Reply to the referee 2

We thank Dr Tesi for its review of our manuscript and its positive evaluation *"the paper warrants publication on BG and I believe such a study will be widely cited in the future"*. We have taken into account his comments in order to improve our manuscript. In addition, we have added a more thorough description of the study area including explanations for the low phytoplankton biomass and primary productivity (see comments to referee# 1) as well as bulk isotopic measurements on surface sediments. This supplementary information will also partly respond to the points that have been raised by referee#2.

Please find our answers to the review below (abbreviations are RC: referee comment; AC: author comment).

RC: *"I found most of conclusions completely not coherent with the data presented… For example, the event-dominated supply in the Rhone falls behind the subject of the paper. Also, the first couple of sentences in the conclusions are not accurate at all. In the prodelta, nutrient supply does enhance primary productivity. Their sentence reads like river discharge is not important. Authors looked in the wrong place if they were really interested in phytoplankton as any suspended material was collected. "*

AC: Our initial conclusion has been revised before submission to follow the advice of the associate editorial board. We were asked to replace our data in the more general context of RIOMAR functioning in order to point the specificities of the Rhône system. To do so, it has been necessary to provide information on processes that we have not studied but were relevant to our study. We did not intend to imply that riverine nutrient inputs have no effect on primary productivity. However, many studies realised off the Rhône river mouth have demonstrated that close to the river mouth (i.e. the 5 km radius area defined as the "prodelta" in our study) phytoplankton biomass and primary production are low, while the area of enhanced primary production may be located quite far from the river mouth (Conan and Pujo-Pay, 1995; Pujo-Pay et al., 2006; Naudin et al., 2001). In many other coastal systems, primary production is also limited in the inner shelf because of high turbidity (Dagg et al., 2004 and citations therein; Cloern, 1987).

The beginning of the conclusion has been rephrased in order to avoid this misunderstanding. The reference Hedges et al. (1994) has been replaced by Ittekkot (1988) and Hedges et al. (1997), which are more appropriate to support our point on the expected low lability of terrestrial OM. Also, we removed the last couple of sentences concerning the high temporal variability of the Rhône inputs.

RC: "*Also, I suggest to do some reading about the fate of terrigenous OC in river dominated margins and rephrase the first sentence considering that Hedges et al 1994 is not the most appropriate paper to support their statements. Current budgets indicate that only a little terrigenous OM supply by river is buried in marine sediment."*

AC: We agree that budgets on OC preservation highlight the low burial of terrestrial OM in marine sediments on a global scale. However, when looking at the scale of the Rhone deltaic system, Pastor and collaborators (2011) have evidenced high burial efficiency of terrestrial OM off the Rhône river mouth (80 % within 3 km of the river outlet). Burial efficiently rapidly decreased further offshore on the continental shelf, indicating that the Rhône deltaic system is an important sink for the particulate OM delivered by the Rhône (Durrieu de Madron et al., 2000). Anyway, we did not discuss this point in the conclusion.

RC: *"Prodeltas … are also affected by lateral transport and sediment sorting. As coarse material rich in vascular plant debris is trapped in shallow waters and fine sediment moves offshore (Tesi et al., 2007) I would expect to see differences in FA as different proportion of fresh vascular plants vs humified soil-derived OM on surface sediments. Therefore in addition to diagenesis that likely occurs in sediments, sorting might explain the 13C across-shelf trend of long chain FA."*

AC: We agree that sediment sorting is a process that deserves to be taken into consideration. We indeed observed a marked decrease of the sand fraction along our longitudinal transect. This point is discussed in the revised version. Concerning the pool of OC from terrestrial sources, Goni et al. (1997) reported that the $\delta^{13}C$ of some lignin derived phenols (syringic acid and p-coumaric acid) became enriched along the transect in the Gulf of Mexico (from the Mississippi river mouth to shelf). Their explanation is that OM from C3 plants (with a depleted $\delta^{13}C$ of -30 ‰) would primarily deposited in coastal sediments while those from C4 plants (with a relatively enriched $\delta^{13}C$ of -15 ‰) would be transported towards the shelf and deposited there. However, their conclusion was not supported by their isotopic data for other lignin derived compound (vanillin) with constant $\delta^{13}C$ values along the same transect. For our case, we have to clarify two things if we want to suggest the sorting mechanism for the change in FA isotopic signatures. First, both C3 and C4 terrestrial organic matter are important in the area. Second, C3 OM is associated in coarse particles and deposited in sediments near the river mouth while C4 OM is soil associated and transport offshore. However, based on lignin products and their $\delta^{13}C$ signatures (-27 to -31 ‰ across the transect), it was confirmed that terrestrial OC from the Rhône river was mostly from a C3 source (Cathalot et al., 2011). Moreover, Kim and collaborators (2010) have estimated using the BIT index the percentage of soil-derived OM. They have demonstrated that Rhône inputs were predominantly composed of soil-derived OM in April 2007 (more than 80 % at A) and decrease seaward (lower than 20 % at F). Thus, based on the available information, we more favor the diagenetic effect on the positive shift in FA $\delta^{13}C$, as degradation continuously occur in the sediments along the transect. Anyway, this is a complicated issue, and other factors (e.g., bacterial contribution, see Gong and Hollander, 1997) may be involved.

RC: *"I am not convinced by the strict division between marine and fresh water phytoplankton. Algal material living in estuarine condition (like in the prodelta) are affected by the DIC coming from the river. Rivers are usually supersaturated in ^{13}C depleted CO_2 because of intense decomposition of terrestrial biomass and in river-dominated margins where the air-sea exchange cannot balance the influence of the river, you will end up with phytoplankton having an estuarine-like signature (something in between fresh water and marine phytoplankton)."*

AC: We discussed the occurrence of two phytoplankton communities (freshwater and marine) from our fatty acid data. This argument was based on the fact that polyunsaturated FA concentrations were maximal at the nearshore and offshore stations, with minimal values in the inner part of the adjacent shelf. These results point to the spatial separation of these two phytoplankton communities. Close to the river mouth, the sharp gradient of salinity does not allow marine phytoplankton species to benefit from the input of nutrients (Naudin et al., 2001), so one may legitimately propose that the phytoplanktonic PUFAs derived from freshwater inputs (See Harmelin-Vivien et al., 2010 for the importance of freshwater phytoplankton). Moreover, typical values of marine phytoplankton are observed a little more offshore (south to the Rhône outlet at depths of ~50 m and ~100 m), suggesting that the influence of terrestrial DIC on the isotopic signature of the phytoplankton is limited (Harmelin-Vivien et al., 2008).

Minor points:

RC: *"As end-members were not analyzed it might be helpful to compare FA and THAA OC-normalized data of soil, plants, bacteria and phytoplankton from literature to have a semi-quantitative assessment of the influence of different end-members. For example, if terrigenous material is the major source of OC, as the author suggested, long chain FA should show unambiguous evidence such as high OC-concentrations as observed in soil-derived OC."*

AC: Bulk isotopic $\delta^{13}C$ of surface sediments have been added to the revised version following the comments of referee#1. These data show that the terrestrial contribution is comprised between 97 % (station A) to 72 % (station C) in the prodelta area, whereas terrestrial and marine contributions are equivalent in the shelf area. Biochemical results obtained for a terrestrial end-member (river suspended OM) were added in order to support our argument that continental inputs delivered by the Rhône are the main sources of POM in the nearshore sediments. Organic carbon content, fatty acid and pigment compositions as well as values of the degradation index are comparable for the samples of river SOM and surface sediments collected at station A. Also, the proportion of LCFA in the river inputs is equivalent to the values measured in the surface sediment and decrease with distance o the river mouth.

RC: *"There are many "submitted or in prep" papers throughout the text. I am not sure if this is fine with the journal. Please check with the editor. "*

AC: Only one cited paper is still in preparation, the others have been accepted. We will replace that reference by a personal communication.

RC: *"Page 3357 line 25. The GoL is probably one of the smallest margins in the Mediterranean sea. Look at any bathymetry map."*

AC: We indeed make a mistake. The GoL is not the largest, but one of the largest continental platforms in the Mediterranean (Tesi et al., 2007). This sentence will be rephrased as follow: "The Gulf of Lions is one of the largest shelves of the Mediterranean occidental basin".

RC: *"What does "ref-site" stand for in figure 7? I could not find it anywhere."*

AC: Ref-site refers to our marine reference (station J), we modified this in figure 7 for more homogeneity within the manuscript.

RC: *"What are BHT and IS in figure 7??"*

AC: We added in the legend that BHT stands for butylhydroxytoluene (antioxidant) and IS stands for nonadecanoic acid (internal standard).

RC: *"Check the bibliography. Some references are missing or not properly cited (for example Tesi et al., 2007 is related to the Adriatic sea)"*

AC: The references have been checked and corrected when necessary.

RC: *"What is the point of showing grain-size data in the results? They are not used in the discussion. Either incorporate these data in the discussion or remove them."*

AC: We made the choice of keeping grain-size data and use them in the discussion. This parameter gives insight on particle sorting across the deltaic systems. The proportion of coarse particles (>63 µm) drastically decreased from station A seaward. Within 6.7 km, the proportion of sand was reduced by 90 %. As in river-influenced marine margins, there is a general relationship between sediment grain size and plant-derived organic matter content (Tesi et al., 2007 and citations therein; Gordon and Goni, 2004), grain size can give us an insight of the spread of plant-derived organic matter upon the prodelta and the adjacent shelf. Salt induced flocculation seems to play a minor role in the deposition of suspended matter near the mouth of the Rhône River (Thill et al., 2001). As a consequence, particle flux toward the sediment mainly results from hydraulic sorting. Coarser particles settle more rapidly and the finest material is removed by hydraulic sorting generated by southeast winds. The observed sediment grain-size gradient confirms the occurrence of such sorting processes on the prodelta and the adjacent shelf.

Solveig Bourgeois on behalf of all the authors.

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