Reply to referee #3

"Source and flux of POC in a karstic area in the Changjiang River watershed: impacts of reservoirs and extreme drought"

General overview:

The authors measured $\delta^{13}C_{POC}$, $\delta^{15}N_{TN}$ and C/N ratios in both suspended and surface sediments along the Wujiang River and attempted to identify source and flux of POC in the Wujiang River and addressed the impacts of reservoir on POC flux into the Changjiang (or finally into the East China Sea). I think the authors had lots of data sets in two different seasons, but the whole paper presentation is not very good. I am confused about the title, introduction and interpretation about the content. Overall, I think the paper need a major revision before it can be considered to be published.

Response: Thank you very much for reviewing the manuscript and for the valuable comments. We have revised the manuscript based on the comments and suggestions.

My major comments are as follows:

Comment 1. The title is not suitable because the data set of POC flux and POC sources in the Changjiang River is only from upper branch. The authors mentioned POC fluxes in different rivers in the introduction, but it did not touch real POC flux in the Changjiang River mouth or the East China Sea. The title should be modified.

Response: Thank you for the comment. The Wujiang River is the largest tributary of the upper Changjiang River in its south bank. Although there are many tributaries for Changjiang River, Wujiang River is a typical karst watershed. Thus, we think that the title can represent the major objectives of our study.

Comment 2. As addressed above, the introduction described the importance of riverine POC flux to different marginal seas and the main objective of the manuscript seems to emphasize the effect of Three Gorge Dam on POC flux to the East China Sea. I suggest that the authors should review possible difference of POC flux in the Changjiang before and after the construction of Three Gorge Dam. For example, the authors keeping saying POC flux to marginal seas are quite important, but they said that….. "Wujiang River is still scarce after the Three Gorges Dam began impounding sediment in 2004. Based on analyses of $\delta^{13}C_{POC}$, $\delta^{15}N_{TN}$ and C/N ratios in the suspended and surface sediments, this study identified source and flux of POC in the Wujiang River and examined the impacts of reservoir and climate." I did not see the description above associated with whole Changjiang watershed because the Wujiang River is only a part of Changjiang branches. Plus, they attempted to study the impacts of reservoir (Three Gorge Dam?)

and climate based on two season data sets. I think the little data can not wholly support their perspective. Instead, the author should point out what POC flux in the Changjiang River before the construction of Three Gorge Dam are in the introduction? In the next step, they want to examine the impacts of trapped POC in Three Gorge Dam affecting the output of Changjiang River. Anyway, the introduction and abstract need to be re-worked. A useful reference should be helpful for the authors. Hung et al. (2003). Fluxes of particulate organic carbon in the East China Sea in summer. BG, 10, 6469-6484.

Response: Thank you for the comment. As suggested in the comment, variations of POC flux in the Changjiang River before and after the construction of Three Gorges Dam are important to identify the influence of damming on the local carbon cycle and even on the global carbon cycle to some extent. The related review has been added in the introduction. Eleven artificial dams have been constructed along the mainstream of Wujiang River (Fig. 1). However, related study on the impacts of these cascades of dams is limited. Thus, one of the objectives of our study is to estimate the impacts of the above eleven cascades of dams on the POC source and flux in a karstic watershed. The objectives of this study in the introduction have been made clearer. Two season samples were collected in the present study. These data may lead to a high level of error when estimating the impacts of reservoirs and drought of 2013. However, we think that it is helpful for understanding the variations of POC source and flux in the Wujiang River in the special drought year of 2013.

Comment 3. Source of organic carbon in suspended particles and sediments are roughly separated to two main sources which may not be right. I can see authors discussed the percentage of each compound (C3 and phytoplankton) in equations 1~3 in the text, but they also explain possible sources such as C4 and C4-soil and include these compounds into equations. It is quite inconsistent for the data interpretation. I suggest the authors need do it based on other sources.

Response: Thank you for the comment. According to the comment, we have carefully modified the mixing model using indicators of $\delta^{13}C$ values and C/N ratios. The combination of $\delta^{13}C$ values and C/N ratios is also used in other studies (Jiang and Ji, 2013; Lu et al., 2013).

Lu, F. Y., Liu, Z. Q., Ji, H. B.: Carbon and nitrogen isotopes analysis and sources of organic matter in the upper reaches of the Chaobai River near Beijing, China. Science China Earth Science, 56(2), 217-227, 2013.

Jiang, Y. and Ji, H.: Isotopic indicators of source and fate of particulate organic carbon in a karstic watershed on the Yunnan-Guizhou Plateau. Appl. Geochem., 36, 153−167, 2013.

Results.

Comment 3.1 line 25-26, it has been descripted in the method, delete it.

Response: Thank you for the comment. The mentioned description has been deleted.

Comment 3.2 Line 21-23 content should show in the method section

Line 27, how significant? Showing p and n

Response: Thank you for the comment. The mentioned content (Line 21-23) has been moved in the method section. The values of relation coefficient and p have been added in the Table S2.

Discussion

Comment 4.1 ….line 23 suggested the dominant terrestrial contribution to SPM in May and increased phytoplankton input in August. As discussed, all samples were collected in the fresh water suspended particles or sediments, it is absolutely from terrestrial source.

Response: Thank you for the comment. As mentioned in the comment, POC is generally derived from terrestrial source in the fresh water. However, aquatic source increases as more and more artificial dams are constructed. A similar study can be seen from one tributary of Wujiang River (Jiang and Ji, 2013), in which POC of SPM was mainly derived from phytoplankton.

Comment 4.2 line 27-29 showed a relatively significant positive correlation, which suggested that a fraction of TN was inorganic nitrogen in the SPM. Why? Thus, the phytoplankton inputs might be overestimated based on C/N ratios. How can you explain this? Is it related to Redfield ratio?

Response: Thank you for the valuable comment. According to Meyers (1997), ratios of C/N are used to distinguish sources of organic carbon in marine and coastal environments based on the assumption that all of the sedimentary TN exclusively reflects N bound to organic matter. As discussed in the manuscript, the slope of linear relationship between TN and POC content depend on organic C/N ratio and the intercept value could reflect the inorganic nitrogen. In the present study, the linear relationship of TN and POC was relatively weak (May: TN=0.07*POC+0.09, R^2=0.54, P<0.001; August: TN=0.04*POC+0.23, R^2=0.39, P<0.001) compared with other studies (R^2=0.71 in Hu et al., 2006; R^2=0.9 in Guerra et al., 2013). The intercept of the above regressions was more than zero, which suggested that a fraction of TN was inorganic nitrogen in the SPM (Guerra et al., 2013; Hu et al., 2006). Because contents of total nitrogen included some inorganic nitrogen in the study area, measured C/N ratios were underestimated, which led to phytoplankton inputs overestimated based on measured C/N ratios.

Guerra, R., Pistocchi, R. and Vanucci, S.: Dynamics and sources of organic carbon in suspended particulate matter and sediments in Pialassa Baiona lagoon (NW Adriatic Sea, Italy), Estuar. Coast. Shelf S., 135, 24-32, 2013.

Hu, J., Peng, P. A., Jia, G., Mai, B. and Zhang, G.: Distribution and sources of organic carbon, nitrogen and their isotopes in sediments of the subtropical Pearl River estuary and adjacent shelf, Southern China, Mar. Chem., 98(2), 274−285, 2006.

Meyers, P.A.: Organic geochemical proxies of paleoceanographic, pleolimnologic, and paleoclimatic processes. Organic Geochemistry 27, 213-250, 1997.

Comment P6, line 9-20, are C3 and phytoplankton POC only two sources? How about other

sources? Do authors have other C sources like C4 etc.? If other C sources exist, the equations 2 and need to solved? There is a useful reference (Hung et al., ECSS, 84, 566-572) which reported that POC/Chl-a ratio in summer ranged from 50 to 70, if the authors have Chlorophyll-a data. They can estimate POC source from phytoplankton based on suspended POC data.

Response: Thank you for constructive comment. The method in the study of Huang et al. (2003) is useful to estimate POC source from phytoplankton. Unfortunately, we did not measure the values of Chlorophyll-a in our study. As mentioned in the comment, there exist C4 source in addition to C3 and phytoplankton. The mixing model of end-members was modified.

Comment Line 25-34 why the phytoplankton in affected and the unaffected areas has large difference? They are both affected by fresh water largely. Is it due to residence time or other carbon sources?

Response: Thank you for the comment. Two mechanisms could explain the elevated phytoplankton contribution in sites affected by reservoirs: (1) extended water retention time in reservoirs with low flow; (2) increasing light availability due to the low TSS concentrations in reservoirs. This related discussion was included in the section 4.4 (Impacts of reservoir and climate on riverine POC).

Comment P7, …Compared with SPM, the elevated C/N ratios of surface sediments indicated more land-derived fraction contribution to the surface sediments. What other sources contributed to POC in sediments? Line 10-13, If C4 is partially associated with POC, then the end member mixing model should be modified.

Response: Thank you for the valuable comment. According to the comment, we have carefully modified the mixing model using indicators of $\delta^{13}C$ values and C/N ratios.

Comment 4.3 & 4.4 Flux of POC in Wujiang River, as mentioned early, the amount of POC flux is totally into Three Gorge Dam? It is quite simple to estimate POC and PIC fluxes. The important thing should be focused on how much POC are trapped in the TGD and affect the POC export flux to the East China Sea. I think this portion should need deep discussion. For example, the author should compare the POC flux at the upper and lower watershed of TGD before and after construction of TGD. Plus, the authors keep saying possible impacts of the TGD, …the variations of suspended sediment load could reflect the POC flux variations under the condition of dam and extreme drought….” What my understanding is that the authors should provide POC flux in the lower watershed of TGD rather than upper watershed because these upper POC finally will empty TGD, right?

Response: Thank you for the comment. The Wujiang River flows into the Three Gorges Reservoir in Chongqing Municipality. It is better to estimate the POC flux using a depth-integrated concentration (Coynel et al., 2005). However, due to the large elevation gradients with about 1500 m in its upper reach and 500 m in its lower reach, Wujiang River has high flow rates. This makes it difficult to collect samples in different water depths. The POC concentration of river mouth is used to calculate the POC flux, which is frequently used in other studies (Aucour et al., 2006; Tao et al., 2009). As mentioned in the comment, it is very important to study the influence of TGD on POC export flux to the East China Sea. For our study area, there are eleven cascades of reservoirs along the mainstream of Wujiang River. The objective of our study is to examine the impacts of these cascades of reservoirs. The impact of TGD on the POC export to East China Sea is not our goal. Because suspended sediment at the mouth of Wujiang River directly flowed into Three Gorges Reservoir (TGR), the impact of climate on TGR sediment revealed the similar impacts on the mouth of Wujiang River. Thus, in order to estimate the impacts of climate on Wujiang River, we compare sediments inputs in the upper watershed of TGR between normal and drought year.

Coynel, A., Seyler, P., Etcheber, H., Meybeck, M. and Orange, D.: Spatial and seasonal dynamics of total suspended sediment and organic carbon species in the Congo River, Global Biogeochem. Cy., 19, doi:10.1029/2004GB002335, 2005.
Aucour, A.M., France-Lanord, C., Pedoja, K., Pierson-Wickmann, A.C., and Sheppard, S.M.F.: Fluxes and sources of particulate organic carbon in the Ganga-Brahmaputra river system, Global Biogeochem. Cy., 20, doi:10.1029/2004GB002324, 2006.
Tao, F.X., Liu, C.Q. and Li, S.L.: Source and flux of POC in two subtropical karstic tributaries with contrasting land use practice in the Yangtze River Basin, Appl. Geochem., 24 (11), 2102−2112, 2009.

Comment Figure 2, the authors should provide water discharge data in the lower watershed of Changjiang such as Datong station and compare what is the difference of water discharge and POC flux between flood and drought seasons. If the authors have those data sets, the manuscript will provide evidence if TGD has significant impact or not.

Response: Thank you for the comment. We agree with the comment that data in the Datong station is important to estimate the impact of TGD. Unfortunately, we fail to provide POC flux in Datong station. We think that this would not influence our conclusions since our study is to examine the impact of eleven cascades of reservoirs along the mainstream of Wujiang River on the POC export flux.

Comment Figure 5, there are five carbon components in the figure showing different contributions of carbon sources to suspended and/or sediments. However, the authors only used two end-member to calculate possible contributions of phytoplankton and C3-plant. Why?

Response: Thank you for the comment. According to the comment, the mixing model has been modified by combined use of indicators of $\delta^{13}C$ values and C/N ratios.