Interactive comment on “Multi-grid algorithm for passive tracer transport in NEMO ocean circulation model: a case study with NEMO OGCM (version 3.6)” by Clément Bricaud et al.

Anonymous Referee #1

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The manuscript presents a method for simultaneously applying spatial grids of multiple resolution to a popular ocean model for the purposes of reducing the computational cost of running complex biogeochemical modules. It estimates a factor 6.7 reduction in cost while achieving similar results to the single-grid high resolution version. Improving computational efficiency in models with large user groups and code bases is a priority in earth system modelling. This manuscript represents a substantial contribution to the science that is within the scope of GMD. The authors use valid methods to assess their model at a variety of spatial scales and provide sensitivity tests and examples to demonstrate their decision-making. Results are presented clearly and appropriately. Model code and other necessary scripts are provided with instructions.
Specific comments:

Climate is mentioned a couple of times in the manuscript, but what is demonstrated in this study is that a very slow model can be made faster (but, relative to e.g. EMICS, it is still very slow). The general motivation of making a model faster is clearly laid out in the Introduction, but even with the demonstrated improvement in runtime, as a reader I am left with uncertainty exactly what is gained with a 3X faster NEMO+PISCES. Some discussion of this in Sections 6 or 7 could help to clarify e.g. 1) does this improved runtime move NEMO+PISCES into a new category of earth system models? 2) what new kinds of applications are made possible by the improved runtime?

Simulations of 1 year are compared, but how close is the model to steady-state after only 1 year if the model is started from rest? A statement regarding why 1 year of simulation is selected for the comparison would be informative.

Some of the language needs revisiting, please see below.

Technical corrections:

P1L4: “to compute” should be “the computation of” P1L7: “allows to reduce” should be “reduces” P1L8: “tracers” P1L10, P1L11: “factor of 3”;“factor of 7” P1L13: “Propositions for further reducing this cost are discussed.” P2L31: run a spell-check for “op” erational” and “pannel” P2L34: “ecosystems” P2L45: “and is used in the” P2L47: This sentence is confusing. I suggest “The concept of effective resolution of physical ocean models provides a theoretical justification...” P3L50: “observation” P3L53: “experiments”, “difference” P3L54: “with the velocity field... has been...” P3L65: “in particular detail” P3L69: “grid in which” P3L72: “by the hydrodynamical” P4L98: “consists of” P4L101: “that will be discussed” P6L127: “surface area” P6L135: remove “autoref” P7L137: “of the multi-grid... consists of defining...” P9L167: “very sensitive to” P9L170: “such a method” P10L181: “using the multi-grid” P10L186: “use the domain” P12L224: “Throughflow” P12L225: “close to” P13L251: remove “grid” before “multi-grid” P13L253: remove “subsection” P15: please make the x and y val-
ues larger in Fig. 5 b, c, d P15: please explain in the text why HRCRS is missing from Fig. 5 b, c, d at the smaller spatial scales. For example, it appears both LR and HR can simulate low KE but HRCRS cannot. P16L290: remove “subsection” P16L293: remove “appendix” P17L310: “Despite the degraded spatial resolution operating on the velocities…” P17L311: remove extra “the” P17L316: “responsible for…passive tracer…” P17L317: “…but it might be computed on…” Although, as I understand the vertical diffusion coefficient is calculated on HR and coarsened using the several methods tested. A better phrasing might be: “and coarsened to the HRCRS grid” P18L320: remove extra “section” P18L327: “results more comparable to LR” P18L329: “skill” P18L335: “extends” P18L338: “…we assess the…at simulating the…the Ross…” P19L344: “solutions…performances than the…” P19L347: “Figure 9 show…HRCRS solution…” P19L351: “…the convection…” P20L362: “caused by” P20L363: “except in the area” P22L376: “…only with large…” P23L381: “the coarsened grid” Table 4: “with/without” should be “without/with”. What are the time units? P23L384 and Table 4 caption: Do you mean row? P23L386: “allows us to reduce” P23L392: remove extra “table” P23L395: “than the ocean/sea…” Table 5: “without versus with” P24L399: “their” should be “there” P24L402: “both grids share” Figure 13: “Outer” P25L411: “perspective” should be “extension”; “in its present form” P25L421: “which resolution” should be “whose resolution” P25L422: “allow the switch” P26L435: “…the reduction of elapsed time might be substantial…” (An estimate has been provided but not proven) P26L436: “case of comprehensive”; “allows us to reduce…” P26L438: “for further improving the performance” P26L439: “allow us to increase” P26L441: ”even closer to” P27L458: “configurations” P27L467: “configuration”…”too noisy” P27L468:”of the tracer” P27L471: “in terms of the ” P28L478: “development"