

Interactive comment on “Ancient versus modern mineral dust transported to high-altitude alpine glaciers evidences saharan sources and atmospheric circulation changes” by F. Thevenon et al.

Anonymous Referee #1

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General comment:

The authors offer an interesting set of analysis of ice core and aerosols samples collected in the Western Alps. They conclude that the Saharan region was and still is an important source of dust for the Alps during the last few centuries. While data presented are certainly interesting and the conclusions reached are relevant and well within the scope of ACP, their data analysis and especially their presentation and discussion are not accurate and can be very much improved as well as the English. This might imply a very general revision of the text that goes well beyond the suggestions

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provided below that, in most cases have just to be taken as examples of how the manuscript might be improved.

Specific comments:

It seems that a significant contribution of local dust is ruled out by the authors. While this is possible, it is not demonstrated in the paper and no discussion about the local geomorphology and geochemistry is presented to support this idea.

In addition to the Saharan dust input to CG and Jungfraujoch, the authors suggest that intercontinental transport of background dust has a secondary role, at least in this part of the Alps. Also this idea should be better supported. For instance, a background like this, should be not only characterized by a very fine particulate size but its composition may resemble the mean crustal one. In addition, this general background should significantly differ from the Saharan dust composition. This needs to be convincingly demonstrated.

A very interesting aspect of this work is the largest Saharan dust event occurred around 1790. This event might be discussed in a broader context as it apparently shows up also in the Dasuopu ice core in the Himalaya, as indicator of an exceptional monsoon failure (Thompson et al. Science Vol. 289 no. 5486 pp. 1916-1919).

Here a reference is necessary. “Moreover, despite the striking increase of mineral dust transported over Europe during the last decades”.

The structure of the introduction is somewhat confusing. The sentence “In order to link dust sources. . . and potential source areas” is a kind of conclusive for an introduction while it is unexpectedly placed right in the middle.

This sentence is not clear. “The CG ice-core dust samples were extracted from cellulose membrane filters mounted on smear slides using Canada balsam, previously analyzed for total aerosols and mineral grain size by image analysis, using the procedure as described in Thevenon et al. (2009).”

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Filtering the samples might imply a fractionation of trace elements. The authors should discuss very carefully and eventually take into consideration this important analytical detail, providing also adequate references.

The description of trace element determination is not precise and lacks very important aspects. First, among the trace elements determined, only La is a REE. Details about blanks, accuracy, precision and how spectral interferences were circumvented during the analysis should be offered and adequate references presented.

The equations used to estimate the percentages of clays should be referenced.

Paragraph 4 “Results and discussion” should be structured (4.1, 4.2 etc.).

A table summarizing the statistics of concentrations and crustal enrichment factors should be provided. It is not clear why the authors chose different crustal references (Sc, Ta, Hf, Th): this makes the discussion somewhat confusing and/or redundant (please, see also my comment on Fig. 2)

“EFs were very low ($EF < 2$) for Ti, Ba, and La, thereby excluding important anthropogenic-induced fluxes of crustal elements (i.e. enhanced dust due to deforestation and agricultural activities).” This is a strange argument: I’m not sure how one would distinguish changes in dust emission caused by natural or anthropogenic factors.

“The Sr and Nd isotopic similarity between CG ice core data . . . is remarkable, demonstrating the overall Saharan origin for the paleodust reaching the Alps (Fig. 3)”. The authors make too much from their two close sampling sites. This situation is likely to occur in the Western Alps but has still to be demonstrated to take place in the Central and in the Eastern Alps.

The authors may want to check the statement that maximum Pb emissions in Europe occurred not only in 1970s but also around 1910 and 1935. Are they referring to relative maximum? In addition, the presumed correlation between changes in Sr isotopes ratios and Pb should be evidenced quantitatively.

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“Such features may also explain the fact that the JFJ samples are relatively depleted in radiogenic Sr with respect to CG samples (Fig. 3), since the accumulation time is very low.” This sentence is not clear.

“CG isotopic data furthermore suggest that intercontinental Saharan dust sources might contaminate glacial ice at summit Greenland and that Asian dust (e.g., Gobi desert) might reach the Alpine summits after long-range intercontinental transport within northwesterly winds (Burton et al., 2006; Svensson et al., 2000)”. CG data might just be consistent with a long transport of Saharan and Asian dust to the Alps and Greenland. However, the fallout of Asian dust to the Alps remains extremely speculative and not at all well constrained.

“Weaker summer southwesterlies trade winds inferred from CG dust record during the latter part of the LIA, are consistent with the synchronous decline of the meridional overturning circulation (MOC)”. In this sentence the word “consistent” seems inappropriate. The authors may want to check and reformulate their point.

Also this sentence is not clear. “Post-1850 increase in carbonaceous residues of combustion, or black carbon (BC), and in trace elements content, likely highlighted additional human impact on recent insoluble pollutant emissions”.

The conclusions might be reformulated according to the previous suggestions while the last two sentences of this paragraph might just be cut.

Figure 2 seems too busy while some important variations are not very well evidenced (e.g. 1780-1790 dust event). The concomitant use of EF and trace elements ratios (e.g. EF_Pb and Pb/Sc) seems redundant. Together with EF, it would be much more informative to display concentrations or fluxes. Finally, remarkable differences recorded at CG and Jungfrauoch for Ba, Ti and especially mean mineral size are not discussed within the text.

Figures 3 and 5: Adding the composition of the local rocks would help to rule out a

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significant local dust contribution.

Technical corrections:

The following is an example of how the text is lacking accuracy and how it might be improved. “Polar ice core studies document enhanced atmospheric crustal dust transport during glacial/interglacial colder climates” might be changed in “Polar ice core studies document enhanced atmospheric crustal dust deposition at a glacial/interglacial time scale”

“By contrast, Pb, and to a lesser extent Cs and U presented higher EFs ($EF > 10$), suggesting the impact of atmospheric emissions of trace elements from anthropogenic sources (e.g. mining and open pit operations, smelting, nuclear tests)”. This is just another example where the authors might be more precise and accurate: speaking about nuclear sources, do they refer to Ce and to the period 1950-1960? Is the Ce enrichment compatible with what was found in other studies? Also the other sources should be discussed (mining and smelting, for Pb? when? references? comparison with other studies?).

“Variations in crustal element abundances are primarily influenced by total and mineral dust inputs (Fig. 2)”. The authors probably refer to variations in concentrations and not changes in dust composition as discussed in Fig. 2. When they mention “depleted heavy elements”, they probably refer to concentrations and not changes in compositions.

“In order to evaluate European preindustrial atmospheric dust emissions” maybe the authors mean “In order to evaluate European preindustrial atmospheric dust concentrations”

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 859, 2011.