

Reply to referee 1 (R. Sparkes)

**Interactive comment on “Biogeochemical  
characterization of the riverine organic matter  
transferred to the NW Mediterranean Sea” by  
M. Higueras et al.**

**R. Sparkes (Referee)**

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**General Comments**

In this paper, Higueras and co-workers present a spatial and temporal analysis of Particulate Organic Matter fluxes from eight rivers in France and Spain into the Mediterranean Sea. Monthly samples from a series of fluvial catchments, varying in size and location, show that Total Suspended Matter (TSM), Particulate Organic Carbon (POC), Particulate Nitrogen (PN) and the  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  isotopic ratios vary seasonally and depending on the river features. As the authors state, a comprehensive characterisation of the fluvial inputs to a sedimentary system such as the Mediterranean allows further studies of deposition on the continental shelf and deep sea to be carried out with a fuller understanding of the input compositions.

The fourteen monthly samples collected from each site should be sufficient to characterise temporal and spatial differences, although as the authors recognise their sampling duration does not include some of the largest discharge events, which are often disproportionately important for POC and sediment transfer (see Hilton et al., Nature Geoscience, 2008). I believe that this paper is suitable for publication in Biogeosciences, subject to some revisions. More detailed comments follow below.

Dear Dr. Sparkes,

We thank you very much for reviewing the manuscript and for your constructive comments. We have revised the manuscript considering each of the comments. Next, the detailed responses to your recommendations are formatted in blue text.

1. Does the paper address relevant scientific questions within the scope of BG?

Yes – this paper contains useful biogeochemical characterisation of a series of Mediterranean rivers

2. Does the paper present novel concepts, ideas, tools, or data?

Yes – this paper presents the first co-ordinated sample dataset from a series of rivers in France and Spain

3. Are substantial conclusions reached?

Yes – the authors provide biological and climatological interpretations for the variations seen in the dataset, and link spatial and temporal changes in chemical composition to observed processes

4. Are the scientific methods and assumptions valid and clearly outlined?

Yes – the sample analysis appears to have been carried out to a suitable standard

5. Are the results sufficient to support the interpretations and conclusions?

Yes – there are only 14 months' of data presented here, which allows characterisation of changes throughout a single year but prevents the authors from studying the effects of inter-annual variation. In terms of characterising seasonal and spatial variations, the presented results will suffice.

6. Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)?

Yes – the sampling locations and analytical techniques are described adequately.

7. Do the authors give proper credit to related work and clearly indicate their own new/original contribution?

Yes – there is a comprehensive reference list and the new data is clear.

8. Does the title clearly reflect the contents of the paper?

Yes – the title is ideal.

9. Does the abstract provide a concise and complete summary?

Yes – the abstract clearly describes the aims, results and conclusions.

10. Is the overall presentation well structured and clear?

Yes – the paper generally follows a logical and clear structure. The section from P13288 Line 5 to P13289 Line 25 could potentially be moved from the discussion to results section.

11. Is the language fluent and precise?

No – there are some linguistic inconsistencies, which are addressed in the technical review.

12. Are mathematical formulae, symbols, abbreviations, and units correctly defined and used?

Generally yes – there are one or two typographic errors reported in the technical comments.

13. Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated?  
Yes – there are a few areas that could be clarified, these will be discussed in the specific comments below.

14. Are the number and quality of references appropriate?  
Yes

15. Is the amount and quality of supplementary material appropriate?  
Yes – there does not appear to be any supplementary material, but none is required

### **Specific Comments**

P13278 L2: The abstract does not mention the possibility of marine remineralisation of exported terrestrial organic matter, despite this being a common process throughout the world (Ittekkot, 1988, *Nature*; Hedges and Keil, 1995, *Limnology and Oceanography*)

**Response:** Corrected according to the review's suggestion

P13281 L24: Typical values of  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  for terrestrial organic matter and algae have not been mentioned at this point, so the statement that POM in the NW Mediterranean is a mixture of these two inputs is unsupported

**Response:** This part has been removed. Typical values of  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  for terrestrial OM and algae are described in Discussion (§ 4.2).

P13284 L25: Were any precautions taken to remove dolomite from the sediments? HCl at room temperature can have difficulty removing dolomite (Galy et al., 2007, *Geostandards and Geoanalytical Research*)

**Response:** We did not experience difficulty to remove carbonates (HCl 25%) from river sediments whatever the river. Previous studies used successfully diluted HCl (1%) for removing carbonates from the Rhone river (Harmelin-Vivien et al., 2010; Darnaude et al., 2004) and Têt River (HCl 2N; Garcia-Esteves, 2005). Thus, we assumed 1) that HCl 25% guaranty the removing of carbonates in all our samples, as Fabres et al. (2002) assumed for his Mediterranean settling particles, and 2) that dolomite is not significantly present in our rivers. Moreover, we can check easily when carbonates remain in the sample as carbonates present a more  $^{13}\text{C}$ -enriched signature ( $>-15\text{‰}$ ) than river POC ( $<-25\text{‰}$ ).

Fabres, J., Calafat, A., Sanchez-Vidal, A., Canals, M., and Heussner. Composition and spatio-temporal variability of particles fluxes in the Western Alboran Gyre, Mediterranean Sea, *J. Marine Syst.* 33-34, 431-456, 2002.

P13286 L23: Given that TSM changes enormously throughout the year, depending on discharge (Q), are the contributions of POC to TSM weighted to take this into account? It appears that the raw measurement of POC for a given sediment sample have been reported. Since the text states that high Q values tend to give high TSM values and low POC concentration values, it would be interesting to provide calculations where the POC and TSM discharge is presented weighted by Q. For further studies of the fate of this exported sedimentary material, these characterisations could be very useful. Do occasional extreme events have a disproportionate effect on the sediment and POC export?

**Response:** Q-weighted means of TSM, POC and PON have been added in Table 2, Results. Contributions of floods in the export of TSM, POC and PN have been calculated when significant correlations (Table 3) have been found and discussed in § 4.1.

P13288 L8: The text states that the NW Mediterranean is affected by winds from the N-NW, E-NE and S-SE, yet only the latter two of these are discussed further.

**Response:** Added according to the review's suggestion

P13290 L29: The global range of PN concentrations are given as 0.1-1.3 %, yet the study reports PN up to 4.6%. No comment is made about this being three times the apparent global maximum. Is there a typographic error in one of these numbers, or is there an extreme nitrogen input in this region?

**Response:** There is no typographic error, we really encountered high POC and PN contents in coastal rivers. As discussed in §4.2, the freshwater production is higher in coastal rivers mainly when the water flows are low. These highest contents coincide also with a low water turbidity. The suspended particles are therefore only biological particles.

P13293 L22: There is a significant overlap between the  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  ranges quoted for plant material, soils and freshwater POM, which are then apparently useable for determining sources of fluvial POM. Only the C/N ratios are suitably different to provide source separation. Were any un-mixing methods (c.f. Hilton et al., 2010, *GCA*) used to determine the inputs of each source?

**Response:** It was not the purpose of this paper to determine the relative contribution of each source in the fluvial POM. As you mentioned in Hilton et al. (2010), such methods require to accurately determine the  $\delta^{13}\text{C}$ ,  $\delta^{15}\text{N}$ , C/N ratios of all the potential sources as bedrocks, terrestrial plants, freshwater algae,... Our main objectives were to estimate the POC and PN fluvial inputs into the NW Mediterranean Sea and to isotopically determine the signature of this material in order to complete further C and N coastal budgets and to follow this terrestrial material in the ocean.

P13295 L15: What do the errors represent? Are they one or two standard deviations?

**Response:** We are sorry, but we don't understand the question.

## **Technical Comments**

There are several grammatical errors in the text. I have highlighted many of these below, along with some suggestions for ways to clarify the text or make it easier to read. Most common errors were inconsistencies in tense or plurality.

P13278 L27: “On” average rather than “in” average

**Response:** Corrected according to the review's suggestion.

P13279 L14/L15: A verb is missing. Either “represent the primary transport pathway” or “. . .terrestrial organic matter) to be transported to the marine. . .”

**Response:** Corrected according to the review's suggestion.

P13279 L16: “Yr-1” missing after 35 000 km<sup>3</sup>

**Response:** Corrected according to the review's suggestion.

P13280 L2: Remove “therefore”

**Response:** Corrected according to the review's suggestion.

P13280 L4: Replace “from” with “by”

**Response:** Corrected according to the review's suggestion.

P13280 L10: Replace “may cause” with “may have caused”

**Response:** Corrected according to the review's suggestion.

P13280 L11: Rephrase as: “Second, rivers are highly affected by artificial river damming, often related to water extractions for irrigation, which alters the natural functioning. . .”

**Response:** Corrected according to the review's suggestion.

P13280 L23: Pluralise “act” to “acts”

**Response:** Corrected according to the review's suggestion.

P13280 L28 / P13281 L1: Replace “for understanding” with “to understand”

**Response:** Corrected according to the review's suggestion.

P13281 L19: Tense inconsistency. Replace “are” with “were”

**Response:** Corrected according to the review's suggestion.

P13281 L25: Remove “up”

**Response:** Corrected according to the review's suggestion.

P13282 L1: “. . .and to investigate their role. . .”

**Response:** Corrected according to the review's suggestion.

P13282 L20: Insert a colon at the start of the list “5000km<sup>2</sup>: the Herault. . .”

**Response:** Corrected according to the review's suggestion.

P13283 L23: “only one of”

**Response:** Corrected according to the review's suggestion.

P13283 L24: Is it the journal’s style to italicise Latin names?

**Response:** Yes, Foreign words that have not come into general use are italicized.

P13284 L17: Clarify where the sampling took place. Do the authors mean “middle of the river channel”?

**Response:** The sampling strategy has been clarified and the term "banks" has been replaced with "channels".

P13284 L23: Replace “weighted for determining” with “weighed to determine”

**Response:** Corrected according to the review's suggestion.

P13286 L2: “Drier” rather than “dryer”

**Response:** Corrected according to the review's suggestion.

P13288 L10: “. . .and when they meet the cold air. . .”

**Response:** Corrected according to the review's suggestion.

P13288 L16: Hyphenate “so-called”

**Response:** Corrected according to the review's suggestion.

P13290 L13: “. . .reported that rivers with flash flood events may take years to recover their original sediment curve”

**Response:** Corrected according to the review's suggestion.

P13290 L16: Pluralise “term” to “terms”

**Response:** Corrected according to the review's suggestion.

P13290 L18-20: Rearrange to: “In many fluvial systems the impact of dam constructions, which intercept half of the water discharge, store at least 30 % of sediment fluxes (in major fluvial systems) and produce variations in the composition of suspended material has been documented (refs).

P13290 L29: Replace “of” with “for” in each case

**Response:** Corrected according to the review's suggestion.

P13291 L8-9: There is a tense disagreement, with “reduce” and “emphasized” in the same sentence.

**Response:** Corrected according to the review's suggestion.

P13291 L23: “On average” rather than “in average”

**Response:** Corrected according to the review's suggestion.

P13291 L27: “. . .river damming may also be responsible for the poor. . .”

**Response:** Corrected according to the review's suggestion.

P13292 L6-7: Missing “x” signs in numbers

**Response:** Corrected according to the review's suggestion.

P13293 L15: “On the other hand” is not really necessary, since it is not a contrasting statement compared to the previous sentence.

**Response:** Corrected according to the review's suggestion.

P13294 L12: Replace “in” with “the”

**Response:** Corrected according to the review's suggestion.

P13294 L18: Plural: “. . .nutrients are. . .” Typo: “provoke”

**Response:** Corrected according to the review's suggestion.

P13295 L1: “As seen in the York River”

**Response:** Corrected according to the review's suggestion.

P13295 L5: Plural: “watersheds”

**Response:** Corrected according to the review's suggestion.

P13297 L20: Plural: “reflects”

**Response:** Corrected according to the review's suggestion.