Response to Editor

We sincerely thank the Editor for the careful and thorough evaluation of our revised manuscript and for the constructive comments provided. We have carefully addressed all points raised and have taken this opportunity to further improve the clarity, consistency, and robustness of the manuscript. Below, we provide a detailed, point-by-point response.

1. Clarification of interpretations versus hypotheses

Editor's comment:

The manuscript should ensure that interpretations about erosion drivers are clearly presented as hypotheses rather than definitive conclusions.

Response:

We fully agree with the Editor's recommendation and have undertaken a thorough revision of the manuscript to ensure that all interpretations related to the driving mechanisms of cliff retreat are presented in a cautious and hypothesis-based manner.

In particular, statements that could be interpreted as deterministic have been rephrased to reflect their interpretative nature. For example, expressions such as "cliff retreat is best interpreted as…" have been revised to "cliff retreat could be interpreted as…". This revision has been consistently applied throughout the manuscript (Sections 6 and 7, e.g. L599, L604, L702, L722, L725, L753, L776), especially in the discussion of coastal–periglacial coupling and process attribution.

This adjustment ensures a clearer distinction between empirical results (robustly supported by the statistical analysis) and process-based interpretations (which remain conceptual and require further validation).

2. Reference correction (Jackson et al.)

Editor's comment:

A reference appeared to be missing or incorrect in the reference list

Response:

This issue has been corrected. The reference has been updated to Jackson et al. (2012) (L63, L118, L1098) which is the appropriate citation, and it has now been properly included in the reference list.

3. Distinction between positional uncertainty and trend uncertainty

Editor's comment:

The manuscript should better distinguish shoreline positional uncertainty from trend (rate) uncertainty.

Response:

We appreciate this important observation and have revised the structure of the methodology section to improve clarity in this regard.

Specifically:

The former subsection structure has been reorganised. The previous subsection 4.4 has been removed to avoid conceptual ambiguity.

Section 4.2 now explicitly addresses shoreline extraction and positional uncertainty, including all contributing sources (pixel resolution, orthorectification, georeferencing and digitisation).

Section 4.3 now focuses exclusively on shoreline change statistics and regression modelling, clearly explaining how positional uncertainties are incorporated into the weighted least-squares framework.

In addition, we have revised the wording to avoid any implication that uncertainties are simply "absorbed" by regression confidence intervals.

4. Source and characteristics of satellite imagery (Google Earth Pro and others)

Editor's comment:

Clarification was required regarding the origin of satellite imagery, acquisition platforms, and download sources.

Response:

We have substantially revised the manuscript (Section 3.2 and Table 2) to clearly distinguish:

The original data providers (e.g. USGS, DigitalGlobe/Maxar),

The platforms used for access or visualisation (e.g. Google Earth Pro),

And the licensing requirements associated with each dataset.

We have clarified that (L253):

Optical imagery from 2001–2013 was accessed via Google Earth Pro, but their original sources are properly indicated.

The QuickBird-2 image (2003) was directly acquired from DigitalGlobe and used as the georeferencing reference dataset.

This clarification ensures transparency regarding data provenance.

5. Pixel size and resampling of Google Earth imagery

Editor's comment:

Concern regarding the effective spatial resolution of images downloaded from Google Earth Pro.

Response:

This aspect has been clarified in the revised manuscript (Section 3.2 and Table 2, L255 and L330).

We now explicitly distinguish between:

The original ground sampling distance (GSD) of the satellite sensor, and

The resampled pixel size (GSD^d) resulting from Google Earth Pro downloads.

Furthermore, for uncertainty estimation, we conservatively use the original GSD values rather than the resampled pixel size, thus avoiding overestimation of spatial resolution.

6. Handling of topographic effects and georeferencing approach

Editor's comment:

Clarification requested regarding orthorectification, GCP distribution, and treatment of topographic effects.

Response:

We have expanded the methodological description (L255 and L330) to clarify that:

Images obtained from Google Earth Pro were treated as quasi-orthorectified products with minimal terrain exaggeration.

All optical images lacking embedded georeferencing were aligned using a map-to-map georeferencing approach against the orthorectified QuickBird-2 reference image.

Ground Control Points (GCPs) were: (i) selected from stable geomorphic features (e.g. rocky outcrops, infrastructure), (ii) uniformly distributed across an area significantly larger than the study subset shown in Figure 1C, and (iii) used to ensure spatial consistency across the entire dataset.

We also clarify that reported RMSE values correspond to the entire georeferenced area, not only the subset of interest.

Additionally, a dedicated section has been included in the Supplementary Material (Section 1), providing: the imagery catalogue, their geographical location, and the spatial distribution of GCPs for each dataset.

7. Panchromatic vs multispectral imagery

Editor's comment:

Clarification needed on the type of satellite imagery used.

Response:

This has now been explicitly stated in the manuscript (L258 and L278). The analysis was conducted using panchromatic data, consistent with the spatial resolutions reported.

8. Inclusion of imagery and data availability

Editor's comment:

Suggestion to include imagery examples and improve data accessibility.

Response:

We have addressed this by:

Including a comprehensive image catalogue in the Supplementary Material (Section 1), covering both optical and SAR datasets used in the analysis.

Indicating our intention to make the dataset publicly available (e.g. via a repository such as Zenodo) upon acceptance, in accordance with journal policies.

9. Description of SAR PAZ data

Editor's comment:

Insufficient detail on SAR data characteristics and acquisition mode.

Response:

We have revised the description of SAR data (Section 3.2, Table 2 and Section 4.1 L345) to clarify that: (i) PAZ data correspond to high-resolution spotlight mode acquisitions, (ii) the native resolution is rectangular (0.6 × 1.05 m), (iii) terrain correction was applied using the Range Doppler Terrain Correction (RDTC) algorithm in SNAP, and (iv) the output products were resampled to a consistent 0.6 m grid for analysis.

This ensures an accurate and transparent description of the SAR dataset.

10. Figure quality

Editor's comment:

Figure 1 lacked adequate resolution.

Response:

The figure has been re-exported using a higher-quality rendering pdf workflow. We expect the revised pdf file version to be significantly clearer and fully legible. Individual versions of each image, with sufficient print quality, can also be provided if required.

11. Terminology and headings

Editor's comment:

Suggestions regarding terminology and section headings.

Response:

All recommended changes have been implemented, including:

“Case study location” to “Study area” L141

“Multitemporal imaging geoinformation”to “Multi-temporal imagery” L213

“Orthophotogrammetric restitution” to “photogrammetrically derived orthophoto” L322

These revisions improve clarity and align terminology with current conventions.

12. Cliff height information

Editor’s comment:

Cliff height was not reported.

Response:

Cliff height has now been included in the Study Area section (Section 2, L198), derived from recent UAV-based photogrammetric reconstructions.

We believe that the revisions made in response to the Editor’s comments have substantially improved the rigour, clarity, and transparency of the manuscript, particularly with respect to geospatial processing and uncertainty treatment.

We are grateful for the Editor’s detailed and insightful feedback, which has significantly strengthened the final version of this work.