

We sincerely thank the editor and reviewers for their constructive feedback, which has been invaluable in shaping the manuscript to publication standard. We have carefully addressed all minor comments, as outlined below and incorporated into the revised manuscript, with changes reflected in the updated line numbering.

Minor comments:

L235 and elsewhere in the text, figures and captions: A climatology is usually defined as a 30-year period or longer. Here you examine the period 2002–2022 which is shorter than a ‘climatology’. Please, write out the period extent rather than using the term climatology.

Author’s response: In the revised manuscript, we have replaced the use of climatology with explicit reference to the study period (2002–2022) throughout the text, figures, and captions to avoid confusion.

L145 -146: This effectively produces mass anomalies with respect to the 2002–2022 GRACE period.

L238: depicted in the figures represent anomalies from the 2002–2022 period for each relevant.

L243: whereas negative anomalies indicate a reduction in mass relative to 2002–2022.

L248–249: statistical significance was assessed relative to the 2002–2022 baseline using a two-sample *t*-test assuming unequal variances.

Also, in the supplementary file.

L27–28: Figure S3. Map of RACMO2.4p1 SMB changes, expressed as a percentage relative to 2002–2022 during El Niño-dominated periods.

L35–36: Figure S4. Map of RACMO2.4p1 SMB changes, expressed as a percentage relative to 2002–2022 during La Niña-dominated periods.

Reviewer comment: L240: “reduction in mass relative to 2002–2022.”

Author’s response: We have revised the text as suggested, which now reads: “L243: reduction in mass relative to 2002–2022.”

Reviewer comment: L250: Here you state that Fig. 2b shows a (quadratic) acceleration, but units are in “kg m⁻² yr⁻¹”. This should rather be “kg m⁻² yr⁻²”. Please modify the units in Figure 2b if relevant.

Author’s response: Figure 2b has been revised, and the acceleration is now expressed with the unit “kg m⁻² yr⁻²” (L265–266).

Reviewer comment: L281–282, 321, 394–395: Statistical significance is generally obtained for *p* < 0.05. Here you state the opposite, please clarify.

Author’s response: Thanks for pointing it out. We have clarified it in the text as “(*p* > 0.05)” to show

that non-significant regions are stippled. This correction has been applied at L271, L286, L325, L399, L465 and L44 in the supplementary file.

Reviewer comment: L380: I guess the authors mean “(Supplementary Fig. 4)” here.

Author’s response: Correct, we meant “(Supplementary Fig. 4)”. However, based on your comment regarding maintaining consistency between “(Supplementary Fig. 4)” and “Fig. S4”, we have edited the text as follows: “Absolute mass changes are shown in this section, while relative mass changes can be found in Fig. S4” L383-384.

Reviewer comment: L623: I am not sure to understand what the authors mean. Is the 22-year time series too short to fully sample the influence of ENSO-SAM on SMB variability? Please reformulate.

Author’s response: The intention here is to state that the time span might not be sufficient to capture the full range of ENSO variability. The text has been revised to reflect this clearer.

“Given that our analysis spans a 22-year period, it is insufficient to capture the full range of ENSO variability, which requires a longer time period to be fully represented (Stevenson et al., 2010). Future studies should therefore consider a longer record, together with climate models, to better isolate and capture purely ENSO-driven signals” L630-633.

Supplementary Figures:

Reviewer comment: Across the text, refer to “Supplementary Fig. X” or “Fig. SX” and remain consistent.

Author’s response: In line with your comment, to remain consistent we have revised the text with “Fig. SX”. The revision can be found on L197, 288, 290, 316, 384, 572, 574.

Reviewer comment: Supplementary Figure 1: Add labels a) and b) for individual subplots and refer to Supplementary Fig. 1a or b accordingly in the text and captions. Explicitly mention what “NEP” and “NCP” mean in the figure caption.

Author’s response: We have added labels a) and b) to the figure (Fig. S1) and accordingly refer to it in the text “Fig. S1b” L196. The “NEP” and “NCP” meaning has been mentioned in now in the figure caption, which now reads “Figure S1. Timeseries of ENSO metric indices. The Niño Eastern Pacific (NEP, blue), Niño Central Pacific (NCP, red), and Niño3.4 (black) indices are shown” L7-8 in the supplementary file.

Reviewer comment: Supplementary Figure 2: Add labels a-d) and modify the figure caption accordingly.

Author’s response: The figure has been updated and labels (a–d) have been added. The figure caption has been revised accordingly and now reads: “Figure S2. Composite maps showing the impact of El Niño and La Niña events on ERA5 mean sea level pressure (shading and contour, hPa) and 10 m wind anomalies (vectors, m s^{-1}), together with surface mass balance (SMB) anomalies ($\text{kg m}^{-2} \text{ y}^{-1}$) from RACMO2.4p1 over 2002–2022: (a, b) ERA5 mean sea level pressure and 10 m wind

anomalies for El Niño and La Niña, respectively; (c, d) SMB anomalies for El Niño and La Niña, respectively.” This revision appears on L16–21 in the supplementary file.

Reviewer comment: Supplementary Figure 3: Add labels a-d) and modify the figure caption accordingly. In supplementary text 3, please list and provide the periods extent. I suggest refraining from using the term “climatological” for periods shorter than 30 years.

Author’s response: The figure has been updated and labels (a–d) have been added. The figure caption has also been revised to reflect this and now reads: “Figure S3. Map of RACMO2.4p1 SMB changes, expressed as a percentage relative to 2002–2022 during El Niño-dominated periods: (a) Apr 2002–Aug 2005, (b) Mar 2014–Jun 2016, (c) Apr 2009–Apr 2010, and (d) Jun 2018–Apr 2020, corresponding to the defined El Niño-dominated periods.” This revision appears on L27–29 in the supplementary file.

Reviewer comment: Supplementary Figure 5: Please provide a caption for this figure, including references to subplots using individual labels.

Author’s response: A caption has been provided for Fig. S5, with references to the subplot labels in the supplementary file (L41–44): “Figure S5. Map showing the rate of change of SMB anomalies during the 2020–2022 La Niña-dominated period: (a) with the inclusion of the March 2022 extreme event, (b) with the March 2022 event excluded, and (c) the difference between (a) and (b).”

Reviewer comment: Supplementary Figure 4: Add labels a-d) and modify the figure caption accordingly. In supplementary text 4, please list and provide the periods extent. I suggest refraining from using the term “climatological” for a period shorter than 30 years.

Author’s response: We have updated the figure and added labels (a–d). The figure caption has been revised to avoid the use of the term climatological and now reads: “Figure S4. Map of RACMO2.4p1 SMB changes, expressed as a percentage relative to 2002–2022 during La Niña-dominated periods: (a) Feb 2007–Apr 2009, (b) Jun 2016–Jun 2018, (c) Mar 2010–Mar 2014, and (d) Apr 2020–Dec 2022, corresponding to the defined La Niña-dominated periods.” This revision appears on L34–37 in the supplementary file.

Main Figures:

Reviewer comment: Figure 2: Please add labels a) and b) for individual subplots and explicitly mention these labels in the figure caption as e.g. , “a) Linear rate and b) acceleration of AIS mass change ...”

Author’s response: The figure and caption have been revised to include labels. The figure caption now reads: “Figure 2. a) Linear rate and b) acceleration of AIS mass change (2002–2022) based on GRACE data using univariate regression.” This revision appears on L267.

Reviewer comment: Figure 3 caption: “Regression of cumulatively summed...” Remove “(” between “anomalies” and “represented”.

Author’s response: We have revised as suggested and now reads “Figure 3. Regression of cumulatively summed sea level pressure (shaded region and contour) and 10 m wind anomalies represented by reference vectors (m s^{-1}) from ERA5 reanalysis (a), cumulatively summed RACMO2.4p1 model SMB anomalies (b), and GRACE ice mass change anomalies (c) regressed against

cumulatively summed Niño3.4. The u and v wind components were regressed separately. All panels reflect regression anomalies over the period 2002–2022. All variables were linearly detrended prior to regression using the full data periods. Stippling indicates regions where the regression results are not statistically significant ($p > 0.05$). (L279–285)

Reviewer comment: Figure 4 caption: Replace “(left), (middle) or (right)” by proper labels “(a–d), (e–h) and (i–l)”.

Author’s response: Revised accordingly and the “(left), (middle) or (right)” has now been replaced with the proper labels “(a–d), (e–h) and (i–l)”.

“Figure 4. Atmospheric circulation anomalies relative to the GRACE period (2002–2022) (a–d), rate of change in cumulative SMB anomalies from RACMO2.4p1 model (e–h) and linear rate of GRACE-derived ice mass anomalies (i–l) during El Niño-dominated period.” (L317–320)

Reviewer comment: Figure 5 caption: Same comments as for Fig. 4.

Author’s response: We have revised according to the previous comments. “Figure 5. Atmospheric circulation anomalies relative to the GRACE period (2002–2022) (a–d), rate of change in cumulative SMB anomalies from the RACMO2.4p1 model (e–h), and linear rate of GRACE-derived ice mass anomalies (i–l) during La Niña-dominated period.” (L390–392)

Reviewer comment: Figure 6: Add labels a–f) and modify caption accordingly.

Author’s response: Revised as suggested and labels have been added to the figure and caption. “Figure 6. The composites are generated based on the results of the four defined ENSO-dominated periods combined. ERA5 mean sea level pressure and 10 m wind anomalies (a–b), RACMO2.4p1 SMB (c–d), and GRACE-derived ice mass change (e–f).” (L459–462)

References:

Reviewer comment: L209: Add a reference to the RACMO2.4p1 data at the end of this sentence.

Author’s response: A reference has been added to the end of this sentence. “We used modelled SMB output from the Regional Atmospheric Climate Model RACMO2.4p1 model (Van Dalum et al., 2025; Van Dalum et al., 2024).” (L211–212)

Style:

Reviewer comment: L53: “decades, meaning that the regional ...”

Author’s response: We have included “that” in the revised text “decades, meaning that the regional” L53.

Reviewer comment: L88: “... , rather than a mean signal.”

Author’s response: We have replaced “response” with signal “rather than a mean signal” L88.

Reviewer comment: L117: “... GRACE Follow On data, provided by the GFZ ...”

Author's response: We have revised the sentence as follows: "We used the GRACE and GRACE Follow On data, provided by the GFZ German Research Centre for Geosciences (Landerer et al., 2020)" L117-118.

Reviewer comment: L123: "The data are provided on a 50 km grid ..."

Author's response: We have corrected the spelling to "are," and the sentence now reads: "The data are provided on a 50 km grid." This revision appears on L123.

Reviewer comment: L133-134: "... redistribution are modelled in a similar fashion to spherical harmonic ... 1 terms, i.e., based on the approach ..."

Author's response: The text wasn't the correct description and has been revised to reflect the right description. "The effects of atmospheric and oceanic mass redistribution are modelled using standard de-aliasing products. Spherical harmonic degree-1 terms are added based on the approach of Swenson et al. (2008)." L133-135

Reviewer comment: L152: "... ENSO based on SST anomalies in the central ..."

Author's response: Sea surface temperature has been abbreviated as SST, and the text now reads "ENSO based on SST anomalies in the central" L153.

Reviewer comment: L171: "... (Fig. 1b) and further detrended them (Fig. 1c)."

Author's response: We have inserted "further" and "them" in the sentence "(Fig 1b) and further detrended them (Fig. 1c)" L172.

Reviewer comment: L229-230: Remove the first sentence and start with "We use the term 'El Niño- or ... or simply 'period' when considering periods of sustained ENSO phase as defined using our ..."

Author's response: We have removed the first sentence and revised as follows: "We use the term 'El Niño- or La Niña-dominated period' or simply 'period' when considering periods of sustained ENSO phase as defined using our cumulatively summed index" L232-235.

Reviewer comment: L260: "large-scale"

Author's response: The error "large-scle" has been corrected to "large-scale." L263.

Reviewer comment: L290: "SMB and ice mass increase"

Author's response: The "s" at the end of "increases" has been deleted. "SMB and ice mass increase" L294.

Reviewer comment: L292-294: "Since SMB fluctuations are closely linked ... ice mass change vary (Fig. 3b-c)."

Author's response: The sentence has been revised "Since SMB fluctuations are closely linked to ice mass change, the spatially coherent patterns between SMB and GRACE-derived ice mass change vary (Fig. 3b-c)" L296-298.

Reviewer comment: L295: "..., which indicates ..."

Author's response: We have added "s" to the end of indicate "which indicates" L299.

Reviewer comment: L312: "(Supplementary Fig. 3)"

Author's response: For consistency we have replaced it with "Fig. S3" L316.

Reviewer comment: L336: "(Fig. 4g, k)"

Author's response: The comma has now been replaced with a period "(Fig. 4g, k)" L340.

Reviewer comment: L354: "show consistent patterns with negative SMB..."

Author's response: "Show" and "patterns" has been added to the sentence " show consistent patterns with negative SMB" L358.

Reviewer comment: L390: "illustrate variability in AIS mass ..."

Author's response: "ASI" has been corrected to "AIS" L394.

Reviewer comment: L394: "pronounced north-south..."

Author's response: We have added "d" to the end of pronounce "pronounced north-south striping" L398.

Reviewer comment: L456: "mean sea level pressure"

Author's response: "Seal" has been corrected to "sea" and now reads "mean sea level pressure" L461.

Reviewer comment: L457: "mass change (e-f) "

Author's response: Labels have replaced "right" and now reads "mass change (e-f)" L461-462.

Reviewer comment: L459: "wind anomalies as vectors ... SMB and GRACE data ... Non-significant areas are stippled ..."

Author's response: Revised as suggested " wind anomalies as vectors (m s^{-1}). SMB and GRACE data ($\text{kg m}^{-2} \text{y}^{-1}$) are shown. Non-significant areas are stippled" L464-465.

Reviewer comment: L466: "pattern"

Author's response: We have inserted "r" for the correct spelling "pattern" L471

Reviewer comment: L467: "Antarctica during El Niño periods, and vice-versa during La Niña ..."

Author's response: Revised accordingly "Antarctic during El Niño periods, and vice-versa during La Niña" L472.

Reviewer comment: L471: “SMB variability drives ice mass changes...”

Author’s response: Revised as suggested and “s” has been added to “drive” and “of” deleted “SMB variability drives ice mass changes” L476.

Reviewer comment: L477: “(Figs. 4, 5)”

Author’s response: Space inserted between Figs. And 4 “(Figs. 4, 5)” L482.

Reviewer comment: L518: “pattern”

Author’s response: Spelling corrected “pattern” L523.

Reviewer comment: L529: “(e.g., Figs. 4j, 5i)”

Author’s response: Edited and corrections made “(e.g., Figs. 4j, 5i)” L534.

Reviewer comment: L535: “pressure patterns by modulating their positioning which further highlights the dominant role of SAM as mass change driver in East Antarctica”, Do you mean “mass change” by “climate” here? Please clarify.

Author’s response: We meant SAM as a climate driver of mass change. The text has been revised for clarity and now reads: “The SAM phase largely governs these pressure patterns by modulating their positioning, which further highlights the dominant role of SAM as a climate driver of mass change in East Antarctica.” This revision appears on L540–542.

Reviewer comment: L537: “showed a mass change pattern that is consistent”

Author’s response: Revised as suggested “showed a mass change pattern that is consistent” L542–543.

Reviewer comment: L542: “mass gain in Dronning Maud Land”

Author’s response: Deleted “the” in the sentence “mass gain in Dronning Maud Land” L548.

Reviewer comment: L548: “East Antarctica”

Author’s response: We have added “a” to the end of Antarctic “East Antarctica” L554.

Reviewer comment: L550: Add a period “.” At the end of this sentence.

Author’s response: Period has been added at the end of the sentence “However, in Dronning Maud Land, atmospheric rivers explain about 77 % of interannual variability (Baiman et al., 2023).” L554–556.

Reviewer comment: L560: “in our analysis combining La Niña with positive SAM (Fig. 1c).”

Author’s response: Revised as suggested “in our analysis combining La Niña with positive SAM (Fig. 1c).” L566–567.

Reviewer comment: L563: “event likely influenced the mass anomaly ... La Niña period.”

Author’s response: The text has been revised “event likely influenced the mass anomaly patterns of the 2020–2022 La Niña period” L569-570.

Reviewer comment: L568-569: “events in October 2021 and March 2022 ...”

Author’s response: Date arranged in ascending order “events in October 2021 and March 2022” L575.

Reviewer comment: L573: “long-term time series”

Author’s response: “term” added “long-term time series” L579.

Reviewer comment: L589: “cumulative SAM index shows a neutral phase”

Author’s response: Phase has been replaced with “index” now reads “cumulative SAM index shows a neutral phase” L596.

Reviewer comment: L590: “between 2000 and 2020”

Author’s response: We have replaced “to” with “and” now reads “between 2000 and 2020” L597.

Reviewer comment: L598-599: “Regarding the impact of SAM on basal melting, ...”

Author’s response: We have replaced “In terms” with “Regarding” and inserted “of SAM” before on basal melting “Regarding the impact of SAM on basal melting” L605-606.

Reviewer comment: L601: “the timescale of the upstream ice response ...”

Author’s response: Revised as suggested “the timescale of the upstream ice response of the upstream to positive” L608-609.

Reviewer comment: L627: “(which we removed)”

Author’s response: “d” has been added to remove ““(which we removed)” L636.

Reviewer comment: L651: “which influences its impact on the”

Author’s response: Revised as suggested “which influences its impact on the Antarctic” L659.

Reviewer comment: L653: “...2013), and ENSO has its strongest ... West Antarctica. In East Antarctica, atmospheric ... moisture influx affecting ice mass variability.”

Author’s response: Revised as accordingly “(Hosking et al., 2013), and ENSO has its strongest impact in West Antarctica. In East Antarctica, atmospheric pressure patterns over the Southern Ocean play a crucial role in regulating moisture influx affecting ice mass variability.” L661-663

Reviewer comment: L663: “resemble more”

Author's response: "more" added "resemble more an" L671.

Reviewer comment: L666: "net ENSO effect on AIS mass change as explored here."

Author's response: Revised as suggested "net ENSO effect on AIS mass change as explored here" L674.

Reviewer comment: L671: "... (2003) are available"

Author's response: Inserted "are" on L679: "(2003) are available".

Reviewer comment: L688: "... (2024) for providing RACMO2.4p1 SMB."

Author's response: Dataset deleted and RACMO2.4p1 added before SMB "(2024) for providing RACMO2.4p1 SMB." L696