

Reviewer Report

Manuscript Information

Title: Potential glacier contributions to the 2024 La Bérarde flood

Journal: Natural Hazards and Earth System Sciences (NHESS)

Manuscript ID: egosphere-2026-466

General Assessment

This manuscript investigates the potential contribution of subglacial water pockets to the June 2024 flood event at La Bérarde in the French Alps. The authors combine ground-penetrating radar (GPR) measurements, mass-conservation ice thickness modelling, hydraulic potential calculations, and Monte Carlo uncertainty propagation to estimate the potential volume of subglacial water stored beneath the Glacier de Bonne Pierre.

The topic is highly relevant for natural hazard research since glacial outburst floods represent an increasing risk under ongoing glacier retreat and climate change. The study contributes to the understanding of water pocket outburst floods (WPOFs) and their possible role in extreme hydrological events. The methodological framework is generally appropriate and integrates several complementary techniques.

However, several conceptual and methodological issues require clarification before the manuscript can be considered for publication. In particular, the link between the modelling results and the actual flood event remains somewhat speculative. In addition, key modelling assumptions require stronger justification, and the discussion of uncertainties and model limitations should be expanded.

Overall, the manuscript is promising but requires revisions to improve clarity, strengthen interpretations, and better justify modelling choices.

Major Comments

1. Attribution of the flood mechanism

The study estimates a potential subglacial water storage volume of approximately $160 \times 10^3 \text{ m}^3$, but it does not demonstrate that this water actually contributed to the 2024 flood event. The manuscript acknowledges that the results represent theoretical storage capacity rather than a reconstruction of the event, yet the discussion sometimes suggests that the water pocket outburst flood mechanism is strongly supported.

The authors should clarify more explicitly that the study does not confirm the existence of a subglacial water pocket and that the results represent potential storage capacity. It would also be helpful to discuss whether the estimated volume could realistically account for the magnitude of the observed flood.

2. Justification of the flotation fraction

The flotation fraction parameter plays a dominant role in the uncertainty analysis. The manuscript assumes a flotation fraction range of

$$f \in [0.9, 1.1]$$

but the justification for this range is limited.

The authors should provide stronger references supporting this assumption and discuss whether values exceeding the ice overburden pressure ($f > 1$) are realistic in the study area. Since the results show that the flotation fraction contributes most to the uncertainty in water storage estimates, a more detailed discussion of this parameter is necessary.

3. Limitations of the steady-state hydrological model

The study relies on a steady-state hydraulic potential model to estimate subglacial water routing. However, the flood event itself was clearly dynamic and transient.

The authors should expand the discussion of the limitations associated with applying steady-state models to extreme flood events. In particular, it should be clarified that transient pressure changes and rapid drainage reorganization are not captured by the modelling framework used here.

4. Interpretation of GPR observations

The GPR survey detected possible subglacial water signals but did not identify clear evidence of large cavities or reservoirs.

The authors should discuss the detection limits of GPR and whether large water pockets could remain undetected due to signal attenuation or resolution limitations. This discussion is important given that the modelling results suggest the possible presence of a relatively large water volume.

5. Interaction between supraglacial and subglacial water systems

The manuscript proposes that the drainage of a supraglacial lake may interact with a subglacial reservoir to produce a compound flood event. However, this interaction is not directly demonstrated.

The authors should clarify whether hydraulic connections between the supraglacial lake and the subglacial system are observed or inferred. It would also be useful to discuss whether similar lake drainages have occurred in previous years and why the 2024 event might have been different.

Minor Comments

1. Terminology such as “water pocket”, “subglacial reservoir”, and “cavity” should be defined clearly and used consistently throughout the manuscript.
2. Section 5 (Discussion) is relatively long and could benefit from clearer sub-structure, for example by separating interpretation of results, flood mechanism scenarios, and model limitations.

3. Some figures (particularly Figures 3 and 4) are visually dense and could be improved by increasing contrast between hydraulic contours, flow paths, and water storage areas.
4. The uncertainty analysis is valuable but somewhat difficult to follow. A summary table presenting deterministic estimates, ensemble means, and uncertainty ranges would improve readability.
5. Minor language editing would improve clarity in several sections where sentences are particularly long.

Recommendation

Decision: Minor to Moderate Revision

The manuscript presents a valuable contribution but requires revisions to clarify interpretations, strengthen the justification of modelling assumptions, and expand the discussion of uncertainties and limitations. Addressing these comments will significantly improve the clarity and robustness of the manuscript.