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Physical/biogeochemical coupled model : impact of an offline vs online strategy

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Mercator-Ocean, the French ocean forecasting center, has been developing several operational forecasting systems and reanalysis of the physical and biogeochemical 3D-Ocean. Here we study the impact of an offline vs online strategy to couple the physical (OPA) and biogeochemical (PISCES) modules included in the NEMO platform. For this purpose, we perform global one-year long simulations at 1° resolution. The model was initialized with global climatologies. The spin-up involved 10 years of biogeochemical off-line simulation forced by a climatology of ocean physics. The online mode consists in running physical and biogeochemical models simultaneously whereas in the offline mode, the biogeochemical model is launched alone, forced by averaged physical forcing (1 day, 7 days,...). The Mercator operational biogeochemical system is currently using the offline mode with a weekly physical forcing. A special treatment is applied to the vertical diffusivity coefficient (Kz): as it varies of several orders of magnitude, we compute the mean of the LOG10 of Kz. Moreover, a threshold value is applied to remove the highest values corresponding to enhanced convection. To improve this system, 2 directions are explored. First, 3 physical forcing frequencies are compared to quantify errors due to the offline mode: 1 hour (online mode), 1 day and 1 week (offline modes). Secondly, sensitivity tests to the threshold value applied to Kz are performed. The simulations are evaluated by systematically comparing model fields to observations (Globcolour product and World Ocean Atlas 2005) at global and regional scales. We show first that offline simulations are in good agreement with online simulation. As expected, the lower the physical forcing frequency is, the closer to the online solution is the offline simulation. The threshold value on the vertical diffusivity coefficient manages the mixing strength within the mixed layer. A value of 1 m2.s-1 appears to be a good compromise to approach the online solution. Our sensitivity tests show that increasing the temporal resolution of the forcing induces a temporal shift in the surface chlorophyll seasonal cycle: less chlorophyll in winter and a stronger spring bloom in offline mode. We attribute this behavior to the entrainment/detrainment process of chlorophyll and nutrients at the bottom of the mixed layer during winter.