

## ***Interactive comment on “ICGEM – 15 years of successful collection and distribution of global gravitational models, associated services and future plans” by E. Sinem Ince et al.***

### **Anonymous Referee #1**

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#### General Comment

The manuscript provides a summary about the ICGEM service and its role in geodesy and other Earth sciences. I highly appreciate the preparation of such a manuscript in order to enhance the visibility of this service, which in my view is one of the best in geodesy. Indeed ICGEM nowadays is the central node for global gravity field models of various kind. The paper is very well written and I have no general comments related to structure and content. Nevertheless, in the following I provide some detailed comments which could be considered for the final revision. In summary I recommend a minor revision without the need for a re-review.

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#### Detailed Comments

##### 1. Introduction

The list of references in this section seems to be a little bit arbitrary. There are many other publications addressing the various items, which sometimes would be even better suited as they would be more of a review type. I would recommend to go through the list again and may be to cite mostly review papers. As a minimum I would add “e.g.” in order to indicate that these are just examples of papers from a larger selection.

Page 2, line 21 to 32: I would recommend to mention the gravity gradients and measurements of non-gravitational accelerations right before mentioning the satellite missions (i.e. at line 24). Otherwise it sounds like these measurements are not taken from the satellites. Then one could continue after the satellites with: “Other fundamental datasets . . . . . are terrestrial gravity measurements from moving platforms . . . and collected on the Earth surface.”

Page 4, line 9: I think the references to Drewes and Toth are not required here.

##### 2. Background of the ICGEM Service

###### 2.1 History of ICGEM

Page 5, Figure 2, Caption: Please make clear that compared to the satellite models the EIGEN6-C4 is based also on terrestrial data. May be re-phrase the following sentence: “. . . . Note that the EIGEN6-C4 is not the truth but a better approximation to the real gravity field, because it includes terrestrial and altimetry derived gravity field information”. Last sentence: I think it is EGM96S (and not EGM96).

Page 6, Line 1: Currently? Please indicate a date because numbers are changing .

Page 6, Line 10: Delete last part of the sentence: “. . . and promises future developments”.

###### 2.2 Scientific Background and ICGEM's Data

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In general I think this section should be shortened and reference to the ICGEM documentation should be made. It is impossible to completely write the geodetic gravity theory with all details in such a paper. I think the main purpose should be an explanation that global models are represented by spherical harmonics.

Page 9, Line 6-7: Update sentence: “. . . . pure gravitational forces . . . .the Earth’s gravitational attraction (V) . . . . and potential of the centrifugal force due to Earth rotation”.

Page 9, Line 21 to Page 10, Line 7: I think this is not needed here (including equ. (19 to (3)). Instead reference to the ICGEM documentation or another book shall be made.

Page 11, Line 12: Find a better wording. Proposal: “. . . . normalisation is defined such that the average square . . .”.

Page 13, Line 7-8: The geoid is introduced. In my opinion the definition is a bit misleading. Undisturbed in my view doesn’t include the MDT because it is a permanent disturbance and therefore the statement is not correct. I would write as follows: The geoid is an equipotential surface that in average approximates the mean sea surface.

Page 13, Equation (10): I would recommend to write equation (7) and (10) in the same way.

Page 13, Line 24: Why can these quantities be computed approximately? The calculation is correct, just the models are incomplete. Gravity disturbances can be computed exactly, while for geoid one needs to do assumptions. Please re-phrase.

Page 14, Line 5: “above the geoid” instead “over”

Page 14, Equations (11) and (12): I don’t think this is needed here. Just refer to the manual. Otherwise one should provide equations for all derived quantities.

#### 2.2.1 Static global gravity field models of the Earth

Page 15, Line 4: EGM2008 expansion to degree and order 2159 is for ellipsoidal harmonics. After conversion to spherical harmonics the expansion is up to degree 2190.

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Modify the sentence accordingly.

Page 15, Line 9: Write: “As an example one of the high resolution . . .”

Page 15, Line 18: Is the gravity attraction really stronger? This depends where you observe it. If you stay on the equipotential surface the gravity attraction becomes smaller because the neighbouring equipotential surfaces are separated by a larger distance. Please rethink this sentence and be more specific.

Page 15, Lines 19-24: This is confusing and in my view, specifically the sentence about the North Atlantic (why only there?). Please rephrase and leave out unclear statements.

Page 17, Line 5: “over land” not “in the land”.

#### 2.2.2 Temporal global gravity field models

Page 19, Line 4: I think monthly gravity field models do not provide a resolution of 160 km. May be only when looking to the maximum degree of the SHS but not in the sense of real data content. Please make this clear.

Page 19, Line 16: It is not only water mass, but could also be geophysical signals (solid Earth).

Page 20, Line 9: Reference Wahr, 2007 is missing.

#### 2.2.3 Topographic global gravity field models

Page 21, Figure 10, Caption: a) and b) is not indicated in the sub-plots. Instead write left and right.

Page 21, Table 1: Monitoring sea level variations is a temporal gravity field signal if the pure mass variation is meant. If just the geometric change of the sea level is meant it is no gravity field signal at all. Please correct. Correct also the Atmosphere section (no underlining).

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### 3. Services of ICGEM

#### 3.1 Calculation Service

Page 23, Line 7-8: I think the semi major axis is missing here.

Page 23, Lines 19-27: This section is quite confusing and I would recommend to rephrase it in simpler words as it is not very clear to non-experts. May be it would be again sufficient to refer to the ICGEM manual.

Page 25, Table 2: For `second_r_derivative` one could also write vertical gravity gradient. This is a more convenient name. Just a proposal for future development: Why not offering also the horizontal gravity gradients. These might be useful for some purposes.

#### 3.2 Visualisation Service

Page 31, Figure 16, Caption: For b) I think it should be written "... Represent the mass change." Instead of "distribution".

#### 3.3 Evaluation of global gravity field models

##### 3.3.1 Model evaluation with respect to other models in the spectral domain

Page 32, bottom: wrong font

Page 33, Figure 17: I think the green line are the "Cumulative difference amplitudes ...". Please correct

##### 3.3.2 Model evaluation with respect to GNSS/levelling derived geoid undulations

In my view this chapter either needs to be significantly extended or its value is very limited as the procedure to do comparisons with GPS/levelling geoid heights is much more complicated as it is done here. Therefore the numbers provided in figure 18 are not really meaningful, e.g. the omission error is not considered at all. In the last paragraph of page 34 the authors even explain that this is not a fair comparison. So why

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do they show it or why is it offered in ICGEM at all? There are also missing references to publications dealing with GPS/levelling comparisons. I would consider to delete the complete paragraph and even to consider not to offer this in ICGEM as long as it is not a fair comparison. It only provides misleading results to the not experienced user.

Appendix 2:

I am not sure if this is really needed. Why not setting a link to the web site with the models.

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