



EGUsphere, referee comment RC2  
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## **Comment on egusphere-2022-606**

Catherine Jeandel (Referee)

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Referee comment on "Simulating marine neodymium isotope distributions using Nd v1.0 coupled to the ocean component of the FAMOUS-MOSES1 climate model: sensitivities to reversible scavenging efficiency and benthic source distributions" by Suzanne Robinson et al., EGU sphere, <https://doi.org/10.5194/egusphere-2022-606-RC2>, 2022

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The manuscript egusphere#2022-606 proposes the implementation of the oceanic cycles of the Nd isotopes (143 and 144) in the FAMOUS-MOSES1 climate model. There are interesting novelties in this work as 1) the use of the detailed epsNd map established by the author and comprising the bottom sediment signatures (Robinson et al, 2021); 2) exhaustive sensitivity test of two main parameters driving Nd and epsNd cycles: the reversible scavenging and the external flux, mostly the sediment one here. Actually, this represents a tremendous work; the manuscript is well written (although sometimes a bit wordy) and illustrated. It certainly deserves publication in *egusphere*. Nevertheless, I have some comments that I submit here to the authors.

### ▪ **Sediment flux vs Boundary Exchange (BE) processes**

I think there is a misunderstanding or a confusion between these two terms that needs to be clarified.

At several places in the manuscript, it is written that sedimentary flux is encompassing Boundary Exchange (e.g lines 250-255, around 345 but also 998-1000 and at other places highlighted in the manuscript) while to me, it's the opposite (ie BE is encompassing sedimentary flux, down to 3000 m -which is already deep!) in our preceding works).

Let's consider lines 250 and after

*"Seafloor sedimentary fluxes, an umbrella term that refers to a multitude of processes*

*encompassing boundary exchange (Lacan and Jeandel, 2005), submarine groundwater discharge (Johannesson and Burdige, 2007), and a benthic flux released from pore waters (Abbott et al., 2015a), are simulated via a combination of a sedimentary source applied across sediment-water interfaces together with a separate sink occurring via particle scavenging"*

I suggest to write this paragraph differently (as well the other places where it's a bit confusing, identified in my direct comments in the pdf). Indeed, when we proposed the "BE Concept" with F. Lacan (EPSL, 2005), we did not pretend to describe any specific processes that occur at the land-ocean interface and more specifically along the margins because we could not differentiate them. Later, I listed the potential processes that could explain the "BE (Jeandel, 2016). In other words, "BE" broadly comprises all the processes that could release Nd from the solid to the liquid but also those which would scavenge it, more or less at the same time and in the same area (note that this comprises reversible scavenging too!). More recently, one of the conclusions of the PAGES-GEOTRACES workshop (2018) pushed by Martin Franck was to "kill the BE", in other words to disentangle these processes, among them the seafloor sedimentary fluxes (either through early diagenesis or dissolution of resuspended sediments), low temperature hydrothermalism, SGD, benthic fluxes etc...

The point here is that the authors removed the depth limitation of 3 km which was forcing the model to consider sedimentary fluxes along the margins only. But the sedimentary flux they consider are occurring everywhere including along the slopes. This does not mean that the Sed Flux (a specific mechanism) encompasses the BE (a broader concept). This just means that this flux is extended to the whole ocean in the proposed work.

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- **“Top down” versus “Bottom up” processes** (issue linked to what is discussed in 1)

I'd cautiously use this opposition which was never clear to me (and I had long debates with B. Haley on this issue). By the way, the earliest Nd budgets proposed 2 sources: dissolved rivers and hydrothermal (see the historical works of Goldstein, O'Nions etc...). To my knowledge, hydrothermal is not “top down”. Consider now the most recent budgets: most of them invoke “Boundary exchange” which includes processes that occur in the deep waters, down to 3000 m depth (see above), in other words they include “bottom processes”. Thus, although I agree with what is written line 103 and after (reported below), it seems to me that this was not “new” because the *benthic* flux is occurring at any place where there is a contact between sediment and water, in other words everywhere from the beach to the deepest parts of the ocean. Again, there is a confusion between the processes and the location. Thus, I strongly suggest to the authors to be cautious here. What was “new” is that it could concern sediments below 3 km depth.

“Recent pore fluid concentration profiles measured on the Oregon margin in the Pacific Ocean indicate that there may be a *benthic* flux of Nd from sedimentary pore fluids, presenting a new, potentially major seafloor-wide source of Nd to seawater (Abbott et al., 2015b, a).”

- **The choice of the  $N_{dp}/N_{dd}$  ratio to conduct the  $f_{sed}$  sensitivity test.**

I did not understand why the authors did not kept the value of 0.004 instead of that of 0.003 to do these sensitivity tests. Indeed, as underlined in Table 5, the value of 0.003 leads to residence times larger than 1000 y, leading to more moderate range of 40 years difference in the  $f_{sed}$  simulations Nd

I did not see a clear justification of this choice in section 3.1 and would be keen to see the same sensitivity tests but with the  $N_{dp}/N_{dd}$  ratio of 0.004, which was the most consistent with the data.

- **The discussion on the reasons leading to epsNd modelled profiles that do not fit the data** is often too shy and not clear enough. Perhaps the sedimentary flux is too strong? Or the choice to attribute a constant flux for the deepest (bottom) and shallowest sediment (margin) is not appropriate? This is well exemplified by Figure 17 and the discussion lines 930-950. What would happen if the Fsed would allow differentiating the strength of the SedFlux deposited on the margin (fresh deposits from rivers, easy to remobilize) vs that of the bottom (too strong, "counterproductive" as it is written line 942)?
  
- **Minor comments:** they are highlighted in the attached pdf. I also identified some unit issues and rare typos but they are already listed by B. Pasquier ( who I thank for the exhaustive list!).

As a whole, I'd also suggest to the authors to shorten the manuscript by 10%-15% if possible.

Please also note the supplement to this comment:

<https://egusphere.copernicus.org/preprints/2022/egusphere-2022-606/egusphere-2022-606-RC2-supplement.pdf>