Solid Earth Discussions

Solid Earth Discuss., referee comment RC2
https://doi.org/10.5194/se-2021-145-RC2, 2022

Comment on se-2021-145

Anonymous Referee #2

Referee comment on "Benchmark forward gravity schemes: the gravity field of a realistic lithosphere model WINTERC-G" by Barend Cornelis Root et al., Solid Earth Discuss., https://doi.org/10.5194/se-2021-145-RC2, 2022

In this work, detailed comparisons are carried out in order to assess and compare the accuracies of four different gravity field forward modelling codes. These widely used techniques are based either on spherical harmonics decompositions or on local integrations using triangular, tesseroid or hexahedral meshes of the volume of mass sources. After a description of each modelling technique, the authors set-up different tests, progressively increasing the complexity of the sources structure : homogeneous equal thickness shell, equal thickness shell of laterally varying density, homogeneous shell of varying thickness, and the WINTERC-G upper mantle density model (Fullea et al., 2020). Except for the first test case, all sources structures are based on geophysical settings : typical lithospheric lateral density variations for the case 2, CRUST1.0 Moho depth variations for the case 3, and finally, the WINTERC-G model. Such benchmarks are extremely useful and needed in my opinion ; the comparisons between the results of the different approaches clearly show the performances and the limitations of the different approaches. They validate the use of the spherical harmonics, the triangular grids and tesseroid elements, and underline an important limitation in accuracy of the ASPECT geodynamic software based on hexahedral integration. I believe that the numerous tests presented in this work will provide a useful reference for the users, and thus recommend the publication of this paper.

Minor comments

1) The benchmarks involving WINTERC-G based density structures show two different comparisons : the WINTERC-G forward modelling code is compared to the spherical harmonics code using the geoid signals (this corresponds to the data used to constrain the WINTERC-G density structure), and then the spherical harmonics code is compared to the three local integration codes using a different observable, namely the radial gravity at GOCE satellite height. Why not using the same observable for all the comparisons ?

2) The authors have chosen geophysical settings for the sources in the benchmarks. Maybe it could be interesting to also consider purely synthetic settings, involving localized or oscillating sources at different spatial resolutions, to show how the different algorithms perform on elementary-type of sources with a controlled spatial resolution? Rather than the relatively smooth radial gravity at satellite altitude, you could also consider ground gravity as a high-resolution observable ? However, the manuscript already comprises a whole set of logically organized examples with a detailed discussion of the results, which is valid enough to me – so this is just a suggestion, this could also be part of another paper, please decide yourself.