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Interactive comment on "Neodymium isotopes in the ocean model of the Community Earth System Model (CESM1.3)" *by* Sifan Gu et al.

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To directly compare climate models and proxy reconstructions, the authors implemented Nd isotopes in the ocean model of the Community Earth System Model (CESM). Tuning parameters, fboundary (Nd flux from continental margins) and [Nd]p/[Nd]d (Nd concentration ratio between particulate and dissolved phases), were optimized based on the cost function of [Nd] and εNd. Since this study provides Nd isotope code to the CESM community, rigorous validation is appreciated. The way to optimize fboundary and [Nd]p/[Nd]d is identical to the previous study by Rempfer et al. (2011) who had used intermediate complexity model Bern 3D model. Considering that the spatial resolution of CESM is higher than Bern 3D and that available seawater Nd concentration and εNd data were almost doubled meantime, the authors could provide significant advance about oceanic Nd cycle by numerical modelling. Nonetheless this study just confirmed the findings of the previous study. Indeed, the objective of the

study about the oceanic Nd cycle is too general and originality relative to the previous studies is not clear. The comparison between "abiotic" and "biotic" Nd was proposed as a novel point although only small part of text is attributed to this theme because of very small difference of simulated [Nd] and εNd.

This MS has a good potential to contribute to the improvement of our knowledge on oceanic Nd cycle even if the authors did not try to go further (maybe it would be realized by future works). If the authors' objective is to present this paper as a reference for future studies using Nd isotopes in the CESM, more efforts will be required. My major concerns are (1) the way to optimize tuning parameters and to evaluate simulation performance and (2) the assumption of homogeneous Nd flux from margins. Below I develop my suggestions and comments.

(1) Way to optimize tuning parameters and evaluate simulation performance fboundary and [Nd]p/[Nd]d are optimized by cost function J (Figure 3). There is no information about spatial distribution of difference between observation and model simulation except for several selected profiles (Figures 9 and 10). Histograms (Figures 6 and 7) only present the trend in major oceanic basins for four depth layers. The size and spatial distribution of difference between observation and model will provide the information about under and/or over-estimation of source and sink terms. For instance, I would like to see the results of the tuning that is realised separately for different oceanic basins (Atlantic and IndoPacific separately and Southern Ocean as buffer zone to ensure the continuity, for example). The upper layers affected by dust and river water will be treated separately from and the lower layers. With higher spatial resolution and more observational data relative to the previous study, such treatment would be possible. Since lithology and distance from continental margins are different between Atlantic and IndoPacific, it is not surprising that different parameterization lead to better simulation of seawater Nd concentration and εNd values. About the evaluation of simulation performance, the authors continued to use a track of vertical sections from Atlantic to Pacific (Figure 2a). Because of large gradient of Nd concentration and εNd

from Atlantic to Pacific, moderate amplitude of discrepancy is not visible with this presentation. Basin-scale transect is more appropriate for this study. About the criteria of good agreement (± 3 ε-units) should be revised because this size is equivalent or larger than changes in glacial/interglacial intermediate/deepwater εNd values.

2) Assumption of homogeneous Nd flux from margins This assumption was already questioned in the study of Rempfer et al. (2011) by the authors themselves ("a globally uniform flux of fbs probably is not valid"). It will be really interesting to tackle this difficult issue because there are some new evidences. The first clue is the partial dissolution of river particle. This potential source had been considered independently from margins before the idea of the boundary source is generally accepted. A recent study on Amazon river mouth demonstrates the dissolution of detrital fraction and Nd release to the ocean (Rousseau et al., 2015). Since river runoff was simulated in CESM, river sediment flux could be quantitatively evaluated by assuming ratio(s) between dissolved and solid phases, a partial dissolution rate and a Nd concentration in solid phase. It is a similar treatment to dust Nd flux. This consideration will contribute to establishing weighted Nd flux from margins. The second clue is Nd release from poorly chemically weathered detrital fraction in relation to the dynamics of cryosphere (Howe et al., 2016). Howe et al. (2016) indicated detrital Nd contribution in the Labrador Sea due to Laurentide ice sheet retreat in the early Holocene. At present, glacier and ice sheet retreat at high latitudes during warm seasons could form Nd flux to the ocean by similar processes. Even if it will be difficult to quantitatively estimate such Nd flux, some sensitivity tests will provide new insight into Nd flux from this source.

Considering a high potential of this work and significant points to be revised, I recommend an overhaul revision and eventual resubmission of the work.

Specific or minor comments Figures 9 and 10: What are the criteria of selection to show the profiles comparing Nd and εNd values between observation and simulation?

More recent compilation of seawater Nd and εNd as well as Holocene εNd values of

sedimentary authigenic fraction and biogenic carbonate by Tachikawa et al. (in press) provides hydrography parameters (temperature, salinity, nutrients) that could be useful for data model comparison, for instance with Figure 11.

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