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Understanding ice cave microclimate through thermo-fluid dynamics approaches: a case study from the southeastern Alps

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A critical topic in ice cave studies is the understanding of how the internal environment interacts with the external one and how these systems react to changes in the external conditions.
In this work, developed in the frame of the project C3 (Cave's Climate and Cryopshere), a numerical approach to understand ice cave microclimate is proposed.
Numerical studies can greatly contribute to a better understanding of the processes involved in the formation and preservation of permanent ice deposits in caves. Furthermore, computational fluid dynamic methods can be a valuable support to define new experimental setups and to interpret experimental results.
The cave studied in this work is the Leupa ice cave located in the Canin Massif, a sector of the Julian Alps (Italy and Slovenia), where the number of know cryo caves is close to 1,000 units.
Airflows inside Leupa ice cave are characterized with an integrated approach using both experimental and numerical methods. A finite volume solver is employed to solve the thermal fluid-dynamic behaviour inside the cave. This allows studying the influence of the external conditions on the internal dynamics and different cases are thus simulated.
New insights on the fluid-dynamic behaviour of this ice cave are achieved, showing that numerical methods could represent a powerful tool to study ice caves, improving and integrating the information that could be obtained from standard experimental measurements. This, in turns, could also lead to a more refined interpretation of paleoclimate archives preserved in such environments.