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Interactive comment on "Inclusion of a suite of weathering tracers in the cGENIE Earth System Model – muffin release v.0.9.10" *by* Markus Adloff et al.

Anonymous Referee #2

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The contribution by Adloff et al. describes a new module of the cGENIE model, devoted to the calculation of the elemental and isotopic cycling of several trace metals (namely Sr, Ca, Li and Os).

The paper is globally organized in three sections: (1) a brief but very well written review of the trace metal behavior in the surficial Earth System, (2) a description of the implementation of those processes, and (3) results for the present day configuration and a test exploring the response of the trace metals (including their isotopic signature) to a transient perturbation.

Overall, the paper is very well organized. From my reading, I have three comments.

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Discussion paper

As clearly mentioned and explained in the paper, the cycling of the trace metals (TM) and their isotopic signatures is heavily dependent on the continental weathering processes, in a way making them difficult to simulate. Here the authors choose to link the trace metal fluxes to the weathering flux as calculated by another cGENIE module (ROKGEM). The authors assume that TM fluxes are proportional to the silicate and/or carbonate weathering fluxes. This is probably true for Sr and Ca, but not for Li and Os. Os is heavily dependent on the presence of particulate organic matter. Continental Li fluxes and their isotopic signature are controlled by the interactions between secondary phases and the continental waters. Those processes are not included in the model. Typically, periods of intense weathering will be characterized by a large retention of Li inside secondary minerals, strongly reducing the Li fluxes during the phase of regolith growth, while major cation fluxes released by the weathering of fresh rocks will be at a high level (Vigier and Goddéris, 2014). Li fluxes and isotopic signature are further impacted by the presence of large flooded areas on the continents, where continuous exchanges with clay minerals can occur, directly impacting the isotopic signature of the continental Li discharge (Dellinger et al., 2015; Maffre et al., 2020). I'm not saying that it is mandatory to include all this in a global scale model, but I fear a bit that the proportionality hypothesis will generate wrong interpretations of the seawater isotopic signal. This should be discussed in the paper, for example by stating that this is a first step towards something closer to the physics of the weathering system.

My second point is related to the residence times of the TM. A clearly stated by the authors, the residence times of the fourth considered TM in the ocean is much longer than the mixing time of the ocean. This implies that the seawater signal will be uniform all around the world. This is shown on figure 1. So why using a complex 3D oceanic model ? The mixing will generate a uniform distribution of the TM and their isotopic signature. The interest of including those TM in the model is more to constrain the contribution of the continental and oceanic crust weathering to the flux of elements. If the objective is to constrain the oceanic mixing, elements displaying shorter residence time are best fitted, such as the Nd. This said, the long residence time does not preclude spatial variations, especially on continental margins as it is the case for strontium (El Meknassi et al., Geology, 2020). But those margins are generally not represented in the models. So, I'm just wandering whether a better description of the objectives should appeared or not ? (I would say yes).

My last point is related to the implementation of the runoff. I checked in the Colbourn contribution, but I was not able to understand precisely how it works. A brief description should appear in the text. In summary, this contribution is valuable and should be published, with the above points clarified.

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