follow.

AR: In the future manuscript, we will provide additional explanation and context for the frequency-domain analysis methods and results. Around line 133, we will add a conceptual statement about how the time-domain analysis will be interpreted. Additionally, we will consider adding a figure like the one below to clarify the phase shifting described on lines 148-150 and provide more contextualization in the results section.



Specific Comments:

39: Briefly identify the other sources of water released from rock glaciers other than meltwater.

AR: We will add a brief description of other potential sources of water released from rock glaciers, such as precipitation, snowmelt and groundwater.

51: The hypotheses are nicely presented. Perhaps you could clarify that these hypotheses are not mutually exclusive. I.e., "…several hypotheses (which are not mutually exclusive) have been proposed…" if that is the case.

AR: Thank you for this suggestion. We will indeed revise the text to clarify that the hypotheses presented are not exclusive.

63: Could you add a sentence as to why this is the case?

AR: We will consider removing this hypothesis taken from the literature, as it is not highly pertinent.

64: The objectives are stated in the last paragraph of the introduction, but they come after mentioning the methods and the word objective is not used. I suggest stating 2-3 numbered objectives for maximum clarity.

AR: the reviewer is right that the actual format of the introduction can lead to confusions. We will reformat it and clearly state 2-3 numbered objectives.

121: Some basic details around sampling/analytical procedure (e.g., bottles, preservation, analytical equipment) would be expected here.

AR: In the future manuscript, we will include details on the sampling and analytical procedures used.

124: At this point, it's not clear what the correlation analysis is used for. Some explanation of the bigger picture is needed.

AR: The statistical analysis is aimed to identify the main water end-members. We will clarify this in the text illustrated by the new scatter plot figures.

Figure 4: Neat figure!

AR: Thanks!

158-169: These data sources and methods should be included in the methods section. Are there any limitations associated with ERA5 performance in mountains that should be acknowledged?

AR: Indeed - thanks for this suggestion. We will move the description of data sources and methods to the methods section and add a description on the limitation of ERA 5. We will include an assessment of ERA5 with nearby weather stations.

Figure 7: There are blocks in the EC data for April for S1, August for S2, January to March for S3 where EC is jumping between a certain value and 0 many times. Does that represent some kind of sensor error? Or is the spring going dry and reactivating in quick succession? This should be explained in the text.

AR: Thanks for spotting this. Indeed, it is when the sensors are not immersed because the water level at the spring is too low. We will modify the figures accordingly. We will also consider removing S2 and S3 because they are not analysed in depth in this study.

Figure 10: I suggest adding a legend entry for the light grey geologic material since all others are labeled (seasonally frozen talus hosting perennial ice lenses?). Also, why does the hillslope-scale flow line have such a bend? I found the captions "freezing conditions" and "thawing conditions" a little unclear and suggest simply "winter" and "summer" might be more intuitive.

AR: Indeed - we will simplify the flow lines in the conceptual model and modify the labels.

Technical Corrections:

188-189: The phrasing of this sentence is awkward, consider re-phrasing.

AR: A modification of this sentence will be considered in the future manuscript.

201: Should be "…this sampling campaign…"

AR: Noted.