

## ***Interactive comment on “Seasonal characterization of CDOM for lakes in semi-arid regions of Northeast China using excitation-emission matrices fluorescence and parallel factor analysis (EEM-PARAFAC)” by Y. Zhao et al.***

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Overall: the language needs corrections, additional check and corrections by native speaker would be advised. Authors should more careful interpreting the components. And there are way too many methodological details in the manuscript. Response: Thank you for your suggestions. The fourth co-author (Professor Lin Li from IUPUI, USA) has corrected the language carefully. The components were interpreted more

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carefully in the revised manuscript. As suggested by the reviewer, these unnecessary methodological details in the manuscript were removed. Your kind suggestion has been adopted in the revised manuscript.

**Abstract** The abstract should be written in more concise way. Right now it is quite confusing. Only the most important findings should be emphasized (which is not the case now). The less important findings should be removed from abstract. I do not really understand what authors mean by the sentence line 14-15? Response: Thank you for your suggestion. The authors have rewritten the abstract and a more concise abstract was achieved in the revised manuscript. The revised manuscript is written as “The seasonal characteristics of fluorescent components in CDOM for lakes in the semi-arid region of Northeast China were examined by excitation-emission matrices fluorescence and parallel factor analysis (EEM-PARAFAC). Two humic-like (C1 and C2) and two protein-like (C3 and C4) components were identified using PARAFAC. The average fluorescence intensity of the four components differed under seasonal variation from June and August 2013 to February and April 2014. Components 1 and 2 exhibited strong linear correlation ( $R^2 = 0.633$ ). Significantly positive linear relationships between CDOM absorption coefficients  $a(254)$  ( $R^2 = 0.72, 0.46, p < 0.01$ ),  $a(280)$  ( $R^2 = 0.77, 0.47, p < 0.01$ ),  $a(350)$  ( $R^2 = 0.76, 0.78, p < 0.01$ ) and  $F_{max}$  for two humic-like components (C1 and C2) were exhibited, respectively. A significant relationship ( $R^2 = 0.931$ ) was found between salinity and DOC. However, almost no obvious correlation was found between salinity and EEM-PARAFAC extracted components except for C3 ( $R^2 = 0.469$ ). Results from this investigation demonstrate that the EEM-PARAFAC technique can be used to evaluate the seasonal dynamics of CDOM fluorescent components for inland waters in semi-arid regions of Northeast China; and to quantify CDOM components for other waters with similar environmental conditions.”

**Introduction:** In general the introduction is too long, it should be shortened. Page 5727, line 10: reformulate “terrestrial imported substance” Too many technical details

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in the introduction: (page 5727, line 22-28). It is not necessary to describe it. There are repetitions. For example it is not necessary to introduce the two main components twice (page 5727, line 20 and 5728, line 17). Page 5729, line 11: I did not understand what was the actual motivation to perform this research? The novelty of this research has to be emphasized. Response: Thank you for your suggestion. The introduction has been shortened. Your kind suggestion has been adopted in the revised manuscript. On page 5727 in line 10, the content “terrestrial imported substance” was replaced by “terrestrially imported substance”. On page 5727 from line 22-28 and On page 5728 from 1-2, the content was removed. The contents on page 5729 in line 11 have been revised. The Songnen plain is a fluvial plain with semi-arid climate, in which many fresh and brackish waters are distributed due to its geomorphology (Song et al., 2013). Dissolved organic carbon (DOC) characteristics of these fresh and brackish waters across the Songnen Plain have been studied by Song et al. (2013); the results indicated that a huge amount of DOC were stored in these waters. In particular, brackish waters would exhibit high average DOC concentration and significantly contributed the carbon budget to inland waters (Duarte et al., 2008; Song et al., 2013; Tranvik et al., 2009). However, little studied has been made on the detailed information of DOC sources for these waters in the Songnen Plain. Therefore, it motivated us to investigate the components in CDOM for both fresh and brackish waters in the semi-arid region.

Materials and Methods Overall too long, way too many methodological details. However I am missing the description of absorption coefficients? Which ones did authors calculate? What these absorption coefficients indicate? Response: Thank you for pointing out the questions. The absorption coefficient  $a_{CDOM}$  was calculated from the measured optical density (OD) of the sample using Eq. : which was explicitly described on page 5731 from line 15-20. The absorption coefficient  $a_{CDOM}$  and the spectral slope  $S$  were calculated. These absorption coefficients indicate the absorption intensity of CDOM in the UV and visible region of spectrum.

Why these lakes were sampled during these four times? (page 5730, line line 11)

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To obtain information about seasonal changes, rainfall, dry season or what was the reason behind it? Response: On page 5730 in line 11, the lakes were sampled four times at different seasons to assess the dynamics of individual fluorescent components under seasonal variation in the Songnen Plain. For a long and cold winter, the lakes in the study region were frozen in February. The optical properties of ice-melt and the under-ice sea water have been studied in other papers (Stedmon et al., 2007; Thomas K., 1983; Uusikiv et al., 2010). After April, the ice-covered lakes were just melting into water. In order to study the differences of fluorescent components in CDOM for these lakes from ice-covered to melted-water, two seasons in February and April were chosen. With dry and windy seasons, spring and autumn are very short. The season in June is at the turn of spring and summer. In August, there is plenty of rainfall which results in flooding in summer. The CDOM in rainwater for other region has been studied by the findings of Cheng et al. (2010) (in Chinese). To study the properties of CDOM in lake-water after flooding, the samples were sampled in August 2013. Therefore, the lakes were sampled during these four times which can present obvious seasonal variation for fluorescent components. Not necessary to explain the unit (page 5730, line 19) Response: Thank you for your suggestion. On page 5730 in line 19, the content “. . .with the  $\mu\text{Scm}^{-1}$  (micro-Siemens/centimeter) unit at room temperature ( $20 \pm 2^\circ\text{C}$ ) in laboratory... “ was removed in the revised manuscript. In the section “2.3 DOC concentration measurement”, the citation of the method is missing. Response: Thank you for pointing out the question. APHA 1998 and Song et al. (2011) were cited in the method of DOC concentration measurement (APHA/AWWA/WE F.: Standard Methods for the Examination of Water and Wastewater, Washington, DC, 1998; Song, C. C., Wang, L. L., Guo, Y. D., Song, Y. Y., Yang, G. S., and Li, Y. C.: Impacts of natural wetland degradation on dissolved carbon dynamics in the Sanjiang Plain, Northeastern China, *J. Hydrol.*, 398, 26-32, 2011 ).

In section “2.6 The PARAFAC modeling” it is not necessary to describe PARAFAC model, appropriate citations would be enough. This PARAFAC section was shortened significantly in the revised manuscript. Response: Thank you for your suggestion. On

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Page 5733 from line 4-22, the content was removed. Your kind suggestion has been adopted in the revised manuscript. On page 5733 in line 4, The content “Parallel factor analysis (PARAFAC) . . . . .” should be replaced by “PARAFAC, . . . . .”.

Section “2.7 Statistical analysis” Page 5734, line 18 and 19: correct “analyses” to “analysis” Did the authors check if the data were distributed normally? If not, then t-test can't be applied. Response: Thank you for pointing out the error. On page 5734, in line 18 and 19, the word “analyses” was replaced by “analysis”. We are sorry for making the error. The regression and correlation analysis in SPSS was used in the paper. On page 5734 in line 19, the content “paired t test” was removed. Results and discussion Overall: too many methodological details, too little of actual discussion. Response: Thank you for your suggestion. The unnecessary methodological details were removed and more discussion in the section ‘Results and Discussion’ was added in the revised manuscript.

“3.1 Water quality conditions” Why do authors pool all the samples together? It would be important to show the differences between fresh and saline lakes during different seasons. Page 5735, line 8 “salinity with other three seasons” should be reformulated. Repetition of word “reduced” (page 5735, line 10) Response: For the data in the paper, there was no obvious difference between fresh and saline lakes as shown in the tables and figures. Also, these brackish and fresh water are endowed with similar geological, hydrological and climatic settings, thus we presume that similar process may control the CDOM components. To study the differences of the four fluorescent components for both fresh and saline lakes under seasonal variation from June and August 2013 to February and April 2014, we pooled the samples together. The differences of fluorescent components in CDOM between fresh and saline lakes during different seasons should be studied in further study, particularly with larger saline gradients as presented in Song et al., (2013). However, the salinity is not significant different from two groups of waters, thus all data were pooled together, and the two groups of lakes were only divided according to the study region rather than salinity. On page 5735 in line 8,

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the content “salinity with other three seasons. . .” was replaced by “relatively constant values (around 0.40 PSU) were exhibited in the other three seasons” in the revised manuscript. Thank you for your suggestion. On page 5735 in line 11, the content “and then reduced. . .” was replaced by “and the lowest value of. . . was recorded in February 2014”. Section “3.2 EEMs characterization of CDOM” Again too many methodological details, they should be removed. Response: Thank you for your suggestion. The unnecessary methodological details were removed in the revised manuscript. Your kind suggestion has been adopted in the revised manuscript. Page 5735 line 20: reformulate “While the two protein-like components consist of two dissolved amino acids, i.e., tryptophan and tyrosine that are originated from microbial...” One component is tyrosine-like only and another is tryptophan-like only, not both. Response: Thank you for your suggestion. The content “While the two protein-like components consist of two dissolved amino acids, i.e., tryptophan and tyrosine that are originated from microbial...” was replaced by “With respect to the protein-like components, i.e., tyrosine-like and tryptophan-like substance, mainly consist of dissolved amino acids.” in the revised manuscript. It is not necessary to provide the Ex/Em of each component again (page 5735, line 24-26). The description of the components was already provided before by the authors, it is repetitive here. Page 5736, line 1-2. This sentence should be reformulated “The measured peak intensity of these fluorescence centers is dependent on the concentration of the main fluorophores dissolved in water bodies”. Page 5736, line 3-15: this part belongs rather to the method section. Response: Thank you for your suggestion. On page 5735 from line 24-26, it only show the Ex/Em of each component at approximate wavelength range based on EEMs ‘peak-picking’ technique. When identified by PARAFAC modeling, each fluorescent component was characterized by specific Ex/Em wavelength On page 5736 from line 16-28. We have revised the section on page 5735 from 24-26. Your kind suggestion has been adopted in the revised manuscript. On Page 5736, line 1-2, the content “The measured peak intensity of these fluorescence centers is dependent on the concentration of the main fluorophores dissolved in water bodies” was replaced by “The measured fluorescence

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intensity is dependent on the concentration of dissolved fluorophores in waters” in the revised manuscript. On page 5736 in line 3-5, the content ““ To determine the appropriate number of PARAFAC components, the split-half validation procedure was executed to verify whether the model was valid by comparing the emission and excitation loadings from each half (Stedmon and Bro, 2008)” was placed on page 5734 in line 11 in the method section. Section 3.3 “Temporal distribution of the PARAFAC components” and section 3.4 “CDOM vs. EEM-PARAFAC extracted components” Overall: The general patterns and only the main findings of the results should be just emphasized. These two sections should be re-written, otherwise the reader is lost. And discussion of the results should be more extensive. Response: Thank you for your suggestions. The general patterns and the main findings of results were emphasized. Section 3.3 and section 3.4 were re-written. More discussion of the results were added. Your kind suggestion has been adopted in the revised manuscript. Page 5737, line 8: Why would authors pool the results from all the samples together? Again, I think it would be good to show the differences between different types of lakes, seasons or flood and no flood samples. However there are too many results, describing just patterns (increase, decrease). These two sections should be shortened and only main findings emphasized. For me as a reader, the most important results and findings are not clearly stated. Page 5738, line 9: “protein-like peaks” should be replaced “protein-like components” Page 5738, line 14: “reached to” should be replaced by “reached” Page 5739, line 1: “quantities of rainfall taking place” should be reformulated. Page 5740, line 1: what are “common sources” ? Response: Thank you for your suggestion. We pooled the results from all the samples together in order to study the common characteristics of fluorescent components under seasonal variation. The samples at different seasons showed different characteristics in the next paper from page 5737-5738. The two sections were revised and show the important results. Your kind suggestion has been adopted in the revised manuscript. On page 5738 in line 9, the content “protein-like peaks” was replaced by “protein-like components”. On page 5738 in line 14, the content “reached to” was replaced by “reached”. On page 5739 in line 1, the content “quantities of rainfall

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taking place” was replaced by “quantities of rainfall take place”. On page 5740 in line 1, the content “common source” refers to a common processing mechanisms leading to similar dynamics (Zhang et al., 2010, 2011).

Page 5741 line 1, 2, 5 Authors should use “components” rather than “peaks” Page 5741 line 4-6 The sentence “The lowest C2 represents only a small portion of CDOM from terrestrial import to water bodies through rainwash and soil leaching” should be reformulated Page 5741 line 6: “intensities” change to “components” Response: Thank you for your suggestion. On Page 5741 in line 1, 2, 5, the content “peaks” was replaced by “components”. On Page 5741 in line 4-6, the content “The lowest C2 represents only a small portion of CDOM from terrestrial import to water bodies through rainwash and soil leaching” was replaced by “At all four seasons, the fluorescent component C2 contributed less to total fluorescence than the other three.” On Page 5741 in line 6, the content “intensities” should be replaced by “components”.

Figures: Figure 2. What is the purpose of presenting figure of this one specific sample? Response: In Figure 2, it present examples of EEMs for one water sample from Xindianpao Lake in the western part of Jilin province at different seasons which showed that the fluorescence properties of CDOM differed under seasonal variation. For Xindianpao, the protein-like fluorescence peaks were higher than the humic-like fluorescence peaks in June 2013, whereas, the humic-like fluorescence peaks were higher than the protein-like peaks in August 2013.

Figure 5. It would be good to present seasonal variations of Fmax of each component in the separate figures. Right now there is too much information in one figure. Also it would be interesting to see if there was any correlation between rainfall and any of the components? Response: Thank you for your suggestion. The Fmax of seasonal average of the components in Figure 5 was separated from the four single seasons in the revised manuscript. The rainwater, which also contained much lower humic-like concentration, was mostly characterized by protein-like components. The correlation between rainfall and any of the components will be studied in future study.

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