Anonymous Referee #3

In this paper the authors study the seasonal variability of organic matter mineralization in sediments from the prodelta of the Rhône River and nearby continental shelf during normal and flood regimes of the river. For this they carried out 4 samplings during the years 2007 and 2008, in one of which (June 2008) the Rhône River was experiencing an annual flood. The sediment oxygen demand is studied with three different methodologies: ex situ oxygen profiles, in situ oxygen profiles, and core incubations. The concentration of oxygen is measured with electrodes that have previously been calibrated with measurements of oxygen made using the Winkler method. From the results obtained it can be seen that oxygen demand decreases with the distance from the river mouth, during seasons when discharge conditions are normal. However the oxygen demand in the prodelta decreases during flood discharge conditions, in response to the deposition near the river outlet of low reactivity organic matter associated with the fine material. The initial spatial distribution was found again six months after this event.

The work is of considerable interest for publication and would be of great value for the scientific community, but several aspects would need to be revised:

The English should to be revised since in some places it is not easy to understand what the authors want to say. This can lead to confusion.

Reply: Thanks to the referees' comments, the discussion and, in general, the whole manuscript has been carefully scanned for improper English and grammatical constructions, and rephrased when necessary. The revised manuscript has also been checked by a native speaker.

The methodology utilized is adequate. However, certain doubts occur to me: In the cores in which the ex situ measurements were made, the conservation of overlying water oxygenation was achieved by a soft bubbling system. How was this bubbling performed? Which gas was used? Was any kind of estimation made prior to the sampling to confirm that the bubbling does not alter the oxygen content of the overlying water? Did they check that the bubbling does not alter the most superficial layer of the sediment? Equally, during the incubation of cores (part 2.8 of the text, pg. 8), overlying water was kept homogenised by a rotating floating magnet fixed to the upper core cap. Was any kind of measurement done to check that the agitation in the core did not alter the most superficial layer of the sediment and therefore the DBL?

Reply: At all stations, in situ oxygen concentrations were above 90% saturation. Hence, the potential change of oxygen due to air bubbling was minimal. Therefore, the bubbling in cores designed for microsensors measurements was lightly performed, using a fine air bubble diffuser. This latter was located approximately at 5 cm above the sediment-water interface. Oxygen Winkler titrations were performed on the overlying water in the cores prior to starting profiling: differences between in situ and cores concentrations were less than 5%. A visual monitoring was performed during the profiles to ensure that no resuspension occurred that may alter the sediment water interface.

There was unfortunately no real way of checking the DBL thickness during the core incubations, because the cores were sealed to avoid oxygen invasion. Nevertheless, the stirring speed was adjusted to ensure no resuspension of the sediment by performing visual monitoring of the sediment water-interface.

When they estimate the Diffusive Oxygen Uptake (DOU) using the 1-D Ficks first law of diffusion, what expression of D0O2 have they utilized? It would be appropriate to include the name of the author who proposed the expression utilized. Is it that of Broecker and Peng (1974)? Should Ds be put in the equation presented, instead of D0O2? Where Ds is the molecular diffusion coefficient and D0O2 is the coefficient of diffusion at infinite dilution. Given this, what expression that relates Ds and D0O2 has been considered?

Reply : As a matter of fact, D_{0O2} was evaluated from temperature and salinity using tables from Broecker & Peng, 1974. The reference has therefore been added in the revised manuscript.

Ds was estimated from D_{0O2} as $Ds = \frac{D_{0O2}}{1+3(1-\varphi)}$ (Iversen and Jorgensen, 1993). This equation has been included in the flux calculation method.

More could be commented in the paper from the TOU/DOU ratio, and the data obtained should be compared with those from other systems. Equally, the plotting of DOU against OPD could give some interesting results.

Reply: TOU/DOU ratios were on average 1.2 +/- 0.4 and not significantly different from unity except for stations J and I, less influenced by the Rhône River inputs. These values are in agreement with values recorded previously in the same area by (Lansard et al., 2008, 2009). These authors already discussed these TOU/DOU values and their implications for the benthic ecosystem. They also compared them to other similar environments: they pointed out that most of the sediment oxygen demand off the Rhône River mouth is driven by diffusive processes and largely influenced by the Rhône River inputs.

Moreover, as suggested by the referee, we plotted the DOU versus the OPD (Figure 1). Previous studies suggested that in homogeneous sediments both are related as $OPD = 2\phi Ds \frac{[O_2]_{bw}}{DOU}$ (Cai and Sayles, 1996), where ϕ stands for porosity, Ds for the diffusion oxygen coefficient in the sediment and $[O_2]_{bw}$ for the oxygen concentration in bottom waters.

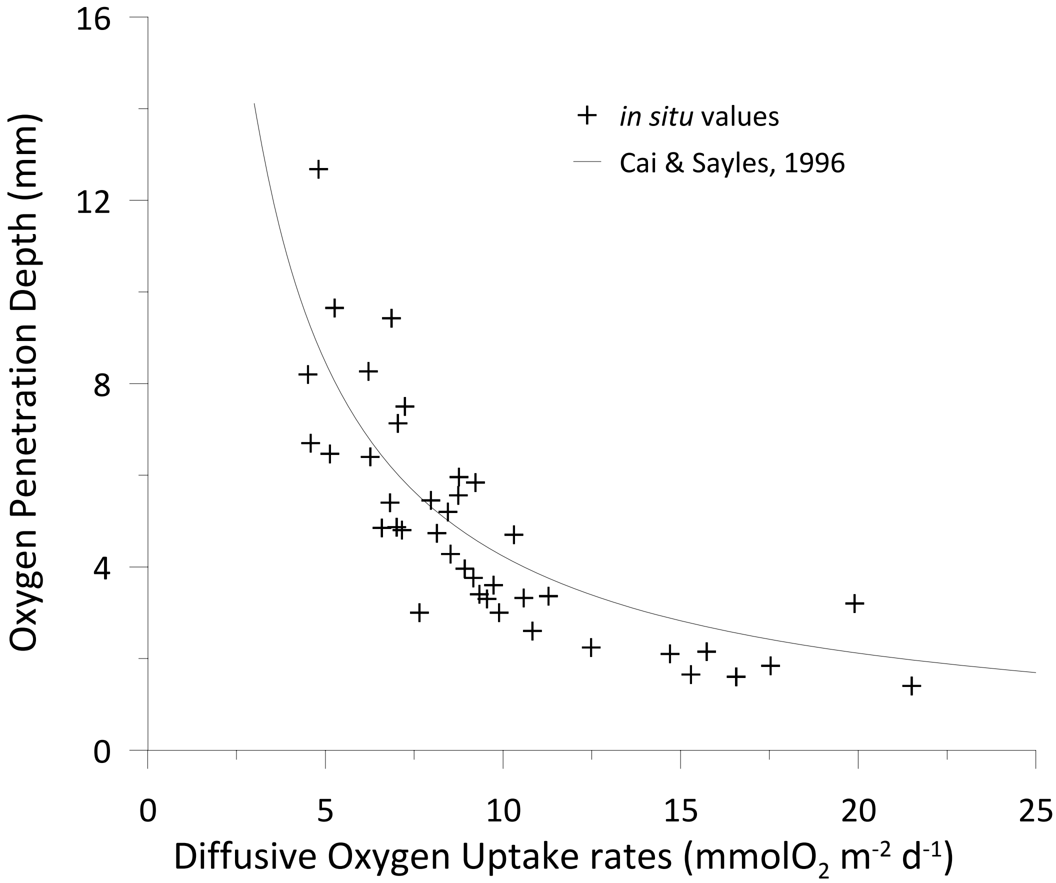

Figure 1. Diffusive Oxygen Uptake (DOU) rates plotting against Oxygen Penetration Depth (OPD). + represents values from our data set. The solid line stand for the predicted relationship proposed by Cai and Sayles (1996) : $OPD = 2\phi Ds([O_2]_{bw}/DOU)$**.**

We observe a good agreement between this relation and our data (cf. Figure 1). This likely indicates steady-state O_2 distribution, uniformly distribution of organic material and negligible irrigation in the Rhône River prodelta sediments, as have been observed in other shelf and continental margin sediments (Cai and Sayles, 1996). The Rhône River prodelta would therefore be a diffusive system, with benthic mineralization driven by microbial processes rather than macrofauna activity. As stated earlier, this has already been evidenced and discussed in (Lansard et al., 2008, 2009), in particular, based on TOU/DOU ratios, and our dataset does not provide any significant new insights or further argument on this issue. We therefore chose to focus on the originality of our dataset, namely the evolution of DOU rates during a flood period.

When they speak in the text of figure 9, it would be convenient to state there that, in this figure, the stations close to the river outlet have been separated from the offshore station. They should also give the reason for this separation.

Reply: A clear slope break appears on the chart between the SW gradients near shore and off shore. The linear regression plotted were then only a way to highlight these gradients, and mostly their discrepancy depending whether you consider stations close to the river or more off-shore stations. This has been added in the paragraph corresponding to the description of Fig. 9 (section 3.4, p. 10788).

Figure 11 shows the evolution of the flood deposit in September and October 2008 (as well as in June and December) at a depth of 45 m, 2.7 km of the river mouth. These two samplings should be included in Material and methods.

Reply: As suggested, these samplings sites have been added to the corresponding section in Material and Methods (section 2.2).

DATE	LATITUDE	LONGITUDE	DEPTH (m)
8 june 2008	43° 18.427	04° 51.316	42
6 september 2008	43° 18.420	04° 51.300	45
16 october 2008	43° 18.435	04° 51.321	46
4 december 2008	43° 18.418	04° 51.370	46

Since the study is based on diffusive fluxes, in which the processes of bioturbation are very important, the text would be improved if some references were included in Material and Methods to the species of macrofauna that are most abundant in the zone.

Reply: The following brief description has been added to the study site section (2.1): “The benthic macrofauna community presents a low specific diversity compared to those of other soft bottom communities in the region. It is dominated in abundance by polychaetes mainly Sternaspis scutata. and Laonice cirrata, and by surface and subsurface deposit-feeders (Salen-

Picard and Arlhac, 2002;Darnaude et al., 2004). The maximum richness in species is recorded at 70 m depth (Salen-Picard, 1982).

Minor comments:

In all the bibliographical citations the proper names (Rhône, Mediterranean: : :..) and those of geographical features (River, Sea…) appear without a capital letter. These must be corrected.

Sometimes abbreviations appear in the text that are only explained later. For example in the Abstract on line 6, DOU appears and it is on line 7 that it is explained as referring to Diffusive Oxygen Uptake. Similarly TOU appears on line 10 but there is no explanation of what the initials mean. In part 2.9. of the text (Pg. 8 Ln. 24) the authors speak of OPD but it is only in part 3.4 (Pg. 10, Ln 11) where it is explained that these initials correspond to Oxygen Penetration Depth.

Some bibliographical citations are missing, such as: Cachalot et al., In Prep.; Ulses et al., 2008; Eyre et al., 2006, and Rees et al., 2005.

In table 1 ïA˛ D and not ïA˛ M appear as units of [O2]bw.

In table 3 an asterisk appears and it is not specified to what this refers. Also in this table the number of digits for the same variable is not homogeneous.

Reply: This has been previously corrected. The correct version with above corrections is available online.

References:

Cai, W. J., and Sayles, F. L.: Oxygen penetration depths and fluxes in marine sediments, Mar. Chem., 52, 123-131, 1996.

Darnaude, A. M., Salen-Picard, C., and Harmelin-Vivien, M. L.: Depth variation in terrestrial particulate organic matter exploitation by marine coastal benthic communities off the rhone river delta (nw mediterranean), Mar. Ecol.-Prog. Ser., 275, 47-57, 2004.

Iversen, N., and Jorgensen, B. B.: Diffusion-coefficients of sulfate and methane in marine-sediments - influence of porosity, Geochim. Cosmochim. Acta, 57, 571-578, 1993.

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Salen-Picard, C., and Arlhac, D.: Long-term changes in a mediterranean benthic community: Relationships between the polychaete assemblages and hydrological variations of the rhone river, Estuaries, 25, 1121-1130, 2002.