

Interactive comment on “What drives the spatial variability of primary productivity and matter fluxes in the North-West African upwelling system? A modelling approach and box analysis” **by Pierre-Amaël Auger et al.**

Anonymous Referee #3

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Summary In this study a coupled physical-biogeochemical model is used to understand the spatial variability of primary production in the NW African upwelling system. Homogeneous regions are chosen based on similar horizontal current patterns and individually analysed with regard to drivers of primary productivity. Their results indicate that coastal upwelling is modulated by coastal topography and large-scale geostrophic currents, effectively enhancing upwelling off Cape Boujdour and limiting it off Cape Blanc. Coastal upwelling of nitrate, and therefore new production, was found to be significant everywhere except Cape Blanc, but dominant only in the northern Saharan Bank and Senegal-Mauritanian regions, elsewhere it is predominantly provided by meridional ad-

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vection. Therefore, off Cape Blanc the net coastal phytoplankton growth is sustained by high levels of regenerated production. The offshore pattern of nitrates and phytoplankton is driven by coastal circulation patterns: in the north of the domain the coastal circulation is predominantly alongshore explaining the limited offshore extent of high productivity and further south, large filaments associated with large offshore fluxes result in high productivity much further offshore.

Recommendation This work is beneficial to the understanding of physical-biological interactions in the NW African upwelling system and should be published, with some minor corrections and condensing of some of the sections.

General comments Title could be shortened to: What drives the spatial variability of primary productivity and matter fluxes in the North-West African upwelling system? A modelling approach.

Throughout the manuscript 'explicit' is used as a verb. It is not a verb, it can be used as a noun (eg. The explicitness of the data allow us to draw some very solid conclusions) but usually an adverb (The data allow us to explicitly show that...) or adjective (e.g. The data is explicit, it shows that...).

It seems a bit unclear as to why the spring means are used for the offshore domains and annual means for the coastal domains. It is mentioned only later in the discussion, but it should be clearer sooner. Why not show the spring mean for coastal and offshore domains (surely using the annual mean for the coastal domain masks the seasonal signal and is therefore unrealistic?). Does it make sense to link the coastal and offshore domains in terms of the offshore fluxes for example if you are looking at averages for different periods?

The results section is very laborious and therefore difficult to read, especially sections 3.1.3 and 3.2.3 (the percentages in parentheses are not necessary), and could be shortened.

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Specific comments page 2, line 4: 'of coastal topography are' should be 'of coastal topography is'

page 2, line 5: '...and then the response of nutrient upwelling to wind forcings'. This is unclear. Are you saying that the large scale circulation pattern impacts the wind driven upwelling of nutrients?

Introduction Page 3, line 17: 'in regards of enironmental forcings' should be 'with regard to enironmental forcings'

Page 4, line 2: 'To this end, comparative box analysis...' should be 'To this end, a comparative box analysis...' or 'To this end, comparative box analyses.....have been conducted'.

Page 4, line 3, 'Those subregions' should be 'The subregions'

Page 4, line 4,' in regards of' should be 'with regard to'

Page 4, Line 14: 'explicit' cannot be used as a verb, try 'identify',

Last two paragraphs of Introduction are laborious and could be more succinctly summarised.

Last two sentences of Introduction seem out of place.

Methods Page 4,line 26: unbalanced parenthesis

Page 5, line 23: 'thinner' is ambiguous in this context, 'narrower' is clearer

Page 6, line 3: 'The upwelling filaments off Cape Ghir and Cape Boujdour are responsible for strong seaward deflections of the coastal current.' I wouldn't necessarily say that the filaments are responsible for the seaward deflection – they are 'connected', both associated with the same initial mechanism (perhaps wind/topography) and then they probably enhance one another.

Page 6, Line 2: 'explicit' cannot be used as a verb, try 'identify'

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Page 6, line 2-4: '.....the meridional variability of primary productivity off the NW African coast, we carried out a box analysis focusing on nitrate (the main limiting nutrient) and phytoplankton carbon budgets (12–27° N, see Fig. 1)',

rather say:

'.....the meridional variability of primary productivity off the NW African coast between 12–27° N, we carried out a box analysis focusing on nitrate (the main limiting nutrient) and phytoplankton carbon budgets'

Page 6, line 7: '...was split into five latitudinal bands.' rather: '...was split into five latitudinal bands (see Fig. 1).'

Page 6, line 12: remove 'On the opposite,', start with 'In the southernmost...'

Page 6, line 17: what do you mean by 'globally'? It usually refers to something involving the whole globe/world.

Page 6, line 20: 'In like manner...' rather 'Similarly.'

Results Page 8, line 6: 'Wind curl shows a clear maximum off Cape Blanc but a weak meridional variability'. This sentence is not clear. Do you mean that the meridional variability in wind stress curl is weak or do you mean that the alongshore variability of meridional wind stress is weak?

Figure 2 c : this is labelled as upwelling intensity (vertical velocity at the bottom). For upwelling intensity, it would be better to use vertical velocity at the base of the Ekman layer (your 100 m depth of the boxes is probably too deep?).

Page 8, line 24: remove 'inversely'

Page 8, line 32: '...associated to...' should be '...associated with...'

Page 9, line 11: 'does not translate in...' should be 'does not translate into....'

Page 9, line 14: 'Noteworthy, the phytoplankton biomass is found maximum off Cape

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Blanc and the South Saharan Bank contrasting with minimum upwelling-induced nitrate supplies (Fig. 3a).

rather:

'It is noteworthy that maximum phytoplankton biomass is found off Cape Blanc and the South Saharan Bank despite the fact that upwelling-induced nitrate supplies are at a minimum at those locations (Fig. 3a).'

Section 3.1.3: laborious

page 10, line 6: 'sinks' should be 'sink'

page 11, line 12: 'enlightened' is very archaic in this context. Replacing it with 'euphotic zone' would be better.

Page 11, line 14: 'explicit' cannot be used as a verb and whole sentence is unclear.

Page 11, line 17: 'Alternatively' since you're not offering an alternative to a previous statement, something like 'On the other hand' works better.

Page 11, line 22: 'Noteworthy, at the western...', change to 'It is noteworthy that at western boundaries velocities are...'

Page 11, line 23: replace 'happen to be' with 'are'

Page 11, line 29: replace '..falls in the same order of magnitude than diffusion...' with '..is the same order of magnitude as diffusion...'

Page 11, line 31: replace 'Noteworthy...' with 'It is noteworthy that vertical nitrate supply...'

Page 12, line 10: In the text it states that Fig. 10 is annual mean, but the figure caption says Spring mean.

Page 12, line 18: replace '....., in less manner,....' with '...., less so,...'

Page 13, line 2: In the text it states that fig 12 shows the annual mean source and sink terms but the figure caption says it is the spring mean.

Discussion Page 14, line 9: 'in relation with the...', should be 'in relation to the...'

Page 14, line 10: 'Finally, we will seek to explicit...' should be 'Finally, we will seek to identify...'

Page 14, line 13: 'In our simulation, the meridional variability of coastal upwelling is not correlated to the local variability of wind-driven Ekman transport and Ekman pumping. This result questions the estimation of vertical velocities based on local wind forcing that were commonly used in EBUS'.

- two points on this statement: 'were' should be 'are'

The estimation of upwelling using alongshore wind stress is for vertical velocities at the base of the Ekman layer. Your level of 100m, or the bottom in places shallower than 100 m, may be too deep.

Page 14, line 16: You state that the large scale transport could be a factor explaining the mismatch in upwelling intensity and Ekman transport. With the model output you can calculate it directly to verify your statement.

Page 14, line 22: '...explicit...', can't be used as a verb. You could use 'identify'

Page 14, line 23 and figure 14: you use the bottom velocity to assess the sensitivity of coastal upwelling to wind forcing. You should rather use vertical velocity at the base of the Ekman layer.

Page 14, line 26: 'lead' should be 'leads'

Page 15, line 18: instead of 'Albeit' use 'Although'.

Page 16, line 31: sentence starting with 'This points a gap...' is confusing

Page 17, line 13: 'the coast, the wind stress curl...' should be 'the coast, (ii) the wind

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stress curl...' Page 17, line 14: 'hypothesis' should be 'hypotheses'

Page 17, line 15: 'explicit' should be 'identify'

Page 17, line 20: 'associated to' should be 'associated with'

Page 17, line 22: 'Our results indicate downward and upward wind-induced Ekman pumping of respectively north and south of Cape Blanc' should be 'Our results indicate downward and upward wind-induced Ekman pumping north and south of Cape Blanc respectively'

Page 18, line 1: 'participate' should be 'help'

Page 18, line 8: '2ZOTLathuliere2008' – a latex referencing bug?

Page 18, line 10: 'thatfilaments' should be 'filaments'

Conclusion Page 18, line 21: 'of the primary production spatial distribution in' should be 'of the spatial distribution of primary production'

Page 18, line 25: ' production in' should be 'production with'

Page 18, line 31: 'excepted' should be 'except'

Figures Figure 1: include the box labels that you use in the text and in other figures

Figures 1-4: in some you include just the abbreviations of the box areas, in others you have the full name. When you don't have the full names in the legend, you could include them in the caption

Figure 6: label x-axis with latitude as well, or at least show where north is

Figure 10 and 12: the captions dont agree with the text (Annual vs. Spring mean)

Figure 14: it is not clear how these averages are calculated (in the caption or in the text). In the caption you state: 'within and at the boundaries of coastal boxes'. Is it an average of meridional wind, bottom velocity, cross-shore velocity and alongshore

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velocity within the entire coastal strip? If so, does this make sense, given that your interest is the meridional variability of primary productivity.

Please also note the supplement to this comment:

<http://www.biogeosciences-discuss.net/bg-2016-156/bg-2016-156-RC3-supplement.pdf>

Interactive comment on Biogeosciences Discuss., doi:10.5194/bg-2016-156, 2016.

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