AUTHOR'S RESPONSES TO REFEREE 2

We thank the reviewer for his careful reading of our manuscript. We considered his suggestions and critics. A point-by-point reply is presented hereafter.

General comments:

1. important details about the model simulation are lacking
- do you include tidal mixing?

Author's response 1:
We acknowledge the importance of tidal mixing.
A parameterization of the vertical mixing induced by internal tides has especially been developed for OPA/NEMO, by artificially enhancing vertical viscosity and diffusion coefficients, and gives satisfying results on Indonesian seas (Koch-Larrouy et al., 2007, 2010). While it considered in this study, it is part of the physical configuration. All technical aspects concerning the physical configuration are detailed in the companion paper (Tranchant et al., submitted).
We nevertheless added a sentence to Section 3.1 of the revised paper: "A parameterization of the vertical mixing induced by internal tides has especially been developed for OPA/NEMO (Koch-Larrouy et al., 2007, 2010).".

- you fixed mean run off and nutrient supply. Is this realistic for such a dynamic environment.

Author's response 2:
We thank the reviewer for highlighting the importance of river nutrient supply.
For physical runoff, a monthly global climatology is built with data on coastal runoffs and 99 major rivers from Dai and Trenberth (2002) and prescribed with a flux formulation into the model. In addition, two important missing rivers (Mahakam and Kapuas on Borneo Island) with large enough rates (class 3) were added to this database.
For nutrient supply, we are forced to use an annual climatology for want of observations at high temporal resolution. In the paper, we point to the major role of river discharges in this region governed by the seasonal monsoon system, which supply huge quantity of nutrients to the ocean. We also concede that at present data are lacking to improve model forcing by river nutrient input. Figure 11 of the revised manuscript presents the poor temporal correlation between the modelled chlorophyll-a and satellite data along the coasts. On the conclusion part, we recommend the contracting organization of this operational configuration to consider the importance of river discharges in order to simulate realistic biogeochemical features along the coasts.

- it is a short simulation and I would like to see some upper ocean diagnostics to show how key fields like NPP and surface phytoplankton, nitrate, iron and silicate evolve over the simulation. Do the model upper ocean nutrients drift with time?
- should show for the domain what the difference in the nutrient fields between the start and end of the simulation as a depth time plot of the annual change in nutrients over the simulated period reference to the start of the simulation.

Author's response 3:
The objective of Figure 1 is to demonstrate the model has a satisfying behaviour all along the simulation length, without drift due to mass conservation problems. To this end, tracers' concentrations over the whole 3D domain are presented. Strictly speaking, the model can not reach steady state as open boundary conditions and surface forcing come from global forecasting systems. Interannual variability, as well as temporal drift is introduced in the domain configuration.

We follow, however, the suggestion put forward by the reviewer and add the following figures to the supplementary material. Figures A to F present the evolution of tracers' concentrations at various depths: surface, 0-100m, 100-600m and 600m-bottom, in order to detect abnormal drift with time. Please find as example the evolution of nutrients, chlorophyll-a and net primary production (NPP), but also the main stressors of marine ecosystems: sea surface temperature (SST) and oxygen concentrations. It can be seen that:
(1) Chlorophyll-a and NPP do not significantly drift over the time of the simulation (Figure A), with an averaged chlorophyll-a concentration about 0.51 mg Chl m-3 at the surface and 0.35 mg Chl m-3 between 0-100m and vertically integrated NPP about 58.9 mmol C m-2 d-1.

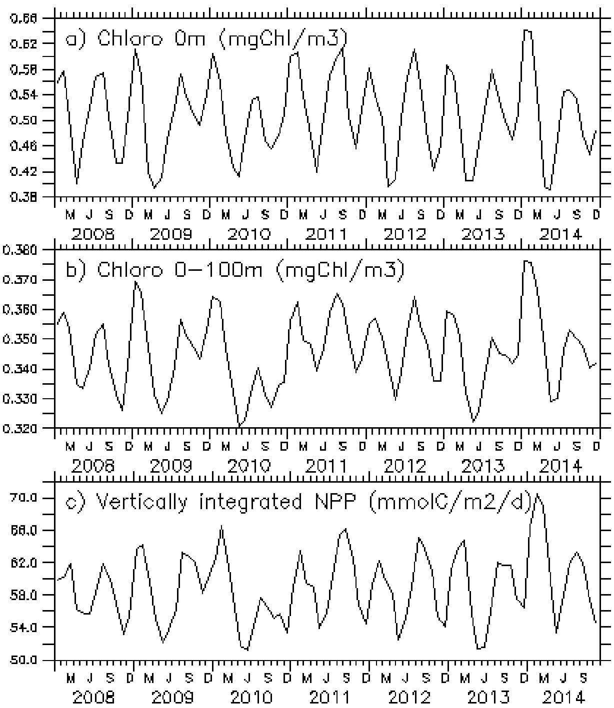

Figure A: Temporal evolution of chlorophyll-a concentrations at the surface (a) and in the first 100m depths (b) and vertically integrated NPP (c), averaged over the whole INDO12BIO domain.

(2) Nutrients do not present a clear trend, but display a vertical adjustment in course of simulation (Figures B, C, D and E; please note different scales on ordinate axes). Nitrogen and Phosphate are almost stable in the upper 100m. They slightly decrease at depth (600-to bottom) during the first years of simulation and then increase the following years. Dissolved Si increases in the top 600m and decreases below. Conversely, dissolved Fe decreases in the 100 to 600m depth interval and increases below.

(3) Dissolved oxygen does not present a clear trend in the first 100m (Figures B and C). However, over the whole 3D domain, a mean drift of -0.006 ml O2 l-1 yr-1 is simulated by the model. The strongest negative trends are mainly located in the top 200m, in the archipelago (South China Sea, Banda Sea, and semi-enclosed areas), but also in the open ocean (not shown). Some areas also exhibit positive trends. The strongest are found in the Pacific and Indian parts of the model domain and are mainly situated between 300 and 1500m depth (not shown). Again a negative oxygen trend is simulated below. As for nutrients, the model reorganizes the vertical distribution of oxygen during the simulation.

(4) The simulated time series of SST (Figure F) is compared to the Reynolds product based on remotely sensed SST data. The positive bias is discussed in Tranchant et al. (this volume). Here, we are more interested by the phasing and the temporal trend between simulated and observed SST. Temporal variations are realistically simulated by the model, with an excellent correlation between the two time series (r = 0.94). Simulated monthly averaged SST presents a positive trend of +0.023°C yr-1. Monthly averaged Reynolds SST indicates a positive trend of +0.032°C yr-1.

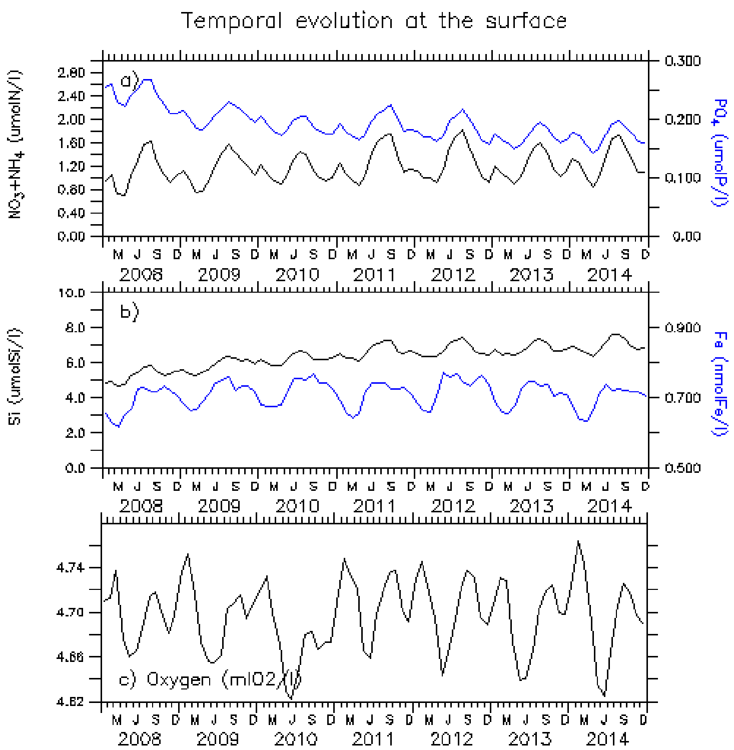

Figure B: Temporal evolution of nutrient (nitrate+ammonium, phosphate, Dissolved Si, and Dissolved Fe) and oxygen content at the surface, averaged over the whole INDO12BIO domain.

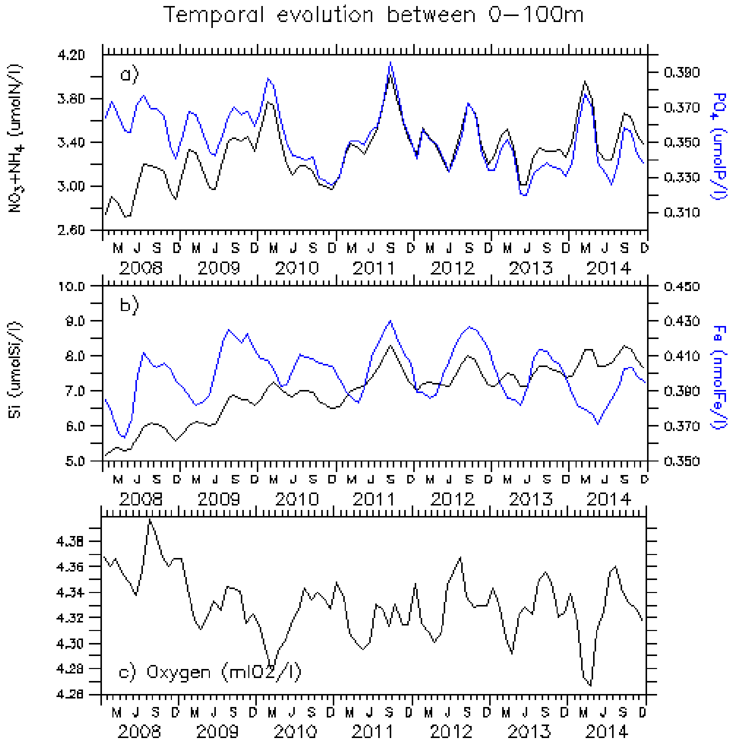

Figure C: Temporal evolution of nutrient (nitrate+ammonium, phosphate, Dissolved Si, and Dissolved Fe) and oxygen content in the first 100m depths, averaged over the whole INDO12BIO domain.

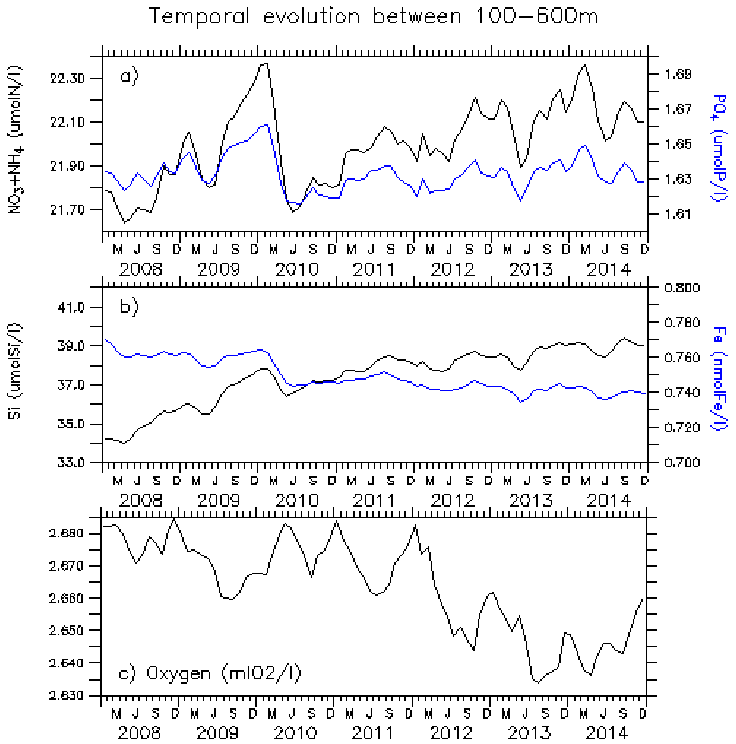

Figure D: Temporal evolution of nutrient (nitrate+ammonium, phosphate, Dissolved Si, and Dissolved Fe) and oxygen content between 100 and 600m depths, averaged over the whole INDO12BIO domain.

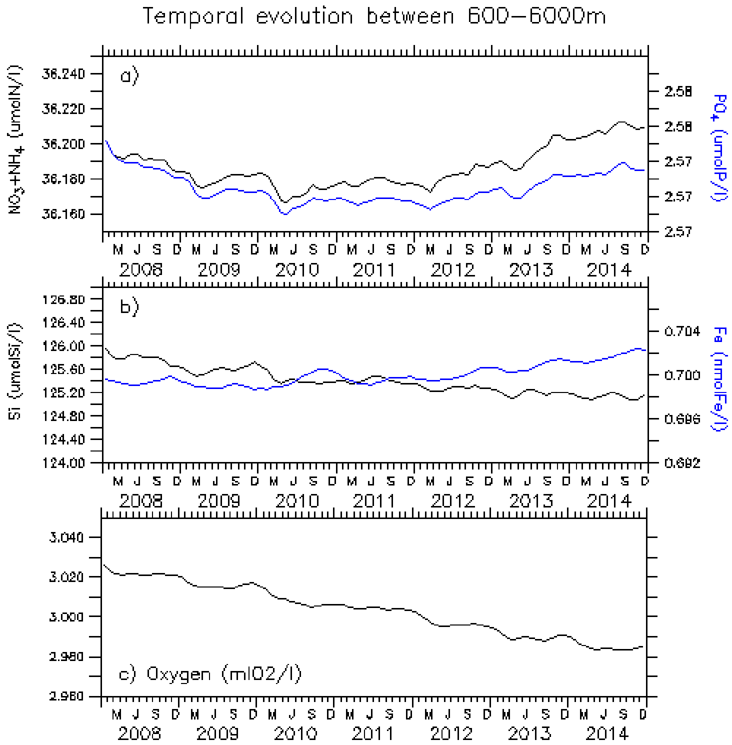

Figure E: Temporal evolution of nutrient (nitrate+ammonium, phosphate, Dissolved Si, and Dissolved Fe) and oxygen content at depth (between 600 and 6000m depths), averaged over the whole INDO12BIO domain.

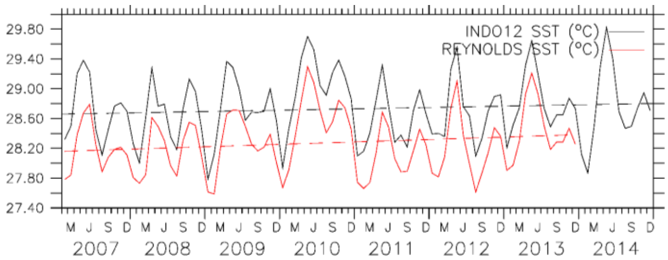

Figure F: Temporal evolution of Sea Surface Temperature over the whole domain (solid line) and associated trend (dashed line), computed from INDO12BIO monthly outputs (black) and from Reynolds satellite product (red).

To conclude, the model tends towards a "steady state", in terms of numerical equilibrium. There is no loss of material (temperature, carbon, oxygen, …) due to numerical deviation. For the physical part, a realistic temporal trend is simulated in SST as compared to satellite data. For biogeochemistry, chlorophyll-a and NPP are almost stable during the time of the simulation, while nutrients and oxygen need a longer-term vertical adjustment.

However, it is not straightforward to conclude on a potential drift of the model as the simulation is too short to estimate accurate temporal trends, and the region has very few data to compare with. This is why we did not include these plots to the main section of revised version, but decided to add them to the supplementary material. However, in the revised version, we now include the interannual variability of chlorophyll-a.

- in the coastal environment how important is iron supply from river run off vs iron supply from sediments? similar thoughts on the nitrate budget may also be useful.

Author's response 4:
You raise a very interesting question. However, the crucial lack of in-situ measurements prevents us to provide an answer with relevance to the region of interest. We foresee, however, that in the framework of the INDESO project more in-situ data will be sampled in the future, which will enable us to answer this question.

-Some additional details about the larger scale model that helps sets some of the boundary conditions for the regional model would be helpful. How long was this model run for, what were the initial conditions, are properties in the global simulation on the boundary of the regional model changing with time? How do they compare to the observations.

Author's response 5:
For the physics (see Tranchant et al., this volume), daily open boundary conditions are given by the Mercator-Ocean Global Ocean Forecasting System at ¼° (PSY3V3R3) (Lellouche et al., 2013) started in October 2006 from a Levitus climatology. These conditions include temperature, salinity, currents and Sea Surface Height. Open boundary conditions are located on a relaxation band of 10 grid points (~1°).
For biogeochemistry, open boundary conditions are derived from climatological data bases, satellite data, analytical values, or global model (ORCA2 simulation). The global scale model configuration ORCA2 at 2° of resolution has been integrated 3000 years, until PISCES reached a quasi steady-state with a mean state and seasonal variations similar to those observed for nutrients and chlorophyll (see Aumont and Bopp, 2006). For INDO12BIO configuration, we used a monthly climatology based on this simulation. A detailed comparison between model and data is given in the auxiliary material of Aumont and Bopp (2006).

For the revised manuscript, we now clarify this point in Section 3.2:
"For tracers for which this information is missing, initial and open boundary conditions come either from a global scale simulation, or have to be estimated from satellite data, respectively build using analytical values. The global scale model configuration ORCA2 at 2° of resolution has been integrated 3000 years, until PISCES reached a quasi steady-state with a mean state and seasonal variations similar to those observed for nutrients and chlorophyll (see Aumont and Bopp, 2006). For INDO12BIO configuration, a monthly climatology was used for dissolved iron and DOC based on this simulation."

2. Paper states it is focused on the assessment of the simulation but little quantitative numbers are provided.
-What is the total NPP in the domain (model verse observations derived products)
- Provide quantitative assessments of the annual mean spatial variability and seasonal temporal variability of chla (by at least providing correlation and variance comparisons).

Author's response 6:
We preferred to present mean values, standard deviation and temporal correlation for modeled and observed chlorophyll-a on maps rather then in a table. Spatial mean and standard deviation values over the INDO12BIO domain are provided for surface chlorophyll-a and vertically integrated NPP (model and observations) in 2011 relative to Figure 4 and 5 of the revised version. The temporal correlation between modelled chlorophyll-a and estimates derived from remote sensing is spatially presented. In addition, we provide the mean temporal correlation over the entire INDO12BIO domain in the revised version.

Note the multiple data products should also be compared to provide a perspective on the acceptable agreement.

Author's response 7:
We voluntary decided not to multiple ocean color data. We acknowledge that the error associated with satellite product is large, particularly in the coastal ocean. We clarify this point in Section 4.3. Moreover, MODIS ocean color product is the only sensor covering the entire period of simulation, so it was a natural choice.

-From the timeseries of Chl it appears the model captures the variability but overestimates the mean value - good result. Problem with Carbon to Chl use in the model? or excessive Phytoplankton in the coastal regions of the model? what is it?

Author's response 8:
We agree with the reviewer that the model overestimates the chlorophyll-a content of oligotrophic waters and that the cross-shore gradient is too weak. These systematic misfits are discussed in Section 6. We point towards the main role of the numerical advection scheme. As a matter of fact, the current advection scheme for passive tracers (MUSCL) is too diffusive and smooths vertical profiles of nutrients. As a result, too much nutrients are injected in the surface layer which triggers too high levels of production and hence chlorophyll-a.

The double peak in the Chla is also interesting, do you think this is a real feature?

Author's response 9:
The double peak in the simulated chlorophyll-a is also present in the satellite product; a double peak in Souch China sea, a significant secondary peak in Banda sea, and sometimes a minor secondary peak in Sunda area. The model-data comparison suggests thus that it is a realistic feature.

-Showing water properties down to 1000 m is not very useful given the short run where only significant changes in the upper ocean have a chance to develop. Further the range in values between 0 and 1000m makes it difficult to see key differences in the upper ocean. It would be helpful to show some surface plots. I would like to know what is limiting phytoplankton in the coastal areas of the simulation. How does nutrient limitation in the simulation compare to the observations ?

Author's response 10:
This comment raises several points:
- "Showing water properties down to 1000 m is not very useful given the short run where only significant changes in the upper ocean have a chance to develop." We acknowledge that due short simulation time, biogeochemical properties at depth are expected to reflect initial conditions. However, and as pointed out by the reviewer under comment 3, the regional model could potentially display strong drifts at depth. The comparison between observed and modeled biogeochemical tracer profiles provides additional means for evaluating the stability of the model. In order to improve the readability of changes in the upper ocean, we adjusted the vertical scale of Figure 3 in the revised manuscript. To allow the reader to appreciate differences in vertical gradients, profiles are still presented down to 2000m.
- "It would be helpful to show some surface plots." Surface plots are presented as part of Author's response 3, please refer to Figures A, B and F.
- "How does nutrient limitation in the simulation compare to the observations." The model allows to identify limiting factors of phytoplankton production (e.g. specific nutrient, light). There are, however, to our best knowledge no in situ data on nutrient limitation available in this area. It is does impossible to compare simulation and observations.

3. There is some discussion of the limitations of the model but some change in the organisation of this section would make it more useful. Perhaps dividing the discussion into coastal and open ocean would be better. I would also like a bit more detail on the weakness and strengths of the simulation presented.

Open Ocean
Produce the large scale seasonal variability in chla.
Too weak a vertical nutrient gradient in the open ocean with some issues with the water properties (e.g. silicate in the Pacific part of the domain)
- numerics of the advection scheme -> need to know how tidal mixing is prescribed since this is an important source of vertical mixing in the Indo Seas

Coastal
Too much chla on the shelves.
- shelf to open ocean gradients - could be linked to how river run off parameterizations. How do you assess whether it is a problem with river run off, a problem with the ocean dynamics and problem with sediment BGC. Did you consider a simulation without river run off? How important is river run off to the open ocean behaviour?

Author's response 11:
We are not certain to fully understand this recommendation. Does it refer to Section 5: Evaluation or Section 6: Discussions and conclusions ? Reviewer 1 also suggested a restructuring of Section 5. We followed his suggestion and Section 5 is now structured as: 5.1 Annual mean states (nutrients, oxygen, chlrophyll-a, NPP, zooplankton); 5.2 Mean seasonal cycle; 5.3 Interannual variability; 5.4 INDOMIX cruise.

Following your comment, we clarified Section 6 as follows: 1/ strengths of the simulation, 2/ weaknesses: coastal ocean (due to sedimentary processes and river inputs); shelves and open ocean (due to implemented numerical scheme).

Tidal mixing is described in the companion paper (Tranchant et al., submitted), and is discussed in Author's response 1 above.

The problem of shelf to open ocean gradients is related to numerical scheme. The MUSCL scheme is too diffusive and smooths vertical profiles of nutrients in the open ocean. Too much nutrients are thus injected in the surface layer and trigger too high chlorophyll-a levels and NPP. This problem is clearly identified and will be treated in a future release of the INDO12BIO operational system.

We did not consider a simulation without river run off. The contribution of river run off to setting biogeochemical characteristics of open ocean waters is an open question which deserves further investigations.

Details:

pg 2 l5- no mention of large marine predators in the paper

Author's response: As stated in the introduction, the forecasting system developed within the framework of the INDESO project, will ultimately consist of 3 numerical models coupled physics, biogeochemistry and fish population dynamics). The focus of this paper is on the presentation and evaluation of the biogeochemical component of the suite of models. The upper trophic level model, which represents population dynamics of large marine predators, will be presented in a separate paper.

l14 - focus of the paper is on the skill assessment - hence it would be useful to provide a few more quantitative diagnostics both to assess this simulation and allow others to compare their simulations too this model.

Author's response: As detailed above (please see Author's response 6), we added quantitative diagnostics to the revised version.

l15 - very short run, 8 years. Need to convince me the drift in the upper ocean is not significant.
l24 - the short simulation makes the assessment to nutrient and oxygen irrelevant in the deep ocean where the water properties remain similar to initial state. Again some diagnostics of how water properties evolve over the simulation are needed to show they change. This should also be supplement with a quantitative assessment of nutrient simulation in the upper ocean.

Author's response: These points are detailed above; please see Author's response 3 pg4 l19, some additional details of what the physical model does well and not so well would be helpful here.

Author's response:
We ask the reviewer to kindly consider the companion paper by Tranchant et al. It presents a complete evaluation of the physical model.

We added information to the introduction of the revised paper:
"The regional configuration of the ocean dynamics is fully described in Tranchant et al. (this volume, hereafter Part I). The physical model reproduced main processes occurring in this complex oceanic region. Ocean circulation and water mass transformation through the Indonesian Archipelago are close to observations. Eddy Kinetic Energy displays similar patterns to satellite estimates, tides being a dominant forcing in the area. The volume transport of the Indonesian ThroughFlow is comparable to INSTANT data. TS diagrams highlight the erosion of South and North Pacific subtropical waters while crossing the archipelago."

pg5, line 10, how does the ITF nutrient transports compare to recent estimates? [e.g. Ayers, J. M., Strutton, P. G., Coles, V. J., Hood, R. R. and Matear, R. J.: Indonesian Throughflow nutrient fluxes and their impact on Indian Ocean Â˘abiogeochemistry and productivity , Geophys. Res. Lett, 41(14), 5060–5067, doi:10.1002/2014GL060593, 2014.)

Author's response:
Figure G presents nitrate fluxes at the three exit passages of the ITF (Lombok starit, Ombaï start and Timor passage). Simulated fluxes integrated to the sill depths are compared to Ayers et al. (2014). Negative flux indicates nutrient transport from Indonesian seas to Indian Ocean, while positive flux means a transport from the Indian Ocean back into the Indonesian seas. Simulated fluxes are smaller than estimated ones. Main characteristics are, however, preserved. Across the shallow Lombok strait, the flux is low and towards the Indian Ocean. Across Ombaï and Timor straits, nutrient fluxes are seasonally reversed, due to deep currents seasonally directed towards the Indonesian seas while strongest negative fluxes are in the first 300-400m depth (not shown).

A direct comparison of model estimates to Ayers et al. (2014) is not possible for mainly three reasons:
(1) the INSTANT program took place in 2004-2006, while the simulation started later.
(2) nitrate flux estimates are sensitive to the position of the currents and the feature of the nitracline. A small shift between modeled and observed features will result in a large bias of modeled fluxes.
(3) the methodology used by Ayers and coworkers relies on a set of hypothesis hampering a direct comparison with model output.

For all these reasons, we decided against adding the comparison to the revised paper.

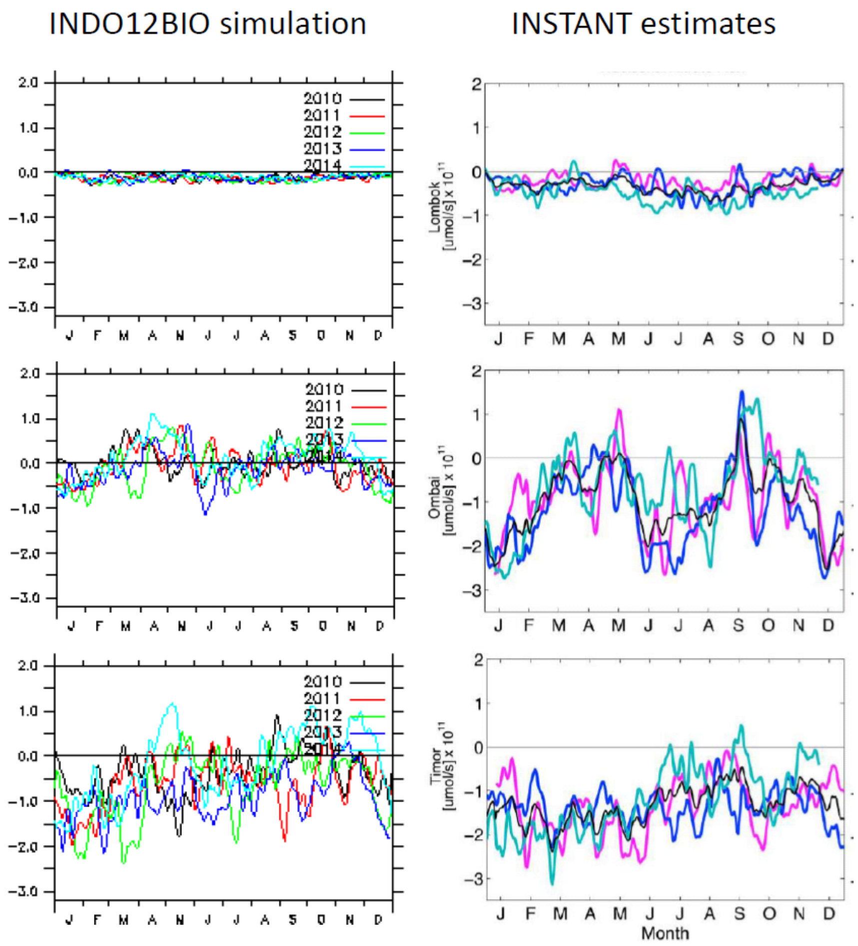

Figure G: Nitrate fluxes integrated to the sill depths, resolved in time (10^{11} µmolN/s). Top) Lombok 0-300m, middle) Ombaï 0-900m, bottom) Timor, 0-1250m. INDO12BIO fluxes (2010-2014) are on the left, INSTANT estimates (2004-2006) on the right.

Pg8 l9, no explicit diffusion - is this just horizontal? isopycnal? Is tidal mixing included?

Author's response:
Vertical diffusion is considered in the advection/diffusion scheme for passive tracers. As mentioned before, the advection scheme (MUSCL) used for the biogeochemical variables is too diffusive. This implicit numerical diffusion is large enough and no additional explicit diffusion is needed. This is a classical feature for numerical simulations using a diffusive advection scheme such as MUSCL. In case a less diffusive advection scheme (i.e. QUICKEST-Zalezak) will be used in future model set-ups, explicit diffusion will have to be taken into account.

Tidal mixing is discussed above (please see Author's response 1).

l16, cite table 1 so it is clear where the initial conditions come from.

Author's response: Yes, it is written in Section 3.2:
"Initial and open boundary conditions are presented in Table 1."

l26, no seasonality to river run-off? This could be a significant issue.

Author's response: This point is already discussed above (please see Author's response 2).

pg 9
l5 the tweaking of sediment loss needs some more justification. For such short run is the increase in nutrient significant? The model may not conserve nutrients since the nutrient transport out of the open boundaries is not necessarily conserved.
l14, short simulation period. You need some additional diagnostics showing how the upper ocean evolves over the simulation. This needs to be plot as a difference from the initial state so enable the changes to be evident in the plot since nutrient display a large vertical gradient that makes it impossible to see how the upper 200 m differs from the observations.

Author's response:
- We agree with the reviewer that the total conservation of nutrients is not expected in a regional configuration due to the open boundaries.
- Concerning the adjustment of nutrient loss to the sediment, it mimics sediment burial of particulate organic carbon. A local equilibrium (at the scale of the regional configuration as opposed to the global ocean) between deposition, burial and remineralization of POC is not a realistic assumption in coastal zones. The small disequilibrium between external inputs and sediment losses allows to compensate for sediment resuspension (e.g. due to tidal forcing) and transport out of the model domain.
- As recommended, additional diagnostics showing how the upper ocean evolves over the simulation are presented in Author's response 3 (see above). The evolution of tracer concentration is presented for the surface, between 0-100m, 100-600m and 600m up to the bottom. Changes can easily be highlighted. The final state can be compared to initial state allowing to appreciate changes. Nutrient, chlorophyll-a, net primary production, sea surface temperature and oxygen concentrations are analyzed. There is no clear temporal trend but rather a vertical adjustment over the length of the simulation. Please refer to Author's response 3 for more details.

l20, you don't just show seasonality much to the assessment.

Author's response: We agree. The evaluation of seasonality has been added to the revised manuscript.

pg12-13 - need to provide a more quantitative assessment for at least chla and nutrients because this would provide a useful benchmark for other model simulations. -some regional numbers would also be useful. What is regional NPP of the model and the observational products?

Author's response: As detailed above (please see Author's response 6), we added additional quantitative diagnostics.

p15l1, hows does the simulated oxygen and nutrient transport through the ITF compare to other estimates?

Author's response: Nutrient transports through ITF exit passages are discussed above.

l8, change "sluggish" to "weak"

Author's response: "sluggish" has been changed to "weak".

pg15, l25, not clear what maximum phase is? change it to month of maximum Chla

Author's response: "maximum phase" has been changed to "month of maximum Chla".

pg 17, l1, model gets the seasonality with no seasonal river input this suggest the rivers are not a important driver of the seasonality.

Author's response: We agree with the reviewer that the model reproduces the large scale seasonality. However, Figures 10 and 11 of the revised manuscript show a lack of temporal correlation between simulated chlorophyll-a and satellite data around the coasts. This weakness hints at the importance of seasonal river inputs of nutrients and carbon.

Comment l20, expand on what the weakness in the model was

Author's response:
We expanded the discussion of the difference between model and observed dissolved Si vertical profiles in the revised version:
"Vertical profiles of nitrate and phosphate are pretty well reproduced, while dissolved Si concentrations are overestimated below 200 m depth. But t should be noted that 2010 is a strong La Niña year and important modifications in the zonal winds, rainfall, river discharges and ocean currents occur. While interannual variations are taken into account in atmospheric forcing and physical open boundary conditions, this is not the case in biogeochemistry. External inputs from rivers are constant, and open boundary conditions come from monthly climatologies. Monthly WOA2009 climatology are close to simulated distributions (not shown), suggesting non-standard conditions during the time of the INDOMIX cruise. "

pg18, some quantitive model data comparison would be useful since this is the focus of the paper.

Author's response: Quantitative numbers are presented in Section 6.

l19, ITF assessment would be useful here.

Author's response: Nutrient transports through the ITF exit passages are discussed above.

l27, focus on sediment BGC but you also do not consider seasonal variability in river run off which also is important. Also the disequilibrium could simply mean the supply of nutrient to the open ocean is required. Perhaps the model is failing in this aspect. It appears the model has too much diffusion of nutrients off shore hence you need to unrealistically increase nutrient remineralization to get the Chla seasonality right. I think this is not a robust result because you lack seasonality to river run off. I think the key point is the coastal nutrient budget needs further development to better reflect the processes like seasonality of nutrient supply, sediment BGC and ocean exchanges. Perhaps having a section on this issue would be helpful since the next paragraph about excessive diffusion is important to getting nutrients off shelf.

Author's response:
We point out the major role of both nutrient supplies: riverine nutrient input and sedimentary processes. Both supplies are discussed in Section 6. Yearly river discharges do not allow the simulation to produce chlorophyll-a maxima along the coasts of Australia and East Sumatra while adding a slight enhancement of water column remineralization leads to higher coastal chlorophyll-a concentrations (Figure H). This slight increase in nutrient remineralization is not unrealistic; it is only a first step to show the importance of sedimentary processes (resuspension and biogeochemistry). While sedimentary processes are required to reproduce chlorophyll-a maxima along the coasts, they do not allow to get the chlorophyll-a seasonality right. This is clearly demonstrated by the poor temporal correlation between the model and the data along the coasts (Please see Figure 11 of the revised paper). Instead monthly river inputs appear key to reproduce observed temporal variations of chlorophyll-a maxima. We point out the crucial role of river run off. Sensitivity tests using the QUICKEST-Zalezak advection scheme (not diffusive) show great impact over the Indonesian archipelago and offshore, but not along the coasts (Figures H and I). Excessive diffusion introduced by MUSCL is not compensated by increased nutrient remineralization. Otherwise, the QUICKEST-Zalezak advection scheme would produce higher chlorophyll-a concentrations along the coasts due to absence of diffusion and increased nutrient remineralization. Both phenomena are decorrelated.

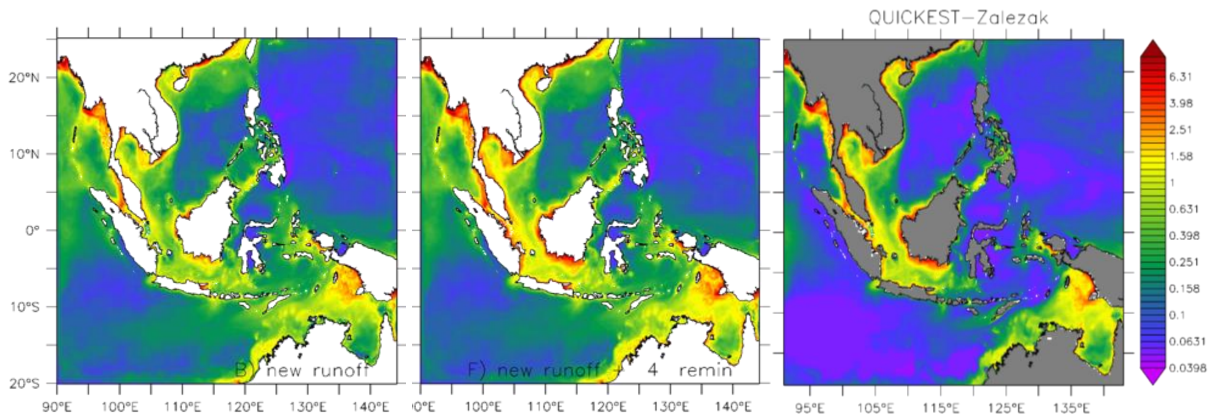

Figure H: Annual mean (year 2010) of surface chlorophyll-a concentrations (mg Chl m^{-3}) with external inputs balanced by sediment losses (left), with + 4% of water column remineralization (middle; corresponding to INDO12BIO configuration), INDO12BIO (+ 4% of water column remineralization) with QUICKEST-Zalezak advection scheme for passive tracers (right).

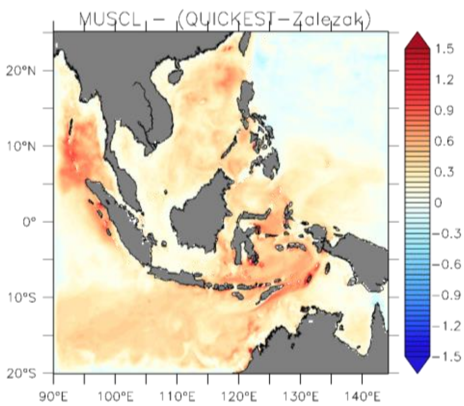

Figure I: Bias of log-transformed surface chlorophyll-a (MUSCL – QUICKEST Zalezak) for year 2010.

pg19,

l20, how does the regional NPP compare to observations. Does it suggest too much NPP?

Author's response: Quantitative numbers have been included. Yes, they report the overestimation of Chla and NPP in the simulation.

l23-24, sentence has a typo Please summarize what the problems are in the open ocean and why they occur and how they could be improved.

Author's response: The sentence was reforumlated: "However, the scheme applies to much pressure on the vertical gradient of nutrients, and the nutricline is considerably strengthened. Hence, before shifting from MUSCL to QUICKEST-Zalezak, model physics needs to be further improved."

This paragraph explains that QUICKEST-Zalezak scheme is better than MUSCL , as it is not diffusive and coherent with model physics. But MUSCL tends towards smoothed fields masking by the way problems of the physics, while QUICKEST-Zalezak accentuates these problems. This implies that the enhancement of the skill of the biogeochemical model through a shift from MUSCL to QUICKEST-Zalezak requires first an improvement of model physics.

l28, how does the open boundary paramterization affect the simulation? No results are discuss to show this impact and the problems it causes.

Author's response:
- The algorithms used for the open boundary conditions are the same than those used for physical tracers (temperature and salinity). They are described in the companion paper by Tranchant et al.

Figure 2 - the most apparent difference is the simulated excessive phytoplankton in the coastal environment. This interesting because ocean colour often overestimates Chla in these regions because of the contamination by non chla signal. What does this imply about the model simulation?

Author's response : Indeed, bias (model - MODIS) is almost positive everywhere, with highest values in the coastal environment. This overestimation was discussed above at several occasions (impact of numerical advection scheme, lack of seasonality of river inputs etc.).

Are these coastal region nitrate limited?

Author's response: Please see Author's response 10.

Figure 3. clarify what production model refers to - sum of variance of the 3 different PP models

Author's response: We modified the legend in Figure 5 of the revised manuscript: "Standard deviation of the 3 averaged production models."

Figure 5. It would be useful to know what nutrient is controlling phytoplankton growth. Could you show the surface nitrate, silicate and iron with a scale where it would be easy to distinguish where nutrient limitation is occurring. This would also help answer what is causing the bias in the coastal regions.

Author's response:
For nutrient limitation, please see Author's response 10.
Concerning the bias in the coastal regions, the reason is clearly identified, and already discussed above.

figure 6. dispersion? say it is variability in the data. spread in of WOD in f) does not seem to match averaged value

Author's response:
We modified in Figure 3 of the revised manuscript to: "All the raw data available on each box and gathered in the WOD (light blue crosses) are added in order to illustrate the spread of data."

Simulated dissolved Si in Banda sea (f) matches with WOA and CARS. For WOD, two distinct profiles can be distinguished: one with deep values around 80 mmol Si m^3 and a second one close to 140 mmol Si m^3. Simulated profile, WOA and CARS profiles match with the second one. So, the question is: why is there two distinct profiles in WOD ? In-situ raw data of WOD can situate in very distinct areas of the Banda box, close to the coast of Sulawesi or Malucu Islands or in the middle of Banda Sea, with distinct hydrodynamical conditions.

Figure 7. Why is there a double peak in the simulation and is this believable? State what you are showing in the maps.

Author's response: The double peak is discussed in Author's response 9.

Figure 8. explain what phase is - timing of the maximum Chl? is so then say this instead.

Author's response: Yes, "phase" means "timing of maximum Chla". We modified this to avoid confusion.

Figure 9. state how normalised sd was estimated

Author's response:
Normalized standard deviation means: standard deviation of the model normalized by the standard deviation of the data.
We clarify this point in the legend: "normalised standard deviation (std(model)/std(data)) estimated between the INDO12BIO simulation and the MODIS Case-1 ocean colour product."

Figure 10. big difference in f) at 800m. Why? initial state (WOD) is much different the what was observed on the cruise?

Author's response:
There is indeed a big difference in f). This point is discussed in Section 5.4. We added vertical profiles for the climatological month of July for CARS2009 and WOA2009 on Figure J. The CARS profile of dissolved Si is different from of both, INDO12BIO and INDOMIX profiles, while WOA is closer to INDO12BIO. However, the vertical profile measured during the INDOMIX cruise stands out, especially between 400 and 1000 m. The INDOMIX cruise took place during a La Niña year and we hypothesize that corresponding strong modifications in the zonal winds, rainfall, river discharges and ocean currents could explain the peculiar shape of profile.

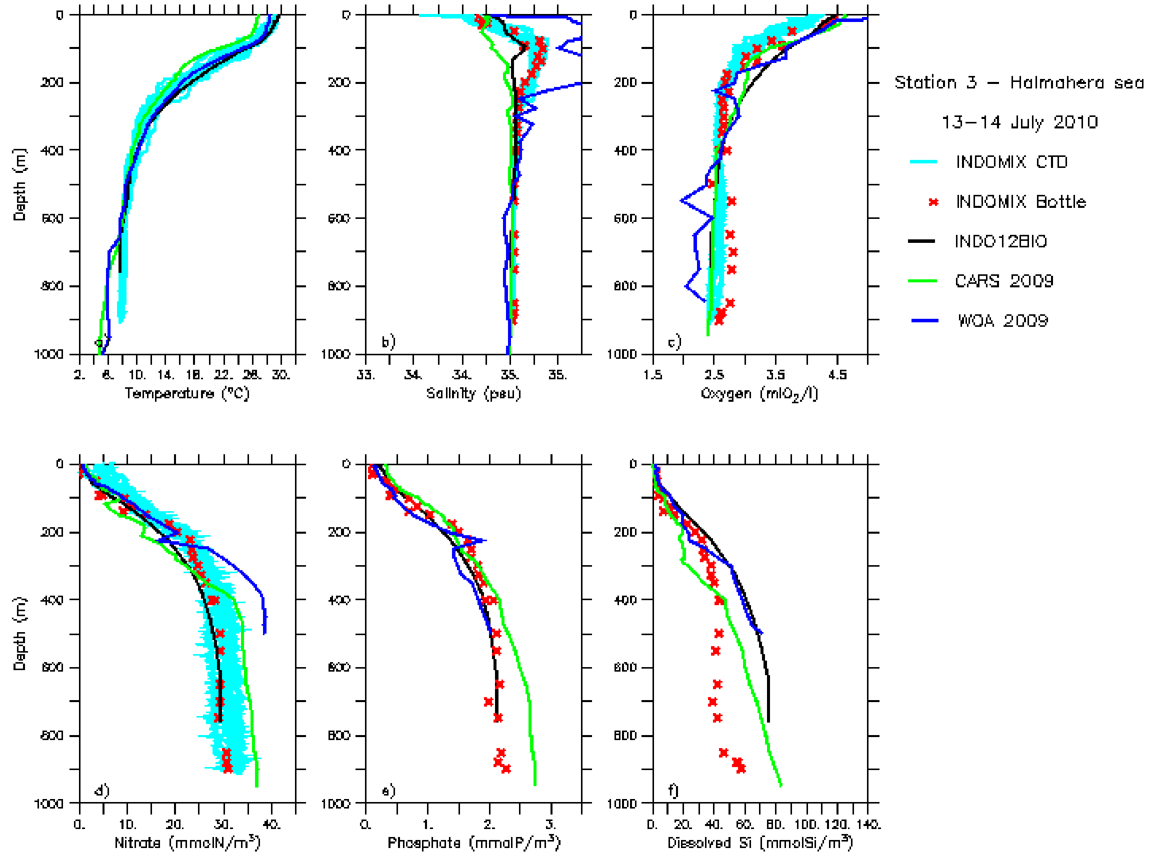

Figure J: Vertical profiles of temperature (°C; a), salinity (psu; b), oxygen (ml O2 l-1; c), nitrate (mmol N m-3; d), phosphate (mmol P m-3; e), and dissolved silica (mmol Si m-3; f) concentrations at INDOMIX cruise Station 3 (Halmahera Sea; 13 - 14 July 2010). CTDO or ISUS sensor (light blue lines) and bottle (red crosses) measurements represent the conditions during cruise, 2-day model averages are shown by the black line. CARS2009 (green) and WOA2009 (blue) for climatological July are added.