Dear Reviewer:

First, I would like to sincerely apologize for the delayed response to your review comments. I regret that my reply has come so late. I only received the revision notification recently after sending a reminder email to the editor. The delay was caused by an operational error on the editor's side last year, which prevented me from receiving the notification in time. I truly apologize for the long wait this has caused.

Finally, we sincerely thank you for your valuable comments and suggestions. In accordance with your recommendations, we have made major revisions to the manuscript. Your insightful and constructive feedback has greatly improved the quality of this paper. Our responses to the reviewer's comments are provided below:

Major Comments

Point 1： Although the reference topography is now obtained by applying a spatial filtering approach to the detailed topography, the corresponding description in the manuscript was not updated accordingly. As a result, the Earth2014 reference topography model was still incorrectly described and presented.

Response 1: We sincerely apologize for this oversight. As suggested in your previous comment, we have already abandoned the use of Earth2014 as the reference topography model. Instead, a new reference topography model has been generated from the SRTM–GEBCO dataset using a

spatial filtering approach based on the moving average (MA) method. In this revision, we have carefully reviewed the manuscript to ensure the accuracy of all relevant descriptions.

Abstract, lines 21-22 (page and line numbers are referred to the clean version of the revised manuscript): “and then combined with the reference topography model Earth2014 to construct the RTM”.

~~First, the high-resolution terrestrial digital elevation model SRTM V4.1 is merged with the marine bathymetry model GEBCO_2024, and then combined with the reference topography model Earth2014 to construct the RTM.~~

“Specifically, a high-resolution detailed topography model of the study area, referred to as the SRTM–GEBCO model, was first constructed by merging the land digital elevation model SRTM V4.1 with the ocean bathymetric model GEBCO_2024. Based on this model, the reference topography was then derived using a spatial filtering approach based on the moving average method.”

Page 3, lines 84-85: “in combination with the Earth2014 spherical harmonic reference topography model” .

~~in combination with the Earth2014 spherical harmonic reference topography model~~

“This study aims to improve the accuracy of the XGM2019e-2159 gravity anomaly (XGM-GA) model in coastal regions and to compensate for

truncation errors. The 3″×3″ SRTM V4.1 terrestrial digital elevation model data are first integrated with the 15″×15″ GEBCO_2024 marine bathymetry data to construct a combined SRTM–GEBCO dataset. Based on this dataset, a reference topography model is constructed using a spatial filtering approach based on the moving average (MA) method, from which the RTM is derived. Subsequently, the high-frequency gravity anomalies of the RTM within the study area are computed in the spatial domain, and are used to refine the XGM2019e-2159 gravity anomaly model. ”

2.4 Reference Topography Model. In this section, the authors gave a brief introduction of the Earth2014 model. However, if the authors used the spatially filtered reference topography, this section makes no sense.

This section has been removed. The corresponding description of the residual terrain model derived using the spatial filtering method has been provided in Section 3.1, “Construction of the RTM”.

“The reference topography model is obtained by applying a spatial filtering approach based on the moving average to the SRTM-GEBCO data. The core idea of this method is to replace the value of a target point with the average of all points within a certain neighborhood around it. In essence, it acts as a low-pass filter, removing high-frequency topographic details while retaining low-frequency large-scale topographic variations. To maintain consistency with the spatial resolution of the

XGM2019e-2159 gravity field model, we set the resolution of the filtered reference terrain model to 5′×5′ as well.”

Page 7, lines 161-162: “The residual terrain in the study area is derived from the high-resolution SRTM-GEBCO topographic model and the Earth2014 reference topography”.

~~The residual terrain in the study area is derived using the high-resolution SRTM-GEBCO topographic model and the Earth2014 reference topography, as shown in Fig. 4.~~

“The RTM of the study area is obtained using the above method, as shown in Fig. 4. In the marine regions, the RTM is constructed using the RET method. ”

Page 18, line 380:

“Earth2014 (https://ddfe.curtin.edu.au/models/Earth2014)”.

The description related to this data source has been removed.

Point 2： Regarding the deletion of Figure 6 in the original manuscript.

We sincerely thank you for your valuable suggestion. Retaining and revising Figure 6 can indeed help readers better understand the RET and mass center offset correction (MCOC). In accordance with your suggestion, we have revised Figure 6 in the original manuscript accordingly.

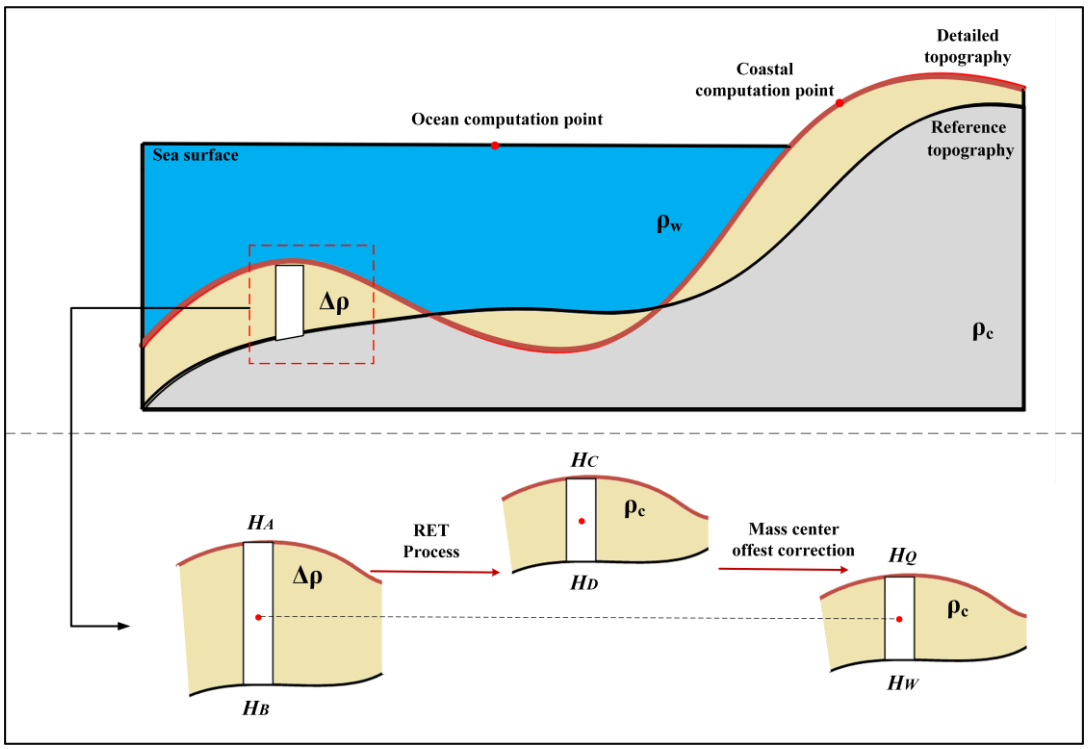

Figure 6: Location of coastal computation points and schematic diagram of the RET method and mass center offset correction.

Point 3： Abstract should be revised in some extents. From my point of view, the mass center offset correction is the main novel point of this work. And thus, it should be highlighted in the abstract.

We sincerely thank the reviewer for this valuable suggestion. In the revised manuscript, we have carefully modified the abstract accordingly. In particular, the mass center offset correction (MCOC), as the main novelty of this study, has been further emphasized to better highlight its contribution.

"To address this issue, a gravity forward modeling-based refinement method using the residual terrain model (RTM) is proposed for coastal regions. In this study, a mass center offset correction (MCOC) is introduced as the main innovation to mitigate prism position shift errors

induced by the rock-equivalent topography (RET) method. Specifically, a high-resolution detailed topography model of the study area, referred to as the SRTM–GEBCO model, was first constructed by merging the land digital elevation model SRTM V4.1 with the ocean bathymetric model GEBCO_2024. Based on this model, the reference topography was then derived using a spatial filtering approach based on the moving average method. The RTM is then discretized into regular grid prisms, and the GA generated by the RTM at target points is computed in the spatial domain using the prism integration method to refine the XGM2019e-2159 gravity anomaly (XGM-GA) model. For computation points located in coastal areas, the RET method is adopted to avoid distinguishing between the densities of land and ocean prisms during forward modeling, and the MCOC is further applied to correct the resulting positional bias."

Minor comments：

Point 4： Page 2, line 42: "Guo et al.,2010" should be "Guo et al., 2010".

We thank the reviewer for pointing out this formatting issue. The citation has been corrected to "Guo et al., 2010" in the revised manuscript.

Point 5： Page 2, line 48: "beyond this degree.(Gruber, 2009)." should be "beyond this degree (Gruber, 2009)."

We thank the reviewer for pointing out this formatting issue. The text has been corrected from "beyond this degree.(Gruber, 2009)." to "beyond this degree (Gruber, 2009)." in the revised manuscript.

Point 6: Equation (2) should be removed as the spherical harmonic topography is not used here.

We thank the reviewer for this helpful suggestion. In the revised manuscript, Equation (2) has been removed, as the spherical harmonic topography is not used in this study.

Point 7: Figure 3 only gives the example of the RTM for the land area. The one using the RET for the marine area should be added.

"The schematic diagram of the RTM for land and marine areas is shown in Figure 3, where the RTM for the marine area is obtained using the RET method."

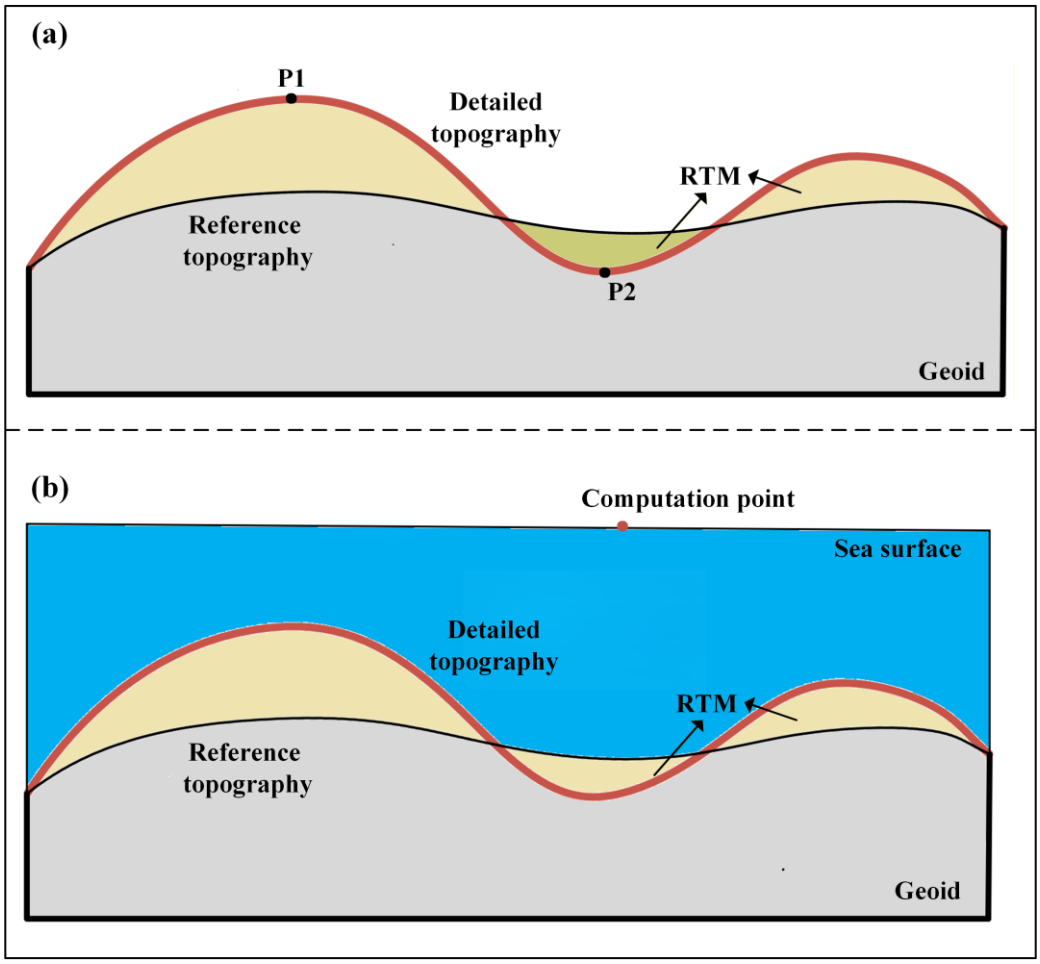

Figure 3: Schematic diagrams of the RTM over land (a) and over the marine area (b).

Point 8： The caption of Figure 4 should claim that the RET has been applied over the marine area.

We thank the reviewer for this helpful comment. The caption of Figure 4 has been revised to clearly indicate that the RET method has been applied over the marine area.

"Figure 4 ： RTM of the study area with RET applied in the marine area."

Point 9： I suggest to replace the variable "R" in Equations (3)-(5) by the variable "l". This is because R usually denotes the mean radius of the Earth, while l means the Euclidean distance between two points.

We thank the reviewer for this valuable suggestion. The variable l ,which represents the Euclidean distance between two points, is indeed more appropriate. Accordingly, Equations (3)–(5) have been revised in the manuscript, and the corresponding descriptions have been updated as well.

Point 10：Page 8, line 195: "total gravitational anomaly" should be "total gravity anomaly"

We appreciate the reviewer's comment. The term has been corrected from "total gravitational anomaly" to "total gravity anomaly" in the revised manuscript.

Point 11:" ρ_c =2670kg/m" should be ρ_c =2670kg/m^3".

We appreciate this comment. The unit has been corrected accordingly in the revised manuscript.

Point 12: Page 10, line 236: “downward-continuous” should be “downward continued”.

We appreciate the reviewer’s comment. The term has been corrected from “downward-continuous” to “downward continued” in the revised manuscript.

Point 13: Table 3: “[-3400m,1600m)” should be “[-3400m,-1600m)”

We appreciate the reviewer’s comment. The range in Table 3 has been corrected from “[-3400 m, 1600 m)” to “[-3400 m, -1600 m)”.

Point 14: Table 4: In the first column of “variant”, the last two terms of “NGS99-(XGM/RTM)” can be removed. Furthermore, in the case of using the RTM over the entire area (the last row), what about the differences of the results while considering and not considering the MCOC in the marine area?

We appreciate the reviewer’s valuable comment. The first column in Table 4 has been revised by removing the last two terms in “NGS99-(XGM/RTM)” for clarity. The comparison of the results before and after introducing the MCOC when both marine and terrestrial residual terrain are considered has also been updated in Table 4, and the corresponding description has been added in the manuscript.

“It is noteworthy that when only the ocean residual terrain is considered, the RMS is reduced by only 0.34 mGal without applying the mass center offset correction (MCOC), whereas it decreases by 0.71 mGal when the

correction is applied. When both marine and terrestrial residual terrain are considered, the application of the MCOC further reduces the RMS by 0.25 mGal compared to the case without applying it. This indicates that introducing the mass center offset correction in the RET method can effectively enhance the accuracy of the model."

Table 4: GA statistics at land-coastal points (mGal)

Variant	RTM	Min	Max	Mean	STD	RMS	IR
NGS99-XGM	Not applied	-32.62	49.71	0.75	14.96	14.98	
NGS99-(XGM/RTM)	Land-only	-19.51	30.02	1.98	8.48	8.71	41.8%
	Sea-only (without-MCOC)	-29.08	47.02	0.35	14.63	14.64	2.3%
	Sea-only (with-MCOC)	-26.54	49.82	3.01	13.95	14.27	4.7%
	Land/sea (without-MCOC)	-23.52	28.11	2.08	7.95	8.22	45.1%
	Land/sea (with-MCOC)	-18.54	28.61	1.79	7.77	7.97	46.8%