Thank you for your comments and meticulous check of our manuscript that make the paper more interesting and informative. Below, please find our point to point responses to the comments in the list of revisions.

We have made a revision to the manuscript and displaced some materials in the text. We have marked all the revisions in red on the revised manuscript.

A list of revisions

1. Please add more information for the figure caption of Figure 1 on page 3, for instance what are these colors represent? Although we know from the text that red/green displays XGM2019e/ EGM2008, and blue shows shipborne gravity data. However, it may be more clear by adding these captions, and readers can directly catch the meanings of this figure without finding materials from the text in different locations.

Answer: Thanks for the suggestion. The caption is rephrased:

Figure 1. Division map for deriving gravity anomalies and tracks of NCEI shipborne data. The red and green areas means that the reference gravity anomalies are obtained from XGM2019e and EGM2008, respectively. The lines in blue present the cruises of shipborne gravity. The areas in cyan boxes are the special areas for analysis.

2. The iterative method for determining the noise variances are presented by a long text. It is better to add a flowchart and shorten the text.

Answer: The flowchart of the iterative method is added. The text is shortened.

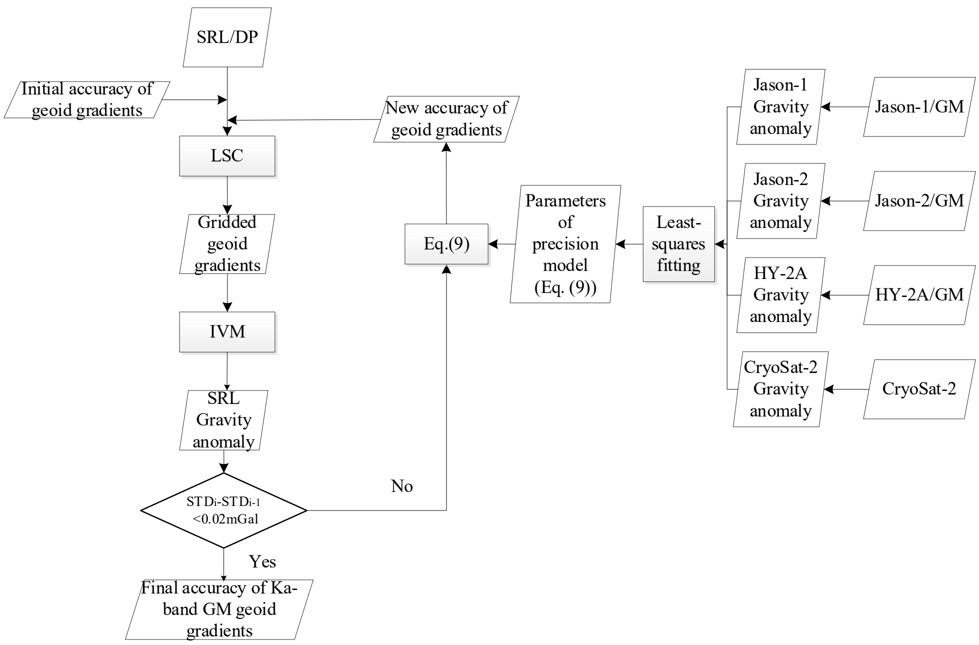

Figure 3. Iterative method of assessing the accuracy of SRL/DP-measured along-track geoid gradients. Initial accuracy of geoid gradients is only used for the first calculation of gravity, and new accuracy is used for other calculations.

The accuracy of along-track geoid gradients of SRL/DP can be obtained following the method in Figure 3. First, initial precision of along-track geoid gradients of SRL/DP is also assessed by the Equation (8). Gravity anomalies are derived from SRL/DP-measured SSHs based on the initial precision. Second, the precision of SRL/DP-derived gravity is assessed by shipborne gravity and SIO V30.1 model, then used to calculate the new precision of along-track geoid gradient from

SRL/DP by Equation (9)(Equation(10) in the original manuscript). The new SRL/DP gravity anomalies are derived based on the new precision of along-track geoid gradients. Final, the calculation of step second is repeated, and terminated when the difference in precision of altimetric gravity between adjacent times is less than 0.02 mGal.

3. As the authors stated in introduction on page 2 line 40 "HY-2A-measured altimeter data are rarely used for published global models of gravity anomalies", while the development of SDUST2021GRA included HY-2A data. To quantify the effects of HY-2A data on global gravity anomalies inversion, the authors may consider additionally computing one solution without HY-2A, the difference between this solution and SDUST2021GRA can study the contribution of HY-2A data. This model can also be validated against shipborne gravity data to assess its quality, and compared with SDUST2021GRA.

Answer: Thanks for the good suggestion. The altimeter-derived gravity anomalies without HY-2A in Area A~D are obtained, and compared with shipborne gravity. The accuracy is added in Table4.

Table 4. Accuracy of altimeter-derived and shipborne gravity data in different areas (Unit: mGal)

	Area A	Area B	Area C	Area D
SDUST	1.39	1.82	3.34	2.22
DTU	1.72	2.54	3.81	2.60
SIO	0.97	2.52	4.81	2.30
NCEI	3.30	4.04	3.68	3.95
SDUST(no HY-2A)	1.39	1.89	3.38	2.28

HY-2A-measured altimeter data are excluded from the multi-satellite altimeter dataset, and the residual altimeter data are used to derived gravity anomalies marked SDUST(no HY-2A), as listed in Table 4. Compared with the accuracy of SDUST2021GRA, that of SDUST(no HY-2A) reduces by 3.8%, 1.2% and 2.7% in Area B, C and D, respectively. These indicate that HY-2A has an important role in gravity anomaly recovery in areas with complex coastline and many islands.

4. In this study, SDUST2021GRA was compared with DTU17 and SIO V30.1 for cross validation, and concluded that the former has better quality over offshore areas. It is noticeable that the SAR altimeter data from Sentinel-3A/B had been used in the computation of SIO V30.1, and it is well known that these SAR data has great advantages over traditional radar altimeter over coasts. While, these SAR altimeter data were not used in developing SDUST2021GRA (as shown in Table 1 on page 4 line 85), the authors may consider using SAR altimeter data to further improve the marine gravity anomaly model.

Answer: Sentinel-3A/B perform the exact repeat mission (ERM) with the sparse track coverage. Data from ERM have a small effect on gravity recovery, so the data from Sentinel-3A/B are not used for SDUST2021GRA. That is a good suggestion. We will study on the performance of SAR altimeter data from Sentinel-3A/B on gravity recovery to further improve the marine gravity anomaly model in the future study.

5. Figure 5 shows the differences between SDUST2021GRA and the two recognized marine gravity anomaly models (DTU17 and SIO V30.1). The differences between DTU17 and SIO V30.1 should be also calculated to illustrate the differences of gravity anomaly models. Please also give the error information (the formal errors) of these three models if it is possible.

Answer: The differences between DTU17 and SIO V30.1 are calculated, and added as Figure 6(c).

The error information of DTU17 and SIO V30.1 cannot be obtained from their value and reference papers. The error information of SDUST2021GRA is added in the revised manuscript.

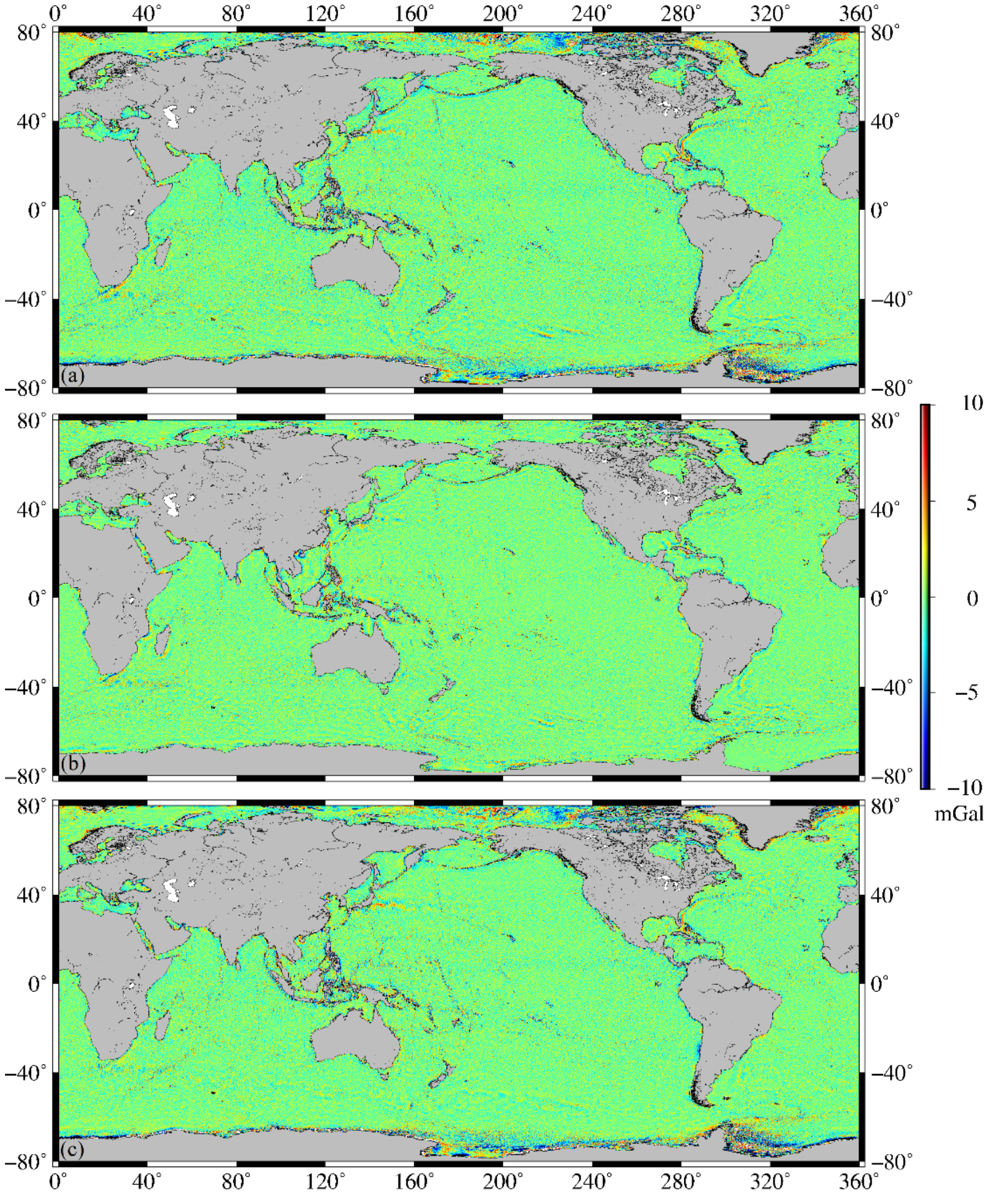

Figure 6. Different between SDUST2021GRA and recognized marine gravity models: (a) is for SDUST2021GRA and SIO V30.1, (b) is for SDUST2021GRA and DTU 17, and (c) is for DTU 17 and SIO V30.1.

High-resolution error information of SDUST2021GRA is useful for potential users. Therefore, following the method proposed by Sandwell et al. (2021), first, for each mission of each satellite, the median absolute deviation of the along-track geoid gradients with respect to gridded DOVs in a block (10 min longitude and 6 min latitude) is calculated. The median is presumed related to the noise in the along-track geoid gradients. Then, the average of median for all missions of all satellites is divided that by the square root of the number of observations in every block. These values can be used to approximate the accuracy of gravity anomalies, because that accuracy of along-track geoid gradients is approximately proportional to that of altimeter-derived gravity anomalies (Sandwell et al., 2013). Final, the overall map of approximate precision of SDUST2021GRA in Figure 10 is calibrated using a scaling factor that makes the value in Area A equal to the 1.39 mGal.

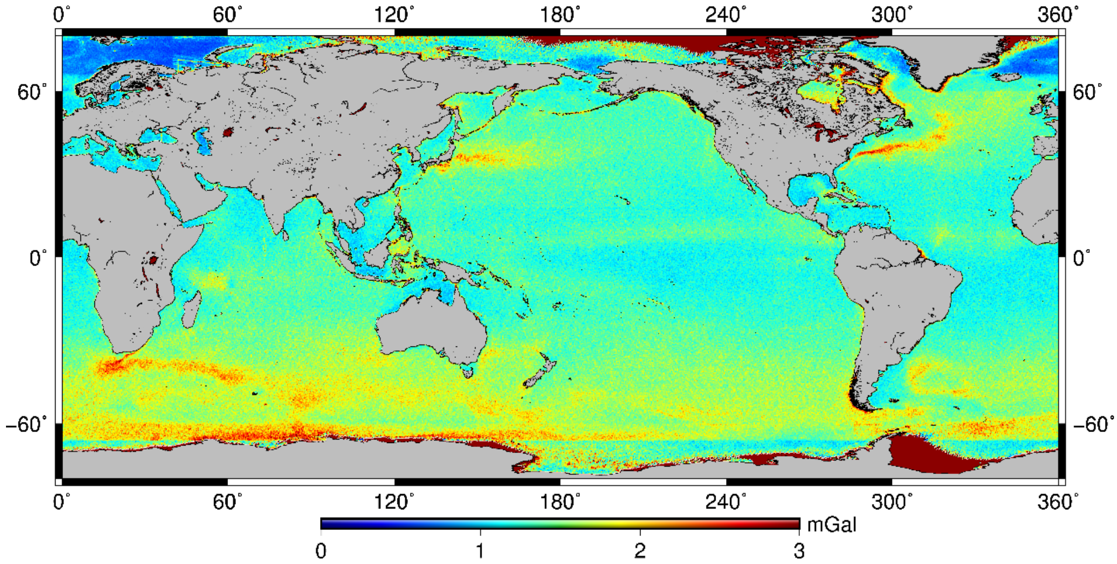

Figure 10. Map of gravity anomaly error based on deviations of along-track geoid gradients from all altimeters.

6. There is no data in some areas in Figure 8 on page 15. Please explain it in more details in the manuscript.

Answer: Thanks. The explanation is added in the manuscript.

In Figure 9 (Figure 8 in the original manuscript), there is no data in region L4B7, L5B7, L6B7 and L13B7, which is because that these areas have no sea. There is no data in other regions in Figure 9, which is caused by no shipborne gravity data in these areas.

7. Please plot a global picture of formal error of SDUST2021GRA via the law of error propagation, as the same did by the authors on page 16, line 345. This picture contains the error information of SDUST2021GRA over different areas, which are useful for the potential users. Moreover, the authors may consider comparing the difference against shipborne gravity data of SDUST2021GRA and its formal errors over different areas, to see if the formal error of SDUST2021GRA is reliable.

Answer: That is a good suggestion.

High-resolution error information of SDUST2021GRA is useful for potential users. Therefore, following the method proposed by Sandwell et al. (2021), first, for each mission of each satellite, the median absolute deviation of the along-track geoid gradients with respect to gridded DOVs in a block (10 min longitude and 6 min latitude) is calculated. The median is presumed related to the noise in the along-track geoid gradients. Then, the average of median for all missions of all satellites is divided that by the square root of the number of observations in every block. These values can be used to approximate the accuracy of gravity anomalies, because that accuracy of along-track geoid gradients is approximately proportional to that of altimeter-derived gravity anomalies (Sandwell et al., 2013). Final, the overall map of approximate precision of SDUST2021GRA in Figure 10 is calibrated using a scaling factor that makes the value in Area A equal to the 1.39 mGal.

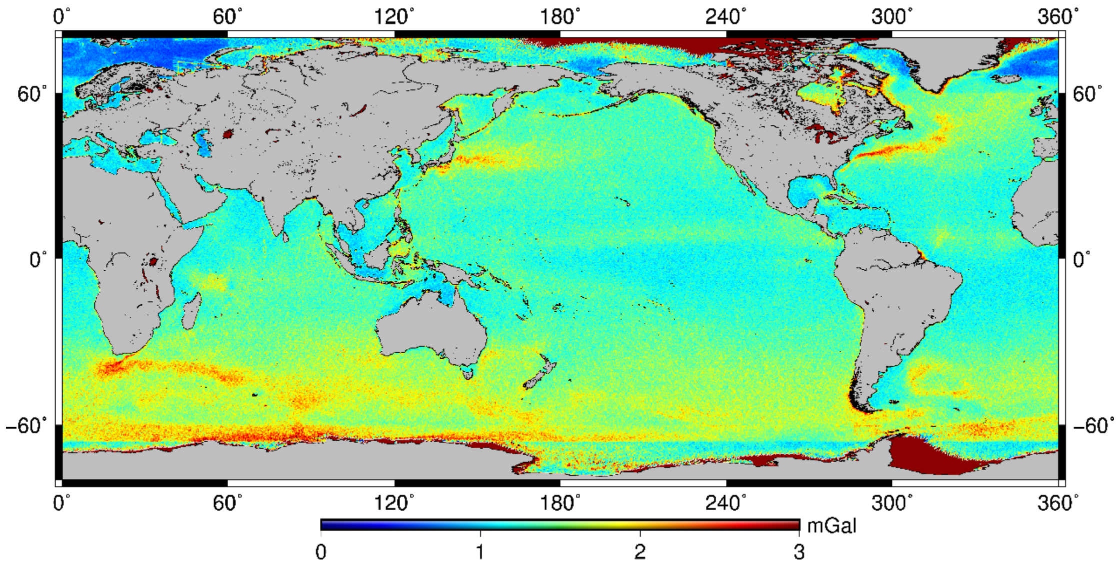

Figure 10. Map of gravity anomaly error based on deviations of along-track geoid gradients from all altimeters.

In order to compared with the results assessed by shipborne gravity, the accuracy of SDUST2021GRA in Area A, B, C and D is calculated by averaging values at the shipborne observation points by interpolation of the gridded errors in Figure 10, respectively. The corresponding accuracy is 1.39 mGal, 2.66 mGal, 3.47 mGal and 1.72 mGal. The accuracy of gravity in Area C is the lowest and that in Area A is the highest, which is the same as that evaluated using shipborne data. However, the accuracy in Area B is lower than that in Area D, which is different from that evaluated using shipborne data. This is because that Area D has the larger land area and more complex coastlines than those in Area B. Gravity anomaly in a grid point is derived from along-track geoid gradients in a large area around the point, so the land and coastlines have more effects on gravity anomalies than those on along-track geoid gradients. The accuracy of along-track geoid gradients can only be used to assess approximately that of altimeter-derived gravity anomalies.