

Dear reviewer:

Thank you very much for your comments on our paper. We have carefully revised the manuscript according to your suggestion. Our responses to the comments are listed below:

Comment 1: To make it clear, please use the same color bar in Fig.2 and the same bound for vertical axis (PSD) in Fig.4.

Reply: We have modified the Fig.2 and Fig.4.

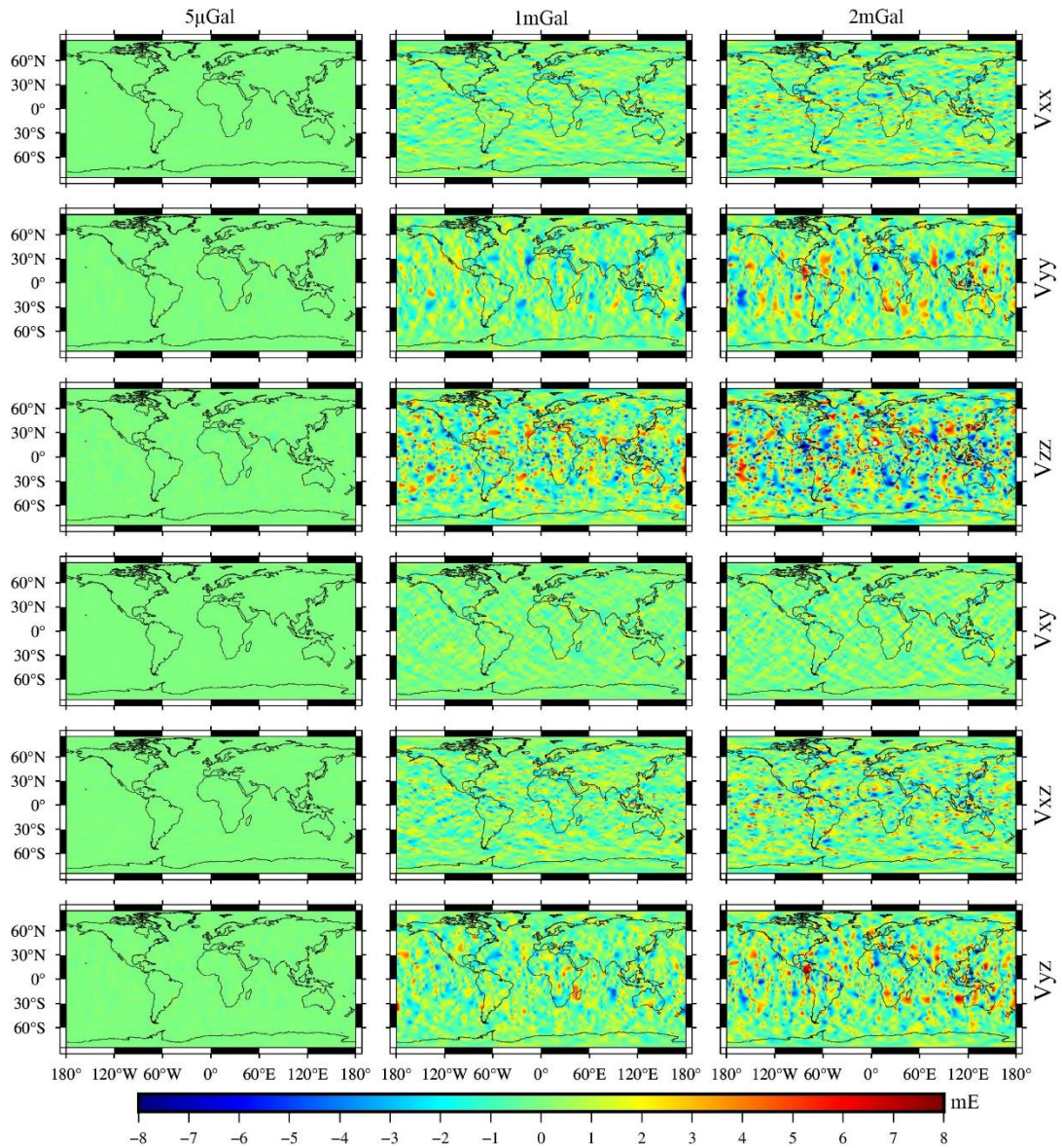


Figure 2. Distribution of upward continuation errors of the gravitational gradients using ground gravity data.

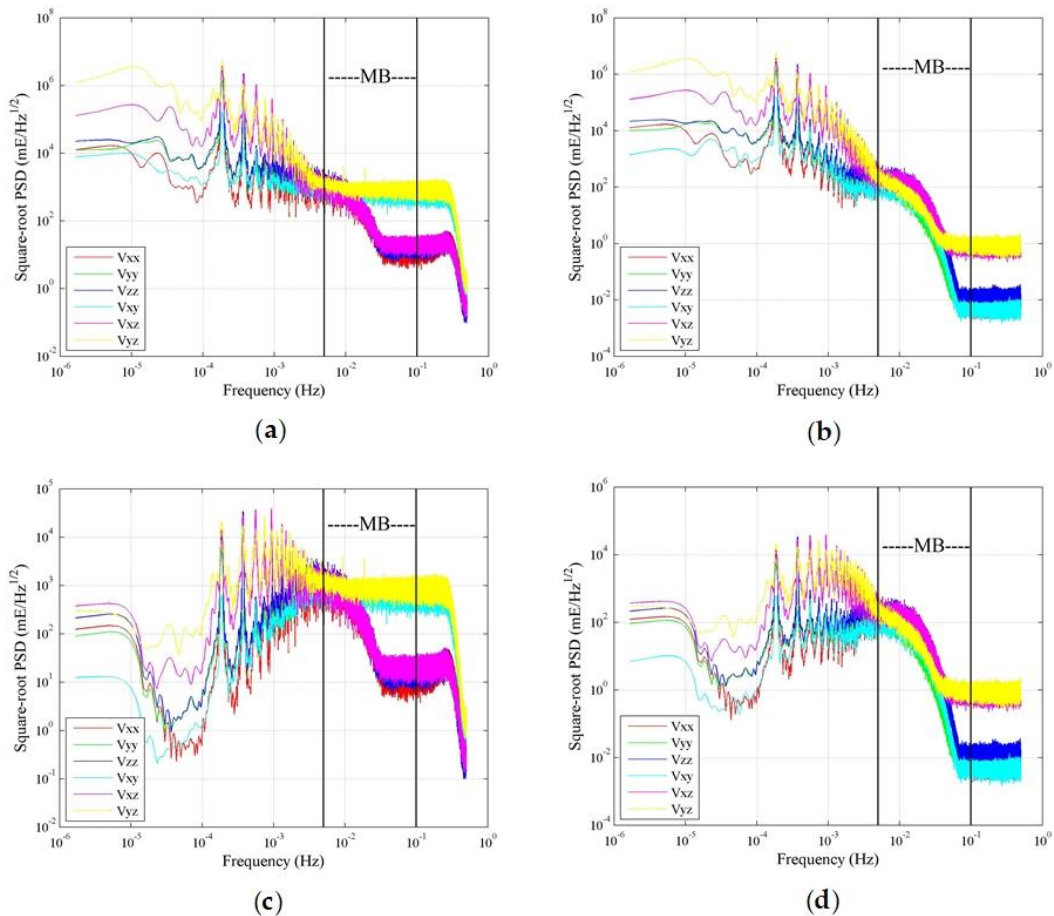


Figure 4. Power spectral density of gravitational gradients: (a) GOCE observations; (b) upward continuation values; (c) GOCE observations after high-pass filtering; (d) upward continuation values after high-pass filtering.

Other modifications include:

1.[Page 2, line 40-41] Replace “The calibration of GOCE gravitational gradients using ground gravity data will be examined and outlined here.” with “The calibration of GOCE gravitational gradients using ground gravity data will be examined and outlined in the following.”

2.[Page 2, line 42-44] Replace “Arabelos and Tscherning (Arabelos and Tscherning, 1998) described a simulation study of the external calibration approach for SGG data with ground gravity data and used the least-squares collocation (LSC) method to detect the systematic errors of gravitational gradients.” with “Arabelos and Tscherning (1998) described a simulation study of the external calibration approach for SGG data with ground gravity data and used the least-squares collocation (LSC) method to detect the systematic errors of gravitational gradients.”

3.[Page 2, line 44-46] Replace “The a priori covariance relationship of the upward continuation of ground gravity data onto gravitational gradients was discussed in Bouman et al. and Pail (Pail, 2002;Bouman and Koop, 2003).” with “The a priori covariance relationship of the upward continuation of ground gravity data onto gravitational gradients was discussed in Pail (2002) and Bouman et al. (2003).”

4.[Page 2, line 46-47] Replace “Denker (Denker, 2002) applied the least squares spectral combination technique to the upward continuation of the ground gravity data onto gravitational gradients at satellite altitude.” with “Denker (2002) applied the least squares spectral combination technique to the upward continuation of the ground gravity data onto gravitational gradients at satellite altitude.”

5.[Page 2, line 48-50] Replace “Two methods for the upward continuation of ground gravity data onto gravitational gradients, namely, the LSC and integral formula methods based on the spectral combination technique, were discussed and compared in Wolf and Denker (Wolf and Denker, 2005).” with “Two methods for the upward continuation of ground gravity data onto gravitational gradients, namely, the LSC and integral formula methods based on the spectral combination technique, were discussed and compared in Wolf and Denker (2005).”

6.[Page 2, line 50-52] Replace “A synthetic geopotential model, which combined the GRACE geopotential model, EGM96 geopotential model, and GPM98C geopotential model, was used to simulate the gravity anomalies on terrain and on an ellipsoid.” with “A synthetic geopotential model, which combined the GRACE geopotential model, EGM96 geopotential model, and GPM98C geopotential model, was used to simulate the gravity anomalies on terrain and on an reference ellipsoid.”

7.[Page 2, line 52-55] Replace “This study revealed that the results of the two methods were similar and the accuracies of six components were 0.1–0.6 mE and 0.3–1.4 mE, respectively, when the gravity anomalies on the terrain and ellipsoid were applied for the continuation..” with “This study revealed that the results of the two methods were similar and the accuracies of six components were 0.1–0.6 mE and 0.3–1.4 mE, respectively, when the gravity anomalies on the terrain and ellipsoid were used for the continuation.”

8.[Page 2, line 55-57] Replace “The integral formulas based on the extended Stokes and Hotine formulas were used by Kern and Haagmans (Kern and Haagmans, 2005) to determine all the components of the gravitational gradients from terrestrial gravity data.” with “The integral formulas based on the extended Stokes and Hotine formulas were used by Kern and Haagmans (2005) to determine all the components of the gravitational gradients from terrestrial gravity data.”

9.[Page 2, line 58-60] Replace “To validate the SGG data, an external calibration model based on the regional ground gravity data was described in Bouman et al. (Bouman et al., 2004;Bouman et al., 2009;Bouman et al., 2011).” with “Bouman et al. (2004, 2009, 2011) did more research about the external calibration model based on regional ground gravity data to validate the SGG data.”

10.[Page 2, line 62-64] Replace “A least squares modification of the extended Stokes formula and its second-order radial derivative was proposed by Eshagh (Eshagh, 2010). ” with “A least squares modification of the extended Stokes formula and its second-order radial derivative was proposed by Eshagh (2010).”

11.[Page 2, line 65-66] Replace “The airborne gravity data of the Antarctic region were applied to validate the GOCE gravity gradiometry data in Yildiz et al. (Yildiz, 2012;Yildiz et al., 2016). ” with “The airborne gravity data of the Antarctic region were applied to validate the GOCE gravity gradiometry data in Yildiz et al. (2012, 2016).”

12.[Page 2, line 66-69] Replace “They concluded that the differences between the calculated gravitational gradients from the LSC upward continuation method and the GOCE gravitational gradient observations were 9.9 mE, 11.5 mE, 11.6 mE, and 10.4 mE in the high-precision components V_{xx} , V_{yy} , V_{zz} , and V_{xz} , respectively.” with “They concluded that the differences between the calculated gravitational gradients from the LSC upward continuation method and the GOCE gravitational gradient observations were 9.9 mE, 11.5 mE, 11.6 mE, and 10.4 mE for the high-precision components V_{xx} , V_{yy} , V_{zz} , and V_{xz} , respectively.”

13.[Page 2, line 69-71] Replace “The validation of the V_{zz} component of the GOCE gravitational gradients by geoidal undulation using semi-stochastic modifications of the Abel-Poisson integral was discussed in Eshagh (Eshagh, 2011).” with “The validation of the V_{zz} component of the GOCE gravitational gradients by geoidal undulation using semi-stochastic modifications of the Abel-Poisson integral was discussed in Eshagh (2011).”

14.[Page 2, line 71-72] Replace “Šprlák et al. (Šprlák et al., 2015) presented new integral transforms of the gravitational potential disturbances derived from satellite altimetry data onto the gravitational gradients at satellite altitude.” with “Šprlák et al. (2015) presented new integral transforms of the gravitational potential disturbances derived from satellite altimetry data onto the gravitational gradients at satellite altitude.”

15.[Page 2, line 76-77] Replace “The inverse matrix of the large covariance matrix is very difficult to solve in massive data processing, however.” with “The inverse of the large covariance matrix is very difficult to solve in massive data processing, however.”

16.[Page 3, line 79-80] Replace “In this article, we discuss the possibilities of spherical harmonic analysis for the upward continuation of the ground gravity data onto the gravitational gradients at satellite altitude.” with “In this article, we discuss the feasibility of applying spherical harmonic analysis to the upward continuation of the ground gravity data onto the gravitational gradients at satellite altitude.”

17.[Page 8, line 188-189] Replace “Referring to Bouman et al. (Bouman et al., 2011), the calibration period was set to 7 days. Hence, the data were divided into 19 weeks.” with “Referring to Bouman et al. (2011), the calibration period was set to 7 days. Hence, the data were divided into 19 weeks.”

18.[Page 8, line 198-199] Replace “Various filter cut-off frequencies were discussed in Bouman et al. (Bouman et al., 2011).” with “Various filter cut-off frequencies were discussed in Bouman et al. (2011).”

19.[Page 9, line 219-221] Replace “These results are larger than those of Veicherts et al. (Veicherts et al., 2011) for Australia, Canada, and parts of Scandinavia, but smaller than those of the Norway area.” with “These results are larger than those of Veicherts et al. (2011) for Australia, Canada, and parts of Scandinavia, but smaller than those of the Norway area.”

20.[Page 14, line 305-306] Replace “The trace of the gravitational gradients after calibration was smaller than before calibration,” with “The trace of the gravitational gradients after calibration was smaller than that before calibration,”