

# ***Interactive comment on “Evaluation of NorESM-OC (versions 1 and 1.2), the ocean carbon-cycle stand-alone configuration of the Norwegian Earth System Model (NorESM1)” by J. Schwinger et al.***

**Anonymous Referee #2**

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## **General comments**

### Appreciation of the manuscript

J. Schwinger and co-authors present NorESM-OC, a standalone version of the three-dimensional ocean carbon cycle sub-model of the Norwegian Earth System Model (NorESM1). Two versions are described: NorESM-OC1, the version actually included in NorESM1, and an updated one, NorESM-OC1.2, which can be used on finer grids,

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and which includes two newly implemented parametric representations of the particulate transport in the water column.

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The paper falls well within the scope of Geoscientific Model Development. It is overall well structured, although in detail, information can not always be found where one would expect to find it (some parameter values are only reported in the discussion section, instead of the model description part). The English language is generally good. There remain a few minor shortcomings that can nevertheless be easily fixed.

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The presentation and description of the model is rather complete, the discussion of the results is to some extent merciless: the authors put much emphasis on the biases in their model results. I would be pleased to read a few more sentences about the strengths of their model.

Although I have not found any major problem in the manuscript, I have come across a series of details that could be better explained. I am confident that the authors will be able to address all of the shortcomings mentioned.

#### General model presentation: scope

The model is clearly global in scope. Time frames for applications are not clearly stated. The paper presents simulation experiments over a few centuries, following 800 or 1000 year spin-ups. Can it also be reasonably used on longer time-scales (a few thousands to a few tens of thousands of years)?

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The code is not openly available, but only upon signing licence agreements (at least two, one for NorESM, one for HAMOCC, but perhaps even more – this is not clear).

As a reviewer, I was nevertheless granted access to the code. It is written in Fortran (much FORTRAN77-style, with some Fortran 90 elements). A C-style pre-processor is required to compile it. Some files are well commented, others almost devoid of comments. The presence of OpenMP compiler directives suggests that it has been prepared for usage on multi-platform shared memory multiprocessing computing facilities, which is definitely a noteworthy feature of interest to prospective users.

Unfortunately, the manuscript does not provide much information about the code, nor about numerical methods adopted in general (except for time-stepping, which seems to follow a leap-frog scheme in combination with a filter with unspecified characteristics though). These are, however, the informations that are typically expected in a “Development and technical paper” in Geoscientific Model Development. I would recommend to add a short, descriptive paragraph about such aspects, the more since the code is not publicly available. Finally, it would also be interesting to read about typical execution times of the three versions.

## Specific comments

page 4, line 19: “[...] NorESM-OC1 corresponds to the fully coupled NorESM1-ME [...]” would better read “[...] NorESM-OC1 corresponds to the version included in the fully coupled NorESM1-ME [...]”

Although the paper reads as if NorESM-OC1 was a sub-model isolated from NorESM1, its setup is highly similar to the earlier “isopycnic ocean carbon cycle model” of Ass-C3

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mann et al. (2009). How does NorESM-OC1 actually differ from the model described by Assmann et al. (2009)?

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page 7, lines 14–17: I presume that the preformed tracer values are set to the mixed-layer concentrations each time that a water parcel leaves the surface mixed-layer. Please rephrase for clarity.

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page 8, line 26 – page 9, line 7: the detailed approximation adopted for TA is given, but it would also be interesting to know how the speciation of the acid-base systems is calculated, or, equivalently, how pH is calculated from the TA expression.

page 12, lines 6–8: I may possibly misinterpret this, but I am wondering how the loss of material (and alkalinity) through the sediment is compensated for, if the model does not take into account the influx of carbon, alkalinity and nutrients? Does it operate in some kind of closed-loop configuration (mass an alkalinity that are lost via the deep-sea sediment are re-injected at the top)?

Please clarify how the global inventories of the model ocean are conserved.

page 13, lines 12–13: while I find it rather obvious how  $M$  can be a prognostic variable, I do not immediately see how NOS can be handled as such. Please give a few details about how NOS is predicted.

page 15, beginning of section 2.4.1: I recommend to introduce this section by one or two general sentences that summarize which data are required to force the model, before coming to the specific versions of datasets used.

page 16, line 8: Only the fate of the Antarctic freshwater influx is detailed. How is the rest of the freshwater treated?

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page 16, line 8: 365 days for v. 1 and 350 days for v. 1.2: why this difference?

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page 17, line 8: is atmospheric pCO<sub>2</sub> prescribed or is it prognostic?

page 17, lines 13–14: the carbon flux of 0.26 GtC/yr from Mv1 is about 50 times larger than the fluxes for the other two and not truly negligible (it is of about the same order of magnitude as the atmospheric CO<sub>2</sub> consumption rate by continental weathering). Is this correct, and if so, what is the reason? Furthermore, the drifts of Mv1.2 and L1.2 are of the order of 5–10%, which is far from negligible over 100 yr. This may point out significant deviation from the sought near-equilibrium state.

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page 19, lines 19–23: “[...] if this trend would be removed.”: is it possible to remove it? Where does it actually come from?

page 27, line 26: I find these biases rather strong (50% or so). Comments?

page 32, lines 8, 25 and 27: please provide references for the cited numbers (they can be found in the figure captions, but it would be good to have them in the text as well).

page 36, lines 23–29: It is fairly possible that the new sinking parametrisations are simply more efficient in counterbalancing the effects of the (too?) strong Southern Ocean ventilation. Using a model biogeochemical process to reduce biases arising from shortcomings in the model physics can hardly be considered an improvement.

page 37, line 11: “[...] a long standing problem [...]”: please provide a reference to support for this statement.

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Throughout the paper: please consistently use either “parameterisation/parameterise” or “parametrisation/parametrise” as a spelling

page 2, line 14: “[...] scheme prescribing a linear increase of sinking speed [...]” would better read “[...] scheme that uses a linear increase of the sinking speed [...]”

page 3, lines 15–24: please indicate which versions of CESM, CAM-Oslo, MICOM and HAMOCC are used, respectively.

page 3, line 28: “persue” should read “pursue”

page 4, lines 23–24: It is at this point not entirely clear what “on a numerically more efficient grid in 1° and 2° resolution” means. Based upon what we read later on, this should actually read “on a numerically more efficient grid at either 1° or and 2° resolution”. Also: are these actual or nominal resolutions? If they are nominal, what are the extremes?

page 7, sect. 2.3: which version of HAMOCC is finally used? 5 or 5.1? Please check and make sure the text is consistent.

page 7, line 26: “seriously” would better read “significantly”

page 7, line 27: “[...] the tracer transport fully consistent [...]” should read “[...] the tracer transport scheme to make it fully consistent [...]”

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page 7, line 28: I suggest to replace “on two time-levels” by “on both time levels of the leap-frog scheme”

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page 8, line 6: I suggest to replace “is determined by three components:” by “is controlled by three factors:”

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page 9, line 15 – page 10, line 2: please include references for the chosen  $\alpha$ ,  $\sigma$ ,  $\mu_{\text{phy}}$  and  $R_{\text{C:Chl}}$  values; I have furthermore not been able to find any quantitative information about  $k_w$  and  $k_{\text{chl}}$  – please amend.

page 9, line 20: “based on” should read “calculated from”

page 10, line 14: “by availability” should read “by the availability”

page 10, line 24: while  $K_{\text{Si}}$  is mentioned here, together with a reference, we have to proceed to page 26 to find the adopted value (where it is mentioned rather accessorially). Why? Please provide the adopted value here, where one would expect to find it.

page 11, line 14: “remineralisation of detritus” should read “remineralisation rate of detritus”

page 11, line 14: “bias” should read “biases” (there are two of these)

page 11, line 27: “decomposed” should read “dissolved”

page 12, line 22 – page 13, line 15: although it is explained how  $A$  and  $\epsilon$  are derived from  $M$  and NOS, it is not clear how  $B$  and  $C$  are obtained. Please provide a few words of explanation.

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page 13, line 4: “described” should read “written as” or “given by”

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page 13, line 7 vs. page 14, line 6:  $C$  has a double meaning. Please try to avoid.

page 14, line 9: “would be evaluated” should read “would have to be evaluated”

page 14, line 10: “This, however, is” should read “This is, however,”

page 14, line 21: “tripolar grid in  $1^\circ$  and  $2^\circ$  nominal resolution.” should read “tripolar grids at either  $1^\circ$  or  $2^\circ$  nominal resolutions.”

page 15, line 2: “2000 db” should read “2000 dbar”

page 15, line 2: the way the results are reported, “potential densities” should read “potential density anomalies”

page 15, line 24: “present date” should read “present-day” or “the present”

page 17, line 18: “the data set provided by” can be deleted

page 17, line 23: “At 1 January” should read “On 1st January”

page 18, line 12: “have a too strong” should read “have too strong a”

page 18, line 25: “biased low” should read “biased towards too low values”

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page 18, line 27: “[...] whereas the North Pacific is biased cold and fresh [...]” would better read “[...] whereas in the North Pacific there is a cold and fresh bias [...]”

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page 20, lines 10–11: “estimated as” should read “estimated at”

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page 20, line 15: “for the period” should read “from”

page 22, line 24: “ecosystem” should read “ecosystem model”

page 24, lines 10–11: “[...] has been reported for other models earlier [...]” should read “[...] has previously been reported for other models [...]”

page 25, line 20: “produce” should read “release”

page 28, line 1: “at depths deeper than” should read “at depths greater than”

page 29, line 24: “during” would better read “from”

page 29, line 25: “over” would better read “from”

page 30, line 5: “over 1990–2000” would better read “from 1990 to 2000”

page 31, line 20: “Since already the PP [...] for Lv1.2 is at the low end [...]” should read “Since the PP [...] for Lv1.2 is at the low end already [...]”

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page 32, line 16: please provide publication year for Seiter et al.

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page 33, line 4: “based on” should read “from”

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page 33, line 13: “in terms of” should read “with regard to”

page 33, line 29: “smaller than” should read “lower than” or “below”

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page 34, line 18: “more recycling” should read “more intense recycling” or “stronger recycling”

page 34, line 19: “smaller values for export efficiency” should read “lower export efficiencies”

page 34, line 24: “the scheme simulates also” should read “the scheme also leads to”

page 35, lines 7 and 9: the correlation cannot be of 0.32 or 0.22, the correlation *coefficient* can

page 35, line 20: “[...] NorESM-OC1 corresponds to the fully coupled [...]” should read “[...] NorESM-OC1 corresponds to the version included in the fully coupled [...]”

page 35, line 21: “[...] in CMIP5.”: please provide a reference to one or two relevant CMIP5 papers.

page 35, line 24: “grid” should read “grids”

page 35, line 24: “in high latitudes” should read “at high latitudes”

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page 36, line 24: “[...] a reduced ocean circulation (reduced AMOC) [...]” should read “[...] a more sluggish ocean circulation (weaker AMOC) [...]”

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page 37, line 11: “which still is” should read “which is still”

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Interactive comment on Geosci. Model Dev. Discuss., doi:10.5194/gmd-2015-256, 2016.

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