

We wish to thank referee #1 for his/her detailed analysis and his/her thoughtful comments, which will improve the quality of this manuscript. Here, you will find a detailed reply to each comments :

Response to Referee#1's Comments

Major Comments

1) Verbose “Results” Section

The paper by Auger et al. has the great merit of analyzing in depth the results of the model and of using cross-analysis of several different quantities to validate the hypothesis of the Authors. However, I have found the Results section pretty heavy to read, especially due to the amount of numbers listed within the text. This has a peak in sections 3.1.3 and section 3.2.3. I strongly suggest to summarize the results sections since the plots already contain much of the information that is explained in words in these chapters. The many many numbers listed in sections 3.1.3 and section 3.2.3 could instead be included directly in the pictures, for example above the bars, or in a table. As a general comment, I suggest to summarize/reorganize the Results section and use it to highlight general features and important trends in the Figures, rather than describing them element by element. This way the readers can really grasp the major highlights and findings without getting lost in too much information, while they can still look at the plots/tables for more details.

We agree that some parts (in particular section 3.1.3 and 3.2.3) of the « Results » Section is dense, and that our major findings are perhaps lost in too much numbers listed in the text. According to the referee's suggestion (shared with referee #3), numbers in sections 3.1.3 and 3.2.3 will be removed from the text. The Results Section will also be clarified to highlight the major features of the study region shown in the figures.

2) Why Spring

It was not clear to me until the Discussion section 4.3 the reason why some of the analysis in the paper was focusing on spring and I am still not sure that I have comprehended all the rational behind it. I suggest to motivate this choice more in depth before to present the results to the reader, stressing on the motivations that lie behind the choice of presenting a detailed analysis of the fluxes in this specific season only, despite all the known subregional variability of upwelling and seasonality in the system.

Indeed, the three referees noted that the justification of why we partly focus on spring should be done earlier than in section 4.3. The main justification is that observed offshore extension of Chl-a do present a marked seasonal variability with a peak in boreal spring. Therefore, focusing only on annual averages would have raised questions about the significance of our results during the time period that sees most of the offshore export. Choice has thus been made to show annual average but also the spring period.

According to shared referees' comments on this point, the choice of the spring season for the analysis of offshore boxes will then be clearly motivated in the introduction by modifying the sentence p.3/l.8 from :

« The following section is focused on the description of the meridional

variability of annual wind forcings, ocean response and primary productivity as simulated by the model in the different coastal boxes (Section 3.1) and offshore boxes (Section 3.2). »

to

« Then, we describe the meridional variability of wind forcings, ocean response and primary productivity as simulated by the model in the different coastal (Section 3.1) and offshore boxes (Section 3.2), on annual mean and also during spring (seasonal maximum of the chlorophyll offshore extension as shown in Lathuilière et al, 2008). »

This will be also mentionned at the beginning of the Results Section 3.2.1 modifying p.10/l.9 from :

« The offshore extension of chlorophyll has been shown to display a marked seasonal variability with a maximum in spring (Lathuilière et al., 2008; see Fig.1). In the offshore region, the chlorophyll variability depends on the export of coastal productivity. Additionally, the wind stress can be responsible for vertical mixing that enhances the exchanges of inorganic and organic matter between the euphotic and aphotic layers. The vertical nutrient supply to the enlightened surface layer and the phytoplankton export below the euphotic layer may also be enhanced by positive/negative Ekman pumping, respectively linked to positive/negative wind stress curl. In order to explicit the offshore extension in spring of the rich phytoplankton pattern, mean wind forcings from March to May (i.e. wind intensity and wind curl) are first presented in Fig. 8 (a & b). During these months, the wind intensity increases from the northern Saharan Bank to Cape Blanc (where it peaks) and then decreases southward (Fig. 8a). »

to

« In the offshore region, the chlorophyll seasonal variability may depend on the export of coastal productivity. Additionally, the wind stress can be responsible for vertical mixing that enhances the exchanges of inorganic and organic matter between the euphotic and aphotic layers. The vertical nutrient supply to the euphotic surface layer and the phytoplankton export below the euphotic layer may also be enhanced by positive/negative Ekman pumping, respectively linked to positive/negative wind stress curl.

Off NW Africa, the offshore extension of coastal chlorophyll has been shown to display a marked seasonal variability with a maximum in spring (Lathuilière et al., 2008; see Fig.1). Thus, spring averages from March to May were considered to investigate the factors driving primary productivity in offshore boxes. Mean spring wind forcings (i.e. wind intensity and wind curl) are first presented in Fig. 8 (a & b). During spring, the wind intensity increases from the northern Saharan Bank to Cape Blanc (where it peaks) and then decreases southward (Fig. 8a). »

3) Model Evaluation: Nitrate

Most of the discussion in the paper by Auger et al. is focusing on Nitrate, however there is no model evaluation of the nitrate distribution in the model. I suggest to include this in the paper.

We propose to add, in Figure 1, white contours of nitrate concentrations at 100m depth (the depth of the boxes defined for our

analysis) both in the model and the CARS 2009 global atlas product. This will permit us to show the sharp change in nutrient concentrations which occurs off Cape Blanc between nutrient-poor North-Atlantic Central Water north of Cape Blanc, and nutrient-rich South-Atlantic Central Water south of Cape Blanc. This will be mentioned in the text p.5/l.12 :

« Noticeably, the flow of the undercurrent over the slope is always poleward (not shown) in agreement with observations (Mittelstaedt, 1983). Besides the model accurately represents, at latitudes around Cape Blanc, the sharp gradient of nutrient concentrations in upwelling source waters between nutrient-poor North Atlantic Central Water (NACW) and nutrient-rich South-Atlantic Central Water (SACW), respectively north and south of Cape Blanc (see contours in Fig. 1). This actually results from the deepening of the poleward undercurrent transporting SACW and its intensive mixing with NACW north of Cape Blanc (Mittelstaedt, 1983). »

4) Box analysis Figures

The paper by Auger et al. presents most of the results in the form of fluxes analysis. However, some of the Figures are confusing. Figure 7, Figure 13: Why are there 2 arrows of different color and size for each one of the lateral fluxes between the boxes? Eg, in Figure 7 the meridional flux between SS and SM in the nearshore is represented by both a large red arrow and a not so large orange arrow, so there are 2 arrows of different size for a single flux. What does this mean? Isn't the size of the arrows proportional to the intensity of the fluxes? Is the size of the arrows of one box comparable with the size of the arrows in the other boxes or do each box have a different scale?

As mentioned in their captions, Figures 7 and 13 present the « contribution of the different source and sink terms of nitrate and phytoplankton concentration within each box defined in this study. Each color corresponds to a box ». The size of the arrows of one box is then comparable with the size of the arrows of other boxes in terms of their contribution to the nitrate or phytoplankton concentration in each box. As this is only mentioned in the figure captions, we propose to also mention it in the text when these figures 7 and 13 are presented at the end of Section 3.1.3 and 3.2.3, respectively.

Minor Comments

1) page 3: title “Material and Methods” maybe should be “Materials and Methods”? (missing s)

We agree and will take into consideration this suggestion.

2) page 3, lines 24-25: What is the output frequency of the model? Monthly means?

Model outputs are saved as 5-day averages. This information will be added in the caption of Figure 1 by replacing the sentence : « Same for ROMS-PISCES in (c) winter and (d) summer. »

by « Same seasonal climatology computed with the 5-days outputs of ROMS-PISCES in (c) winter and (d) summer. »

3) page 4, lines 30-31: The large cyclonic recirculation introduced here and fed by the NECC is generally referred to as Mauritanian Current [J. Arístegui et al./Progress in Oceanography 83 (2009) 33-48] in its northward alongshore component. This current is referred to again in page 5 lines 7-12

We agree and will take into consideration this suggestion by modifying the text p4/l.30 from : « South of 19° N, a large cyclonic recirculation is found between the south-westward flowing Canary Current and the coast, especially in summer when trade winds extend farther north (see Barton et al., 1998; Mittelstaedt, 1983, 1991). » to

« South of 19° N, a large cyclonic recirculation is found between the south-westward flowing Canary Current and the coast, especially in summer when trade winds extend farther north (see Barton et al., 1998; Mittelstaedt, 1983, 1991). It generates a poleward alongshore flow at its eastern flank generally referred as Mauritanian Current (Aristegui et al., 2009). »

The text will be also modified p.5/l.7 from : « Alternatively, a moderate poleward current (which can be seen as an extension of the NECC, see Fig. 1) lays south of Cape Blanc both in the model and in the data during summer when upwelling-favourable winds are weak. » to

« Alternatively, a moderate expression of the poleward Mauritanian Current lays south of Cape Blanc both in the model and in the data during summer when upwelling-favourable winds are weak. »

4) page 5 lines 1-2: “Maximum velocity is found equatorward in the coastal upwelling jet”: this sentence is a bit odd as regard to English syntax, it may be reformulated in a clearer way

This will be reformulated.

5) page 5 line 3: (and all the next occurrences) Cape Boujdour (FR) in English is called Cape Bojador

We agree and will take into consideration this suggestion.

6) page 6 lines 9-18: this block of lines sounds more like a “Model Results” paragraph and it seems out of place; if moved somewhere else the Box Analysis section actually sounds much more coherent; maybe it can be located in a more adequate position

The structuration of the manuscript and the way our results are presented relies on the definition of spatial boxes which represent homogeneous subregions in terms of physical-biogeochemical characteristics. Consequently, this is a key element of methodology that needs to appear in the dedicated Subsection « Box analysis » of the Section « Materials and Methods ».

We would thus prefer to keep subsection as it is.

7) page 10 line 12: I don't think that “enlightened” is the right word here (eg, enlightened = Having or showing a rational, modern, and well-informed outlook; spiritually aware)

« enlightened » will be replaced by « euphotic ».

8) page 10 line 28: at the bottom of the offshore boxes (missing "the" before "offshore boxes")

We agree and will take into consideration this suggestion.

9) page 10 lines 31-32: the sentence about vertical velocities and nitrate supply is not clear to me, this finding may be better explained

This sentence will be modified as follows : « The vertical nitrate supply by advection off the northern and southern Saharan Bank is particularly weak (inward nitrate transport despite averaged outward velocities due to episodic inward events) in comparison to vertical diffusion. »

10) page 11 line 10 page 12 line 2: Annual Mean? Or Spring Mean? In general, suggest always to remark throughout the discussion and conclusions section whether your sentences are referring to the annual mean or spring mean analysis

We agree and will take into consideration this suggestion.

11) Figure 14: Why are the lines in subplot c and d dashed?

The lines in (c) will be set solid and the caption of Figure 14 will be modified as follows to give the signification of solid and dashed lines : « Figure 14: Seasonal climatology of (a) wind intensity (negative is upwelling-favourable, $m s^{-1}$), (b) bottom vertical velocity ($m s^{-1}$), (c) zonal velocities ($m s^{-1}$) and (d) meridional velocities ($m s^{-1}$) averaged within and over each edge of the coastal boxes (i.e. North, South, West and bottom ; defined positive inward, so vertically upward), respectively. Each color corresponds to a box (see legends in Fig. 2). In (d), a solid (dashed) line represents a velocity at a northern (southern) edge of a box, respectively. »