

Interactive comment on “Extraterrestrial dust as a source of bioavailable Fe for the ocean productivity” by Rudraswami N. Gowda et al.

Anonymous Referee #2

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Dowda et al. have measured iron concentrations in cosmic spherules collected in Antarctica and Indian Ocean sediments to quantify extra-terrestrial fluxes of bioavailable iron to the global ocean. Atmospheric iron bioavailability has been given much attention in the recent decade due to its importance as a limiting micronutrient for primary production. As there are very few estimates of extra-terrestrial iron, I can imagine the results will be of interest to the biogeochemical community.

General comments

In its current form, the manuscript is difficult to follow. After reading a paragraph, I am often left wondering what was the main point? Furthermore, much of interpretation is speculative and unsupported. For example, two sampling sites in Antarctica and the India Ocean were chosen and the findings have been extrapolated to global scale

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without consideration of spatial variability or how representative those sites are of the region let alone a discussion of how appropriate it is to upscale these sites. Unjustified assumptions are made throughout the manuscript. In general, the referring is outdated and incomplete. I recommend that the manuscript is revised to improve the clarity, focus and structure.

The manuscript aims to quantify extra-terrestrial fluxes of bioavailable iron to the ocean. However, bioavailability/iron solubility is not taken into account in the equation to estimate total bioavailable iron input (L118-120)? Are you assuming all extra-terrestrial iron is 100 % soluble? This may come down to an operational definition of solubility. For atmospheric iron, generally the operation definition of soluble iron is $Fe < 0.2$ or $0.45 \mu m$ (i.e. that can pass through a filter of that pore size). The introduction is lacking information about extra-terrestrial bioavailability/iron solubility. For atmospheric iron (mineral dust and aerosol), iron solubility ranges from 1-80 % depending on the source and atmospheric processing. What is known about the iron solubility of extra-terrestrial iron?

In the introduction, please define bioavailability and explain how bioavailability is determined in extra-terrestrial/atmospheric samples. Please explain what is known about extra-terrestrial iron content, its bioavailability and delivery to the ocean. Your samples are from the Indian Ocean and Antarctic but there has been no introduction to the iron biogeochemistry and sources in these two regions. It's not clear whether this is a Southern Ocean study or a global study or even why you have chosen these sites? It would be worth mentioning the other sources of new iron to your study sites. Key information is missing in the introduction.

In the discussion, it would be useful to add a section comparing your estimates of extra-terrestrial iron fluxes to atmospheric fluxes, for example in the Southern Ocean and globally to show how important extra-terrestrial iron really is. Please include errors in your flux estimates. A large amount of background information is in the results/discussion section and should be moved to the introduction.

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The audience of this study will include biogeochemists who are not necessarily experts in micrometeorites. A few terms and processes could be given greater explanation.

Lastly, the manuscript requires careful proofreading.

Specific comments

L38 Suggest using a different word to “failure” as dust from Southern Hemispheric continental regions is in fact transported to the polar plateau.

L39-40 Please use up to date references for the Southern Ocean.

L40 Suggest using a different word to “rejuvenating.”

L49 Please add particle size range.

L63-64 Please provide reference and explain the deposition pathway.

L66-69 Please explain what is known about these uncertainties.

L77 Add coordinates of sampling sites.

L83 How did you determine what is a MM in you samples?

L105-114, L127-134 and L141-158 Some of the information in these sections, for example specific to Antarctica, could be moved to the introduction.

L208-223 This section assumes that the deposition flux of extra-terrestrial iron is the same at both sampling sites (Antarctica and Indian Ocean). Please justify this assumption. What about spatial variability? How do you know the samples collected at each site represent that region?

L215 How does a solubility of 5-10 % compare to leaching experiments of extra-terrestrial iron? L225 Add reference.

L182-234 This section is difficult to follow. I think the point of this section is to estimate extra-terrestrial dissolution in buried sediments. Please focus the discussion and give

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the heading that better reflects the content.

L236 Implications for what?

L250 There are now a number of studies quantifying atmospheric iron fluxes and solubility of atmospheric iron in aerosols and snow in the Southern Ocean. Please use actual data and provide references rather than estimate a value yourself.

L259-260 Add reference.

L260-261 Add reference.

L269-281 This section is particularly speculative. References required.

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