Response to reviewer

Title: Interactive comment on "Spatial pattern of K_d(PAR) and its relationship with light absorption of optically active components in inland waters across China

Referee: Rafael Gonçalves-Araujo

SPECIFIC COMMENTS:

1. L 20-22: "absorption coefficient of pigment particulates", "dissolved organic matters" and "inorganic particulate matters" seems a bit odd. I suggest the authors to adopt "absorption coefficient of phytoplankton, colored dissolved organic matter and inorganic particles".

Response: Thank you for the suggestion, and we have adopt the suggestion in the revised manuscript.

2. L 24-25: Need to clarify whether it is considering each of the OACs individually or it takes into account the sum of OACs (i.e., total non-water absorption – atw).

Response: It takes into account the sum of OACs, we used "the total non-water absorption" in the revised manuscript.

3. L 30-32: I cannot see how your results support the affirmation.

Response: This study analyzed the spatial distribution of the K_d(PAR) in China lakes and reservoirs. the relative contribution of CDOM, Chla, and inorganic particles to the total non-water light absorption, and the results showed that when only consider the contribution of absorption of a_{OACs} to K_d(PAR), the total non-water absorption could explain 70%-87% of K_d(PAR) variations (Figure 6). In the lakes with low TSM concnetration and non-eutrophic lakes with high TSM, a_{CDOM} was the most powerful predicting factor on K_d(PAR). In eutrophic lakes with high TSM, a_{NAP} had the most significant impact on K_d(PAR) (Figure 8). These results can support the affirmation in line 30-32.

4. L 42-45: PAR is also attenuated by the water itself.

Response: This is very correct, and we have added this in the revised manuscript.

5. L 51-52: not clear what it meant with that sentence.

Response: We have re-written the sentence. "However, this traditional measuring approach in situ is not well suited for assessment of K_d(PAR) at large spatial scale."

6. L 54-58: How do environmental change (what do you mean by that?) and anthropogenic activity make it challenging to assess K_d in turbid inland waters?

Response: Dramatic environmental changes have taken place in many inland lakes. For example, a decrease in lake area has resulted from lake reclamation. Anthropogenic activities like dam construction have also readjusted the hydrological conditions. Owing to changes in water quantity and sediment discharge, the environmental change and anthropogenic activity make it challenging to assess K_d in turbid inland waters.

Zhang, G., Xie, H., Yao, T., Kang, S.: Water balance estimates of ten greatest lakes in China using ICESat and Landsat data, Chin. Sci. Bull., 58(31), 3815-3829, 2013.

7. L 58-60: Not only for inland waters, it is actually required to all aquatic environments. L 62-63:

“phytoplankton pigment particles (expressed here as the concentration of chlorophyll-a)” – the concentration of Chl-a is an index for the phytoplankton biomass. Absorption by phytoplankton is represented as the absorption coefficient of phytoplankton. L 68-74: authors may want to rephrase this sentence. L 78: “underwater light climate” – I suggest the authors to replace by “underwater light field” L 80-83: those sentences do not make sense to me. Authors may want to rephrase them. L 83-85: it applies for all aquatic systems. L 90: what do the authors mean by plateau waters? And why do they receive such a strong UV radiation?

Response: We totally agree with you, and have re-written these sentences according to your suggestion.

8. L 91-93: repetition of lines 74- 77. Additionally, there is no reference for marine studies.

Response: We have deleted the sentence in line 91-93.

9. L93-94: this condition is not unique for turbid inland waters. L 96: what do you mean by large spatial variability? Is that intra- or inter waterbodies?

Response: The components of OACs had large spatial variations in different turbid inland waters.

10. L 100: what do the authors mean by “OACs component”?

Response: OACs component includess phytoplankton, colored dissolved organic matter and inorganic particles.

11. L 105: give salinity intervals. How much is salinity for a lake?

Response: We have added the range of salinity (1-43.44 psu) for the lakes.

12. L 110: Objective 1 – it is not clear, whether the authors want to compare variability among the regions or if they want to assess the spatial variability in each of the regions.

Response: Objective 1 is to compare the mean K_d(PAR) values in five limnetic regions

13. L 111: what do you mean by “optical variables”? Maybe OACs?

Response: “optical variables” in here mean OACs.

14. L 112: what do you mean by “especially in the different types of lakes”?

Response: The different types of lakes means fresh water lakes and saline lakes, lakes with different TSM concentrations, lakes with different trophic status.

15. L 113: Objective 3 – provide the model based on what?

Response: The model is provided based on the relationship between K_d(PAR) and $a_{OACs.}$

16. L 120-121: Awkward phrasing.

Response: We have deleted the sentence.

17. L 127: What do you mean by “in accordance with the regions and topography”? Are those socio-economic regions? Geomorphologic/Climate regions? Additionally, I did not check for it, but I suspect that there might be other factors other than “regions and topography” behind the division of those regions. Looks a bit simplistic. It is not clear along the MS what kind of regions are those. Authors need to make it clear.

Response: Thank you for the suggestion. This division of Chinese lakes is generally accepted in China, and published in the book of Wang & Dou in 1998. We have added the information about the partition principle. Except the regions and topography, the differences in the climatic and geographical conditions around lakes are also considered.

Wang, S. M., Dou, H. S. 1998. Record of Chinese Lakes. Science Press.

18. L 134: "temporary small lakes" – do you mean perennial?

Response: The "temporary small lakes" mean that some small lakes are seasonal presence. In the dry season, these lakes may are likely to dry up, and in the monsoon, these lakes could appear.

19. L 135: Oligotrophic lakes: you use this terminology here and another few times along the MS and then changes to non-eutrophic lakes. It is necessary to have consistency when it comes to terminology.

Response:

20. L 135-136: this sentence does not make sense. Consider rephrasing it.

Response: Thank you for the suggestion, and we would keep the consistency in the revised manuscript.

21. L 138-141: In what seasons were the surveys carried? All year round? This has great influence on solar radiation. How many stations were performed per lake? Where were the stations located in the lakes? In the borders, in the center? Authors may want to provide such information regarding sampling sites, stations performed, sampling depths, etc. as supplement file to this MS.

L 144: since there is a great variability in the area of sampling lakes, how was the strategy regarding the number of sampling stations with respect to the area of the lakes? - How were the water samples collected? There is no information on that. Were there only surface samples collected? How confident are the authors by providing a model for light attenuation over the water column based on surface measurements?

Response: The surveys were all carried in April and September. Water samples were collected at 4-7 sampling points from lakes on average, these sampling points were evenly distributed across the lake. The number of sampling stations in lake were linking to the area of the lake, it always had 4 points in the lake with area less than 10 km^2, 5-6 points in the lake with area of 10-1000 km^2, and 7 points in the lake with area over 1000 km^2. The surface water (0.2-0.5 m depth) was collected by the portable water collector. The authors provided a model for light attenuation, this model was not only based on surface measurements, the PAR measurements were conducted over the water column.

22. L 142-143: This sentence is confusing and could be easily removed from the MS.

Response: We have deleted the sentence from the MS.

23. L 149-156: It is not 100% clear how the PAR measurements were conducted. Was there a surface reference measurement? What was the general vertical resolution of PAR measurements? Was the PAR measurements spectrally resolved, or was provided an averaged PAR value? If spectrally resolved, what are the channels?

Response: Thank you for the question, and the PAR measurement was first conducted at the water surface, this depth just inundated the spherical quantum sensor of LI-COA 193SA. Then the sensor was vertically dropped down in the water until the PAR values was less than 1% of the PAR value in the water surface. In this dropping down process, the PAR measurements were taken at no less than five point's depth for each station. At each depth in the water, PAR value was continuously recorded for 15 s and automatically output an averaged PAR value, the average value was regarded as the PAR value at this water depth.

24. L 170-172: Not clear whether it was measured directly in water samples or in filters containing the cells.

Response: The water samples with the fixed volume were filtered through 0.45 μm mixed fiber millipore filters (Bandao Industrial Co., Ltd, China) within 24 h of sampling, and these filters were used for Chlorophyll a (*Chla*) extracted using a 90% buffered acetone solution, the *Chla* concentration in the extract was determined by spectrophotometry (UV- 2600 PC, Shimadzu).

25. L 179-181: please provide more information on the equipment. Spectral resolution and range? Was it measured with an integrating sphere? L 187-195: what was the spectral resolution and range of the measurements?

Response: Light absorption of colored dissolved organic matter (a_{CDOM}) in the waters was measured using a UV-2600 spectrophotometer equipped a 1 cm quartz cuvette, the scan range was 200-800 nm, the Milli-Q water was used as a reference. The spectral range of UV-2600 spectrophotometer is 185-1400 nm, and the spectral resolution is 1 nm.

26. L 194: why was the 440 nm wavelength chosen?

Response: We have added the reference in here. The principle and highest phytoplankton pigments absorption is located at 443 nm. Therefore the effect of phytoplankton absorption on total absorption is highest here. The CDOM absorption in visible range have overlaps with phytoplankton pigments absorption at 443, and this effect was introducing errors in ocean color remote sensing algorithms for retrieval of chlorophyll a concentration. In most cases chlorophyll a was overestimated by those algorithms that were not taking into account CDOM absorption at 443 nm. That was a reason for reporting $a_{CDOM}(443)$ or $a_{CDOM}(440)$ in literature, and inclusion of this parameter particularly in semi-anlytical remote sensing algorithms. Please also check the added article listed below.

Prieur, L., Sathyendranath, S.: An optical classification of coastal and oceanic waters based on the specific spectral absorption curves of phytoplankton pigments, dissolved organic matter, and other particulate materials, Limnol. Oceanogr., 26(4), 671-689, 1981.

Lee, Z. P., Carder, K. L., Arnone, R. A.: Deriving inherent optical properties from water color: a multiband quasi-analytical algorithm for optically deep waters, Appl. Opt., 41(27), 5755-5772, 2002.

27. L 198: Would not "L" be 0.05?

Response: Because "*L*" is the cuvette path length, in this study, the cuvette with diameter 0.01 m was used during the analysis process.

28. L 198-199: How was the effective area of the deposited particles on the filter was measured?

Response: the effective area is the area of filter covered by particles.

29. L 205-210: Please provide more information on the calculations of Kd. How was it obtained? Calculations were made for each wavelength and then averaged (spectrally resolved) or PAR was

averaged per depth? L 208: r^2 was obtained based on the relationship of which pair of variables/parameters?

Response: PAR values were measured no less than five point's depth in every sampling point using the LI-COA 193SA. At each depth in the water, PAR value was gotted as an averaged value. So in one sampling point, there are at least five PAR value with different depth. Then, in every sampling point, K_d(PAR) was determined by applying the exponential regression model which utilizes Equation (4), this regression process was based on the PAR values in no less than five point's depth.

$$\mathrm{PAR}_{Z2} = PAR_{Z1} \times e^{-K_d(PAR)\times(Z_2-Z_1)} \quad (4)$$

From the regression model (4), we could infer that K_d(PAR) was an slope value.

$$K_d(\mathrm{PAR})\times(Z_1-Z_2)=\ln(\mathrm{PAR}_{Z2}/\mathrm{PAR}_{Z1})$$

where Z is the water depth, and PAZ_Z is the PAR value at depth Z. The results were accepted only if the coefficient of determination (R^2) was higher than 0.95.

30. L 212: What is SPSS 19.0 ?

Response: This is a data analysis softsare. The total name is SPSS statistics 19.0.

31. L 213: How was the trophic status of lakes assessed in this study? L 229-230: Again, how was the trophic status assessed? L 234-236: Again, how was it measured? What are these results about? What do those numbers mean?

Response: We have added this method in the manuscript. The assessment of the trophic status of lakes was based on the modified Carlson's trophic state index (TSI) (equation 4), using measured Chla, TP and SDD data (Carlson, 1977; Aizaki et al., 1981). The traditional TSI method used numbers (0-100) to express the state of a lake: TSI <30 indicates oligotrophic state, 30 - 50 indicates mesotrophic state, and 50 - 100 indicates eutrophic state.

$$TSI_M(Chla) = 10\times(2.46+\frac{\ln Chla}{\ln 2.5}) \quad (1)$$

$$TSI_M(SD) = 10\times(2.46+\frac{3.69-1.52\times\ln SD}{\ln 2.5}) \quad (2)$$

$$TSI_M(TP) = 10\times(2.46+\frac{6.71+1.15\times\ln(TP)}{\ln 2.5}) \quad (3)$$

$$TSI = 0.54\times TSI_M(Chla)+0.297\times TSI_M(SD)+0.163\times TSI_M(TP) \quad (4)$$

Aizaki, M., Otsuki, A., Fukushima, T., Kawai, T., Hosomi, M., Muraoka, K. 1981. Application of modified Carlson's trophic state index to Japanese lakes and its relationship to other parameters related to trophic state.

Carlson, R.E. 1977. A trophic state index for lakes. Limnology and Oceanography, 22(2), 361-369.

32. L 229: what do you mean by transparency and how was it measured in this study? L 231: Please clarify how the transparency was measured. Is that Secchi disc depth?

Response: "Transparency" could be described by SDD value. Large SDD value means high transparency. We have added this explanation in the manuscript.

33. L 234: Missing references.

Response: Thank you for the suggestion, and we have added the reference in there.

Song, K. S., Zang, S. Y., Zhao, Y., Li, L., Du, J., Zhang, N. N., Wang, X. D., Shao, T. T., Guan, Y., Liu, L.: Spatiotemporal characterization of dissolved carbon for inland waters in semi-humid/semi-arid region, China, Hydrol. Earth Syst. Sci. , 17(10), 4269-4281, 2013.

34. L 237: What do you mean by “proportion of eutrophication”?

Response: It means “the proportion of eutrophic lakes to all studied lakes in NER”.

35. L 238-239: Please, reference accordingly.

Response: We have added the references: Song et al., 2018; Yuan et al., 2018; Zhang et al., 2018.

Song, K., Wen, Z., Xu, Y., Yang, H., Lyu, L., Zhao, Y., Fang, C., Shang, Y., Du, J.: Dissolved carbon in a large variety of lakes across five limnetic regions in China, J. Hydrol. , 563, 143-154, 2018.

Yuan, Y., Jiang, M., Liu, X., Yu, H., Otte, M. L., Ma, C., Her, Y. G.: Environmental variables influencing phytoplankton communities in hydrologically connected aquatic habitats in the Lake Xingkai basin, Ecol. Indicators, 91, 1-12, 2018.

Zhang, M., Shi, X., Yang, Z., Yu, Y., Shi, L., Qin, B.: Long-term dynamics and drivers of phytoplankton biomass in eutrophic Lake Taihu, Sci. Total Environ., 645, 876-886, 2018.

36. L 245: “tectonic origins” – Reference for that?

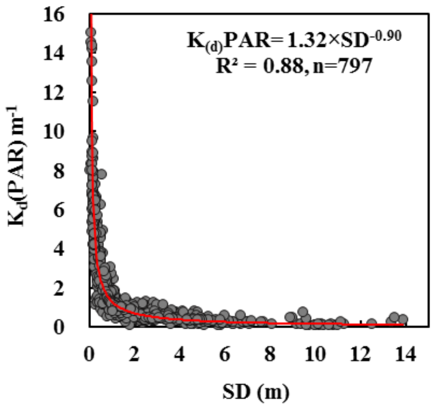
Response: We have added the references: Ma et al., 2017; Yan et al., 2018.

Ma, P. F., Wang, C. S., Meng, J., Ma, C., Zhao, X. X., Li, Y. L., Wang, M.: Late Oligocene-early Miocene evolution of the Lunpola Basin, central Tibetan Plateau, evidences from successive lacustrine records, Gondwana Res. , 48, 224-236, 2017.

Yan, L., Sun, M., Yao, X., Gong, N., Li, X., Qi, M.: Lake water in the Tibet Plateau: Quality change and current status evaluation, Acta Scientiae Circumstantiae, 38(3), 900-910, 2018.

37. L 246-249: Looks like discussion. Question: How was the correlation between transparency and trophic state? And kd vs transparency? I suspect there might be a significant correlation between these variables.

Response: L246-249 This sentence is really a discussion, and we have deleted this sentence from the manuscript. Relationship between K_d(PAR) and transparency (SDD value) has been widely studied, and results showed a significant negatively correlation, K_d(PAR) and SDD are inversely correlated since higher K_d(PAR) values indicate lower water clarity. The relationship of SDD and K_d(PAR) is: $K_d(PAR)=f\times SDD^{-1}$. Where f has the value of 1.44 for turbid coastal waters (Holmes, 1970), 1.38 for turbid inland waters in China (Ma et al., 2016). Other studies have reported different values of f, ranging from 1.7 to 2.3 in different waters (Raymont, 1967; Aertebjerg & Bresta, 1984). In this study, we also got the negative relationship between K_d(PAR) and SDD value (Fig, 1S). Relationship between TSI and transparency (SDD value) was also studied, we showed the result in Fig, 2S.



Fig, 1S Correlation between K_d(PAR) and water transparency (SDD)

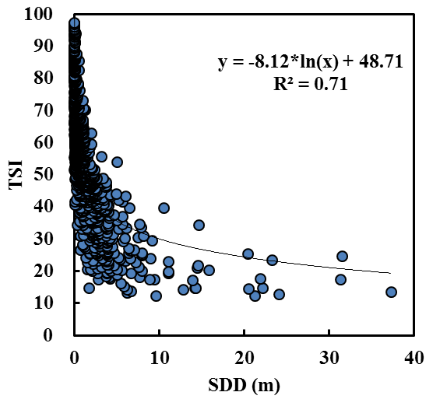


Fig. 2S Correlation between TSI and water transparency (SDD)

Holmes, R. W.: The secchi disk in turbid coastal water, Limnol. Oceanogr., 15(5), 688-694, 1970.

Ma, J., Song, K., Wen, Z., Zhao, Y., Shang, Y., Fang, C., Du, J.: Spatial Distribution of Diffuse Attenuation of Photosynthetic Active Radiation and Its Main Regulating Factors in Inland Waters of Northeast China, Remote Sensing, 8(11), 2016.

Raymont, J.E.G. Plankton and Productivity in the Oceans; Pergamon Press: Oxford, UK, 1967.

Aertebjerg, G.; Bresta, A.M. Guidelines for the Measurement of Phytoplankton Primary Production, 2nd ed.; Baltic Marine Biologists Publication: Charlottenlund, Denmark, 1984.

38. L 254-255: Sentence needs review.

Response: We have rewritten this sentence.

39. L 257-258: Stick to the abbreviations provided. It is confusing when alternating between calling the regions by name and abbreviation. ‘

Response: Thank you for the suggestion, and now we have used abbreviations throughout the manuscript.

40. L 260-264: Confusing and not very informative. Most of the readers have no idea about the locations of the referred lakes. Could be removed from the text. Perhaps authors may want to devote a bit more of effort to describe lakes that have high social-economic impact in the country, instead.

Response: Thank you for the suggestion, and we have deleted the text. This part was rewritten.

41. L 269: “at all sampling sites” – what do you mean by that? Was the correlation tested for each site individually? It is not clear.

Response: We are very sorry for the confusing expression. The correlation was established based on the data in all sampling points.

42. L 271: What that the best linear regression, or was a linear regression the best one to describe the correlation? Have you tested for other types of functions?

Response: We also tested for other types of functions, such as exponential equation, logarithmic equation, and power equation, et al. The results showed that the best function to describe the relationship is a linear model.

43. L 279-280: "all the optically active components had impact on Kd(PAR)" – what do you mean by that?

Response: This means that three OACs: phytoplankton, CDOM, and inorganic particles all had influence on K_d(PAR). The attenuation of photosynthetic active radiation in water was influenced by OACs, and the related results have been showed in Fig. 7.

44. L 282: what is the standardized coefficient of independent variables? Where are those results presented/discussed in the MS?

Response: The standardized coefficient is gotten from the multiple regression analysis. We listed it in Table 1.

Table 1 Summary of multiple regression analysis

	Standardized coefficients			Adjusted R^2	Std. Error	Sig.
	a_{CDOM}	a_{NAP}	a_{phy}			
All lakes	0.130*	0.802*	0.217*	0.866	0.833	0.000
TSM <3.8 mg/L	0.459*	0.408*	0.110*	0.742	0.220	0.000
TSM >3.8 mg/L (Non-eutrophic lakes)	0.536*	0.381*	-	0.770	0.429	0.000
TSM >3.8 mg/L (Eutrophic lakes)	0.086*	0.860*	0.210*	0.762	1.106	0.000

Dependent Variable: K_d(PAR); Predictors: constant, a_{phy}, a_{NAP}, a_{CDOM}; "*" represents p<0.005.

45. L 285: The correlation between Kd and TSM was greater than for kd vs aNAP, how do the authors explain that, since they say that aNAP has the most significant impact on kd(PAR)?

Response: Among a_{NAP}, a_{CDOM}, and a_{phy}, a_{NAP} was the most important influence factor on K_d(PAR), followed by a_{phy}. In this study, the analysis and discussion was only confined to the light absorption characteristic of OACs. TSM was the total concentration of inorganic matters and phytoplankton in water. TSM is not just had the light absorption characteristic, but they could scatter the light. The scattering characteristics of TSM to light may have contribute to the better correlation between K_d and TSM than for K_d vs a_{NAP}.

46. L 294-295: Any reason/hypothesis why that region had the best performance for predicting kd(PAR)?

Response: TQR had the best performance for predicting K_d(PAR), this may be related the natural environment and lake water characteristic, and we analyzed these factors in detail in part 4.1. The following factors, including the strong ultraviolet radiation, deep water, high salinity of water, low nutrient input in lake, and high water transparency in TQR, would result to the low aOACs and a good constituent stability of OACs. Thus the correlation between K_d(PAR) and a_{OACs} in TQR had the best fitting degree (R^2 =0.85) and the greatest relationship coefficient (slope=0.95) than in other limnetic regions.

47. L 303: those relative contributions are related to what?

Response: In all limnetic regions in this study, K_d(PAR) was dominated by inorganic particles absorption/scattering with mean relative contributions of 57.95%, followed by phytoplankton with mean relative contributions of 28.20%.

48. L 304-308: confusing sentences. The authors may want to rephrase them. L 328-329: Confusing sentence.

Response: Thank you for the comment. We have rephrased these sentences.

49. L 315: How was the 3.8 mg/L threshold defined? What is the reason for that value? L 320-322: What about the limnetic regions? Why to use this classification? Any reference for that? Is there any clustering for those stations? In figure 8 the TSM threshold division is further subdivided into non-eutrophy and eutrophy. Authors should state the reason for performing such divisions.

Response: Thank you for the comment. The TSM concentration of 3.8 mg/L used as a threshold to categorize the lakes is the result of regression tree analysis. We have added the related references to this analysis method in the manuscript (Breiman et al., 1984; Hampton et al., 2017). The result of this analysis showed that the tree had two branches with the boundary of 3.8 mg/L TSM. So the TSM concentration of 3.8 mg/L was used as a threshold to categorize the lakes in the subsequent analysis. Mean K_d(PAR) and standard error of K_d(PAR) were calculated for each branch of the regression trees. In figure 8 the TSM threshold division is further subdivided into non-eutrophy and eutrophy. That is because that the trophic status also had important effect on K_d(PAR) and SDD. We have analyzed the correlations between trophic state index (TSI) and water transparency (SDD), between water transparency (SDD) and K_d(PAR) to support this explain (Fig. 1S and 2S in comment 37).

Breiman L, Friedman J, Olshen R (1984) Classification and Regression Trees. Wadsworth International Group, Belmont

Hampton SE et al. (2017) Ecology under lake ice. Ecol Lett 20: 98-111.

50. L 318-319: why to combine oligo- and mesotrophic lakes?

Response: This is a good question. That is because either in oligotrophic lakes (TSM > 3.8 mg/L) or in mesotrophic lakes (TSM > 3.8 mg/L), the total number of sampling points was less than in eutrophic lakes. We try to make have the comparable sampling sites in different trophic status lakes. so we combine oligo- and mesotrophic lakes, this also can be called non-eutrophic lakes, then make the comparation between non-eutrophic lakes and eutrophic lakes.

51. L 336: what do you mean by “relational expression”?

Response: We are sorry for the ambiguity expression, and we have rephrased the sentence “the regression function was $K_d(PAR)=0.30+0.48\times a_{CDOM}+0.72\times a_{NAP}+0.20\times a_{phy}$ ($R^2=0.74$, $p<0.001$)”.

52. L 338-339: where are those results shown? L 339-340: why was aphy excluded? Authors have to estate the reason for that. Results – suggestion: I have the impression that the authors wanted to include all their results in the MS. However, some of those results could be omitted without changing the concept of the manuscript and it would make it easier to present, write and follow. Authors should rethink what results are worth it to be presented in the manuscript.

Response: Thank you for the suggestion. We have added the multiple regression analyses results were all showed in Table 1 (showed in Comment 44).

53. L 349-351: Based on what could you infer that? Are there any thresholds? Please, provide reference.

Response: In the present study, 47.37% of the in situ K_d(PAR) values ranged from 0.11 m^{-1} to 1.00 m^{-1}, and 43.61% of K_d(PAR) ranged from 1.00 m^{-1} to 5.00 m^{-1}. Based on the relationship between K_d(PAR) and water transparency (SDD) (Fig. 1S, see in Comment 37), 43.61% of sampling points had the transparency of 0.26-1.32 m, reflecting that approximately half of these sampling points are the turbid water body. Besides, the previous study has pointed out that when the lakes were in the eutrophic status, the SDD was lower than 1m, presenting by the turbid water (Olmanson, et al., 2008).

Olmanson, L. G., Bauer, M. E., Brezonik, P. L.: A 20-year Landsat water clarity census of Minnesota's 10,000 lakes, Remote Sens. Environ., 112(11), 4086-4097, 2008.

Carlson, R. E.: A trophic state index for lakes, Limnol. Oceanogr., 22(2), 361-369, 1977.

54. L 357-359: Please provide a reference for that statement.

Response: We have added the references.

Budzynska, A., Rosinska, J., Pelechata, A., et al.: Environmental factors driving the occurrence of the invasive cyanobacterium Sphaerospermopsis aphanizomenoides (Nostocales) in temperate lakes, Sci. Total Environ., 650, 1338-1347, 2019.

Richardson, J., Miller, C., Maberly, S. C., et al.: Effects of multiple stressors on cyanobacteria abundance vary with lake type, Global Change Biol., 24(11), 5044-5055, 2018.

55. L 361-363: please provide reference.

Response: We have added the reference.

Ma, P. F., Wang, C. S., Meng, J., Ma, C., Zhao, X. X., Li, Y. L., Wang, M.: Late Oligocene-early Miocene evolution of the Lunpola Basin, central Tibetan Plateau, evidences from successive lacustrine records, Gondwana Res. , 48, 224-236, 2017.

56. L 363-365: please provide reference.

Response: We have added the reference.

Yan, L., Sun, M., Yao, X., Gong, N., Li, X., Qi, M.: Lake water in the Tibet Plateau: Quality change and current status evaluation, Acta Scientiae Circumstantiae, 38(3), 900-910, 2018.

57. L 371-372: Do you mean wind-induced waves? What about the establishment of the seasonal

thermocline? What about the allochthnous input of TSM? What can you say about it?

Response: Thank you for the question. In this part, we discussed that the sediment re-suspension driven by wave disturbance would increase the TSM concentration in the shallow lakes. This sediment re-suspension occurred in shallow lakes, this shallow lakes did not have the seasonal thermocline phenomenon. In addition, the allochthnous input is a very important soure of TSM in the lake water, it is well known that the allochthnous input is ubiquity in all lakes. In this part, we tried to explain the reason of the higher TSM in NER than other area, so we emphasized the sediment re-suspension in shallow lakes.

58. L 379-381: The sentence does not add information to the discussion. Consider removing it or developing it more in deep.

Response: We have deleted it, thank you for the suggestion.

59. L 386: where are those similar inland bodies? Please develop more the discussion instead of making comparisons.

Response: Thank you for the question, we have listed these inland water bodies

60. L 401-404: CDOM photobleaching and photodegradation: how can the authors infer that based on their results? If the information is from other study, please, include the reference.

Response: We have added the reference in the revised manuscript (Song et al., 2018).

Song, K., Li, S., Wen, Z., Lyu, L., Shang, Y.: Characterization of chromophoric dissolved organic matter in lakes on the Tibet Plateau, China, using spectroscopic analysis, Biogeosciences Discuss., 2018, 1-50, 2018.

61. L 410-412: How can the authors infer that form their results? Have you measured phytoplankton biomass prior to the “overbloom”?

Response: This is very good questions, and we have added the references to support the conclusion, and some results have showed in Fig. 2.

Duan, H., Ma, R., Xu, X., Kong, F., Zhang, S., Kong, W., Hao, J., Shang, L.: Two-Decade Reconstruction of Algal Blooms in China's Lake Taihu, Environmental Science & Technology, 43(10), 3522-3528, 2009.

Zhao, H., Zhu, L., Wu, C., Meng, B., Zhou, Y., Jia, X.: Distribution characteristics analysis of algal bloom in Chaohu Lake based on the sky~earth collaborative method, China Environ. Sci., 38(6), 2297-2303, 2018.

Shan, K., Li, L., Wang, X., Wu, Y., Hu, L., Yu, G., Song, L.: Modelling ecosystem structure and trophic interactions in a typical cyanobacterial bloom-dominated shallow Lake Dianchi, China, Ecol. Model., 291, 82-95, 2014.

62. L 412-415: Not clear what the authors want to say in that sentence.

Response: We have deleted the references.

63. L 415-416: Many studies and only one reference?

Response: We have added the references.

Ma, J., Song, K., Wen, Z., Zhao, Y., Shang, Y., Fang, C., Du, J.: Spatial Distribution of Diffuse Attenuation of Photosynthetic Active Radiation and Its Main Regulating Factors in Inland Waters of Northeast China, Remote Sensing, 8(11), 2016.

Zhang, Y. L., Zhang, B., Ma, R. H., Feng, S., Le, C. F.: Optically active substances and their contributions to the underwater light climate in Lake Taihu, a large shallow lake in China, Fundamental and Applied Limnology, 170(1), 11-19, 2007.

64. L 425: Awkward phrasing.

Response: We have rephrased the sentence.

65. L 428: Figure 5 only shows TSM results.

Response: We are sorry for the clerical error, this should be Figure 6.

66. L 428-429: What was the overall absorption budget for the studies regions? I think that your results would be clearer if you present a ternary plot for the absorption of OACs (CDOM x phytoplankton x NAP) for each of the regions.

Response: The overall absorption of OACs could explain 85% of K_d(PAR) in the whole studied region (Figure 4a). As you mentioned, the ternary plot for the absorption of OACs in each of the regions were added in the revised manuscript. This may be helpful in understand the absorption budget in studied regions.

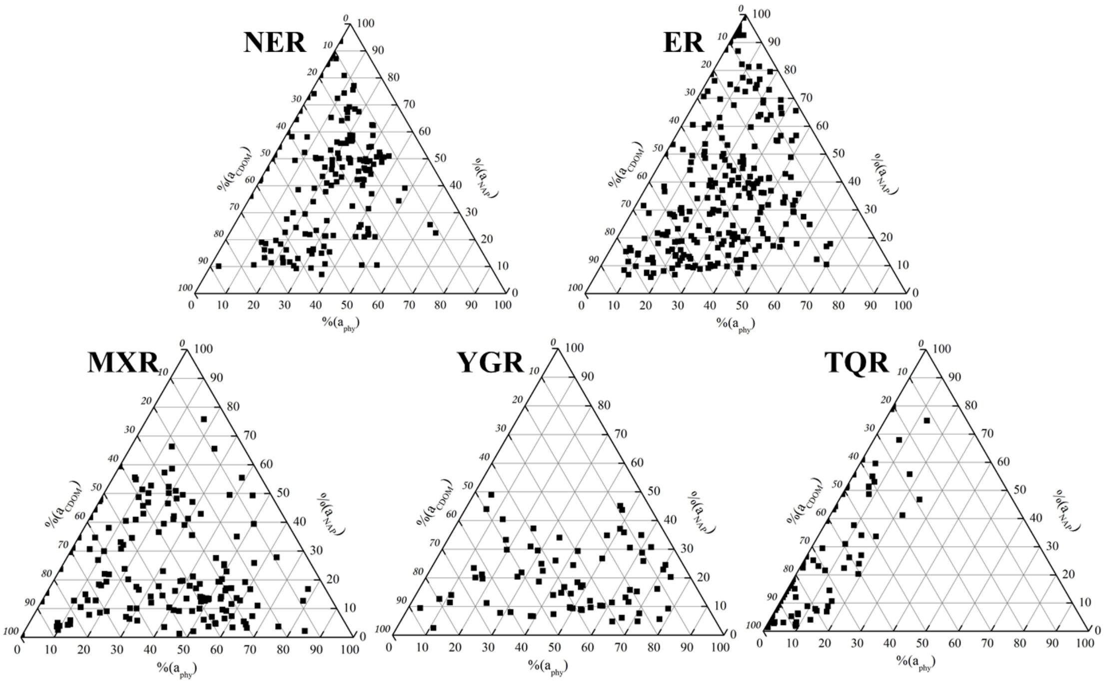


Fig. 3S Relative contributions of phytoplankton, colored dissolved organic matter and inorganic particles to total non-water light absorption at wavelength of 440 nm.

67. L 431-432: Not clear what the authors want to say in that sentence.

Response: We have rephased the sentence.

68. L 439: "Chla" – is not it the contribution of phytoplankton, which is expressed by means of Chla concentration?

Response: Yes, Chla is the contribution of phytoplankton.

69. L 438-442: where are those results presented in the manuscript?

Response: Those results are presented in "3.4 Relationship between K_d(PAR) and a_{OACs} in different lakes".

70. L 442-444: that classification was made for oceanic waters. Additionally, the terminology presented in the manuscript is out of date.

Response: The classification was made for oceanic waters, but now it was also used in the inland water, we listed one related refence in here (Wen et al., 2016). We have adopted the terminology as your in Comment 1.

Wen, Z. D., Song, K. S., Zhao, Y., Du, J., Ma, J. H.: Influence of environmental factors on spectral characteristics of chromophoric dissolved organic matter (CDOM) in Inner Mongolia Plateau, China, Hydrol. Earth Syst. Sci. , 20(2), 787-801, 2016.

71. L 444-449: what can the authors discuss/add/conclude about that information? How does it help the interpretation of their results?

Response: This study analyzed the relative contribution of CDOM, Chla, and inorganic particles to the total non-water light absorption, and the results showed that CDOM absorption played a major role on total non-water light absorption, and Chla played a minor role. In the lakes with low TSM concnetration and non-eutrophic lakes with high TSM, a_{CDOM} was the most powerful predicting factor on K_d(PAR). In eutrophic lakes with high TSM, a_{NAP} had the most significant impact on K_d(PAR). L 444-449 was used to support these informations.

72. L 449.455: those sentences can be deleted without changing the interpretation of results and discussion of this manuscript.

Response: We don't agree with you, in our opinion, these sentences are conducive to understand the contributions of a_{CDOM} and aphy to K_d(PAR).

73. L 461-463: This sentence does not add to the discussion given that the authors do not mention calcite particles in their study.

Response: The calcite particles were included in the inorganic particles, it is one type of inorganic particles. We used this sentence to support the light absorption of inorganic particles (aNAP) had the important impact on K_d(PAR).

74. L 469: are you assuming Chla as a proxy for trophic status?

Response: Yes, in many studies, the Chla could be used as a proxy for trophic status (Doernhoefer et al., 2018; Smith, 2003; Oliver et al., 2017).

Doernhoefer, K., Klinger, P., Heege, T., Oppelt, N.: Multi-sensor satellite and in situ monitoring of phytoplankton development in a eutrophic-mesotrophic lake, Sci. Total Environ., 612, 1200-1214, 2018.

Oliver, S. K., Collins, S. M., Soranno, P. A., Wagner, T., Stanley, E. H., Jones, J. R., Stow, C. A., Lottig, N. R.: Unexpected stasis in a changing world: Lake nutrient and chlorophyll trends since 1990, Global Change Biol., 23(12), 5455-5467, 2017.

Smith, V. H.: Eutrophication of freshwater and coastal marine ecosystems a global problem, Environ. Sci. Pollut. Res., 10(2), 126-139, 2003.

75. L 470-476: Not clear what the authors want to say in that sentence. Additionally, the authors start the sentence with the word "Studies" and present only a single reference.

Response: We have rephrased the sentence. "In these turbid waters, phytoplankton also had important influence on light attenuation. Previous study has pointed out that the effect of inorganic particles on K_d(PAR) could be disturbed by the high phytoplankton concentration in spring and summer. The algal bloom in spring and summer resulted in the increase of phytoplankton concentration in lakes, which would increase the contribution of Chla to K_d(PAR)."

76. L 475-478: how do the results suggest that? It is not clear to me.

Response: In this study, the results showed that spatial K_d(PAR) was relatively dependent on the inorganic particles (average relative contribution of 57.95%). In the lakes with low TSM concnetration and non-eutrophic lakes with high TSM, a_{CDOM} was the most powerful predicting factor on K_d(PAR). In eutrophic lakes with high TSM, a_{NAP} had the most significant impact on K_d(PAR). This study allowed K_d(PAR) to be predicted from a_{OACs} values in the inland waters. This means that the main influence factor of K_d(PAR) in inland waters with different TSM concentrations, trophic status, and optical characteristics is different, so we suggested that new studies on the variability of K_d(PAR) in inland waters must consider the hydrodynamic conditions, trophic status and the distribution of optically active components within the water column.

77. L 484-487: Where is this shown along the MS? How do your results support such an affirmation?

Response: This is an universally accepted affirmation, and we have listed the supporting references in the manuscript. We quoted this affirmation to explain that although we only analyzed and discussed the contribution of OACs absorption on K_d(PAR) in this study, the scattering also had contribution on K_d(PAR) in fact.

Budhiman, S., Suhyb Salama, M., Vekerdy, Z., Verhoef, W.: Deriving optical properties of Mahakam Delta coastal waters, Indonesia using in situ measurements and ocean color model inversion, ISPRS J. Photogramm. Remote Sens. , 68, 157-169, 2012.

Kirk, J. T. O.: Yellow substance (gelbstoff) and its contribution to the attenuation of photosynthetically active radiation in some inland and coastal south-eastern Australian waters, Australian Journal of Marine and Freshwater Research, 27(1), 61-71, 1976.

Zheng, Z., Ren, J., Li, Y., Huang, C., Liu, G., Du, C., Lyu, H.: Remote sensing of diffuse attenuation coefficient patterns from Landsat 8 OLI imagery of turbid inland waters: A case study of Dongting Lake, Sci. Total Environ., 573, 39-54, 2016.

78. L 488-490: How do your results support that affirmation? How was the scattering contribution in this study?

Response: In this study, the results highlight that the total non-water absorption could explain 70%-87% of K_d(PAR) variations (Fig 5, Fig. 8), this supports that a_{OACs} could explain most of Kd(PAR) variations. Due to the limitation of our experimental conditions, the scattering contribution did not analyzed in this study. However, many studies have pointed out that the scattering contribution of particles matters to K_d(PAR) variations in natural waters was relatively small, and we have quoted these research results in this manuscript, such as Belzile et al., 2002 and Lund-Hansen, 2004.

Belzile, C., Vincent, W. F., Kumagai, M.: Contribution of absorption and scattering to the attenuation of UV and photosynthetically available radiation in Lake Biwa, Limnol.

Oceanogr., 47(1), 95-107, 2002.

Lund-Hansen, L. C.: Diffuse attenuation coefficients K-d(PAR) at the estuarine North Sea-Baltic Sea transition: time-series, partitioning, absorption, and scattering, Estuarine Coastal and Shelf Science, 61(2), 251-259, 2004.

79. L 490-496: Not clear how those sentences would help/add to the discussion.

Response: This is a good comment. We have reread these sentences, and have deleted them form the discussion.

80. L 498: I would suggest an AC-S instead, given the much better spectral resolution.

Response: We are agree with you, and we have used AC-S instead in the manuscript.

81. L 501: The sentence does not make sense.

Response: We have rephrased the sentence.

82. L 506: when presenting the given, please indicate at what wavelength the absorption coefficients should be considered.

Response: We are agree with you, and we have added the wavelength in the manuscript.

83. L 511-512: Sentence does not add to the conclusions. I suggest to remove it.

Response: We are agree with you, and have removed it.

84. FIGURES AND TABLES: Captions provide a poor description of figure contents. Authors should put more effort on that. Figure in general are well presented and I have some specific comments/suggestions below:

Figure 1. Very poor resolution and it is almost impossible to read the text and see the inset figure in each panel. In (a) there is no reference for the limnetic region definitions. What do the red dots mean? What is presented in the inset graph? Additionally, the kd(PAR) values presented in panel (b) are not described. Where was that data from?

Response: Thank you for the suggestion, and we have re-plotted the Figure 1. The limnetic region definition was according to the "Record of Chinese Lakes" (Wang, S. M., Dou, H. S. Record of Chinese Lakes. Science Press. 1998.)

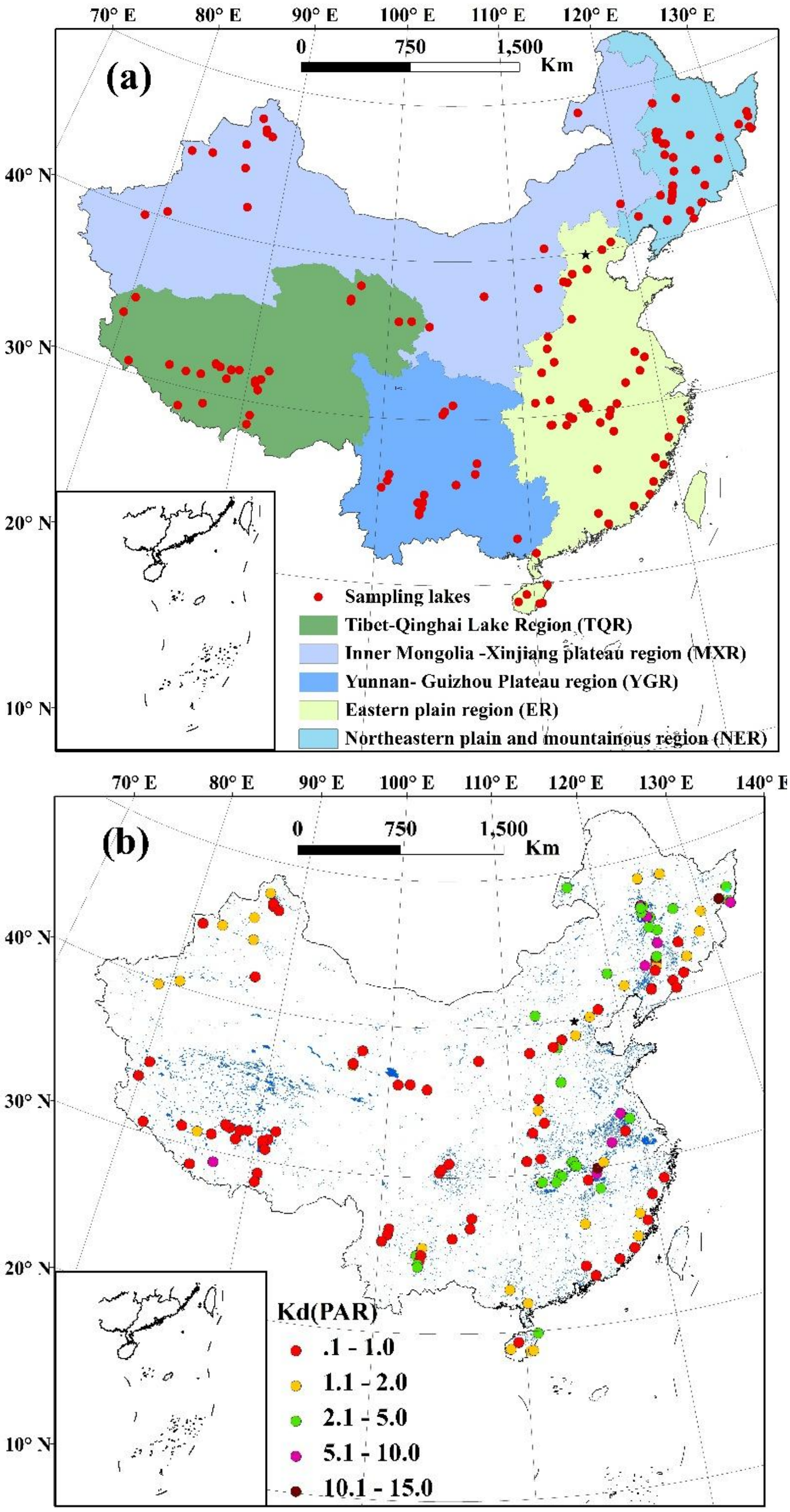


Fig. 1 Study area location and sampling lakes distribution, (a) sampling lakes distribution in five limnetic regions, the limnetic region definition was according to the "Record of Chinese Lakes, 1998" (b) K_d(PAR) values distribution of every sampling lake.

85. Figure 2: Provide more information in the caption.

Response: We have added the full names of the five limnetic regions in the caption

86. Figure 3: Have you tested for the differences among regions? It seems that there is no significant

difference between ER and MXR.

Response: We have tested or the differences among regions, and just as you mentioned, there is no no significant difference between ER and MXR.

87. Figure 4. Please indicate the selected wavelength for absorption coefficients. It is mandatory to provide such an information.

Response: We have added t the selected wavelength for absorption coefficients in the caption "Fig. 4 Scatter plots of diffuse attenuation vs light absorption of optically active components at 440nm, (a) a_{OACs}, (b) a_{NAP}, (c) a_{phy}, and (d) a_{CDOM}"

88. Table 1. What do you mean by adjusted r^2? How did you get to that?

Response: The adjusted r^2 value was gotted from the multiple regression analysis. This adjusted r^2 value was used to evalute the multiple regression model, the closer that this adjusted r^2 value is to 1, the more well-fitted the model is.

89. Figure 5. How is that possible to have a n=788, when you mention that only 741 samples were taken?

Response: We are very sorry for the clerical error, this shoud be 741, and we have corrected it in the Figure 5.

90. Figure 7. How was the K values for each OACs obtained? How was the K_{water} obtained? I suggest you to make ternary plots instead. It gives more information on the absorption budget and you can split it into different seasons/years to see how it varies over time.

Response: The K_d(PAR) is the sum light attenuation by pure water (K_{water}), CDOM (K_{CDOM}), phytoplankton (K_{Chla}) and inorganic particles (K_{NAP}) (Kirk, 1994; Phlips et al., 1995). K_{water} is taken as a constant of 0.027 m^{-1} (Smith & Baker, 1978). K_{CDOM} could be estimated with the product of 0.221 and a_{CDOM} at 440nm (Pfannkuche, 2002). K_{Chla} was estimated from the the specific attenuation coefficient of Chl-*a* and Chl-*a* concentration (Brandao et al., 2017). Finally, K_{NAP} was calculated as K_d(PAR)- K_{water} - K_{Chla}- K_{CDOM} (Zhang et al., 2007). Relative contributions of K_{water}, K_{CDOM}, K_{Chla} and K_{NAP} to total K_d(PAR) were calculated. Because there are four variables, including K_{water}, K_{CDOM}, K_{Chla} and K_{NAP}. was a constant, so we did not plot the ternary figure. The different seasons/years variation over time is a very intresting issue, however, this study did not involve with K_d(PAR) variation along the time series, we will study this in the further research.

Kirk, J. T. O., Light and photosynthesis in aquatic ecosystem. Cambridge University Press, Cambridge, 1994: 1-431.

Phlips, E. J., Aldridge, F. J., Schelske, C. L., Crisman, T. L.: Relationships between light availability, chlorophyll a, and tripton in a large, shallow subtropical lake, Limnol. Oceanogr., 40(2), 416-421, 1995.

Smith, R. C., Baker, K. S.: The bio-optical state of ocean waters and remote sensing, Limnol. Oceanogr., 23(2), 247-259, 1978.

Zhang, Y. L., Zhang, B., Ma, R. H., Feng, S., Le, C. F.: Optically active substances and their contributions to the underwater light climate in Lake Taihu, a large shallow lake in China, Fundamental and Applied Limnology, 170(1), 11-19, 2007.

Brandao, L. P. M., Brighenti, L. S., Staehr, P. A., Barbosa, F. A. R., Bezerra-Neto, J. F.: Partitioning of

the diffuse attenuation coefficient for photosynthetically available irradiance in a deep dendritic tropical lake, Anais Da Academia Brasileira De Ciencias, 89(1), 469-489, 2017.
Pfannkuche, J.: Optical properties of Otago shelf waters: South Island New Zealand, Coast Shelf Sci, 55, 613-627, 2002.

91. Finally, given that the authors present a model to retrieve Kd(PAR), I expected to see a figure where calculated Kd was plotted against in situ observed Kd.

Response: This is very good suggestion. The performance of the relationship was assessed through comparison of independently-measured K_d(PAR) and K_d(PAR) derived from the model provided in this study ($K_d(PAR) = 0.41 + 0.57 \times a_{CDOM} + 0.96 \times a_{NAP} + 0.57 \times a_{phy}$, R^2=0.87, n=741, p<0.001). The validation results showed that the mean ratio of -measured K_d(PAR) to the derived value was 0.89, having a MAPE of 33.23% (Fig. 4S).

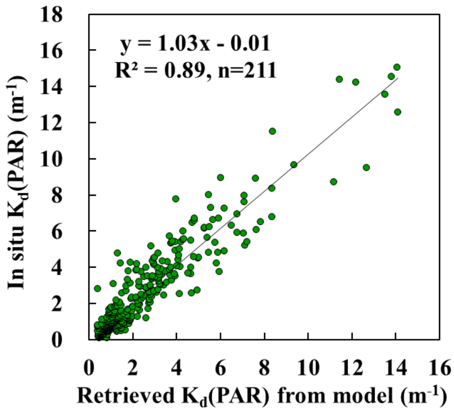


Fig. 4S Relationship validation in sampling points