Reviewer 2

Florian et al. quantified and examined relationships between POM composition and environmental forcings in 23 rivers in France using Bayesian mixing models associated with statistical multivariate analyses. Determining the POM composition and its controlling factors in multiple rivers provides valuable insights for better understanding the carbon cycling along the Land-Ocean Aquatic Continuum. However, it still needs a number of improvements for novelty and discussion. Following is my major concerns and specific comments on the manuscript.

We would like to thank Reviewer 2 for providing a thorough analysis of our work, highlighting the manuscript's quality while offering important suggestions to improve its structure and substance. We are glad to address all of Reviewer 2's concerns.

Major concerns

(1) In this study, the authors analyzed POM composition in 23 rivers in France. However, these rivers are geographically clustered within a similar environmental setting, exhibiting closely comparable temperatures and similar POC composition (C/N and δ13C). These similar features may limit the broader implications of the findings. Thus, I suggest that the authors reconsider and summarize the novelty of the work.

Indeed, the 23 rivers we chose to gather into this study are clustered in the same temperate climate. We will improve the manuscript to better explain the climatic range of our study in a somewhat restrained geographic area and the broad implications of our approach, at least from a technical point of view.

(2) It appears that petrogenic OC was neglected in the mixing model. Petrogenic OC, derived from sedimentary rocks, represents a fossil-derived OC component and constitutes a significant fraction of riverine POM. Furthermore, petrogenic OC is generally characterized by higher $\delta^{13}C$ values (typically ranging from -20‰ to -23‰) compared to OC derived from soil or plant. Thus, lack of petrogenic OC could introduce significant uncertainties into the model results.

Reviewer 2 raises an important point: we did not consider any unique petrogenic source in our mixing models. However, we considered that the refractory terrestrial POM sources we distinguished from the bulk POM can be of petrogenic origin.

Indeed, as raised by Reviewer 2, petrogenic OM, according to the geology, can be defined by a $\delta^{13}C$ between -20 and -26 ‰ (Hilton et al. 2010). Also distinguished by low C/N ratios for a terrestrial source, they can be easily integrated into isotopic mixing models.

For the 23 rivers, rare were the bulk suspended POM values that were higher than -26 ‰ (only a few ones for the Têt and the Rhône Rivers). Thankfully, our method permitted us to discriminate a refractory terrestrial POM source for these two rivers. Since this, we can consider that for the Têt and Rhône rivers, this source is at least influenced by petrogenic POM.

We will better describe the possible petrogenic origin of this source in the manuscripts with the help of this commentary. Also, see our response to Reviewer 1 (first major issue).

Robert G. Hilton, Albert Galy, Niels Hovius, Ming-Jame Horng, Hongey Chen, The isotopic composition of particulate organic carbon in mountain rivers of Taiwan, Geochimica et Cosmochimica Acta, Volume 74, Issue 11, 2010, Pages 3164-3181, ISSN 0016-7037, https://doi.org/10.1016/j.gca.2010.03.004.

(3) Determining a typology of rivers according to their POM composition and dynamics is a key point of this study. However, the analysis is currently focused on a specific regional context. To enhance the broader significance of this work, I suggest that the authors address the potential global transferability or applicability of their proposed typologies.

Absolutely, the actual work is focused on temperate Rivers in Western Europe. Nevertheless, the approach that we used in the manuscript can be applicable to other climates and broadened to a greater range of environmental conditions, including different climatic settings (polar to tropical) and geographical locations (catchment properties) (l.655-658 of the manuscript). This will be better detailed in section 5 and in the abstract.

Specific comments

1. The abstract is a little bit long and contains a lot of redundant parts. I suggest that the authors reorganize the abstract. For example, the content in line 44-46 is redundant as before.

Will be considered.

2. Line 102-103, Actually, a quick literature review showed that many previous works already using mixing models to quantify POM composition in river systems. Consequently, characterizing such analyses as "scarce" appears inconsistent with established research. I suggest reconsider the novelty of this work around more specific research gaps or methodological advancements.

Reviewer 2 suggests that POM composition mixing models are common in rivers.

Indeed, since the 1990s, a few dozen articles have been published, using mixing models to partially or completely quantify POM sources' proportions in freshwater rivers. However, as for Hilton et al. (2010) previously cited, all these articles (except those of l.102-103 of the manuscript) performed outdated deterministic linear mixing models. These models only measure the distances between end-member signatures and the mixture value to give the proportion of the distances. A part of this literature focuses only on a fraction of the POM, as it only accounts for terrestrial origins, or fails to correctly distinguish phytoplankton source (Hilton et al. 2010, Dalu et al. 2016, Lu et al. 2016).

Bayesian (probabilistic) mixing models published in the 2010s until today calculate proportions using isotopic and elemental signatures and their uncertainties, and introduce priors, allowing to give an interval of confidence for each mixing model, and uncertainties to the source's proportions. The credibility of the whole model is then measurable, contrary to frequentist models.

For this reason, particular attention should be paid to the methods used to quantify sources of POM. We would like to reassure Reviewer 2 that the use of the Bayesian mixing model is rare (as pointed out by Reviewer 1), and is unique by the integration of our methodology of source discrimination and taking into account isotopic variability by source is a methodological advancement for riverine biogeochemistry.

Robert G. Hilton, Albert Galy, Niels Hovius, Ming-Jame Horng, Hongey Chen, The isotopic composition of particulate organic carbon in mountain rivers of Taiwan, Geochimica et Cosmochimica Acta, Volume 74, Issue 11, 2010, Pages 3164-3181, ISSN 0016-7037, https://doi.org/10.1016/j.gca.2010.03.004.
Dalu, T., Richoux, N.B. & Froneman, P.W. Nature and source of suspended particulate matter and detritus along an austral temperate river–estuary continuum, assessed using stable isotope analysis. *Hydrobiologia* **767**, 95–110 (2016). https://doi.org/10.1007/s10750-015-2480-1
Lu Lu, Hongguang Cheng, Xiao Pu, Jiantong Wang, Qianding Cheng, Xuelian Liu, Identifying organic matter sources using isotopic ratios in a watershed impacted by intensive agricultural activities in Northeast China,Agriculture, Ecosystems & Environment,Volume 222, 2016, Pages 48-59, ISSN 0167-8809, https://doi.org/10.1016/j.agee.2015.12.033.

3. Line 503-508 and line 561-564. Some simple comparisons were made, but the authors did not explain whether these rivers have similar of environmental forcings and/or climate characteristics.

Reviewer 2 raised a good point. Features common to these rivers will be added.

4. Line 594. The section 4.4 primarily summarizes findings rather than providing critical interpretation. I suggest that this section should be condensed and incorporated into Section 5.

Will be considered.