

Interactive comment on “No role for industrial black carbon in forcing 19th century glacier retreat in the Alps” by Michael Sigl et al.

Anonymous Referee #2

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This paper evaluates the hypothesis that black carbon deposition could play a dominant role in European glacier dynamics. The paper presents black carbon concentrations found in ice cores at Colle Gnifetti along with other tracers of different kinds of combustion. Authors examine the role of mineral dust in possible forcing; since it absorbs light, mineral dust can be a possible confounding factor. They also compare their measurements with those of other ice cores. Finally, they compare the trends of black carbon deposition with those of black carbon emission and point out discrepancies between measured tracers and bottom-up inventories. The work is supported by a careful treatment of timing and uncertainties to interpret the ice core measurements.

Overall, this part of the paper is a quite thorough and welcome contribution to the discussion of black carbon (and other species) emissions and influence during the

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industrial era. I commend the authors on their careful work.

The next part of the work— and the origin of the paper’s title— compares the timing of glacial retreat with the timing of black carbon increase. These glaciers are frequently observed, making them good candidates for such an analysis. Authors identify retreat and advance periods and compare them with time-of-emergence of black carbon above pre-industrial periods, finding no relationship. Finally, on page 11, authors posit that volcanic forcing, and not change in albedo caused by black carbon deposition, is the cause of glacial retreat. The glaciers analyzed (four in a "glacier stack") begin to retreat before the increase in black carbon emissions, so it is unlikely that black carbon, alone, caused the current retreat.

Despite this good point, this part of the work appears less supported by the evidence presented. An important question is on what time and spatial scales one respects a response between a forcing and a regional response. Attribution of climate response typically involves some kind of large-scale pattern matching, considering more factors than given here. One doesn’t expect an increase in black carbon emission to correlate neatly with the glacier retreat— although certainly the fact that glaciers retreated first indicates that other causes are at work. If there were such neat correlations, we should have much less trouble identifying the causes of climate change, overall. So the following questions would have to be answered in order to confidently state the "No role for black carbon" as in the title: What other factors could contribute to glacial retreat; How much do they vary and on what temporal and spatial scales (i.e. what noise could confound the signal and must be averaged out); and *then* how much black carbon does contribute and whether it has a significant effect.

The authors also considered volcanic forcing, which they suggest to be much more relevant than black carbon forcing, yet they did not provide any quantification of or data behind the volcanic forcing, but only some discussion. That quantification would be needed in order to make the statements in this paper with confidence.

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This paper is well-written and organized. One editorial comment: page 3, line 24 should read "light absorbing" instead of "light adsorbing."

In summary, I wholeheartedly support publication of the quite careful work on reconstruction of the black carbon and tracer deposition in ice, the comparison with previous ice cores and the discussion of the mismatches with emission inventories. This is a worthy contribution in itself and it could be published without modification.

In order to publish the discussion on the connection to forcing (and, it seems, the intent/title of the paper), there should be a broader discussion of the spatial and temporal patterns, variability, and other causes. That seems like a substantial amount of effort and I do not wish to minimize the authors' excellent contribution here. I suggest that perhaps, in order to proceed quickly toward publication, authors could include the timing of glacier retreat, point out that many other factors are at play including the volcanic forcing, and soften the title and statements regarding "no role" until a fuller analysis is done. I shouldn't be surprised if authors are already engaging in such a broader analysis.

Interactive comment on The Cryosphere Discuss., <https://doi.org/10.5194/tc-2018-22>, 2018.