**RESPONSE TO EDITOR AND REVIEWERS**

**Manuscript:** Projecting the Response of Greenland's Peripheral Glaciers to Future Climate Change
**Authors:** Muhammad Shafeeque et al.
**MS No:** egusphere-2024-2184

**Following responses represent the implementation of revisions previously outlined to the editor prior to being invited to submit the revised manuscript. We provide concise, point-by-point replies to all comments. All revisions are visible in the track-changes version of the manuscript. The supplementary material has been updated accordingly.**

**Notes:**

1. *Line numbers refer to the tracked-changes version of the revised manuscript.*
2. *This document is a condensed version of the comprehensive responses previously provided to both reviewers.*

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We thank the editor and reviewers for their thorough evaluation and constructive feedback. Below we respond to each comment in the order received.

## EDITOR COMMENTS

**Comment 1:** Catchment-scale approach not possible (agreed), but clarify your glacier-centric approach.

**Response:** We have clarified our glacier-centric "fixed-gauge" approach in the methodology section.

**Where corrected:** Section 2.3.4

**Changes made:**

- Explained that our approach tracks runoff from initial glacier boundaries as glaciers retreat
- Justified why this is standard in glacier hydrology, including relevant literature
- Clarified that OGGM is designed for glacier-centric modeling and cannot handle complex multi-glacier catchments
- Distinguished "glacier peak water" from "catchment peak water"

**Comment 2:** Need more justification on precipitation scaling factor (fp = 1.6), including validation against station data or high-resolution modeling.

**Response:** We have added comprehensive precipitation validation analysis against high-resolution modeling data.

**Where corrected:** Section 2.3.2; Supplementary Information

**Changes made:**

- Added validation against WRF high-resolution data (2014-2018) for FIIC region
- Created **Supplementary Table S1** with statistical metrics (mean bias: 6.4 mm/month, correlation r = 0.57)
- Created **Supplementary Figure S1** with validation analysis showing agreement
- Explained that fp = 1.6 was adopted from OGGM v1.4 framework (Maussion et al., 2019, Cross-Validation Dataset)
- Clarified that glacier-specific calibration of μ compensates for residual precipitation biases
- Created **Supplementary Table S2** listing all model parameters, values, and calibration methods

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## REVIEWER 1

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**MAJOR COMMENTS**

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**1. Multi-model comparison request**

**Reviewer Comment:** Add comparison with global models and statistical comparison.

**Final Response:**
We thank the reviewer for this suggestion. We added a multi-model comparison **Table 2** and relevant discussion in **Section 4.1** (approx. lines 558-585) and in **Supplementary Figures S19 and S20**.
A summary table and statistical metrics (Mean Absolute Difference, Coefficient of Variation, and uncertainty-range overlap) are provided in **Supplementary Table S3**.

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**2. Section 2 restructuring and clearer distinction of data, model, calibration**

**Reviewer Comment:** Improve organization of Section 2.

**Final Response:**
Section 2 has been restructured exactly as suggested.
The new layout appears in **Section 2** (lines 93–345).
The precipitation factor $f_p$ explanation is added in **Section 2.3.2** (lines 237-254) and detailed validation analysis results are provided in Table S1 and Figure S1 in **supplementary information**.

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**3. Reproducibility and OGGM version**

**Reviewer Comment:** Specify OGGM version.

**Final Response:**
We now specify in **Section 2.3** (approx. line 197-198) that we use **OGGM v1.5.3** with the enhanced frontal ablation implementation following **Malles et al. (2023)**.
This is also included in the **Data and Code Availability** statement.

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**4. Missing discussion of oceanic forcing implications**

**Reviewer Comment:** Discuss consequences of lacking oceanic forcing.

**Final Response:**
We added a dedicated discussion of missing oceanic forcing in **Section 4.4** (approx. lines 845-864), describing potential underestimation of solid ice discharge, regional impacts, and how ocean thermal forcing may modify projections.

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**5. Regional variability analysis**

**Reviewer Comment:** Expand regional analysis.

**Final Response:**
We expanded regional interpretation in **Section 3 and 4**.
Additional subregional characteristics, climate drivers, and glacier geometry explanations are added.
Supplementary figures S2–S18 now support this analysis.

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**6. Figure quality**

**Reviewer Comment:** Clarify representation, revise palettes, unify axes.

**Final Response:**
All the Figures including 3 and 4 have been updated.
Clarifications added to captions:

- Glaciers shown as polygons from RGI
- Axis ranges unified
- Colorblind-safe palettes applied
- Smoothing method specified

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**7. Precipitation factor fp calibration**

**Reviewer Comment:** Explain fp and include parameter table.

**Final Response:**
We clarify that fp = 1.6 is a global OGGM value and not calibrated in this study. We have added comprehensive precipitation validation analysis against high-resolution modeling data (**Supplementary Table S1 and Figure S1**).

Explanation added in **Section 2.3.2**.

A complete parameter table is included in **Supplementary Table S2**.

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**MINOR COMMENTS**

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**8. Abstract clarification**

**Final Response:**
Clarified in **Abstract** (lines 17–18) that values represent ensemble mean ± 1 SD across 10 GCMs for SSP126 to SSP585.

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**9. Fig. 1 MT definition and symbol clarity**

**Final Response:**
"Marine-terminating" is defined in **Figure 1 caption**.
Instead of Triangles, we used dots with reduced in size and transparency increased.

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**10. Fig. 1c wording**

**Final Response:**
Changed to "Number of glaciers".

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**11. Delta method explanation (L125)**

**Final Response:**
Expanded description added to **Section 2.2.1** (approx. lines 148–162).

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**12. Clarify statistical test choices (L234)**

**Final Response:**
Clarified in **Section 2.4** why different tests are applied based on data distribution (lines 344–345).

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**13. Figure 3 smoothing and shared y-axis**

**Final Response:**
Caption updated to state LOESS smoothing applied to mean and confidence intervals.
Shared y-axis implemented.
Changes at **Figure 3 caption**.

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**14. Section 3.2 temporal and spatial comparison**

**Final Response:**
Expanded comparisons in **Section 3** and 4.

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**15. Reference format consistency**

**Final Response:**
All references standardized to journal guidelines.

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**16. Zenodo data level**

**Final Response:**
Clarified in **Data Availability** section (end of manuscript) that data include glacier-ID-level outputs and subregional aggregates.

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## REVIEWER 2

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**MAJOR COMMENTS**

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**1. Hydrological catchments vs glacier outlines**

**Final Response:**
We retain the glacier-centric fixed-gauge approach due to OGGM design constraints. Explanation added in **Section 2.3.4** (approx. lines 278-319).

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**2. Regional variability and deeper analysis**

**Final Response:**
Expanded regional analysis added in **Sections 3 and 4**.

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**3. Figure formatting and consistency**

**Final Response:**
All major figures reformatted for consistency.
Updates applied to **Figures 1–8**, with captions revised.

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**SPECIFIC COMMENTS**

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**L57 “significant mass loss process”**

**Response:**
Quantification added in **Section 1** (approx. lines 56–61).

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**L70 cold-based regime explanation**

**Response:**
Brief explanation added in **Section 1** (approx. lines 73–77).

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**L74ff add key dataset/method details**

**Response:**
Paragraph expanded in **Section 1** (approx. lines 82–85).

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**L92 FIIC subdivision**

**Response:**
Clarified in **Section 2.1** (approx. lines 100–106).
Original RGI outline added to **Figure 1b**.

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**L94 active vs inactive calving basins**

**Response:**
Definition clarified in **Section 2.1** (approx. lines 104–106).

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**L105 precipitation correction**

**Response:**
Clarified in **Section 2.3.2** (approx. lines 239–254).

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**L113ff GCM selection justification**

**Response:**
Explanation added in **Section 2.2.1** (approx. lines 125–145).

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**L125 bias correction and interpolation**

**Response:**
Detailed clarification added in **Section 2.2.1** (approx. lines 153–162).

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**L147 resolution suitable for glacier size**

**Response:**
OGGM grid resolution formula added in **Section 2.3.1** (approx. lines 200–206).

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**L161ff lapse rate specification**

**Response:**
Moved climate description to **Section 2.2.1** and clarified lapse rate (constant −6.5 K $km^{-1}$) at approx. **lines 160–162**.

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**L171 precipitation correction confusion**

**Response:**
Sequence clarified in revised **Section 2.2.1–2.3.5**.

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**L197ff runoff terminology**

**Response:**
Clarified fixed-gauge definition in **Section 2.3.4** (approx. lines 278–316).

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**L204ff peak water definition consistency**

**Response:**
Clarified glacier peak water definition in **Section 2.3.4**.

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**L222 subsection title**

**Response:**
Changed to "Statistical Analysis" in **Section 2.4**.

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**Fig. 3 FIIC area stability**

**Response:**
Explanation added in **Section 4.1 and 4.2**.

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**L253 add Central-West volume loss**

**Response:**
Added in **Section 3.1**. (line 373)

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**L256 ANOVA numbers removed**

**Response:**
Defined $p < 0.05$ in **Section 2.4**.
Removed detailed ANOVA outputs from **Section 3**.

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**L290ff remove redundant sentence**

**Response:**
Sentence removed in **Section 3.1**.

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**L303 runoff dominance statement**

**Response:**
Added summary paragraph in **Section 3.2** (approx. lines 431-432 & 483-489).

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**L312ff predictable off-glacier increase**

**Response:**
Clarified rationale in **Section 4.2** (approx. lines 717-721).

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**Fig. 7 off-glacier rain missing**

**Response:**
Updated with decimal precision. Added in **Figure 7**.

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**Fig. 8 non-monotonic peak water in SE**

**Response:**
Brief explanation added in **Section 3.3** (approx. lines 531-537).

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**L345 domain consistency**

**Response:**
Clarified in **Section 4.1** (approx. lines 551-553).

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**L357ff NE and FIIC resilience**

**Response:**
Added detailed but concise explanation at different locations in **Section 4**.

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**L376 calving-dominated wording**

**Response:**
Updated in **Section 3.2** (approx. line 490-491).

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**L384 MT glacier ratios**

**Response:**
Statistics added in **Section 3.2** (approx. lines 447–459).
Time-evolving MT number and area percentages added in Figure 6b.

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**L385 ocean forcing reference removed**

**Response:**
Corrected in **Section 3.2** (approx. line 477-482).

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**L394 regional runoff contribution**

**Response:**
Expanded in **Section 3.2** and 4.2 (approx. lines 490-498 & 664-711).

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**L403 melt season description**

**Response:**
Rephrased in **Section 4.2** (line approx. 721-723).

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**L413 equilibrium statement**

**Response:**
Clarified in **Section 4.2** (approx. lines 736-742).

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**L422 ocean feedback removed**

**Response:**
Corrected in **Section 4.2** (approx. line 747-749).

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**L459 regional impacts**

**Response:**
Expanded in **Section 4.3** (approx. lines 780–794).

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**Section 4.4 restructuring**

**Response:**
Restructured exactly as suggested.
Revised **Section 4.4** now lines approx. **805–897**.

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**L537 add methods summary at start of conclusion**

**Response:**
Two-sentence summary added to **Conclusion** (approx. lines 899–904).

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**L540f catchment remark**

**Response:**
Clarified glacier-centric scope in **Conclusion** (lines 909-914).

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**L544–545 equilibrium vs exhaustion**

**Response:**
Clarified in **Conclusion** (approx. lines 929-935).

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**L551ff expand emission-scenario differences**

**Response:**
Added to **Conclusion** (approx. lines 905-945).

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**TECHNICAL COMMENTS**

All technical corrections implemented exactly as suggested:

- consistent decimals (line 33)
- smaller MT symbols (revised **Figure 1**)
- remove duplicate greys (updated **Figure 1**)
- consistent capitalization of FIIC (**revised**)
- Table 1 font uniform (revised **Table 1**)
- SIA usage standardized (**revised**)
- grammar corrections (**revised multiple locations as suggested**)
- rephrased lines (rephrased **multiple locations as suggested**)
- consistent units (**mm/yr**, **%/yr**) across text and figures
- Figure 3 and 4 colormaps replaced with sequential uniform colormap
- legend cleanup and regional label alignment for Figures 3–8 (revised all)
- axis consistency (y=0 start where relevant)
- explanatory note on $mm/yr^2$ added (**Section 3.1 line 403-405**)

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