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Climate of the Past Discussions

Interactive comment on "Atmospheric Fe supply has a negligible role in promoting marine productivity in the Glacial North Pacific Ocean" *by* Francois Burgay et al.

Francois Burgay et al.

andrea.spolaor@cnr.it

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Dear Reviewer, First, on behalf of all the authors, I would like to thank you for your precious suggestions that contributed for the overall improvement of the manuscript. Please find attached the new version. We would like to point out that in the first version there was a mistake in the calculation of the Fe and nssCa fluxes for the NEEM ice core. We repeated the calculations and the mistake is now fixed. However, this correction does not affect the interpretation of the dataset. We also included in Table 1, the nssCa concentration and fluxes since we referred to them several times in the main text. We also introduced in the method sections more details about the analytical performances

for Ca and Na and more indications on how nssCa was calculated. This info was missing in the first version of the manuscript (L122-131). Best regards,

Andrea Spolaor Corresponding author

We modified the figures accordingly to what you suggested. Your stylistic suggestions are implemented in the main text as well.

The authors should comment on changes in water stratification that may occur during glacial periods in the North Pacific, is productivity more limited by nitrate rather than Fe? What are the upwelling conditions like near the sediment core records you are comparing the ice core dust flux to? Need more information that suggests atmospherically transported Fe (versus upwelling) is the primary source of Fe to these sites. We discussed more in details the reason behind the stronger water stratification during the Last Glacial Period. During that time, the nitrate consumption efficiency was high, despite the low marine primary productivity suggesting an iron limited primary production. More details at L309-327. Considering the negligible role that aeolian Fe fertilization had in these regions during glacials, we assume that other Fe sources played a more relevant role in regulating MPP in the subarctic Pacific Ocean. More details at L347-L356.

Can you comment about oxygen content in the Glacial North Pacific during this time period? We briefly commented about the oxygen content in the glacial North Pacific when we discussed the causes that enhanced water stratification during the Last Glacial Period (L314-319).

Why don't you compare your NEEM record to other Greenland ice core records? Or more information is needed as to why you chose TD, LD and EDC specifically to compare your NEEM Fe flux to. We added a new section where we discussed differences and similarities between our record and a lower-temporal resolution Fe record from the same location. More details at L229-L247. There are not other Fe long-term records for the Arctic region. To our knowledge, iron records from TD, LD and EDC are the only

one that cover a time period which is comparable to the NEEM record.

L16-17: one sentence is attributing Aeolian dust as one of the main Fe sources to the ocean and the second sentence is stating that ice cores provide a sensitive and continuous archive for reconstructing Fe fluxes over last millennia. I suggest the authors add a sentence or portion of a sentence stating how Aeolian dust transported over past climate periods is preserved in the ice core record. We modified accordingly (L15-L18)

L137 - What makes this fraction the leachable Fe concentration? Are you assuming that the 1 month leaching at a pH 1 in HNO3 is the labile portion? We changed the terminology from “leachable Fe” to “Total Dissolvable Fe”, accordingly with Edwards et al., 2006. This fraction represents the amount of Fe that can be effectively dissolved from mineral particles at pH 1 for one month. Our acidic digestion procedure was made following well established protocols as described in Koffman et al., 2014. More details, references etc. . . are reported at L75-78, L97-106 and L167-L171.

L160-163: this is an important point. To know the truly labile portion of Fe present in the ice core dust, it would be necessary to leach the dust in conditions similar to what is observed in the modern ocean. Could be useful to discuss that a bit more here. As for the previous answer, we clearly stated that this represents an upper limit to the amount of Fe that can actually be available for the phytoplankton. We underlinde that previous studies have reported a correlation between DFe (Dissolved Fe) and TDFe (Total Dissolved Fe), meaning that periods with higher TDFe were also periods with higher DFe: DU, Zhiheng, et al. Relationship between the 2014–2015 Holuhraun eruption and the iron record in the East GRIP snow pit. Arctic, Antarctic, and Alpine Research, 2019, 51.1: 290-298. Xiao, Cunde, et al. "Iron in the NEEM ice core relative to Asian loess records over the last glacial-interglacial cycle." National Science Review (2020). L164 - What time periods? Glacial and interglacial? What about Lupker et al, 2010 who suggested Sahara as an additional potential source? We discussed the possibility of other dust sources at L275-L285 where we also reported findings from Han et al., 2018 which refer directly to the NEEM ice core.

L190 - Need more information about what Brassicasterol concentration is informing on We added a paragraph that discusses more in details the proxies used for the determination of past marine productivity (L298-L304)

L205-207 - okay but what about when the sea ice eventually melts? How long is this sea ice though to have persisted for? If atmospheric dust was deposited on sea ice surfaces presumably when the sea ice melted there would be a pulse of Fe to the surface ocean? It would be interesting to expand on this here. Unfortunately, we do not know for how long sea-ice persisted in the investigated regions. However, we know that during seasonal and marginal sea-ice conditions, productivity was higher than during perennial sea-ice periods, which suggests that when sea-ice melted it might have provided micronutrients (as well as sunlight) to the ocean system (L334-336). Conclusions & future perspectives - I think this section can be expanded upon, right now it just reads like a quick summary of the main points brought up in the manuscript without expanding on why we see the largest differences in the Fe record during MIS 4, what this means in terms of dust supplied Fe to subarctic Pacific in previous climate regimes (e.g. Mid Pleistocene Transition_)

L252 - What is the underlying mechanism for this large difference during MIS 4? Or hypothesis? We added a more comprehensive and detailed explanation on the possible reasons behind the enhancement of Fe transport during MIS 4 in Greenland at L210-228. For this reason, we did not discuss it further in the conclusions keeping them short and essential.

Please also note the supplement to this comment:
https://cp.copernicus.org/preprints/cp-2020-77/cp-2020-77-AC3-supplement.pdf

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