Detailed comments to
“Water flow timing, quantity, and sources in a fractured high mountain permafrost rock wall” by Matan Ben-Asher, Antoine Chabas, Jean-Yves Josnin, Josué Bock, Emmanuel Malet, Amaël Poulain, Yves Perrette, and Florence Magni

L 18: AT --> air temperature

L 39: double citation of the same paper. Please correct.

L 48: Scandroglio at al 2020 doesn’t seems to be the right citation here. Remove.

L 69: … data and a snowmelt model to infer *timing and quantities of water flow* and constrain the hydrological pressure in the fractures.

L 69: You should mention here that for the first time they applied recession curves analysis to high alpine bedrock fractures, not later.

L 84: Weber et al 2017 is working on the Matterhorn – what about the Mont Blanc? Please explain.

L 88: Please clearly and precisely define here the research gaps you want to tackle. You might use bullet points or questions. (Remember that timing and quantity of water flow has been already intensively analyzed in Scandroglio et al 2025).

L 96 to 103: Is this description of the MBM relevant in this context? Please reduce and leave only information that is relevant in this context. No need for the whole geotectonical history of MBM. You are just a few meters under the surface, the reader wants to know what is the situation there, and not get confused.

L 118: Add country borders in the small map.

L 121: I suggest the use of local data instead of average data of the whole Europe, that are not necessary very representative for a unique climatic area, like the MBM.

L 122: What you here call AT is MAAT by convention. Please review overall and clarify if you are talking of MAAT or AT (daily or hourly values).

L 125-138: The reader gets completely lost in this paragraph: a lot of numbers and comparisons but it's hard to follow. You don't have to explain every figure. Please rephrase with only important information.

If you improve Figure 2 by adding the long-term comparison (1993-2022) for AT and precipitation, the comparison would be much easier for the reader.

L 131: remove: *“(continuous hourly records started in 1993 in Chamonix)”* – not relevant.

L 135: You talk about spring 2022 in the previous pargraph with other numbers. Why the repetiton? Clarify

L 143: Improve Figure 2: clearly separate data from Chamonix and AdM, add temperatures form Chamonix and long-term averages for both datasets AT /Precipitation

L 148-149-150: *"(Figure 3, Figure 4). Fluorescent dyes were poured into the snowpack on the rock face above the gallery to trace the water. Ground Surface Temperature (GST) sensors were installed on the rock surface, below and around the snowpack where fluorescent dyes were inserted."* These parts are repeated afterwards. Remove here.

L 154: -Figure 3: text overall too small, increase. *"North camera"* not readable because of the color.

L 165 Missing a verb.

L 173: "*in the vicinity*" define more precisely.

L 179: remove *"marks"*

L 191: Provide precise information in the fractures: length, opening, orientation.

L 203: "*five measurements*" of what? since it's a new paragraph, it is not clear what you are talking about. Clarify or unite to previous paragraph.

Figure 4: The yellow box is unclear to me: clarify what you want to show. What is the last picture on the right in the green box showing? please improve caption!

L 252: *"where flow paths could extend for several hundred meters."* You make an assumption that is not included in the cited paper and not based on any scientific data you present. Why do you suppose that?

How did you compute the path length here, at the AdM? I miss clear figures on: the positioning (depth) of your gallery with respect to the surface, the orientation if the clefts in the area, and a clear explanation on how you are computing path length.

From the Photo in Figure 3 it seems there are only a few meters from "Dye1" location and the galley. Add measures to Figure 3 / Text or include a 2D profile of the study area on scale.

L 253: *"widely open, sub vertical"* Quantify. If possible, provide also images. It seems adequate to present here a scan line/ fracture mapping of the tunnel / of the outside.

L 254: *"Additionally, Scandroglio et al. (2025) used a single best-fit curve for their entire dataset, which included only 23 events over eight years. In comparison, we used 93 events for recession curve analysis (out of 144 events that were recorded, see 4.1.5 for more details) over two consecutive.*» This is part of the discussion, move this sentence there.

How do you define events? This can variate from author to author. Add your definition, it seems to me you define an event for each daily cycles, both for rain and snowmelt. On the contrary Scandroglio et al 2025 considered only rain events and clearly defined events: *"An output flow event starts with a sudden increase in the discharge, independent of the starting value, and ends when the flow returns to a value smaller than a threshold … By convention, multiple flow events are classified as one if precipitation interruptions are shorter than 24 h and the resulting hydrograph at the gauges does not reach baseflow status between the two rain event."*
Please be precise and correct or remove this comment.

L 256: Please provide a list of all your events including date, duration and start/peak/end discharge.

L 263: 109 what?

L 268: You don't need to refer multiple time to Fig 5 in the same paragraph.

L 272: *"The timing and magnitude of flow differed between Box 1 and Box 2."* From my understanding box 1 and box2 were collecting water from the same cleft - now I'm confused. Are they not installed on the same metal plate on the ceiling? Please clarify the text before and improve the figures to make it clear!

L 272: Reference missing: please next time you submit a version of your article be sure all references are working. This problem is appearing many times in this article and makes work harder for reviewer.

L 276: This image is hard to read. What is "Max" adding as information here? why not removing it? would strongly improve clarity.
I also recommend using bars instead of a line for the volume of water, since it's "per day".
Is flow rate from 1, 2 or both? Clarify.

L 288: (2581 L): Interesting why so much water so late in summer. Is this summer snow melting?

L 289 Figure 6: You squeeze your most valuable data in these small graphs where it is not possible to properly differenciate the lines and read values. Use the whole page width for B and C, A can go alone or be moved to supplementary
- Showing only the period from mid-May to end of September.
- Maybe even rotate and put full page size.

L 291 – Figure 7: Same problem: This is your central Figure but it's very hard to read.

- consider increasing size and turning it 90°
- hourly flow rates are impossible to read at this scale - consider using daily values and make a zoom for hourly - (see Scandroglio et al 2025 fig. 2)
- add here information on the presence of snow, form the camera
- highlight important events with numbers/letters
- differentiate liquid and solid precipitation (using temperature)
- where is the caption????
- Flow rate = 1+2?

Quite some improvements can be achieved here…

L 293: It's impossible to evaluate the numbers you are suggesting from Fig 7. - provide a zoom (example period) and a statistical analysis.

L 294 - Figure S1: missing the y-axis
I find the analysis presented in S1 not scientifically based and the approach questionable. What is your thesis here, what do you want to prove? You are putting together periods with different length and making an average "curve". How did you decide the length of each period?
It would be much better to provide a statistical analysis. Alternatively, you could plot all cycles together and produce a density graph.

L 294: *"two orders of magnitude lower during the morning time"* where do I see that? please show

L 295: This table is uncomplete. Provide a proof for these values and further statistical information, like standard deviation? Is there a change with time (May to July to September) ?

L 298: S3 should be S2. How did you compute the values (3-9 and 0-3)? Demonstrate how you obtained these values. In the graph for GST the green shape covers the range 0-6.

L 305: *"Most likely fell as rain since the AT was positive«*. Temperature at the end of July 2022is under zero for quite some time (2-3 days… it's impossible to decipher form the picture). Please rephrase correctly.

L 328: *"This event was unusual because it lasted for 3 days"* It is worth to provide a detailed Figure on this event and other special events you talk about, at least in the supporting material. Please add.

L 336 same here

L 338: I suggest moving this information to a table, together with the numbers from 2022, for clarity and comparison.

L 340: 1033 L/day --> similar to Scandroglio et al 2025, comment in the discussion.

L 343: Refer here to fig S2. You extracted the flow recession and then fitted it. Why is just applied on some days and not on others? How do you select which day to fit and which not? Is this based on how well your recession is fitting? ("…values below 0.8…"). Sorry but if you reject the low values, it's not a surprise that you get high R^2 values.

Why are some flow recessions not starting from the maximum value? By selecting arbitrarily, the starting point of your flow recession you strongly influence the results.

From chapter 3.6.1 I understand that you rejected about 1/3 of your events. This is an elevated number, and they cannot be considered just as "outliers". I suggest reviewing the methodology used in this analysis, since these results are very important in your discussion and conclusions.

L 344: Interesting analysis. I see the trends you describe the ranges you provide are not representing what it is shown in the picture.

a = 7-10 to 8.5-5

b = 1-1.08 to 1.04-1.15

L 349: 0.75 … I read in the text 0.8. Use the same number.

L 362: The link with snow melting is clear, not only a hind. Rephrase.

L 364: *"Summer precipitation episodes are suggested when …"* Why don't you detect precipitation periods by using AT? it seems more obvious and direct for me

L 385 Repetition, check and remove.

L 403-404: Move to discussion

L 410 How do you explain the "*extended residence time*"?

L 415-416: move to discussion

L 438 – Figure 10: I very appreciate this analysis. Could you also provide the changes of water temperature in time? Why is there a peak at -8°C for AT?

L 455: "*direct precipitation*": what is direct precipitation? When is it indirect?

L 458: *"we conclude that water flow processes in high mountain rock faces are therefore seasonal,»* This is quite an obvious conclusion, not really a novelty. Your results are applicable "close to the surface" but not to bigger depth.

L 461: "*Show that snowmelt is the main source of water in the fractures during the early and main stages of flow, and contributes most of the water*." Similar result to Scandroglio et al 2025.

L 463 to 468: These are results, please move this paragraph to a more adequate position.

L 475: Definition of **heat wave**: "a prolonged period of unusually hot weather." Please clearly define which periods are "heat waves" for you, also with figures.

L 484: "Assuming that water…" Why assuming when you have measurements of water temperature! Show them in the supplementary material.

L 488: remove "likely"

L 494: What do you mean with "transfer rate" explain.

L 459 *"flow is unsaturated"* If the flow stops, there is no water moving, neither saturated nor unsaturated. Please rephrase.

L 496: *"This unsaturated flow shows that there are preferential flow paths into the fractures, leading to open paths available for the melting water of the snowpack in the following spring."* This is an assumption, prove it.

L 506: *"One reason for the delayed flow in Box 2 could be linked to the location of the draining area closer to the colder north face, while the draining area of Box 1 is closer to the west face, which is exposed to more solar radiation."* You can easily prove this by reporting the orientation of the fractures where you measure water flow.

L 519: Similar to Scandroglio et al 2025

L 529: Please add some references.

L 537: "his change in recession form, from aquifer-type (Equation 1) to channel-type (Equation 3) can be explained by the thawing of ice in wide sub-vertical fractures that are likely to react more individually (rather than as a network) and enable rapid flow in the fractured granite". This is a great finding, very interesting! To prove this hypothesis, It would be very important to see this change directly … e.g. by comparing some of the recession curves. I suggest adding a figure, here in the discussion.

L 555: Leinauer et al 2021 is actually using the model of Lehning et al 1999 : SNOWPACK

L 556: Meteorological forcing is driving the software SNOWPACK, therefore simulations are sensitive to it. Rephrase this sentence.

It seems to me that that hydrogeological parameters are highly uncertain also here. Rephrase.

L 560: which flow rate are you suggesting as a parameter for models? quantify it

L 567: *"..the highest numbers in July"*... any connection with your flow peaks 400 L/d and 1000 L/d ???

L 590: Why is this time indication unsaturated path? Where are you discussing this in the text?

L 615: What about data availability?