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Biogeosciences Discussions

Interactive comment on "Functioning of the planktonic ecosystem of the Rhone River plume (NW Mediterranean) during spring and its impact on the carbon export: a field data and 3-D modelling combined approach" *by* P. A. Auger et al.

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We are very thankful for the constructive comments from the two referees and are pleased to present our answers. Most of the suggestions and corrections of the referees are included in the revised manuscript.

According to the referees' comments and suggestions, the manuscript has been partly rewritten, deeply restructured and reorganized in 1 Introduction – 2 Material and Methods – 3 Validation of the ecosystem modelling – 4 Results – 5 Discussion – 6 Conclusion. BIOPRHOFI measurements within a LSW lens (Trajectory 2) provide us an opportunity for validating an ecosystem model, and have been fully used to validate model outputs in term of stocks and bacterial/primary production without salinity discrimination anymore. Since the Trajectory 1 was not sampled in such LSW lens, all data from this trajectory have been actually removed from the analysis of BIOPRHOFI measurements and the validation data set. This alteration enables to shorten and simplify the new version of the paper. On the whole, the focus on the key factors actually controlling the particulate organic carbon (POC) deposition on the Gulf of Lions shelf has been increased and the discussion part has been significantly enriched. The model provides us a diagnostic on the POC deposition during the study period (spring). Moreover, a sensitivity test to particulate organic matter (POM) inputs from the Rhone River allows us to investigate the role of terrestrial inputs and biological processes on the POC deposition within the Gulf of Lions shelf. Besides, we propose a modification of the manuscript title: "Functioning of the planktonic ecosystem on the Gulf of Lions shelf (NW Mediterranean) during spring and its impact on the carbon deposition: a field data and 3-D modelling combined approach"

Specific response to Referee #2 (Dr. M. Dagg) RC: "In general, the paper needs editing for English and clarification of language. It reads as if it is preliminary in nature, with many awkward sentences, incorrect or missing units on figures, etc." AC: According to referee's comments, the manuscript has been partly rewritten and clarified.

RC: "Modeled temperature does not capture observed temperature well but the agreement is pretty good for salinity. This seems a very basic starting point to me and if temperature is off, this indicates something important about the basic physical model that needs to be addressed." AC: This point is fully discussed in the section "3.1 Validation of the hydrodynamic model": "According to salinity data from CTD measurements performed at each station of the BIOPRHOFI cruise from the surface to 10m depth, the thickness of the plume is ranging between 5m and 10m which is coherent with model outputs (not shown). In addition, the comparison of salinity model outputs against data confirms a correct representation of the salinity gradient and freshwater plume extension (Fig. 8A). The statistical scores indicate a significant correlation coefficient (Fig. 7A), low percent bias (Fig. 7B) and very good RSD and cost function scores (resp. Fig. 7C and 7D). The large number of samples (238 samples) gives even more significance to these statistics. Regarding temperature (Fig. 8B), scores are globally very good despite an underestimation of simulated temperatures ($\sim 0.4°C$). However, the density distribution inside the river plume being mostly driven by salinity (Marsaleix et al., 1998), this bias has very little influence on this buoyant structure hydrodynamics'. Moreover, such a temperature underestimation corresponds to a 2.8% underestimation of the Q10 temperature function (see Eq. A.57) and has then little effect on biogeochemical processes ..."

RC: "The integration of all components into total POC, PON, and POP follows. It is stated that these are reasonable outcomes and therefore these totals can be used to make useful statements about total fluxes, both horizontal and vertical. This is a questionable assumption – if many of the modelled parts are unrealistic but the sum happens to be right, how reliable is the modelled sum? Also, it is validated by data from a different study, not from the field study discussed in the paper. And, the validation data are annual averages, not specific to the time period modelled (I.E. the time period of the field study). This is a poor study design. If the initial intent was to use the model to estimate fluxes, then field data should have included flux measurements. Lastly on this point, the scales of the last few figures are well beyond the scales of the field study and the FW lenses." AC: Actually, the concept of the manuscript was clarified. BIOPRHOFI measurements performed in LSW lens confirm a high biological production in such structures (Diaz et al., 2008). BIOPRHOFI measurements in a LSW lens provide us a opportunity for validating an ecosystem modelling on the Gulf of Lions shelf, as added and discussed in the revised manuscript (Section 3.2 "Validation of the ecosystem model"). Besides, the calibration of the model has been adjusted to represent with better accuracy both micro- and mesozooplankton biomasses and their grazing pressure upon POM. The model is then used at greater spatial scale, assuming that the correct representation of biogeochemical stocks within/under LSW lens (especially phyto- and zooplankton biomass and POM contents) ensure a correct representation of the biological fluxes controlling POM contents in the water column at shelf scale. In particular, the vertical profiles of POC contents as observed during the BIOPRHOFI cruise are well represented by the model, which has been added in the revised manuscript (see Fig. 11). Figure 11. Comparison between observed and simulated vertical profiles of particulate organic carbon concentrations (mmolC m-3) in the LSW lens.

We assume that the correct representation of the vertical gradient of POC in the model will provide us reliable estimations of POC fluxes in the water column, and then POC deposition on the seabed. Anyway, high resolution measurements of POC deposition fluxes on the Gulf of Lion shelf remain scarce. Then, our goal is to use the model to estimate fluxes of POC deposition on the seabed and investigate the key factors that control it and precisely the role of biological processes. In fact, the comparison to data of sedimentation rates (Durrieu de Madron et al., 2000) is given to introduce, more than to validate the model results. Overall, this comparison shows that the order of magnitude of POC deposition on the shelf is well represented by the model.

RC: “This paper aims to be a ‘model’ paper and a ‘science’ paper. However, most of the paper is devoted to the model and its degree of fit with data, with little effort spent on the science question(s) until near the end of the paper. [. . .] The scientific question asked and (unconvincingly) “answered” are minor and pretty much already known anyway. Discussion about the control of flux seems unjustified considering the difficulties and problems with many of the model elements. This is especially true for the proposed major role of large zooplankton, which are poorly handled by the model. Overall, the science is not convincing, nor significant, but the model is making good progress.” AC: In order to increase the wide scientific interest of the manuscript, the balance between model and scientific questions has been improved. Actually, the section on the model/data comparison has been shortened and the discussion of our results has been enriched focusing on the key factors actually controlling the POC deposition on the Gulf of Lions shelf. The description of the POC deposition on the Gulf of Lions simulated during the study period has been first enriched (Section 4.1). The results of the sensitivity test to POM inputs from the Rhone River are presented in term of POC deposition (Section 4.2) as well as POC contents in the water column especially near the bottom (Section 4.3). In order to assess the robustness of our results, a sensitivity analysis to POM inputs from the Rhone River has been added assessing the effect of the modification of micro- and mesozooplankton grazing rates (see Section 4.3, Fig. 16). Figure 16. Sensitivity analysis of the model results to micro- and mesozooplankton grazing rates, considering the normalized difference (%) of daily particulate organic carbon deposition rates between reference and "noPOM" simulations.

Actually, this sensitivity analysis shows that our results are weakly sensitive to modifications of zooplankton grazing rates. The role of zooplankton grazing processes in controlling POM contents in the water column appears then robust. The results are now presented as the difference "Reference – noPOM", so in an opposite way than in the first submitted manuscript. Thus, the influence of terrestrial inputs from the Rhone River is highlighted in a much more logical manner. The discussion part has been finally enriched focusing on the role of zooplankton (5.1) and the key factors actually controlling the organic carbon deposition on the shelf (5.2). Our modelling study finally shows that the influence of terrestrial POM inputs on the POC deposition remains limited (maximum 17% contribution of POM terrestrial inputs to the total POC deposition on the shelf) and this highlights the role of trophic interactions within the plankton community such as zooplankton grazing on the carbon deposition.

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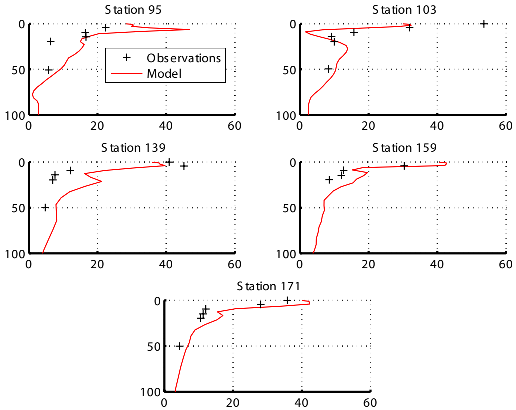

Fig. 1. "Figure 11. Comparison between observed and simulated vertical profiles of particulate organic carbon concentrations (mmolC m-3) in the LSW lens."

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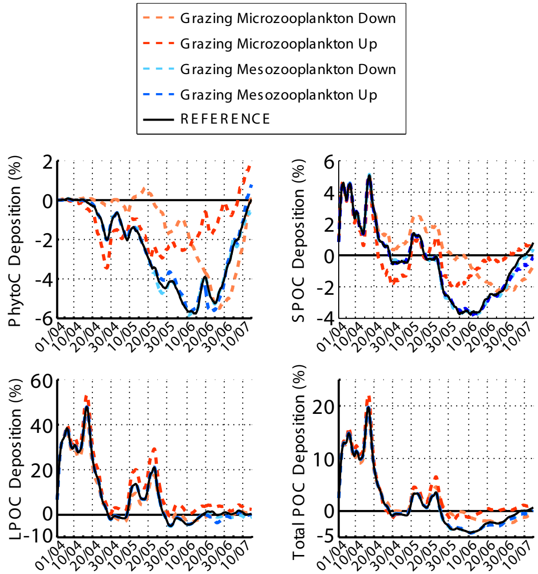

Fig. 2. "Figure 16. Sensitivity analysis of the model results to micro- and mesozooplankton grazing rates, considering the normalized difference (%) of daily particulate organic carbon deposition rates..."

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