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Supplement of

Evaluation of an operational ocean model configuration at $1/12^\circ$ spatial resolution for the Indonesian seas (NEMO2.3/INDO12) – Part 2: Biogeochemistry

Elodie Gutknecht et al.

Correspondence to: Elodie Gutknecht (elodie.gutknecht@mercator-ocean.fr)

Figure 1 aims to demonstrate that 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. But 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.

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}.

(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.

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.

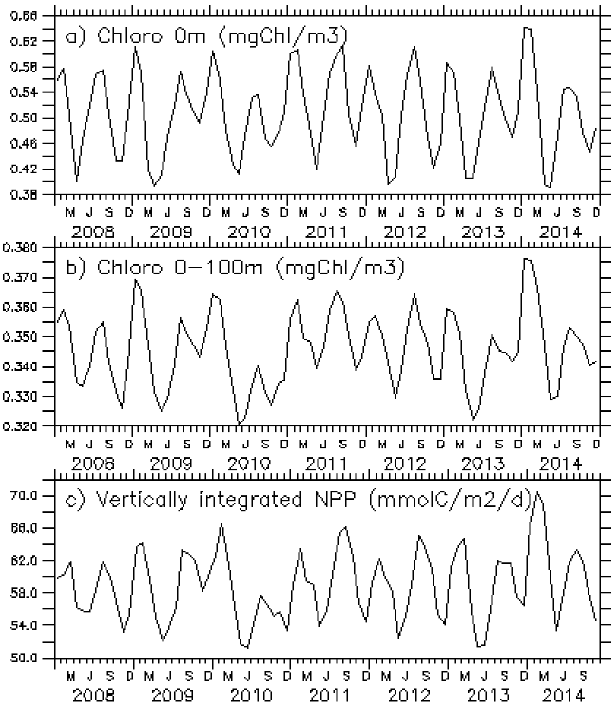

Figure A: Temporal evolution of chlorophyll-a concentrations at the surface (a) and in the first 100m depths (b) and vertically integrated NPP (c), averaged over the whole INDO12BIO domain.

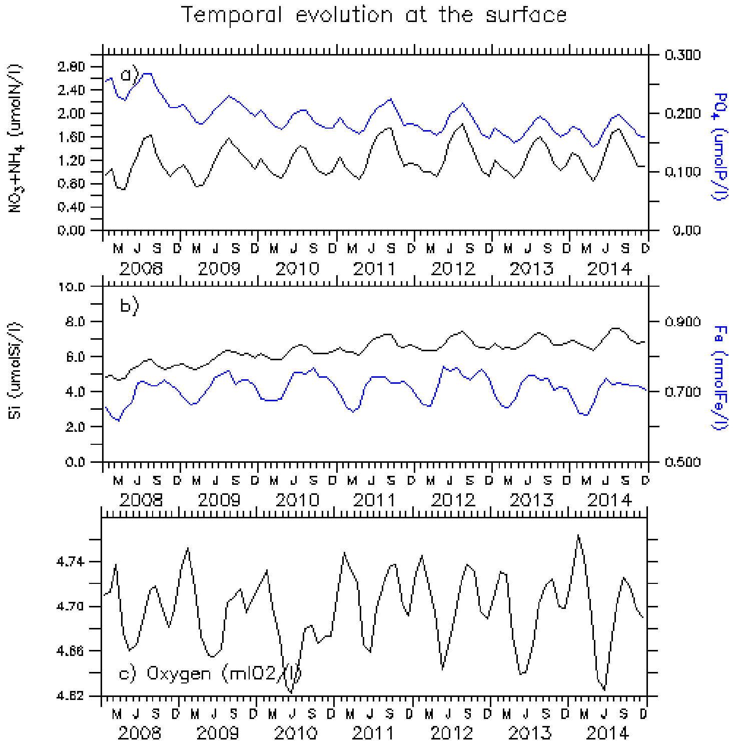

Figure B: Temporal evolution of nutrient (nitrate+ammonium, phosphate, Dissolved Si, and Dissolved Fe) and oxygen content at the surface, averaged over the whole INDO12BIO domain.

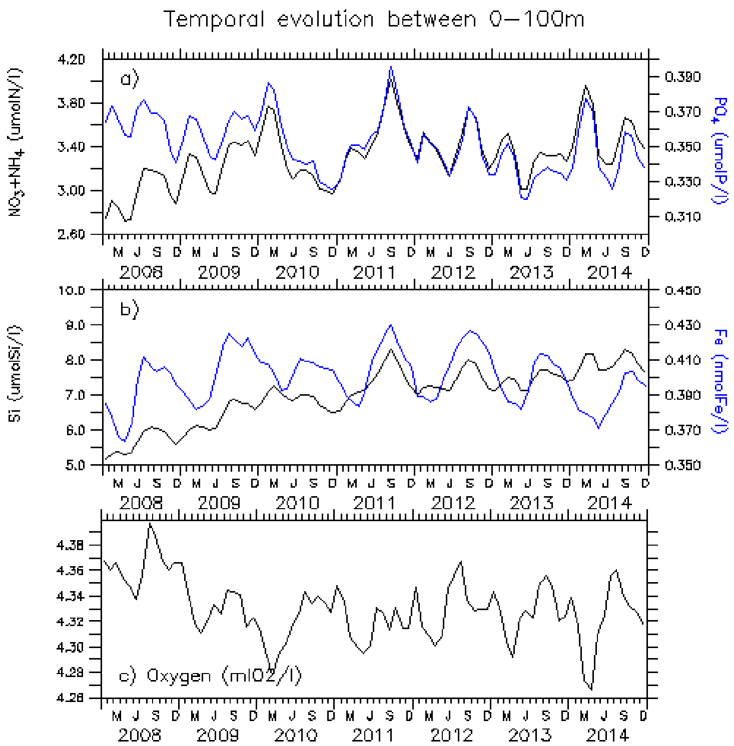

Figure C: Temporal evolution of nutrient (nitrate+ammonium, phosphate, Dissolved Si, and Dissolved Fe) and oxygen content in the first 100m depths, averaged over the whole INDO12BIO domain.

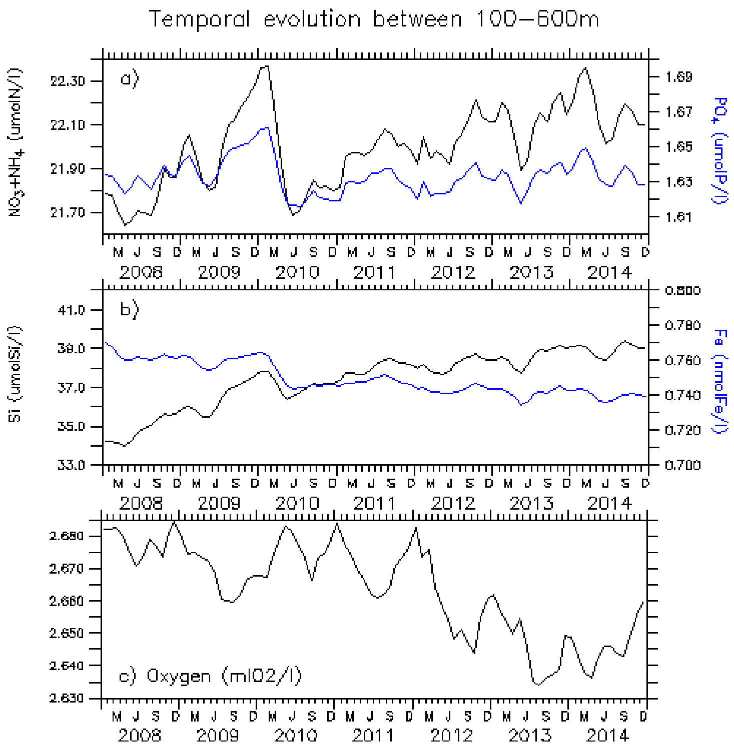

Figure D: Temporal evolution of nutrient (nitrate+ammonium, phosphate, Dissolved Si, and Dissolved Fe) and oxygen content between 100 and 600m depths, averaged over the whole INDO12BIO domain.

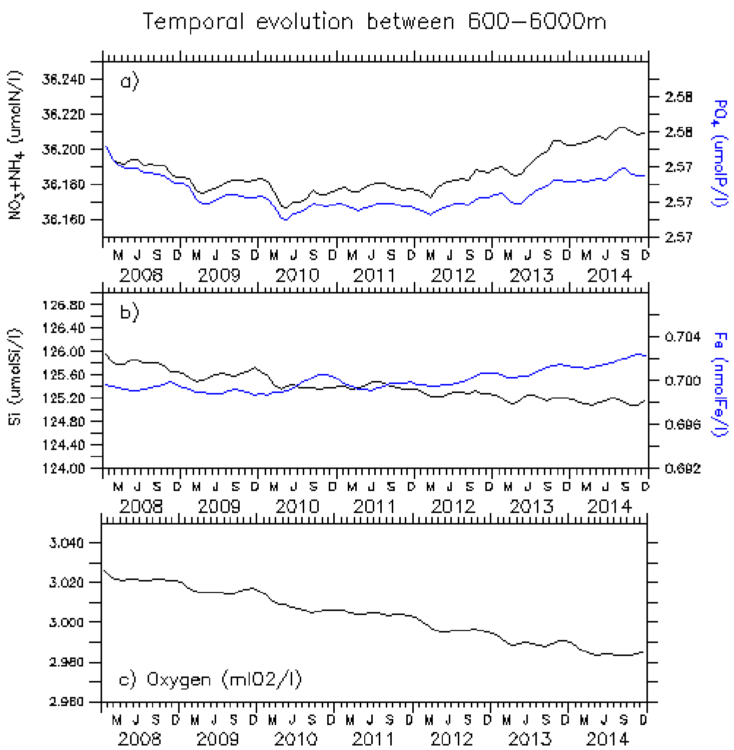

Figure E: Temporal evolution of nutrient (nitrate+ammonium, phosphate, Dissolved Si, and Dissolved Fe) and oxygen content at depth (between 600 and 6000m depths), averaged over the whole INDO12BIO domain.

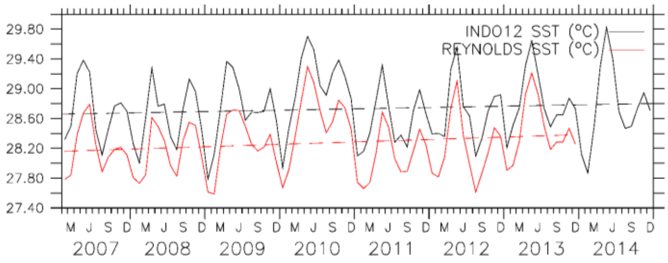

Figure F: Temporal evolution of Sea Surface Temperature over the whole domain (solid line) and associated trend (dashed line), computed from INDO12BIO monthly outputs (black) and from Reynolds satellite product (red).