Response Letter

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Dear Editor,

We would like to sincerely thank you and the reviewers for the thorough and constructive evaluation of our manuscript. We are very grateful for the positive feedback and for the helpful comments and suggestions, which have allowed us to further improve the quality and clarity of the paper.

We agree that the Report format is more appropriate for the current focus of the manuscript. We are therefore pleased to proceed with revising the manuscript accordingly and will address the reviewers' comments in the response letter below, as well as the revised manuscript.

Below, we provide a detailed, point-by-point response to all reviewer comments and highlight the corresponding changes made in the revised version. Reviewer comments are shown in blue, our responses in black, and new text added to the manuscript in green.

Reviewer 1

General Feedback – The paper presents a large-scale experiment involving the deployment of various seismic instruments to monitor the unstable Cuolm da Vi slope. Overall, the paper is well-written, clear, and effectively communicates its objectives. The methodology, including the installation of instruments, design choices, justifications, and parameters, is thoroughly explained. While the focus is on the experimental design rather than data presentation, I look forward to future papers that will use the collected data. The recommendations provided in the discussion section are also particularly valuable.

Response — We sincerely thank the reviewer for the positive and encouraging assessment of our manuscript. We appreciate the constructive comments provided, which have helped us to further improve the potential applicability, clarity and precision of the paper. We respond to the specific comments below.

Point 1.1 — Section 3.2: What might explain the drop in displacement rates after 2003?

Response — In Section 3.2, we attribute the observed reduction in displacement rates after 2003 to the exceptionally dry conditions during the summer of that year (see black quote below). This prolonged drought at CdV presumably affected subsurface hydrogeological conditions, which in turn impacted slope kinematics. We agree that explicitly stating this improves clarity and have therefore added a brief clarification to the manuscript (in green), as shown in the revised text below.

> Annual displacement rates in the central area of CdV decreased markedly after 2002, from 20-40 cm/year in 2002 to 10-20 cm/year in subsequent years. This reduction followed the exceptionally dry year of 2003, which presumably induced long-lasting, large-scale changes in subsurface hydrological conditions (Amann, 2006).

Point 1.2 — The cost of such an experiment is not discussed in detail. While I understand costs may vary by country, it would be useful to provide a rough estimate. In addition, could the planning time be addressed? While the number of people involved and deployment duration are mentioned, a summary of the total time and cost would give the reader a more complete picture.

Response — We agree with the reviewer that summarizing the personnel involvement and time investment associated with the full data acquisition would provide valuable context. We have therefore added a new table to the Discussion section (see tracked manuscript) that roughly summarizes the time requirements for the different stages of the project, including pre-campaign planning, field deployment, and post-campaign data handling. In addition, we have added a short paragraph introducing this table and emphasizing the strong influence of site-specific conditions on these estimates.

With regard to monetary costs, we consider it challenging to provide a representative estimate (range) for several reasons. First, personnel costs vary substantially between countries, and a significant fraction of the work was carried out within the context of PhD and MSc projects. For this reason, we opted to report personnel involvement in terms of time rather than financial cost. Second, a large portion of the required equipment (e.g., fibre-optic interrogators, cables, and STRYDE nodes) was either provided by collaborating partners or already available within our department (see Acknowledgements), meaning that the associated costs would not be representative for other studies. For these reasons, we believe that expressing the "cost" of the experiment in terms of time investment provides a more transferable and useful metric for readers.

> The different stages of full data set acquisition, including pre-campaign planning and post-campaign data management, are time-intensive. An approximate overview of the associated time requirements for our case study is provided in Table 1. We emphasize that these estimates are strongly dependent on local site conditions and the specific objectives of the data acquisition. For example, if the measurements are conducted in more accessible and less challenging alpine terrain, both personnel involvement and overall time requirements may be substantially reduced.
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> Table 1: see document with tracked changes

Point 1.3 — The lessons learned and recommendations in the discussion are well-summarized. However, if you were to redesign the experiment, what, if anything, would you do differently (apart from reducing the DAS channel spacing)?

Response — Considering the resources and prior knowledge available during the survey design phase, we conclude that the implemented sensor layout seems fit for the original objectives and intended analyses. Nevertheless, we agree with the reviewer that it is valuable to reflect on how the experiment could be refined or extended based on the insights gained from the first observations.

We have therefore added a short paragraph at the end of the Discussion section outlining a realistic option for improving the monitoring configuration in a redesigned or future deployment. Rather than revising the existing layout, this paragraph focuses on a potential network extension that could significantly enhance the long-term monitoring capabilities in the CdV slope area. The added text reads:

> The multi-sensor configuration and data acquisition at CdV is an ongoing project including potential future extensions. A particularly valuable network addition would be the deployment

> of a fibre-optic cable extending from the CdV shoulder downslope into the valley, complementing the nodal array in this area. This would enable long-term monitoring of seismicity and strain patterns along the slope. To date, this extension has not been realised due to steep topography and associated logistical challenges; however, it appears feasible with additional resources and could provide substantial added value. If fibre-optic deployment along the slope remains impractical, alternative strategies for long-term seismic monitoring could be pursued, for example through the installation of several long-term seismic stations.

Point 1.4 — Section 4: The introduction paragraph contains some repetitions that could be avoided.

Response — We agree with the reviewer that the introductory paragraph of Section 4 contained some unnecessary repetitions. To improve clarity and conciseness, we have rewritten this paragraph to eliminate redundancies and sharpen the focus of the section. The revised paragraph now reads:

> Our research at Cuolm da Vi (CdV) is centred around three overarching themes: 1) resolving the 3D structure and identifying key subsurface features, 2) studying the slope dynamics and time-dependent processes, and 3) advancing nodal array and fibre-optic seismology for landslide characterization and monitoring. Because the targeted structures and processes likely span a wide range of spatial and temporal scales - from metres to kilometres and milliseconds to decades - multidisciplinary and very broadband observations are pivotal.

Point 1.5 — Section 5.1.2: There is a typo in the first sentence (missing verb).

Response — We thank the reviewer for pointing out the first sentence of Section 5.1.2. We have reformulated the sentence for improved clarity and readability. The revised text now reads:

> We achieved the deployment of 1,048 autonomous seismic STRYDE nodes (Manning et al., 2018; O'Toole et al., 2024) with notable efficiency, facilitated by their compact size and lightweight design (150 grams) proving advantageous in the alpine terrain at CdV. Deployment and retrieval were completed within 4 to 5 days by three teams of two people each. Each node was installed by drilling a 10 cm deep hole followed by tightly installing the node.

Point 1.6 — The scientific notation for gram should be "g," not "gr."

Response — We thank the reviewer for noting the incorrect scientific notation. We have corrected all instances of "gr" to the standard SI unit notation "g" in the manuscript. The relevant corrections in the Discussion section are highlighted below:

> Case 1: Deploying more than 1,000 sensors across terrain with approximately 800 m of elevation change was possible only because of their low weight (150 g) and small dimensions, which allowed one person to carry up to 100 nodes in a dedicated backpack.
>
> Case 2: Furthermore, considering that small explosive charges of around 50 g release limited energy, we are confident that the DAS layout likely allows recording data with a suffi ciently

high signal-to-noise ratio to detect and interpret natural seismic signals even during the noisier periods.

Reviewer 2

General Feedback – The authors present the installation and initial data examples from a comprehensive seismic and fibre-optic monitoring network at the Cuolm da Vi slope instability, one of the largest active deep-seated instabilities in the Alps. The deployment of more than 1,000 nodal seismic sensors and 6.5 km of fibre-optic cable for Distributed Acoustic and Strain Sensing represents an exceptional monitoring configuration, covering spatial and temporal scales from metres to kilometres and from milliseconds to years. This system enables high-resolution characterization of subsurface structures and time-dependent deformation processes across multiple dimensions.

First, I would like to congratulate the authors on successfully completing such an impressive field campaign and acquiring a truly unique, large-scale dataset on a slow-moving landslide. The manuscript clearly describes the installation procedures and provides informative preliminary data examples. It is well written and will serve as a valuable reference for future large-scale field monitoring efforts on slow-moving slope instabilities. I look forward to future studies by the authors that will use this exceptional dataset to reveal the internal structure of the Cuolm da Vi instability and to improve our understanding of its response to external forcing.

Response — We thank the reviewer for the positive evaluation of our manuscript and for acknowledging the scope and quality of the field deployment and dataset. We are grateful for the constructive and encouraging remarks, which underline the relevance of this work for future large-scale monitoring studies. Our response to the reviewer's specific comment is provided below.

Point 2.1 — While the manuscript states that acceleration phases of slope deformation typically occur between April and July, Figure 3b shows 4.5 years of displacement-rate data, and in two years (2021 and 2024) the deformation rate remains high well beyond July. Could the authors explain the factors that may have contributed to this deviation from the typical seasonal pattern?

Response — We agree with the reviewer's observation that in 2021 and 2024 the period of elevated displacement rates extends beyond July. The timing and magnitude of seasonal acceleration are likely controlled by year-to-year variations in meteorological conditions, particularly snow accumulation and temperature/snowmelt evolution from winter through spring to summer. To better reflect this variability, we have revised the corresponding paragraph in Section 3.2. The revised text now reads:

> The zoomed window in Figure 3b reveals pronounced and regular seasonal variations, with a distinct acceleration phase typically occurring from mid-to-late spring through early-to-mid summer. The magnitude and timing of this acceleration phase are likely correlated with the snowmelt period and therefore strongly depend on meteorological conditions from winter through summer. This phase is generally followed by a deceleration in late summer, that subsequently transitions into a longer period of oscillations around a background velocity of approximately 5mm/month during winter time.