

Biogeosciences Discuss., referee comment RC4
<https://doi.org/10.5194/bg-2021-106-RC4>, 2021
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Comment on bg-2021-106

Edward Boyle (Referee)

Referee comment on "Modeling the marine chromium cycle: new constraints on global-scale processes" by Frerk Pöppelmeier et al., Biogeosciences Discuss.,
<https://doi.org/10.5194/bg-2021-106-RC4>, 2021

Review of "Modeling the marine chromium cycle: New constraints on global scale

Processes" by Pöppelmeier, Janssen, Jaccard, and Stocker (bg2021-0106)

The paper serves a useful purpose as a first-stab model for Cr in the global ocean. The model itself is well documented, and for many purposes, of sufficient complexity that many processes can be included. It makes estimates of things that are poorly known (most notably, the benthic flux of Cr), which gives observationalists targets to aim at. And if anyone disagrees with some of the model assumptions, then they are free to make their own model. Hence I recommend publication of a revised version of the manuscript.

That said, there are many things in here that I wouldn't have done if I were the one constructing the Cr assumptions. My major unhappiness is in the assumption of a (relatively large) globally uniform seafloor flux for Cr, although I would also have handled the OMZ assumptions differently. I think the manuscript bears some confusion on the ocean residence time of Cr. If the benthic flux of Cr comes from regenerated biogenic matter that removed it from the upper ocean, it doesn't shorten the residence time in the entire ocean-surface sediment system. I think that the river flux is the main constraint on

that number, unless Cr release from aluminosilicates in sediments is significant. And there is no data upon which to know whether this happens.

As the authors note, the model's handling of oxygen deficient zones (ODZs, which should be distinguished from oxygen minimum zones (OMZs) is inadequate to represent them very well – even for simpler properties such as oxygen. Is there a companion paper on the nitrogen system in ODZs? I bet that it is similarly problematical. Probably someone needs to make a regional model that can do a decent job at representing ODZs before trying to include them in a global model.

The paper misses out on some significant references:

Lines 110-120: Shiller (1991) GCA 55:3241

Lines 120-129: Brumsack (1983) Mar.Chem. 14:89 and Shaw (1990) GCA 54:1233

Lines 180-185: Elderfield (1970) EPSL 9:10 and Shiller (1987) GCA 51:3273

Line 275: Sherrell (1988) DSR 35:1319

And I would also add for lines 285-290, Arctic surface Cr is influenced by Fe(II) oxidation by reduced Fe released from organic-rich Arctic shelf sediments, with Cr(III) formation and Fe oxide scavenging.