

Reviewer 1

The second version of "Reconstruction of Mercury's internal magnetic field beyond the octupole" from Toepfer et al. manuscript tackles well the comments raised by the reviewers from a previous version of the manuscript. For the sake of completeness/clearness of the study, I have few minor comments for the authors to consider.

Note: I am following the manuscript version with tracked changes for the line numbering.

Minor comments:

I 432 - I am not sure if I agree with the statement, specifically with "good precision". In my opinion the authors should develop what it means in this case. When an axisymmetric Gauss coefficient (large coefficient values) is retrieved with only 1 to 2 nT difference, it corresponds to a low % of the initial Gauss coefficient value. However, 1 or 2 nT difference in retrieving non-axisymmetric coefficients (usually lower values) is a large % of the initial value, and therefore the Gauss coefficient is retrieved with possibly not "good precision" but rather "fair precision". In order to avoid misunderstanding in reading this sentence, I would suggest the authors to add relative estimation errors to non-axisymmetric coefficients only, axisymmetric coefficients only, besides all coefficients (already given by the authors). It might happen that the performance of the modeling is not similar between axisymmetric and non-axisymmetric coefficients.

Also, what is the reason of not trying to have a g^4_1 and $g^5_1 \neq 0$ in the new tests? This should be mentioned in the text.

Reply: Agreed. We discussed the errors separately and mentioned the ability for testing different combinations and numerical values of nonaxisymmetric internal Gauss coefficients in future studies (p. 22, ll. 435-445).

I 35 - 43 - I find the paragraph can be further enriched with introductory content as the 3 manuscripts cited here are not the only ones with internal field models using MESSENGER data. The authors can refer to Heyner et al. 2021 for a complete review of internal field models state of the art, however 2 new papers have been published since then: Wardinski et al 2021 and Plattner and Johnson 2021 (I note however, that the authors could not cite these two papers in a previous version of the manuscript because they are very recent publications).

I would suggest to add few lines to this paragraph making a more complete review of the various existing internal field models, and the corresponding modeling aspects. Details missing are: 1) what are the general techniques used by the different authors? Is there a technique more robust than the others? 2) what data each of them are using (a 2012 publication cannot be using all the spacecraft data, for example). 3) are there corrections to the external fields or how the authors are separating internal from external source contributions?

All these details strongly impacts the Gauss coefficients later used by the authors.

Reply: Agreed. We extended the introduction section and the literature list accordingly (p. 2, ll. 35–38, ll. 43–46).

1481 I would suggest the authors to update the Benkhoff et al. 2010 citation to Benkhoff et al. 2021.

Reply: Agreed.

Other:

1419-420 - Probably this comment is out of the scope of this work, but I'll leave it here for future consideration from the authors. This sentence raises the question of: for what coefficient value the performance of the different methods start to clearly decrease?

Reply: This is a very interesting question that should be discussed by performing further simulation and parameter studies in future works.

Typos:

137 "describes" -> "described"

Reply: Agreed.

1485 "Oliveira" -> "Oliveira"

Reply: Agreed.

General changes in the manuscript

- Changes in the manuscript are marked with „latexdiff“, i.e., added text is marked in blue and the old version of the formulation is crossed out and marked in red.
- The position of changes that are related to Reviewer comments are directly stated in the reply.
- p. 2, ll. 35–38, ll. 43–46: The introduction section has been extended by the existing models of Mercury's magnetic field.
- p. 22, ll. 435–445: The relative reconstruction errors for the axisymmetric and the nonaxisymmetric internal Gauss coefficients are discussed separately.
- p. 28–30: The literature list has been extended by the papers of Benkhoff et al. (2021), Oliveira et al. (2015), Plattner and Johnson (2021) and Wardinski et al. (2021).