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MANUSCRIPT TITLE

Turbidity maximum zone index: A novel model for remote extraction of turbidity maximum zone in different estuaries

AUTHORS

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ISSUED ON

June 30, 2021

JOB CODE

GYGCH_2

THE EDITAGE Promise QUALITY GUARANTEE

Vikas Narang

Vikas Narang
Chief Operating Officer - Editage

Juan Antonio Añel (Chief editor):

We have checked the 'Code and data availability' section of your manuscript. We would like to request you some additional information about the LandSat images used in your work. A good way of doing it would be adding the Metadata files that Glovis provides when you get an image as supplementary information to your manuscript, as it includes the version of the software used to produce it, exact time, data product, etc. Another way can be storing them in an external repository that we can accept, such as Zenodo.

Response:

Dear Juan Antonio Añel, thanks for your valuable comments. The more details, the more advantageous to a study, as you point out. Following your suggestion, the **unique ProductID** and the links of the metadata information have been added to illustrate the detail information about the four scans of Landsat images used in the manuscript (Page 8, lines 149-156).

In addition, the relevant contents and the manuscript have been also revised carefully following the two reviewers' comments.

The ProductID of the four scans of Landsat images and the links of the metadata information are listed as below.

LT05_L1TP_122044_20041120_20161129_01_T1, was captured on November 20, 2004, covering Pearl River Estuary.

LC08_L1TP_122044_20151018_20170403_01_T1, was captured on October 18, 2015, covering Pearl River Estuary.

LT05_L1TP_120044_20080813_20161030_01_T1, was captured on August 13, 2008, covering Hanjiang River Estuary.

LC08_L1TP_123045_20131206_20170428_01_T1, was captured on December 6, 2013, covering Moyangjiang River Estuary.

https://www.usgs.gov/centers/eros/science/usgs-eros-archive-landsat-archives-**landsat-4-5-thematic-mapper-tm**-level-1-data?qt-science_center_objects=0#qt-science_center_objects

https://www.usgs.gov/centers/eros/science/usgs-eros-archive-landsat-archives-**landsat-8-oli**-operational-land-imager-and?qt-science_center_objects=0#qt-science_center_objects

Thanks a lot for your consideration.

Stay healthy and best wishes,

Chongyang Wang

Reviewer #1:

The paper developed an index called turbidity maximum zone index (TMZI) and defined it as the ratio of the difference and sum of logarithmic transformation of TSS (total suspended solids) concentrations and chlorophyll concentrations. Through the experiments in Pearl River Estuary (PRE), Hanjiang River Estuary (HRE) and Moyangjiang River Estuary (MRE) in Guangdong Province of China, the paper confirmed that the TMZI index (>0.2) effectively distinguished turbidity maximum zones (TMZs) in these estuaries.

Moreover, the paper illustrated how to extract TSS and chlorophyll from Landsat TM and OLI images. The paper clearly explained the methodology, logically carried out the validation tests, and well presented the validation results. The graphics (figures) were also well designed. The methodology could be easily applied in other estuaries to detect annual or seasonal TMZs changes.

However, the paper could be significantly improved if English writing styles and grammar can be improved. For instance, Line 18: Recognizing and extracting estuarine turbidity maximum zone (TMZ) efficiently is important for kinds of terrestrial hydrological process. This line could be rewritten as "Recognizing and extracting estuarine turbidity maximum zone (TMZ) efficiently is important for studying terrestrial hydrological processes."

There are lots of English writing or expression issues. The authors should ask a native English writer for help.

Response:

Dear reviewer, many thanks for the help and the comments about the English writing style and expression issues in the manuscript.

Following your suggestions, we have asked for native English writers (a professor of Florida State University and an associated professor of National University of Singapore) helping us to pick up grammatical errors and revise the text very carefully. Besides, we also asked the professional English language services, **Editage** (www.editage.cn), to further polish the English writing and grammar.

All the revising have been marked in red in the current version(lines 17-20, 27-30, 34-38, 42-46, 53-57, 64-69, 75-92, 94, 113-115, 123-124, 126-128, 135-136, 139-141, 146-156, 169-175, 187-196, 200-201, 206-208, 215-217, 220-222, 228-232, 236-239, 246, 248-249, 255-256, 260-263, 268, 271-275, 277-279, 285-286, 295-297, 301-303, 306-311, 319-321, 337-338, 343, 356-358, 382-384, 387-389, 395-401, 416-417, 422-428, 436-438, 442-448).

Once again, thanks for your kindly help!

Stay healthy and best wishes,

Chongyang Wang

Reviewer #2:

General comments

This paper describes a new approach to identify turbidity maximum zone using an index (TMZI) that combines observations of Chla and turbidity (TSS), and applies the index to 3 estuaries in Guangdong, China. A key hypothesis is that TSS affects primary production and is thus highly correlated with Chla, which is mostly valid. The manuscript is very poorly prepared and importantly, I have some serious reservation on the claims, and recommend rejection.

Response:

Dear reviewer, thanks a lot for reviewing our manuscript and giving the valuable comments. These thoughtful suggestions are all critical for the improvement of the study.

We agree with you on the points, especially the validation and evaluation issues of the model, and language problems.

The main aims of the study is to develop a new approach, which could distinguish turbidity maximum zone (TMZ) in different estuaries and different seasons, and **provide a new reference** and **fresh perspective** for the study of TMZ.

Following your suggestion, we have revised the manuscript very carefully. The lists below are the responses to each comment and all the revising have been marked in RED in the marked-up mode (lines 17-20, 27-30, 34-38, 42-46, 53-57, 64-69, 75-92, 94, 113-115, 123-124, 126-128, 135-136, 139-141, 146-156, 169-175, 187-196, 200-201, 206-208, 215-217, 220-222, 228-232, 236-239, 246, 248-249, 255-256, 260-263, 268, 271-275, 277-279, 285-286, 295-297, 301-303, 306-311, 319-321, 337-338, 343, 356-358, 382-384, 387-389, 395-401, 416-417, 422-428, 436-438, 442-448). It is expected that the quality of the revised manuscript has been improved significantly and meet the demand of journal.

Major comments

As the authors alluded to, estuarine TMZ's vary greatly in different estuaries, and I think this site specificity is for good reason. As the definition of TMZ suggests, it's not the absolute values of turbidity but local maxima (attributed to physical or biological processes) that lead to TMZ, and the latter should be site specific and potentially not comparable across systems. I suggest they first give a rigorous definition for TMZ, as this underpins the significance (or lack thereof) of the claims. Phrased in another way, how can one measure the accuracy of any method that quantifies TMZ (as they repeatedly use 'accuracy', 'good consistency', 'good performance', 'more natural', 'agreed better with reality' in the texts)? Unless this key issue is addressed, there is no way to assess if the

new method is actually better than previous approaches. I found the 'validation' sections have a lot of hand-waving claims, and lack rigor for scientific journal. Better-than-previous study-results is not sufficient (not to mention that 'better' is ill defined here).
Short of a rigorous metric to measure accuracy, an alternative would be to use pattern recognition technique to quantify the 'better performance', but we still need a definition of 'ground truth'.

Response:

The studies of estuarine TMZ has a long history of over 80 years since it was proposed in the last century (Glangeaud 1938). The current definition of TMZ has been widely accepted and recognized across the world (Page 3, lines 53-57). As far as we are concerned, it is a **much very** challenging task for us to give a **more** rigorous and quantified definition for TMZ.

As you point out, measuring the accuracy of corresponding results **is absolutely critical issues** for the assessment of any methods. Following your thoughtful suggestion, the common accuracy measures of object extraction from remote sensing imageries, **area-based accuracy measures** (Cai et al. 2018), has been added to evaluate and compare the performance of the different methods (*Section 2.4*; Page 11, lines 187-196; Page 16, lines 271-275; Page 19, lines 306-307; Page 24, lines 398-400; Page 26, lines 425-428).

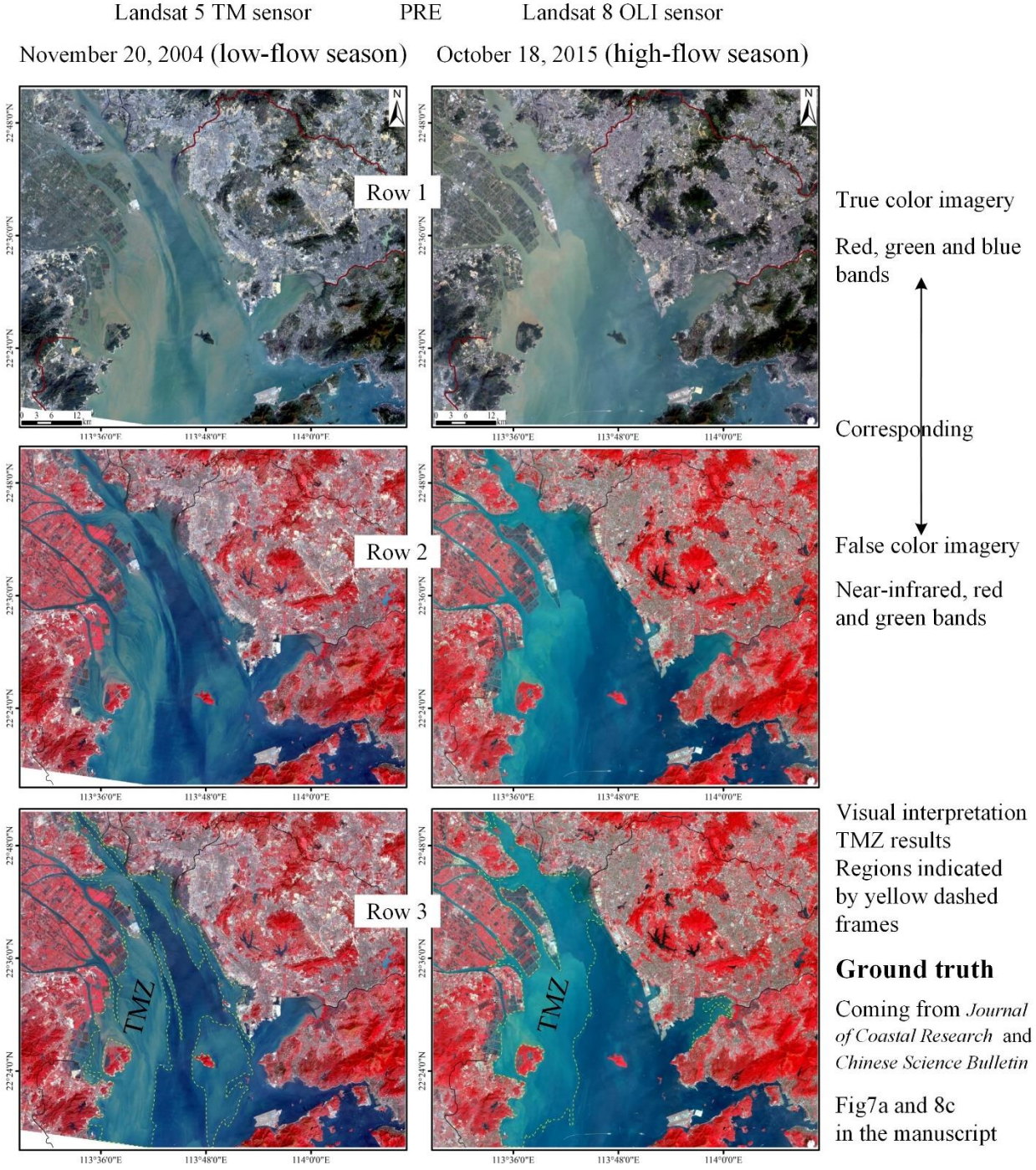
Suppose that A_E is the area of the extracted TMZ, A_C is the correct part of A_E, and A_R is the reference TMZ (ground truth). Then the quality (Q) of the TMZ extraction results in the study could be defined as follow.

$$Q = \frac{A_C}{A_E + A_R - A_C}$$

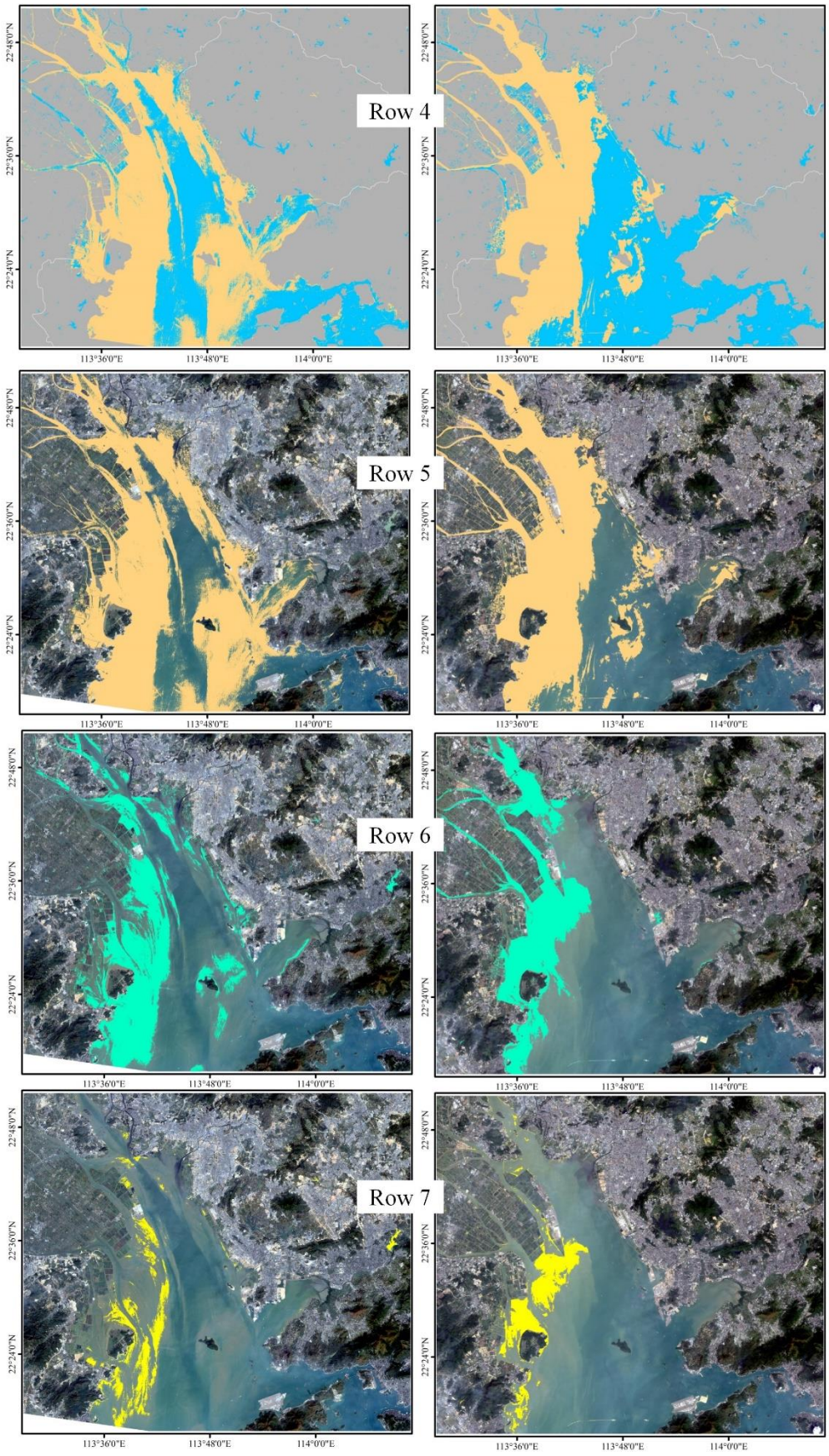
The range of Q is 0 to 1. The bigger Q the value, the higher the accuracy of TMZ extraction results and the better performance of the method.

It should be noted that **the visual interpretation TMZ results** of the Pearl River estuary (PRE) (Pages 17-18; lines 277-278, 301; Figs. 7a and 8c), derived from two scientific and peer-reviewed journals, *Journal of Coastal Research (https://meridian.allenpress.com/jcr)* and *Chinese Science Bulletin (https://www.sciengine.com/publisher/scp/journal/CSB?slug=abstracts)*, **had been defined as 'ground truth' in the study**.

In the PRE, all the TMZ extraction results based on TMZI and previous approaches has been assessed by the visual interpretation TMZ results ('ground truth') and the new added accuracy assessment measures. In order to illustrate the evaluation and comparison process better, some figures (Figs. 7, 8c, 8d and 11) in the manuscript are restructured to a sketch map here.


Landsat 5 TM sensor
PRE
Landsat 8 OLI sensor
November 20, 2004 (low-flow season)
October 18, 2015 (high-flow season)
Row 1
Row 2
Row 3
TMZ
TMZ
True color imagery
Red, green and blue bands
Corresponding
False color imagery
Near-infrared, red and green bands
Visual interpretation TMZ results
Regions indicated by yellow dashed frames
Ground truth
Coming from Journal of Coastal Research and Chinese Science Bulletin
Fig7a and 8c in the manuscript

continue……



TMZ extraction results by TMZI method
Regions indicated by mango colors

Fig7b and 8d in manuscript

Superimposed

True color imagery

Fig 11a, b in the manuscript

TMZ extraction results by the method of Shi et al. (2017)
Regions indicated by cyan color
Superimposed true color imagery

Fig 11c, d in the manuscript

TMZ extraction results by the method of Wai et al. (2004)
Regions indicated by yellow color
Superimposed true color imagery

Fig 11e, f in the manuscript

A sketch map of comparison.

In the third row of the sketch map, **regions indicated by yellow dashed frames** are the visual interpretation TMZ results and defined as 'ground truth'.

In the fourth row, **regions indicated by mango colors** are the TMZ extraction results based on TMZI method. Fifth row shows the **same** results, but with the true color imagery as base map.

In the sixth and seventh rows, **regions indicated by cyan colors** and **yellow colors** are the TMZ extraction results based on Shi et al. (2017) and Wai et al. (2004), respectively.

On the one hand, the TMZ extraction results by TMZI and previous approaches have big difference, which could provide an intuitive and rough comparison. On the other hand, the **quantitative accuracy assessment** also showed TMZI model has a better performance. The quality of the TMZ extraction results by the methods of TMZI, Shi et al. (2017) and Wai et al. (2004) are 0.8429, 0.4238 and 0.1046 in low-flow season, and 0.8171, 0.4770 and 0.1661 in high-flow season, respectively (Page 16, lines 271-275; Page 19, lines 306-307; Page 24, lines 398-400; Page 26, lines 425-428).

The main aims of the studies in the Hangjiang River estuary (HRE) and Moyangjiang River estuary (MRE) are to further assess the applicability of TMZI. The observation is also one of the most basic methods in geography and remote sensing research fields. Given few specialized studies in the two estuaries, the TMZ extraction results in the HRE and MRE were assessed mainly based on remote sensing imageries and the corresponding retrieved results.

We have revised the figures, results validation part, relevant contents and statements in the manuscript carefully (Page 11, lines 187-196; Pages 16-19, lines 271-279, lines 285-286, lines 301-303, lines 306-311; Pages 20-22, lines 326-329, lines 356-358; Pages 24-26, lines 398-400, lines 404-409, lines 422-428).

References:

Cai, L., Shi, W., Miao, Z., & Hao, M. (2018). Accuracy Assessment Measures for Object Extraction from Remote Sensing Images. *Remote Sensing*, 10, 303.

Glangeaud, L. (1938). Transport of Sedimentation Chlans l estuare et l embouchure de La Girronde. *Bulletin of Geological Society of France*, 8, 599-630.

It's also not sufficient to demonstrate that TMZI works for 2 other estuaries in the same province. A variety of estuaries with different physical and biological characteristics is needed to truly support the claim. There are systems that other organic matters than Chla are dominant.

Response:

It is right that the more validation and assessment, the better a new method. In this study, although the PRE, HRE and MRE are all in Guangdong Province, the three rivers and estuaries have significantly difference and its own characteristics (Pages 6-8, lines 123-124, lines 135-141).

The PRE is a horn-shaped estuary. The source of Pearl River is in Yunnan-Kweichow Plateau, southwest China. Pearl River is the fourth longest (2320 km) in China with a drainage area of $4.53 \bullet 10^5$ km^2, and its annual runoff ($3.26 \bullet 10^{11} m^3$) is only smaller than Yangtze River. The sediment load of Pearl River is $7.53 \bullet 10^7$ ton/year.

The HRE is a forking-shaped estuary. The source of Hanjiang River is in Zijin County, east of Guangdong. Hanjiang River has a length of 470 km and has the second largest drainage area ($3.01 \bullet 10^4$ km^2) in Guangdong Province. The annual mean surface runoff of Hanjiang River is $2.45 \bullet 10^{10} m^3$ with sediment load is $6.93 \bullet 10^6$ ton/year.

The MRE is a calabash-shaped estuary. The source of Moyangjiang River is in Cloud Mountains, west of Guangdong. Moyangjiang River has a length of 199 km and a drainage area of more than $6 \bullet 10^3$ km^2. The annual mean surface runoff of Moyangjiang River is $8.21 \bullet 10^9 m^3$ and sediment load is $3.27 \bullet 10^5$ ton/year.

Based on the characteristics of the three rivers and estuaries, it could be found that the source, length, drainage area, shape, runoff and sediment discharge of them are different from each other, Which has a certain representativeness in the study of estuary.

On the other hand, considering that the study of TMZ has long been **a hot topic in many fields**, such as estuary and coast, hydrology, ocean, ecology, environment, geography and remote sensing, it would be better and more persuasiveness if the model could be further validated and assessed by other researchers worldwide.

Minor comments

TSS usually includes CDOM and Chla, so there may be auto-correlation between TSS and Chla, especially for systems dominated by organic matters. This needs to be explored.

Response:

It is no doubt that there exists a **connection** between total suspended solids (TSS) and chlorophyll a (Chla), even other water parameters or color components (CDOM). We have modified the relevant expressions to make it more precise (Page 2, lines 27-30; Page 5, lines 94-102; Pages 13-14, lines 220-222; lines 236-239).

In fact, the **defined relationship** among the water parameters is still in the study and discussion, particularly in estuarine regions of dynamic changes (Zhang and Blomquist., 2018; Hu et al., 2013; Chen et al., 2011; Zhao et al., 2009). It is expected that more detail results and conclusion could be found in the future study and research.

References:

Chen, S., Fang, L., Li, H., Chen, W., & Huang, W. (2011). Evaluation of a three-band model for estimating chlorophyll-a concentration in tidal reaches of the Pearl River Estuary, China. *ISPRS Journal of Photogrammetry and Remote Sensing*, 68, 356-364.

Zhang, Q., & Blomquist, J.D. (2018). Watershed export of fine sediment, organic carbon, and chlorophyll-a to Chesapeake Bay: Spatial and temporal patterns in 1984–2016. *Science of the Total Environment*, 619-620, 1066-1078.

Zhao, J., Cao, W., Wang, G., Yang, D., Yang, Y., Sun, Z., Zhou, W., & Liang, S. (2009). The variations in optical properties of CDOM throughout an algal bloom event. *Estuarine, Coastal and Shelf Science*, 82, 225-232.

Hu, S., Cao, W., Li, J., Yang, Y., Wang, G., & Zhou, W. (2013). Spectral absorption properties of colored dissolved organic matter along 6 ℃N transect of tropical eastern Indian Ocean. *Journal of Tropical Oceanography*, 32, 13-21.

Can't Eq (1) be simplified, as exp and log cancel out?

Response:

In equation 1, the bases of the exponent and logarithm are 'e' and '10', respectively. We are sorry for the unclear statement in the previous version. Following your suggestion, the equation have been revised (Page 11, line 182).

$$Chla = a * e^{b*Log_{(10)}[(\frac{1}{R_1} - \frac{1}{R_2})*\frac{1}{R_3}]}$$

There are also very extensive syntax errors and confusing sentences throughout the texts, and below is an incomplete list. The authors should go over the text very carefully. There are also mentions of geographic names (Neilingding etc) that should be illustrated in plots.

Ln 54: 'within limits'; ln 58: 'progress'; sentence on ln 84; ln 88: 'latent'; ln 133: ''famous'; ln 168: expected; ln 217: while; ln 224: referring to; ln 235: 'null' (near zero is different from null); ln 242: read; ln 256 (sentence); ln 275: extracting; ln 279: season; ln 289 (sentence); ln 298: similar; ln 307: indicated; ln 386-7 (sentences)….

Response:

Dear reviewer, Following you and another reviewer's suggestions, we have asked for native English writers (a professor of Florida State University and an associated professor of National University of Singapore) helping us to pick up grammatical errors and revise the text very carefully. Besides, we also asked the professional English language services, **Editage** (www.editage.cn), to

further polish the English writing and grammar.

All the revising have been marked in red in the current version (lines 17-20, 27-30, 34-38, 42-46, 53-57, 64-69, 75-92, 94, 113-115, 123-124, 126-128, 135-136, 139-141, 146-156, 169-175, 187-196, 200-201, 206-208, 215-217, 220-222, 228-232, 236-239, 246, 248-249, 255-256, 260-263, 268, 271-275, 277-279, 285-286, 295-297, 301-303, 306-311, 319-321, 337-338, 343, 356-358, 382-384, 387-389, 395-401, 416-417, 422-428, 436-438, 442-448).

Once again, thank you very much for your valuable comments and suggestions for the improvement of the manuscript.

Stay healthy and best wishes,

Chongyang Wang