Response to Referee #1

We appreciate the thoughtful suggestions of Referee #1 and their supportive assertion that our "*manuscript is an important contribution to the understanding of the hydrological/hydrogeological system of intact (active) rock glaciers*". Our goal in this study was to evaluate the contribution of water from rock glaciers to the overall hydrology of a high-elevation watershed, particularly late in the melt season. We are happy to see that the reviewer felt that we successfully achieved this objective.

Nonetheless, the Referee did raise several points in their general comments to which we wish to respond here:

First, the Referee felt that our sampling period was too short and that it was a disadvantage that we did not sample the early phase of snowmelt. We offer two arguments in response. The first is practical: the sampling site is more than 30 km away from the nearest plowed road and is completely inaccessible from the start of winter through late June. Thus it was not possible to collect water during the early summer. More significantly, the focus of our study was on the composition of water late in the melt season, thus collecting snowmelt-dominated water early in the year was unnecessary. We admit that in a perfect world it could be illuminating to collect water continuously from the onset of melt through freeze-up in the fall. Yet, given the snow-dominated nature of this mountain system, we would predict that the water we failed to collect in May/June would be nearly 100% snowmelt and not germane to our study objectives.

Second, the Referee notes that it could have been useful for us to collect measurements of spring discharge and electric conductivity. We agree, but unfortunately neither of these was possible during the summer of 2021 when our water samples were collected. Installation of a weir for recording discharge was not allowed in the terms of our research permit, and previous studies (as well as the reviewer themself) have noted the difficulty in accurately assessing rock glacier spring discharge because so much of the water flows below the ground surface. With respect to electric conductivity, a datalogger recording EC was deployed at one of the sites in this study (RG-1) during the summer of 2022. It recorded values that are low (8-16 µS/cm), but consistent with water draining from quartzite bedrock. Notably, values of EC rose steadily during the 2022 melt season, supporting the conclusion that late-summer discharge from this spring is dominated by water with a longer residence time and more extensive contact with fresh weatherable minerals.

Third, the Referee notes that a shorter sampling interval is necessary to see the influence of individual rainfall events. We argue that individual rainfall events, at least the more voluminous ones, are still detectable in our samples, which were collected at 12-hour intervals. As shown in our Figure 6, the local weather data to which we compare our data were collected at 1-hr intervals, and the major spikes in our data (hydrochemistry, isotopes) each align with precipitation events (or clusters of closely spaced storms).

Fourth, the Referee suggests that dye tracer tests would be helpful in evaluating the velocity of the quickflow component in these rock glacier systems. We agree, and although this was beyond the scope of our project, we will consider incorporating this approach in our future work.

Finally, the Referee mentions that a layer of unfrozen sediment could function as a groundwater reservoir below the implied frozen core of the rock glacier, and suggests that geophysical investigations could be used to evaluate this. We are aware of previous published models for rock glacial structure that postulate

such an unfrozen zone, and we would be interested in applying electrical resistivity or other techniques in the future to evaluate whether that model is valid for the rock glaciers we studied. As the Referee notes, such an unfrozen layer could yield water with higher EC, but the shifting isotope values and d-excess that we observed seem better explained by contributions from a reservoir of ice that has undergone numerous melt/freeze cycles.

We wish to thank the Referee for their careful reading of our manuscript, their encouraging assessment of our project's value, and their helpful suggestions of additional approaches to consider. Although we cannot go back to the summer of 2021 to make some of the measurements they recommend, we will certainly keep these suggestions in mind as we design future expansions of our rock glacier research.