

Review report

Manuscript Number: tc-2023-119.

Full Title: Globally consistent estimates of high-resolution Antarctic ice mass balance and spatially-resolved glacial isostatic adjustment

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Submitted to *The Cryosphere*

Recommendation: Minor revision

In this paper, the authors present a successful joint global inversion approach with a primary focus on Antarctica's mass balance. Utilizing diverse datasets, including GRACE/GRACE-FO, CryoSat-2, regional climate modeling, and firn modeling, the study analyzes the spatial characteristics of the Antarctic GIA component (Glacial Isostatic Adjustment). A distinguishing feature of this work is its deviation from previous studies, which predominantly relied on the GIA forward modeling constraints. The paper further indicates its capacity to discern changes in ice mass balance at a high spatial resolution (50 kilometers). Additionally, the authors delve into the quantitative evaluation of result uncertainty, a pivotal component in such analyses, by incorporating weightings that hinge on the input data's uncertainty.

The introductory section of the paper effectively provides a comprehensive overview of the paper's objectives, theoretical framework, and relevance in the context of prior research. This well-structured introduction serves as a solid foundation, elucidating the research's objectives for the readers.

Analysis of Results and Interpretations in Section 4.3, devoted to analyzing results and their interpretations, warrants improvement in structure and clarity. Reorganizing this section, employing clear and concise language, logical arrangement, and distinct paragraphs for each subject, is recommended. These enhancements will significantly enhance the comprehensibility of the information presented, aiding readers in deriving meaningful insights.

The paper is praiseworthy for its meticulous approach to data handling and analysis, which has led to high-quality findings. The results presented in the form possess substantial scientific value, rendering them well-suited for publication in *The Cryosphere*.

In conclusion, with appropriate improvements to the logical structure, particularly within section 4.3, and minor revisions, this study can significantly contribute to *The Cryosphere*. This paper, including the robustness of the results and the comprehensive analysis of various datasets, is suitable for publication.

Below, we will comment on section 4.3 and list technical minor points on this manuscript.

About section 4.3:

In Section 4.3, the discussion primarily centers on the correlation between the spatial patterns derived through the current approach and the interplay between the analysis methodology and its outcomes. Furthermore, this section

aims to enhance the physical comprehension of each dataset about Antarctica in this thesis. Critical objectives for this section include characterizing the spatial distribution of Antarctic Glacial Isostatic Adjustment (GIA) as determined by the current approach, summarizing the distinctive attributes and benefits of the present methodology, and offering physical interpretations. This entails a comparative analysis with forward modeling and other analytical techniques that have historically been utilized for separating Antarctic GIA and interpreting the physical processes of each result related to Antarctic mass balance.

Moreover, this section should touch upon the potential for constraining uncertainties within the input values associated with Antarctic GIA, such as melting history since the Last Glacial Maximum and viscosity structure, based on the findings presented in this study. It is essential to consider how these uncertainties can be addressed through comparisons with forward modeling employed in prior research. If such matters are addressed elsewhere in the paper, it is advisable to provide a concise summary within this section. This recommendation also applies to the Ice Mass Change (IMC) discussion.

Some typos:

P6, line 3: We extent ... -> extend?

P9, line 16: Although dominated by the ... -> dominated?

P14, line 6: IPCC Assessment report ... -> IPCC Assessment Report?

P14, line 17: ...but also prominent differences. -> prominent?

P16, line 11: ...response times of millenia) -> millennia?

P16, line 12 ...deglaciation on millenial ... -> millennial?

P18, line 29 ...-144 ± 27 Gt a⁻¹ und -> and?