

Review Answers

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Dear Editors, dear Reviewer,

we are very grateful for your detailed corrections and annotations. We are confident that your suggestions helped to considerably improve our manuscript. We tried to respond to all comments in the best possible way. The comments are sorted by page-line, which refer to the original, uncorrected document.

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Reviewer 1

Specific Comments:

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RIC1: 2-4: Add a reference for the Swarm mission.

Answer: Done. Added “(Friis-Christensen et al., 2008)”

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RIC2: 2-15: “orbit is at 515 km” please add an epoch, due to drag the altitude diminishes, so add something like “orbit is at 515 km at present”

Answer: Done.

RIC3: 2-16 of Swarm C => of Swarm B

Answer: Done.

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RIC4: 2-32 integral equation approach/short arc: please consider adding the information of your specific inversion method to the abstract, it might useful for readers

Answer: Done. We added the sentence “For this aim, we use the integral equation approach with short arcs (Mayer-Gürr, 2006) to compute more than 500 time-variable gravity fields with different parameterizations from kinematic orbits.” in 1-9.

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RIC5: 5-1: delete “acceleration spikes due to thruster activations, and failures of automatically detecting and correcting errors”. I think both these items are erroneously here. One of the reasons to include accelerometers aboard the gravity field

dedicated spacecraft is to measure and record the action of the thrusters, so that it could be eliminated from further processing. I believe the CHAMP/GRACE/Swarm accelerometers should measure without any need of automatic error corrections.

Answer: The reviewer is right. We deleted this part.

5 **R1C6:** 5-15: The drag coefficient C_d depends on density => The drag coefficient C_d depends on composition

Answer: As suggested by Reviewer 3, we included the equation for computing the drag coefficient and thus reformulated this paragraph.

R1C7: 6-2: please add a reference or a website link for CERES

10 **Answer:** Done. Added "(Loeb et al., 2009)" in 6-2 and the website link in the section "Data availability".

R1C8: 7-7, 7-8: from biases ... from: please re-read these two lines and modify the usage of "from"

Answer: This paragraph has been modified (see R1C10).

15 **R1C9:** 7-7: "sampling problems with the thermosphere density model" What do you mean? One can get whatever sampling needed from the density models.

Answer: The reviewer is right. This paragraph has been modified (see R1C10).

R1C10: 7-9: "accelerometer bias", 7-12 "accelerometer parameterization": Please add a short explanation to readers, who are not familiar with accelerometer data processing, to describe why you like using such a terminology (even if you do not use the actual accelerometer data). Please check this whole paragraph.

Answer: We modified this paragraph and wrote: "As described in Sect. 3.1 we derive non-gravitational accelerations from models, which we then use in the gravity field estimation as a proxy for accelerometer measurements. Due to the presence of errors, e.g. caused by uncertainties in the density model or errors in the macro model, the resulting non-gravitational accelerations might not always reflect the truth. To prevent these errors from propagating into the gravity field estimates, it is common to introduce additional parameters. Here we co-estimate an "accelerometer bias" per arc and per axis, ..."

R1C11: 9-3: IGG comes here as an abbreviation or acronym without any explanation

Answer: IGG is now explained as "Institute of Geodesy and Geoinformation".

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R1C12: 12-3: improved => combined

Answer: This sentence is now corrected as suggested in R2C52.

R1C13: 14-8, 14-9: The same comment applies here as up to 7-9, please explain the reader (or refer him up to your previous explanation), what do you mean by treatment of your non-gravitational models in a way of "accelerometer bias and scale fac-

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tors".

Answer: Thank you. We referred the reader to our new explanation in Sect. 3.2.

5 **R1C14:** 15-2: "One possible explanation might be the different receiver settings". And what about simply a different noise realizations in individual months?

Answer: We reformulated this sentence: "One possible explanation is that the receivers have different settings, which were activated at different times (van den IJssel et al., 2016; Dahle et al., 2017)". We found that the differences in the monthly solutions appear bigger than the noise level would suggest.

10 **R1C15:** 15-7: "the root mean square (RMS) of the GRACE time series" In statistics, the RMS value is equal to the mean value squared plus variance. I guess that what you mean here is only the variance. See, e.g. https://en.wikipedia.org/wiki/Root_mean_square#Relationship_to_other_statistics

Answer: The reviewer is right. We thank him/her for this correction. The computations were conducted with the variance. Table 6 on page 10 was however the RMS. We decided to compute the variance instead, as this is what we actually wanted.

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R1C16: 19-10: "we would have been able, and thus will also be able in the future, to detect La Niña" Consider a slightly less strong statements, even if you demonstrated an example in Fig. 13, still this is only a guess. I mean, one may say "we should have been able ...".

20 **Answer:** We changed the sentence to "we should have been able, and thus will probably also be able in the future, to detect La Niña"

R1C17: 21-6: "could have been easily identified with Swarm" the same comment as the previous one, in my opinion especially the word "easily" is a bit exaggerated

Answer: We removed the word "easily".

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Technical Corrections:

R1C18: 1-5: gaps during => gaps occurred during

Answer: Done.

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R1C19: 1-16: including non-dedicated satellites => including satellites non-dedicated to gravity field study

Answer: Changed to: "including satellites not dedicated to gravity field studies"

R1C20: 3-table 1: van Den IJssel => van den IJssel (twice in the table)

Answer: Thank you. We corrected this mistake.

R1C21: 8-6: to also => also to

- 5 **Answer:** This sentence has been reformulated to “We employed an ocean mask that includes the Arctic ocean and does not have a coastal buffer zone.” (see R2C43).

R1C22: 21-1: by again comparing to => by comparing them to

Answer: Done (also left out “by” as suggested in R2C100).