General Comments:

The submitted work presents a dataset containing several digital outcrop models generated by UAV photogrammetry.

The main objectives of the dataset are to preserve outcrops in a rapidly changing climatic environment and to improve the understanding of low-angle normal fault formation processes..

Data acquisition and processing are described in considerable detail. The resulting DEMs and orthomosaics are evaluated with respect to their geometric quality using control points and official elevation models.

In addition, the authors present several potential applications of the dataset. The dataset is publicly accessible via Zenodo, supporting its findability and accessibility.

Significant & Data Quality: **Good**

In my view, the dataset is significant with regard to the stated objectives, and the overall data quality appears to be good. However, I can assess the broader geological significance only to a limited extent, as my background is mainly in photogrammetry.
Presentation Quality: **Fair**

My main concern relates to the presentation quality. Parts of the workflow are written in the style of a technical report or software manual. Some steps remain unclear, and the motivation for applying particular processing steps is not always sufficiently explained. The Discussion contains several statements that remain unclear or open to debate. It would benefit from a stronger focus on the main findings presented in the Results and from a clearer discussion of their implications. A reorganization of some subsections may also improve the overall structure and readability.

Specific comments:

----

1. The level of methodological detail appears somewhat unbalanced. For example, the manuscript reports detailed information on intermediate products, such as the number of points removed during sparse point-cloud filtering, while important information on the camera sensors is missing. Please provide the relevant camera specifications, including at least the sensor dimensions and image size in pixels.
Currently, Table 1 presents the following information on the cameras used: camera models, sensor type, lens focal length, and image resolution. Following this comment, we have added the sensor dimensions and image dimensions in pixels to Table 1.

2. The description of the photogrammetric workflow is partly too closely aligned with the sequence of processing steps in Agisoft Metashape, while the methodological purpose of these steps is not always sufficiently explained.
For example, around lines 130 ff., the procedure for establishing the GCPs is described, followed only briefly by the phrase “prior to tie-point filtering.” At this point, several important details remain unclear.
We have added additional information explaining the procedure to further clarify the workflow. Notably, we extended the introduction of the targeted use of control points by adding the

following sentence: "The aim was to correct the tens-of-meters georeferencing errors in the x, y, and z directions observed when generating the initial models without control points."

Please clarify what is meant by "Post-Processing Kinematic (PPK) data." Does this refer to PPK-corrected GNSS camera positions, and how were the underlying GNSS observations acquired and processed?
Agreed. "PPK-corrected GNSS camera positions" Is our intended meaning and we have modified the text accordingly. For models 11 and 12, image acquisition of 2022 was conducted using an unmanned aerial vehicle (UAV; Mavic 2 Pro, 20 MP Hasselblad camera) with a TopoDrone post-processed kinematics (PPK) upgrade (L1/ L2 GNSS receiver with built-in IMU). The details and processing are presented in the part "Acquisition and processing" of (Betlem et al., 2023). The reference is included in this manuscript.

Furthermore, the origin and use of the natural markers should be described more clearly. How were these markers identified, how were their coordinates determined, were they manually selected?
Agreed. We have modified the paragraph as follows, incorporating the suggested information: "Natural markers were strategically selected within the study area to correspond to rock features that had undergone limited erosion, as well as persistent landmarks such as hiking paths. They were distributed to provide coverage across the entire model. The coordinates of the markers were determined from the SwissALTI3D DEM for the z coordinate, which has a spatial resolution of 0.5 m (Swisstopo 2022a), and from the SwissIMAGE orthomosaic for the x and y coordinates, which has a ground resolution of 0.25 m in the alpine part of Switzerland (Swisstopo, 2022b). The SwissALTI3D dataset is based on LiDAR data, while the SwissIMAGE dataset is based on aerial imagery, both acquired through aerial surveys. The vertical accuracy of the SwissALTI3D dataset varies depending on elevation and the data acquisition method, with an estimated uncertainty of ±30 cm below 2000 m for recent LiDAR-derived data, ±50 cm below 2000 m for stereo-correlation data, and approximately ±1–3 m above 2000 m; manually updated areas based on measured points, breaklines, and surfaces exhibit mean deviations ranging from approximately 25 cm to 1 m (Swisstopo 2022a). The coordinates were manually selected and extracted in QGIS."

Another example is the filtering of tie points. Here, the text should (shortly) explain the purpose of the applied filtering steps, rather than only naming them.
Around line 110, we added the purpose of each filtering step as follows: "The tie points were consecutively filtered based on *Reconstruction Uncertainty* to remove points whose 3D positions were poorly constrained, *Projection Accuracy* to remove points showing poor consistency between their 3D positions and their projections in the images, and *Reprojection Error* to eliminate matches with high reprojection errors that were therefore potentially erroneous."

3. I suggest moving some aspects of the discussion into the introduction and motivation. In particular, the manuscript should more clearly distinguish the present work from previous studies, identify the resulting research gaps, and briefly summarize the raw data and derived products provided in the dataset.
Following similar comments by Reviewers 1 and 2, the Introduction has been substantially revised. We clarified the introduction by adding a brief overview of previous studies and by more explicitly highlighting the novelty of our work. In particular, we emphasize that our study stands out because of the large area covered and its regional-scale implications, allowing us to map and characterize low-angle normal fault systems over large distances.
In addition, we added a few sentences to clarify the raw data and the potential applications of the products derived from our dataset.
We added in the Introduction: "Previous Alpine DOMs studies have successfully combined high-resolution photogrammetry with field observations to investigate fault zones (Bistacchi et al., 2015; Manna et al., 2023), fracture networks (Binda et al., 2021), and slope instability and

related hazards (Menegoni et al., 2020), but have generally been limited to outcrop- to cliff-scale areas. FATDOM addresses this gap by providing 12 georeferenced DOMs covering 43 km² of the fossil distal rifted margin in the Swiss Alps, enabling regional-scale characterization of LANFs systems and other rift-related structures. The dataset includes high-resolution photogrammetric imagery together with derived DOMs and geospatial products, offering broad applications in structural geology, three-dimensional geological interpretation, quantitative outcrop analysis, comparison with geophysical data, and studies of landscape evolution."

4. Section 5.3, "Usability of the dataset," might be better placed outside the Discussion. The presented applications could be integrated into the Results section and revised within the corresponding subsections. This applies in particular to the 3D geometry of low-angle normal faults, the geological implications of the DOMs and their comparison with seismic data, and the use of the dataset for monitoring deglaciation.

Following this comment, we have reorganized Section "Usability of the dataset" by integrating the presented applications into the corresponding subsections of the Results section: 4.5 Preliminary results from the dataset (4.5.1 3D geometry of Low-Angle Normal Faults and 4.5.2 Use in geomorphology: monitoring deglaciation). In the Discussion, we kept the part 5.3 Geological implications of DOMs and comparison with seismic data. These subsections provide only examples and would require further investigation. Therefore, we believe that it is more appropriate to retain it in the Discussion, as it focuses on the broader geological interpretation and implications of the results.

5. Further methodological aspects and points requiring clarification are provided in the line-by-line comments below. As these comments arise directly from the respective text passages, I have retained them in the technical comments section.
Thank you for your suggestions. We have incorporated them into the revised manuscript.

Technical comments and suggestions(!)

- Abstract: "new possibilities" may be overstated; method established for more then 10 years (see your own related-work references, e.g. Wilkinson et al., 2016).
"new" has been removed.
L17: Unify number formatting (e.g. "12" vs. "twelve"). The number is also repeated within the same section.
The text has been modified accordingly.
- https://doi.org/10.5281/zenodo.18940068:
Consider creating one overarching Zenodo record for the complete dataset, with links to the individual subsets. This could avoid 12 separate references for what is presented as one dataset.
That is indeed something we explored and have done through the unified collection record at https://zenodo.org/records/18940068 (as mentioned in the abstract). The unified record contains both a PDF pointing to the (child)archives, as well as their links embedded in the metadata. However, to correctly persist the reference to the different archives, we also decided to include the record links to the 12 separate archives within the manuscript.
L35ff: "including low angle normal faults (LANF) systems found in present-day, deep-water, rifted margins in the South China Sea ..." — Clarify that the following items are examples in a list.
The text has been modified accordingly: "For example, LANFs systems have been investigated in present-day, deep-water, rifted margins in the South China Sea (Legeay et al., 2024), Galicia margin (Lymer et al., 2019), West of Ireland (Lymer et al., 2023), Somalia margin (Sapin et al., 2021), and elsewhere."

L47ff: “Geological investigations in this region typically rely on ‘conventional’ field methods and are strongly limited by accessibility.” — Specify what is meant by “conventional” field methods; consider combining with the preceding sentence.
The text has been modified specifying: “… including direct geological observations and structural measurements”.
L53: “the Err” — Check font style/formatting.
Font/style formatting has been fixed here and elsewhere throughout the manuscript.
Figure 1: Add units to the x-, y-, and z-axes
The figure has been modified accordingly.
Figure 2a: Red and purple are difficult to distinguish; consider using more contrasting colors.
The figure has been modified accordingly.
L94: “fly-bys” — Check whether the hyphen is needed; “flybys” may be preferable.
The text has been modified accordingly.
L95: “while manually re-focusing was done in between” — This change the internal camera parameter ("focal length") and influnce the quality of reconstruction. Should be discussed.
The text has been modified accordingly: “Manual camera lens focusing was completed between each image to manage variations in distance between the UAV and the outcrop during the flight.”
Table 1: Clarify the meaning of “Distance camera/outcrop normalized.” What does the scale represent, and what are its units?
The table has been modified accordingly. For more information, the script for generating normalized histograms is available as part of the open access processing bundle on Zenodo: https://doi.org/10.5281/zenodo.18417132
L110: Instead of emphasizing the number of points in the text, consider reporting model-quality indicators, such as camera-position accuracy and/or the mean reprojection error, as these are more relevant for the resulting dense point cloud and DEM.
These data can be accessed in the full processing reports available on Zenodo for each model, including camera-position accuracy, reprojection errors, processing parameters, and other relevant processing results. As these processing reports are already referred to in the manuscript, we decided not to include these indicators directly in the main text.
L110 and L116: Consider rounding the point-cloud sizes to millions, as only the order of magnitude is relevant here.
The text has been modified accordingly.
L121ff: Delete these lines.
We have deleted these lines.
L130: “Post-Processing Kinematic data” — Please clarify; do you mean PPK-corrected GNSS positions?
Agreed. The texthas been modified accordingly.
L131: “natural markers” — It is unclear how these markers and their coordinates were obtained. Were corresponding points manually selected in the SwissALTI3D DEM and the point cloud? Please explain.
The text has been modified accordingly. See the full response in the specific comments above.
General: The number of DOMs is repeated frequently (often “10”). Consider reducing these repetitions after stating it once in the relevant sections.
The text has been modified accordingly.
Table 3: Use consistent units (cm or m).
We chose to express the errors in X, Y, and Z in centimeters to be as precise as possible, and the overall error, which is larger, in meters.
L159: Are “DOMs” or “DEMs” meant here? Please clarify, preferably in the Introduction, how “DOM” is defined in this study: only the textured 3D mesh, or the complete set of products including DEM, orthophoto, point cloud, and mesh?
The following has been added in the Introduction: “…accurately georeferenced digital outcrop models (DOMs, corresponding to the textured 3D mesh)”. The following sentence has been changed in the Results: “The 3D reconstructions cover an area of 43 km².”

L174: Maybe add "... overlap of the captured images"
The text has been modified accordingly.
L185: What is the implication of this variation? Does it affect the accuracy or spatial resolution of the results? Consider addressing this in the Discussion.
Agreed. The following has been added in the Discussion : "Distance affects image resolution and, consequently, DOM accuracy."
L213: "Quality was ensured through manual inspection and (internal) error analysis." — Clarify what "internal error analysis" and "manual inspection" refer to. Does the former correspond to the error metrics listed above?
We have clarified the meaning of "internal error analysis" and "manual inspection" in the revised manuscript.
By "(internal) error analysis," we refer to the assessment of the error associated within each specific model (i.e., internal analysis) and between the model and the reference data. This analysis was performed using analytical calculations to quantify the error at the individual control-point level, as well as model-wide comparisons to the reference. It complements the aggregate error metrics derived from processing reported above and provides a more detailed assessment of the quality of the results.
By "manual inspection," we refer to an additional qualitative check of the data and results. We manually reviewed the outputs to verify that the values were plausible, internally consistent, and consistent with the expected characteristics of the data. This inspection was used to identify potential anomalous or inconsistent results that might not be fully captured by the quantitative error metrics. It also allowed for inspection of anomalous regions where models would deviate from the reference (e.g. due to snow packs, rock fall) and for the comparison of areas covered by multiple models (e.g., to compare a potential difference in height, texture, colour)
We have revised the corresponding sentence in the manuscript to make this distinction explicit: "Quality was ensured through internal error analysis (analytical calculations to quantify the error) and manual inspection (additional qualitative check of the data and results: we manually reviewed the outputs to verify that the values were plausible, internally consistent, and consistent with the expected characteristics of the data)."
L214: "model-wide" and "localized DEM differences" — Please clarify these terms. Do you mean overall model differences and local DEM differences? The sentence is unclear.
The text has been modified accordingly: "…including overall model differences and local DEM differences, and changes in terrain information."
Figure 3: Consider narrowing the elevation-difference scale. Since most differences lie between −1 and 1 m, would a narrower range provide more detail and make smaller spatial patterns easier to identify?
This is something which we considered but ultimate decided against in favor of a unified elevation-difference scale. The latter was selected so that it could be applied to all the models and allow direct comparison between each of the datasets.

L216: Are these values really always zero? To assess whether the differences may partly result from georeferencing offsets, consider also reporting the mean difference, mean absolute difference, and/or median.
We have added the mean difference, median difference, and mean absolute difference to better characterize the distribution of the differences.
We have further clarified this in the text: "The mean difference is ranging from -0.95 to 0.39 m, while the median difference is ranging from 0,34 to 1.58 m and the mean absolute difference is ranging to -0.75 to 0.12 m in the dataset. The close agreement between the mean and median, both being close to zero, suggests that there is no substantial systematic offset between the datasets."
And a table detailing these values for each model has been added to the supplementary materials. See Table B13.

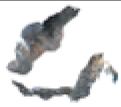
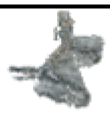
Digital outcrop model	Orthomosaic	Mean difference (m)	Mean absolute difference (m)	Median difference (m)
Piz Bardella	1 	0.090221	0.413848907	-0.0490723
Piz Surgonda and Corn Margun	2 	-0.6536768	0.802434895	-0.459717
Piz d' Err and Piz calderas	3 	-0.9489519	1.439172164	-0.752686
Piz d'Alp Val and Piz Bial	4 	-0.0582792	0.450174481	-0.0266113
Fuorcla d'Agnel south	5 	0.0643481	0.451686069	-0.0578613
Fuorcla d'Agnel north	6 	0.385333	1.357878065	0.0834961
Piz Jenatsch south 1	7 	-0.5518076	1.576015813	-0.148926
Piz Jenatsch south 2	8 	-0.3518944	1.141244093	-0.307861
Corn Alv	9 	-0.2241301	0.544582689	-0.218994
Piz Neir	10 	-0.0517488	0.3417924	-0.107178
Laviner and Jenatsch area	11 	0.1401318	0.539999893	0.117432
Val da Fain	12 	-0.0784191	0.54812367	-0.148193

Table B13: Comparison of each DEM with the regional SwissALTI3D reference DEM, showing elevation difference statistics for each model.

Figure 4: Add units to the axes.
The text has been modified accordingly.
L267: "... robust and stable surface features such as the CP4 in model 9 with an error in xyz of 0.21 m (Table B9)"
Consider focusing on more general patterns, comparisons between the derived parameters, and their relationships, as the detailed results have already been presented and are partly repetitive.

We have kept the general statement and removed the redundant example.
L270: The rationale and criteria for selecting the control points would be better placed in the Methods section.
This paragraph helps make the case for the quality of the checkpoints, so we believe it is best to include it in the discussion.
L294: I am not convinced by this statement. Recent UAV–SfM studies using RTK-GNSS report differences on the centimetre rather than metre scale (e.g. https://doi.org/10.5194/isprs-annals-X-1-2024-169-2024).
We have removed this sentence.
L348: "This can be explained by the acquisition of 3 045 images and 13 flights to cover an area of 4.08 km² for model 11 while model 3 is only based on 1 132 images and 8 flights acquired over a much larger area of 9.84 km² (Table 1)."
I am confused by this explanation. The number of images and survey area alone do not determine spatial resolution or ground sampling distance, which mainly depend on sensor and pixel size, focal length, and flight height. Please clarify.
Agreed. The intent of including that statement was to clarify that the differences in image resolution between models may be related to differences in the acquisition strategy rather than simply to the number of images or the surveyed area. In particular, the additional flights conducted for Model 11 may have included acquisitions at closer distances to the outcrop, providing finer ground sampling distances (GSDs) in some parts of the survey. More generally, variations in flight height, sensor-to-outcrop distance, and acquisition geometry can result in different spatial resolutions between models, even when the surveyed areas and numbers of images differ. We have therefore revised the text to avoid implying that the number of images or the surveyed area directly determines spatial resolution.
We added this paragraph in the text: "This difference may reflect differences in the image acquisition strategy between the models. In particular, the additional flights conducted for Model 11 may have included acquisitions at closer distances to the outcrop, resulting in finer resolution in some areas. More generally, differences in flight height, camera-to-outcrop distance, and acquisition geometry can lead to variations in spatial resolution between models, independently of the total number of images or the overall surveyed area (Table 1)."
L354ff: The following aspects are difficult to follow because the corresponding observations are not clearly presented in the Results. Please clarify what is blurred—the orthomosaic or the DEM—and how this relates to image overlap. It is also unclear why a pre-planned autonomous mission would avoid these effects.
The text has been modified accordingly. It now specifies that is the texture which is blurred, affecting the textured mesh, tiled model (texture), and orthomosaic.
This explanation has been added: "The observed blurring is related to insufficient image overlap, particularly near the edges of the model, where fewer images are available to reconstruct the same surface features. Higher overlap provides more redundant observations of the same areas, thereby improving image matching and the robustness of the photogrammetric reconstruction."
We also added after in the same paragraph: "A pre-planned mission could provide better coverage at the edges of the model if this is taken into account during the acquisition planning."

L361ff: As in the previous comment, the described effects are not clearly visible in the figures or presented in the Results. It is useful to mention them, but they should be described more clearly. Statements such as "The differences must be minor so they cannot be interpreted as geological structures or variations in lithology" appear speculative and should be better substantiated or rephrased.
The paragraph has been revised in accordance with your comments and we have added a figure in the supplementary material: "In the FATDOM dataset, these color and texture variations are generally spatially limited and can be identified as acquisition or reconstruction artefacts (Figure A12). They therefore have a limited impact on the interpretation of larger-scale geological features, such as distinct lithologies (e.g. basement versus sedimentary

rocks) or regional tectonic contacts (e.g. LANFs, as illustrated by model 11 in Figure 3, and Alpine thrusts, as illustrated by model 3 in Figure A3).

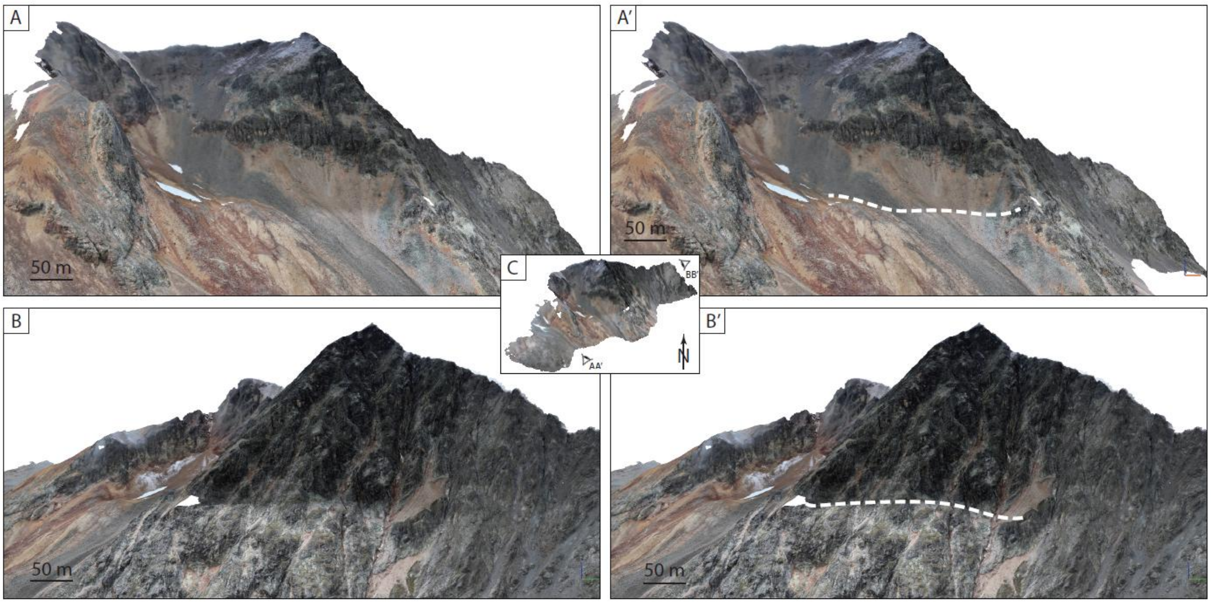


Figure A13: An example of acquisition-induced texture variation across the same lithology. In both A and B the texture variation is caused by A. View toward the northeast of the Fuorcla d'Agnel north model (6). A'. Same view as A, with the change in texture annotated with a white dashed line. B. View toward the southwest of the Fuorcla d'Agnel north model (6). B'. Same view as B, with the change in texture annotated with a white dashed line. C. Fuorcla d'Agnel north model (6).

L372: The statement is too vague in my opinion. Elevation estimates are also affected by image overlap and tie-point distribution. The main difference is that height determination is more sensitive to weak image geometry, such as nadir-only imagery, which can result in unfavorable intersection angles and increased sensitivity to calibration errors.
We modify the text accordingly adding: "Both planimetric and elevation estimates are constrained by image overlap and tie-point distribution. However, elevation determination is generally more sensitive to weak image geometry, particularly in nadir-only image configurations, which can lead to unfavorable intersection angles and increase the sensitivity of height estimates to image-matching uncertainties and camera calibration errors. This results in an anisotropic error distribution, with larger uncertainties typically affecting the vertical component, as documented in UAV-based SfM surveys (Gindraux et al., 2017; James et al., 2019)."
Section 5.2, "Comparison with other DOM datasets": Most of these aspects might be better placed in the Introduction, as they mainly describe the state of the art, define the research gap, and motivate the aims of the dataset. The main points could then be briefly revisited in the Discussion or Conclusion.
The text has been modified accordingly. See the full response in the specific comments.
L430: "All data were reprocessed following the protocol described above with 15 control points, whereas the georeferencing of the first model was based on GNSS data (total error of 0.25 m)." — Unnecessary repetition; consider shortening or deleting.
We have deleted these lines.

L515: Consider listing all published data types (images, GCPs, DOMs, DEMs, orthomosaics, etc.) near the beginning of the manuscript. Are the natural markers (image coordinates) also included in the dataset?
We thank the reviewer for pointing our this oversight. The natural markers (i.e., image coordinates) are to be included in an updated version of the published datasets. This will also

include the real-world coordinate information for each of the markers, as currently included only in in Appendix B (Tables B1–B12). We have clarified the types of published data in the manuscript accordingly.

L525ff: The following paragraph is poorly formatted and repeats information already provided in Table 5.

This paragraph was added to meet the quality check requirements, as the DOIs had to be included in the main text following the initial technical check. We agree that ideally only Table 5 should remain, alongside the master DOI provided in the abstract.

L551: This appears redundant with L555; consider merging both statements.

We have deleted this part of the first sentence: “in a setting heavily affected by ongoing climate change.”

L569: While I also hope this will be the case, the statement seems too informal for the manuscript and should be rephrased more formally.

The text has been modified accordingly: “This dataset provides a valuable resource for the structural geology community, supporting the investigation of extensional processes, oceanic opening, and the subsequent Alpine collision that shaped the present-day mountain belt. It also provides a valuable resource for the geomorphology community, enabling studies of landscape evolution driven by climate-related processes such as glaciation and erosion.”