Comment on gmd-2021-338

Anonymous Referee #3

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., https://doi.org/10.5194/gmd-2021-338-RC5, 2021

Review of "GNOM v1.0: An optimized steady-state model of the modern marine neodymium cycle" by Pasquier et al., submitted to GMD, Dec., 2021

Pasquier and colleagues describe a new inverse model of oceanic neodymium (Nd) and its isotopes (eNd) that attempts to resolve their geochemistry based on optimization of 43 free parameters and a prescribed ocean circulation (OCIM v2.0). The result of the (optimized?) model are compared to published data the authors have collated with laudable success. This ms. is written as a model description so there are only a few conclusions drawn, and these are somewhat guarded (which seems reasonable given the initial nature of the work).

The paper is well written, and I was only lost in the mathematics in a few instances. An honest modeler (not a geochemist such as I) should review this work for the mechanics of the more complicated mathematics (see notes below).

In general, this model does seem to hold potential, and I hope that the authors continue to move forward with it. Again, this ms. does not claim to definitively resolve outstanding problems of eNd-Nd in the oceans, so there is not too much to critique beyond the model itself. For this, I have a few comments:

L22-24: the Sm:Nd of the rock type plays a critical role in the eNd that results; equal to, if not more than, the age of the rocks.

L85-90: note that the internal cycling of eNd/Nd can be argued to be of secondary importance, when the budget of the entire ocean system is not yet resolved. That is, as described in Du's work, water column processes can only redistribute eNd/Nd, they cannot

explain the source functions that are currently wanting.

L104: what is a green function based diagnostic?

L135: why is circulation (Tcirc) a sparse matrix?

L275: hydrothermal vents are known to be fundamentally a sink term for Nd and also eNd. From early work (Klinkhammer, German) to recent (Chavagnac), the magnitudes of fluxes related to hydrothermalism have been found to be generally zero to negative. I do not understand why this is a source (it would make their model more simple too).

L298-302: I did not understand this. It is important though.

Fig.5: the scavenging of Nd in the surface seems exceptionally high in all cases. Nd is low in the surface, certainly, but not so low as might be suggested by these implied removal rates.

L350-375, L391-394: i did not understand much of this, but a modeler might.

L415: perfectly compensate each other? what does this mean?

Table 2: why are Criver and Cgw concentrations and not fluxes? The dust solubilities are indeed very high.

Table 3: this is an interesting table; the main sources to the oceans are dust and sediment. However, the subsequent section 3.3.1 needs to be far better referenced: first off by adding references to the model comparisons. Secondly, the authors should compare their flux estimates to observational flux estimates, and reference these papers.

L.492: I don't understand this section. Also, a molecule of Nd in the oceans is the same as any other; just to make clear that other (non-Nd) parameters are critical. For example, (L 507:) why should sediment sourced Nd be removed quicker from the water column? Unless there are significant nepheloid interactions, there are as many particles to scavenge 10 m off the seafloor as there are 1000m off the seafloor (in the model and largely in the ocean).

Section 3.3.4: i understand the goal for this section, and it seems like a good idea. But isn't the entire thing borne out in eNd in the model? Can't this section be shortened?

L688: "x x x"?

General comments:

The model output does capture a lot of the observed data, but isn't the model trained to do this? through use of 43 free variables? A modeler should offer a critical evaluation of the model skill.

I appreciate the attempts to define input/output functions, but it would be interesting to see how close their approximations are to experimental and geochemical modeling observations of these processes.