

## ***Interactive comment on “First continuous phosphate record from Greenland ice cores” by H. A. Kjær et al.***

### **Anonymous Referee #2**

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This manuscript presents the first continuous phosphate records on 2 Greenland ice cores for the recent period (1880 to 1920 AD) and the last glacial maximum (22 to 37 ka). My first major comment concerns the experimental method used for the measurement of phosphate in ice cores. I am not an expert in the measurement of phosphorus and am not a glaciologist, but I did some sequential leaching for measuring P in deep-sea sediments. Acid citric will normally extract exchangeable or loosely sorbed P plus reactive P (in general P which is bound to oxides and hydroxides of elements like Fe). So, why do the authors call their extracted P phosphate? I would suggest the authors to clarify what they call PO<sub>4</sub><sup>3-</sup>.

My second comment concerns the CFA setup. I am really wondering how the authors can be sure of the quantitative measurement of P in their cores. They explain that

the continuous flow setup for phosphate measurements comprises a 3 meter long coil where reagents and samples are mixed and heated at 65°C in order to increase the sensitivity of the method. They indicate that a filter is introduced in the system between this heated coil and the capillary cell where absorbance is measured. The authors write (p. 3965, l. 24 to 28) that the filter removes “essentially all dust”, and is located prior to the cell “to make sure that all soluble phosphate attached to dust had time to react before detection”. Ok but are they sure that P bound to dust (particles) is totally desorbed from particles before detection? Did they make some tests?

Introduction : The introduction is quite informative, and describes (sometimes with some mistakes) some aspect of the cycling of P. But the aim of this original study is missing there and I finally found it when I read the end of the discussion (page 3974, lines 10 to 24). I suggest the authors to reorganize the introduction.

Page 3961, line 15: “For phosphate, the soluble part of total, etc. . .”. I do not really understand the meaning of this assumption. What do the authors mean with soluble P? Soluble P in what? This is not clear.

Page 3962, lines 15 to 21: Iron does not have any impact on water column denitrification (WCD). WCD occurs in the ocean (generally at subsurface depths in poorly ventilated areas) when oxygen content falls below a threshold level (when waters become suboxic to anoxic). In such conditions, nitrates are used instead of oxygen as an electron acceptor during the mineralization of the organic matter. Whereas WCD is the main sink of oceanic N, Nitrogen fixation (by cyanobacteria for instance) represents the main source, but there is still a big debate among oceanographers and paleoceanographers concerning the N inventory of the ocean over geological and glacial-interglacial time scales, and whether or not WCD and NF are temporally and geographically linked or not.

Page 3969, line 7 to 9: The winter enrichment of Phosphate (but also other nutrients) in the north Atlantic and Pacific is due to its low utilization rate by the phytoplankton,

and not due to general circulation.

Page 3970, line 19: The authors write that “A rough estimate of the maximum amount of P that could theoretically originate from dust was calculated using the mean amount of dust in the coldest period.” I understand the calculation made by the authors using the global mean of P in dust (Tiessen, 95). But what is this P content of dust? Is it the total content of P in dust? Is it only the reactive fraction of P adsorbed onto the dust surfaces? If their estimate is rough as they write, how can they state on page 3971 line 10 that “This is a clear indication that dust inputs alone are insufficient to account for the phosphate concentrations observed in NEEM ice.

Comments concerning the figures: Fig 3: What is the meaning of this figure? What is the light intensity? What does it mean? Fig. 4 and 5 : I would appreciate if the authors could plot their data versus age instead of versus depth. This would make them easier to read for a paleo. Fig. 5 : I would suggest the authors not to replicate the Phosphate curve on each graph.

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