

Interactive comment on “Dissolved iron in the North Atlantic Ocean and Labrador Sea along the GEOVIDE section (GEOTRACES section GA01)” by Manon Tonnard et al.

Anonymous Referee #2

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The authors present a beautiful set of high-resolution, full-depth dissolved iron data in the North Atlantic Ocean, which contributes to our understanding of the biogeochemical cycling of Fe in the ocean. I highly recommend publication of this article in the journal Biogeosciences since it is of great interest to the scientific and wider communities.

I am aware how much effort has gone into obtaining these data (sampling and analyses). That stage is already a major achievement! However, the text still needs to be considerably improved before publication. The discussion is very hard to follow, due to a lack of flow of thoughts and a lack of clear messages in subsections and para-

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graphs. Very often information appears out of context. In general, it is important that the authors rethink what message they want to transmit, organise this information and rewrite the discussion. A similar mistake is repeated, where the authors give almost review type information of published work and then try to find the same in their work. The authors should state what they find, with support of figures, correlations, calculations and ultimately compare their conclusions with the available literature (and not the other way around)! The conclusions section is inherently very poor and needs a revisit. Therefore I suggest major revisions of the discussions section.

Specific comments are listed below:

Line 3: I can spot at least two English native authors and would have therefore expected a better written text.

Page 1, Line 35: “in the Denmark Straight...”

Page 1, Line 35: explain what types of particles you are talking about and briefly explain the differences observed (which ones scavenge and which ones release dFe)

Page2, Line 4: The reasoning is not flowing properly here. You need to say that (1) high productivity leads to high atmospheric carbon capture and that (2) Deep water formation leads to sequestration of this carbon into deeper waters, where carbon is stored for longer. The last sentence comes a little out of the blue, needs to be better linked – instead close the paragraph highlighting why it is important to study trace metals in this area.

Page 2, Line10: I can not follow the reasoning in this paragraph. A little bit of a muddle of all the phytoplankton limiting factors (light, nutrients, wind, temp) without a clear insight what factor limits where. Needs to be better explained

Page 2, Line 15: the connection between light limitation and nutrient limitation is not clearly explained

Page 2, Line26: what about soluble Fe? Is this not considered the most bioavailable

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form?

Page 3, Line5: Aims of this paper are a bit poor. Add better understanding of the biogeochemical cycling of dFe in the oceans - inform biogeochemical models – and why this is important, what you expect to achieve. . .

Page 3, Line 20: remove “national”

Page 3, line 30: do you mean concentrated HCl?

Page 3, Line25: why different filtering methods? Have you compared the Fe concentrations in those fractions? i.e., have you collected the same sample with both filtration cut-offs and checked there is no significant difference?

Page 4, Line 4: remove “daily basis”

Page 4, Line 14: replace “run” with “analytical session”

Page 4, line 19: replace “in nmol L⁻¹” with “to nmol L⁻¹”

Page 4, Line 19: would it not be more correct to multiply by the specific density of each sample? If you do not have this data (normally this is a standard parameter obtained from temperature and salinity.

Page 4, Line 19: Please show a comparison of dFe data at the crossover-station with GA02, as an intercalibration exercise.

Page 4, Line25: Why did you not use the CTD data from the trace metal casts? Please explain

Page 5, Line 12: awkward sentence, difficult to follow, please rewrite!

Page 6, Line 5: which central waters? Names?

Page 6, Line 9: to keep consistency, keep "stations 49 and 60" out of the parenthesis. Rephrase the end of the sentence to do so.

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Page 6, Line 10: specify which stations

Page 6, Line 14: remove "The" from start of sentence

Page 6, Line 19: what is that contribution? 40 %? Please specify!

Page 6, Line 28: ... "was" sourced from...

Page 6, Line 30: and "in the" Labrador Sea

Page 6, Line 34: I am getting a little lost with all those branches, not sure when you're talking about the same one and when you change talking about another one. Not clear, please rephrase this section.

Page 7, Line 5: delete "The" from beginning of sentence. In this entire section please remove "the" in front of water masses. The text should be revised by one of the English speaking co-authors before submission.

Page 7, Line 7: "lower" oxygen. . .

Page 7, Line 4: what do you mean by dense shelf? Do you mean the water masses have higher density? Please rephrase

Page 7, Line 16: "the" Charlie Gibbs. . .

Page 7, Line 19: mixing with... remove "of the overflow"

Page 7, Line 21: Which stations?

Page 7, Line 30: At least put a nitrate section figure in the supplementary file; otherwise text hard to follow. Data not yet available on the site you referenced

Page 8, Line 4: how do you define the "most open ocean station" for the transect? Deepest? Furthest away from land masses? Are you sure this is st 23?

Page 8, Line 4: it is unclear when you switch to talk about non-surface nitrate concentrations. Please rephrase this section to make this clearer.

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Page 8, Line 6: which depths are you talking about?

Page 8, Line 12: isn't the fluorometer calibrated with the Chl-a measurements?

Page 8, Line 13: Specify which depth range you are considering for looking at min/max Chl-a concentrations. Evidently, minimum Chl-a concentrations are found in the deep ocean

Page 8, Line 19: remind the reader here here that all the dFe data can be found in the supplementary file.

Page 9, Line 13: when describing the regions, go in same order as in Figure, otherwise confusing (start Labrador Sea and end WEB)

Page 9, Line 13: remove "the" before MOW and in front of LSW (line 15), SAIW (line 24) and IrSPMW (line 24).

Page 9, Line 20: this is confusing, specify that you mean similar averages and not ranges (the range is larger for IcSPMW)

Page 9, Line 22: LSW and ISOW averages are also similar, combine sentences.

Page 9: Line 24: "composed of" instead of "characterised by"

Page 9, Line 32: Delete "compared to other ones"

Page 10, Line 2: "lowest average dFe value" (DSOW also shows the highest deep water dFe concentrations)

Page 10, Line 9: it is a little odd to start explaining what cannot be included in any of your sub-sections. You start introducing the general structure of your discussion and then you go into much detail explaining dFe trends all the sudden. This is totally out of place here. You should add this paragraph to the end of the discussion or in a new section.

Page 10, Line 20: I don't understand the aim of discussing dFe with water masses? I'd

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rather focus on the sources and sinks of dFe along the section. Discuss then the role of water masses in distributing the dFe signals. This means completely changing the focus of this section

Page 11, Line 2: Flow of thoughts not clear, reasons of deep winter mixing scattered; bits of information thrown in a little randomly. You should start off by saying that deep winter mixing is an important mechanism supplying nutrients to the surface ocean in the North Atlantic Ocean; then say how this deep winter mixing is produced (from what I can understand in your text are you trying to say this is due to the effects of wind + convective mixing+ subduction/upwelling; am I right? This was not clear); then say what the specific conditions were in the year you sampled. I am still giving you corrections on the section, which you can incorporate in your rewritten discussion if fitting. I think you can recycle some parts of your discussion.

Page 11, Line 7: “events” and “with a positive NAO”

Page 11, Line 8: “The winter mixed layer depth”

Page 11, Line 9: instead of “ and were” use “which was”

Page 11, Line 11: “close to those found in LSW”

Page 11, Line 13: sentence incomprehensible, please rephrase

Page 11, Line 24: need to improve a little the flow of thoughts in this paragraph. Start by saying why you see no MOW dFe signal, then support/contradict that argument(s) by what has been seen in other studies.

Page 12, Line 3: “suggesting that the water mass is enriched in dFe during its flow path”

Page 12, Line 4: start by saying what those sources are and then support with the available literature.

Page 12, Line 6: change “the ones” for “those”

Page 12, Line 12: Provide a brief description of how the remineralisation rates were measured...

Page 12, Line 18: You are repeating yourself!

Page 12, Line 19: conspicuous? clearly visible? change this word

Page 12, Line 21: confusing between remineralisation and bacteria mediated ligand production. Please be clear.

Page 12, Line 27: “Hereafter”

Page 13, Line 2: you also need to consider vertical/lateral inputs (think in 3D), so sedimentary Fe could be coming from further north, for example, within nepheloid layers. You can't discard sedimentary inputs just by looking at vertical gradients.

Page 13, Line 3: remove “the” before “Polar Intermediate Water” and “PIW” (line 6)

Page 13, Line 9: instead of thinking that one water mass carries a certain dFe concentration (think of the short Fe residence times), this water mass might have “picked up” some dFe from, e.g., the sediments, on its pathway or It might have picked up particles in suspension which dissolve over time, etc!

Page 13, Line 11: instead of “seawater” use “water masses”

Page 13, Line 11: specify what you mean; 100 % contribution of which water mass at which depth

Page 13, Line 18: watch out, this leads to miss-understanding as the reader thinks you are saying that particulate Fe is sustained by organic ligands. I don't think that is what you want to say.

Page 13, Line 19: restructure this paragraph, say what you think the reasons are behind the high dFe concentrations, then support that by correlations, graphs etc and then compare to literature to confirm or dispute your theory. end the section with a

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stronger statement of what you think is happening in these deep water masses

Page 13, Line 26: your explanation is a little long winded. Say that Mid Ocean Ridges can be a source of dFe but that this has not been found in the Reykjanes Ridge so far

Page 13, Line 30: you are repeating you pattern again; please first explain the signals you see and then compare to the literature

Page 14, Line 4-6: are these located on your transect? If not, you need to give their locations (coordinates) and explain where they are relative to your section. Are these GEOVIDE hydrographic sections (I don't think so) or from other cruises? Specify which ones. Cite appropriate Figures, and supporting literature.

Page 14, Line 11: complete this section with more recent references. There have been previous studies in this area

Page 14, Line 20: restructure, again start by saying what you see, explaining the reason of these signals showing correlations, and then supporting literature

Page 14, Line 26: You can't say "et al." in a personal communication. All people should be mentioned. Also State first name and affiliation in a personal communication.

Page 14, Line 26: Very difficult to follow; why "however"? Start by explaining the typical ratios of different sources before you give the observed ratios in your study. Then discuss the What dFe:dAl ratio is expected from a river source? And from an atmospheric source?

Page 14, Line 29: Difficult to understand; you need to present each option that could lead to the enhanced dFe signal, discuss and then accept or discard

Page 15, Line 18: I don't understand this "extended as close as 200 km from our Greenland stations". Please rephrase. Also avoid parenthesis next to parenthesis, and explain clearly what can be found in the link and what info you got from there.

Page 15, Line 20: how were these calculated? give equations

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Page 15, Line 27: I suggest instead of describing the Figures, you should use them to support your discussion. So try to avoid starting sentences and paragraphs describing Figures! You do this very often

Page 15, Line 27: how is sea-ice fraction calculated? please provide equations (if you calculated it yourself) or references where this data is published. Provide clear info so the reader can understand

Page 15, Line 30: explain why you compare to dAl in these profiles.

Page 15, Line 33: "originates"

Page 16, Line 7: I can't believe that sea-ice can "uptake" Fe! The concentration of Fe in the newly formed ice and in the remaining water should stay the same. You need to find another explanation!

Page 16, Line 10: you mean sea-ice formation? Hence release of brine? Also explain that the brine sinks because it is denser (this is why it is observed below the surface)

Page 16, Line 10: "release of dFe"

Page 16, Line 10: "underlying water column"

Page 16, Line 11: split this sentence, it is too long

Page 16, Line 15: instead of describing the data (this is more appropriate for results section) you should say what correlates with what (e.g., low Fe with low MW). difficult to follow flow of thoughts

Page 16, Line 17: remind the reader in which figure information can be found (Chl-a, ect)

Page 16, Line 24: results in agreement with the capacity of. . .? weird sentence, please change

Page 16, Line 27: so far you have not talked about dFe:dAl ratio in meteoric water.

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Explain if this ratio is used to trace MW inputs and what you see in your profiles. should explain at the start.

Page 16, Line 28: change “noting that” for “although”

Page 17, Line 6: or maybe the brine conditions (pH, salinity etc) make the Fe more bioavailable; or maybe this peak is not Fe related, but related to the release of other TM, or a phytoplankton group that thrives in brine and does not require much Fe? Since this shelf is further south, the environmental conditions may be more favourable for phytoplankton to grow and hence consuming all the dFe more rapidly. You should explore all the possibilities

Page 17, Line 19: You repeat the word “dust” too much

Page 17, Line 20, “proportions”

Page 18, Line 3: you are going into too much detail here about aerosols, which is part of the Shelley papers

Page 18, Line 6: Meskhidze et al. (2017) is not in your reference list

Page 18, Line 10: information is a little randomly thrown in... what is your point? This is not a review paper

Page 18, Line 13: What does OM mean? write abbreviations out first time. Do you mean organic matter?

Page 18, Line 15: So all this background information to lastly say that you don't comment on this? Rephrase, make some assumptions or delete some detail

Page 18, Line 26: of those stations, station 40 is most similar to total aerosol dFe:dAl ratios. station 26 is closer to the soluble than the total composition, so I don't understand what you are saying

Page 18, Line 28: And what about all the other stations where the ratios are different?

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I would say this is more of a "coincidence" that these data fall onto the black line. The multiple reactions occurring as Fe enters the ocean change this Fe:Al ratio rapidly

Page 18, Line 30: remove "time"

Page 19, Line 2: I don't understand.... these station points on your figure 10 are similar to those of other stations. What makes you think they have a higher atmospheric influence??

Page 19, Line 4: in this section you should mention that bottom water dFe concentrations were significantly higher on the Newfoundland margin than on the Greenland margins

Page 19, Line 10: "mol:mol" to stay consistent

Page 19, Line 10: what is the average useful for? Show a plot with dFe:pFe ratios or a table

Page 19, Line 11: as well as different sediment compositions, this could be also due to different supply mechanisms? Different sediment conditions (redox, organic content, temp, etc)

Page 19, Line 17: Where is the predominance of diatoms?

Page 19, Line 21: I think this section is great, but you need to organise the ideas clearly. Now difficult to follow. Also name this section "nepheloid layers"

Page 19, Line 26: explain the criterion first. Explain briefly the PCA and the results you show in figure 11. Information is thrown in a little randomly. Please organise your paragraphs

Page 20, Line 1: I would not call it AOU "concentrations" find another way to express this

Page 20, Line 13: you should look into non-reducing dissolution of lithogenic material.

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You are missing out on a big topic! Radic et al., 2011; Labatut et al., 2014; Abadie et al., 2017

Page 20, Line 14: “lead”

Page 20, Line 16: instead of “these” use “this sediment-derived...”

Page 20, Line 17: do not state this as facts... these are assumptions

Page 20, Line 25: very poor sum-up, please improve

Page 20, Line 26: You should also compare surface dFe data to AOU to look at dFe released from remineralisation. You have done this for >500 m depth, but it will be worth looking at this more closely below the surface mixed layer, where remineralisation occurs (below 100 m depth).

Page 20, Line 30: change the ending of this sentence, not properly expressed

Page 20, Line 31: First explain why you talk about Fe:nitrate ratios. THIS comes out of the blue! Also cite Fig 12.

Page 21, Line 3: what do you mean by influence of the river, and the currents? specify what you mean

Page 21, Line 6: Can you provide a different kind of plot to help visualise this gradient you are talking about. In figure 12 this is impossible

Page 21, Line 18: “disequilibrium” sounds a bit odd, better use the word “ranges”

Page 21, Line 23: do you assume that all the nitrate in seawater comes from remineralisation? Better explain what assumptions this equation relies on

Page 21, Line 26: Rather, negative values of Fe^* indicate the removal of dFe that is faster than the input through remineralisation or external sources and positive values suggest input of dFe from external sources

Page 21, Line 27: remove "out"

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Page 21, Line 28: you talk about surface waters here but the calculations are done below 100 m depth. I would keep discussion on the external sources of dFe and then link to inputs of dFe rich water masses to surface waters above

Page 22, Line 5: what has the low Fe supply to do with the "inefficient" carbon pump? If you want to talk about the carbon pump, and its inefficiency, you need to support with adequate statements/findings. I do not think this is a finding of your study

Page 22, Line 7: this comes a little out of the blue. Explain a little more the high remineralised carbon fluxes and how they were measured

Page 22, Line 12: poor ending. What about other sources? Margins? Rivers?

Page 22, Line 15: first sentence superfluous

Page 22, Line 23: depletion of nitrate? That doesn't make sense

Page 22, Line 27: "entrained it to the deep. . ."

Page 22, Line 29: "in the deep ocean"

Page 22, Line 30: do you mean particles? Sediments are on the seafloor. Same for line 32

Page 23, Line 3: conclusions need to be rewritten after the discussion is reworked.

Page 33, Figure 1: explain why you show two dotted lines for the subarctic front in our figure caption.

Page 34, Figure 2: for consistency, cite here also ODV

Page 37, Figure 5, Line 2: "coastal stations 2 (A), and. . ." Remove "note that" from mine 4. In the figure itself, make dFe scale from 0 to 3 nM in all plots except Stn 78 for better comparison. Similar for all other parameters, make scales the same where possible to better compare stations.

Page 38, Figure 6: if the averaged values are not from exactly the same depths, you

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need to give depth error bars too.

Page 39, Figure 7: Explain what the black bar represents in each colour box, and what the red dotted line represents. Remove “note that”. vertical lines should delimit the different water masses. As of now it is difficult to tell where each water mass starts and ends.

Page 40, Figure 8: which depth range is used for the plot in A? in the text you say mixing between ISOW/PIW and DSOW; why do you say "opposed" here? Confusing

Page 41, Figure 9: you need to add the station numbers to the dots and depth info in the caption.

Page 42, Figure 10: specify which depth the dissolved and particulate Fe and Al data are from. Why is soluble aerosol data higher than total aerosol? This makes no sense. Remove “note that”

Page 43, Figure 11: you don't need to give all the colour coding if you already have this in the caption. What are the units of the colour bar in plots C and D?

Page 44, Figure 12: this figure needs a legend instead of the long-winded explanation in the caption

Page 45, Figure 13: the contour line needs to be made more visible. be careful how you use ODV integration! The aim is not to fill in "empty spaces", but to reproduce something realistic. This goes for the previous section plots too

Page 45, Figure 14: combine this figure with figure 13 (i.e., A and B) since it is about the same topic

Page 47, Table 1: on the last column put “SML dFe” or “Zm dFe”; “surface mixed layer (Zm)” . . . “and number of samples in the SML (n)”

Page 48, Table 2: “As of yet, no consensus value is. . .”

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