Geosci. Model Dev. Discuss., 8, C2713–C2719, 2015
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Geoscientific Model Development Discussions

Interactive comment on "Evaluation of an operational ocean model configuration at 1/12 spatial resolution for the Indonesian seas – Part 2: Biogeochemistry" *by* E. Gutknecht et al.

Anonymous Referee #2

Received and published: 29 October 2015

1/12 degree model

General comments

1. important details about the model simulation are lacking

- do you include tidal mixing?

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

- 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.

- 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.

-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.

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

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

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?

Details:

pg 2, line 5- no mention of large marine predators in the 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.

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.

pg4 l19, some additional details of what the physical model does well and not so well would be helpful here.

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 Âăbiogeochemistry and productivity , Geophys. Res. Lett, 41(14), 5060–5067, doi:10.1002/2014GL060593, 2014.)

Pg8, line 9, no explicit diffusion - is this just horizontal? isopycnal? Is tidal mixing included?

l16, cite table 1 so it is clear where the initial conditions come from. l26, no seasonality to river run-off? This could be a significant issue.

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.

l20, you don't just show seasonality

pg 11, l25 - do you need to use to different nutrient climatologies? I don't think it adds much to the assessment.

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?

p15 l1, hows does the simulated oxygen and nutrient transport through the ITF compare to other estimates?

l8, change "sluggish" to "weak"

pg15, l25, not clear what maximum phase is? change it 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. Comment l20, expand on what the weakness in the model was

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

l19, ITF assessment would be useful here. 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.

pg19, l20, how does the regional NPP compare to observations. Does it suggest too much NPP?

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.

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

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? Are these coastal region nitrate limited?

Figure 3. clarify what production model refers to - sum of variance of the 3 different PP 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 to answer what is causing the bias in the coastal regions.

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

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

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

Figure 9. state how normalised sd was estimated

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

Interactive comment on Geosci. Model Dev. Discuss., 8, 6669, 2015.