

Geosci. Model Dev. Discuss., referee comment RC1
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Comment on gmd-2021-338

Anonymous Referee #1

Referee comment on "GNOM v1.0: an optimized steady-state model of the modern marine neodymium cycle" by Benoît Pasquier et al., Geosci. Model Dev. Discuss.,
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Pasquier and co-authors propose the first inverse model of the global marine biogeochemical cycle of Nd and its isotopes (GNOM). In their approach, the GNOM is embedded in a data-constrained steady-state circulation allowing them to estimate the biogeochemical parameters controlling the Nd/ e_{Nd} cycle (sources, transformation and sink) via systematic objective optimization. This is a very interesting approach, efficient and full of promises. The manuscript is clearly written although sometimes not explicit enough despite its length. The illustrations and figures are correct. I consider that this work deserves publication in GMD, not without some improvements. I hope my comments below will be of use.

My general comment is that most of the working hypotheses are not discussed and argued enough. In addition, references are too often lacking. Some examples below.

Aeolian sources

Line 164 : How is the solubility parameter estimated ? The optimized value of 82.8% solubility for N-Am is incredibly high compared to what is published so far. This surprising value could be better discussed. The same manner, how is e_{Nd} estimated (what are the references leading to the values attributed to each area)? Line 183 : the authors assume a constant Nd value for dust and volcanic ash inputs, but the reference allowing this hypothesis is missing.

Sediments

The paragraph presenting the modelling of the Nd release from the sediments is not clear and could be re-written. Line 210, how the normalization constant was chosen? why 10 per mil? It is written « Extreme sedimentary e_{Nd} values are often associated with rather fresh, and thus reactive, detrital material » (argument used again line 237). Although this is verified for fresh basaltic material (often highly radiogenic and soluble), this is not verified for the very non-radiogenic materials which are of granite or metamorphic origin, and thus not known to be soluble. Again, references allowing such hypothesis are lacking. Thus, the scaling (and the quadratic function) proposed in figure 4 should be better explained.

Line 226 : The hypothesis of not considering enhanced release in Antarctic should be justified (see for example Paul Carter's work)

Riverine inputs

There is no consideration of the estuarine removal, estimated at ca 70%. The initial value is high (100 pM) and the optimized one even higher (376 pM) which is far above what is measured yet at the exit of the estuaries. This could be more discussed, since the real source of Nd to the ocean is at the estuarine mouths.

Reversible scavenging

Line 289 : What are the particle types that will be considered ? What will be the role (and justification) of the divergence operator? Line 298 : which reference allows the hypothesis that reversible exchange is occurring faster than particulate and ocean transport? Line 308 : the vertical velocity of dust (1 km/y) is high when referring to Hayes' estimates using Th isotopes in the oligotrophic areas (ca 300 m/y) ; again, a reference is lacking here.

Line 312 : where are the areas where the concentrations of dust, POC and opal are too low ? which surface of the modelled ocean this represents ? Is this additional arbitrary term important for the modelling?

Actually, I appreciated the initiative, and the effort made to simulate this biogeochemical cycle using an inverse method but I am left hungry for more discussion and critical debate regarding the results. I acknowledge that the manuscript is already long. An option could be to report the different modelling hypotheses (and most of the equations) in the suppl. material (which would allow to better describe them) and to propose more science in the main text. Some sensitivity studies should also be presented (as limiting the dust dissolution rates into published ranges, reducing c to values compatible with estuarine outputs, increasing the sediment release from the shelves...etc...