

Editor's comments on revised version of TCD article "Sensitivity of inverse glacial isostatic adjustment estimates over Antarctica" by Willen et al.

The authors' responses to the previous round of reviewer comments are clear, and all points previously raised have been resolved.

The authors have significantly improved the syntax and grammar of the manuscript following consultation with a native English speaker. However, a number of minor grammatical errors or ambiguities persist; these are listed at the end of this document.

Two sets of wider issues remain:

- (1) I detail below a couple of queries regarding the definition of ρ_α which were missed in previous reviews
- (2) The edits to the text have helped to clarify your arguments, but there are a few areas in the revised version of the Discussion that require further clarification

Wider issues

Regarding the definition of ρ_α in eq. 10: do the inequalities stated in cases (I) and (II) implicitly assume that \dot{h}_{alt} is negative? If yes, then is ρ_α correctly defined in locations where \dot{h}_{alt} is positive? Did you consider comparing the magnitude of the two terms? E.g. the first line of eq. 10 could be rewritten as: "if $|\dot{h}_{alt}| - |\dot{h}_{firm}| < 0$ " (although I note that if you compare the magnitudes then the sign of the inequalities in cases (I) and (II) may need to be reversed).

Definition of values assigned to ρ_α : it seems odd to mention (on page 5, line 11, of manuscript-version4) that ρ_α is set to 917 kg/m³ across the Kamb Ice Stream because this is the same value that is used in all locations where $\rho_\alpha = \rho_{ID}$ (page 12, line 12). It would be useful if you could state the values used for all density constants in one place (most are not listed until section 3.4).

Terminology: You use the phrase 'apparent GIA-mass change' in several places, but occasionally the word 'apparent' is missing. Talking about 'GIA-mass change' is misleading given that the GIA-related process that is primarily detected by GRACE (and to a lesser degree, altimetry) is surface deformation - a process in which there is no net change in total mass within the footprint of the satellite observation. Consider using the phrase 'GIA-related mass change' in some parts of the text.

Section 5.1: on page 19 (lines 7-10) the wording of the text could be taken to imply that a negative value for GIA-induced BEC is unphysical. However, such a result is predicted across various regions of Antarctica via forward modelling, and is related to ice thickness increase since the Last Glacial Maximum due to well-documented accumulation increases. Please review the text with this in mind.

Bias correction assumptions: on page 20 you discuss the assumption that (lines 11-12) "over the LPZ the mean apparent GIA-mass change and the mean ice-mass change are zero". It is not clear from this text whether you assume that each of these terms is independently zero, or whether their sum (i.e. total mass change) is zero – please clarify. In this opening sentence to the paragraph, do you also need to mention that mean BEC is assumed to be zero across the LPZ?

Minor grammatical issues and ambiguities

Note: line numbers refer to manuscript-version4 and suggested edits are in *italics*. Suggestions are made with the intention of either correcting the grammar or helping to clarify the meaning of the text; they are not designed to enforce a particular writing style.

Page 2, line 15: the article by Caron and Ivins is listed as 'in press' in the reference list, please provide a doi if possible. The structure of the sentence containing this reference is awkward - please review.

Page 3, line 1: please define 'SMB' the first time this acronym is used

Page 3, lines 11-12: sentence is confusing, particularly the first half, please review

Page 4, line 9: suggest "The elastic BEC *triggered by* present-day ice-mass changes..."

Page 5, lines 8-9: suggest mentioning that the case described on these lines is case (I) in eq. 10

Page 5, lines 13-14: suggest combining two existing sentences: "If the difference is not significant (smaller than $2\sigma_h$) then $\rho_\alpha = 0$ (case III, eq. 10) and $\dot{m}_{GIA} = \dot{m}_{grav} - \dot{m}_{firn}$."

Page 5, line 16: please clarify whether "This approach" refers to case (III), which is discussed in the previous sentence, or the wider approach of using eq. 10 to define the value of ρ_α

Page 5, line 19: please clarify what you mean by "significant signals"

Page 6, line 6: I think you mean "Step 2"

Page 6, line 14: suggest "the error introduced by..."

Page 8, line 1: "over decadal time scale" – check syntax

Page 8, line 2: it is not clear what you mean by "an adjusted trend"

Page 8, line 3: suggest "the viscoelastic deformation *associated with GIA* may be..."

Page 8, line 6: check the grammar in the opening sentence of section 2.6

Page 8, line 10: suggest "...is applied to *all data sets*"

Page 9, line 8: a comma is needed after "Further"

Page 10, line 3: suggest "...BEC of the solid Earth *due to* present-day..."

Page 10, line 7: suggest "*The* approximative nature..."

Page 10, line 29: suggest "...is adjusted to *fit* the filtered Stokes coefficients". A similar comment applies to lines 25-26 on page 11

Page 11, line 4: "containing" -> "which contains"

Page 11, line 19: check the use of commas in this line

Page 11, line 23: a comma is not needed after "implies"

Page 11, line 27: suggest "based on *the* ECMWF..."

Page 12, line 4: If you use the phrase, "the difference between..." you need to list two things

Page 12, line 6: "through" -> "associated with"

Page 12, line 11: "is by the" – check wording, are there some words missing?

Page 12, line 12: please define what you mean by "the GIA layer"

Page 12, line 24: please clarify what you mean by a “built-up difference”

Page 16, line 4: “to take account for a lower bound” – check syntax, meaning unclear

Page 16, line 8: typo - “density”

Page 16, line 20: suggest just “(d1_SLR), a range of...”

Page 18, line 2: “from” -> “of”

Page 18, line 6: suggest “values of...”

Page 18, line 17: “towards” -> “to”

Page 19, table 3 caption: suggest “...mass changes *calculated* in this study”

Page 19, line 4: “estimates” -> “estimate”

Page 19, line 12: suggest revising the sentence that begins “Even forward models...” to “*This issue cannot be resolved by considering the results of forward models because they also show large variations and sign differences in the predicted spatial pattern of GIA-induced BEC.*”

Page 20, line 8: suggest “derived mass changes *are relative to...*”

Page 20, line 9: suggest re-ordering some text: “...and is made to ensure that the combination approach produces robust mass estimates.”

Page 20, line 26: suggest “*These differences affect the results derived across Kamb Ice Stream...*”

Page 21, line 9: suggest “*an ice-density weight*”

Page 21, line 22: suggest “using” -> “that use”

Page 21, line 27: suggest “i.e. that *net firn-thickness changes occur over the modelling period*”

Page 21, line 30: suggest “*The variability in these estimates...*”

Page 22, line 3: suggest “In contrast” -> “However”

Page 23, lines 6-7: “14 years of used GRACE observations” – check syntax

Page 23, line 12: “eliminate” -> “eliminates”

Page 23, line 16: “over other time intervals” – please be a little more specific

Pippa Whitehouse, 29th November 2019