

Clim. Past Discuss., referee comment RC1
<https://doi.org/10.5194/cp-2021-110-RC1>, 2021
© Author(s) 2021. This work is distributed under
the Creative Commons Attribution 4.0 License.

Comment on cp-2021-110

Yarrow Axford (Referee)

Referee comment on "Glacier response to Holocene warmth inferred from in situ ^{10}Be and ^{14}C bedrock analyses in Steingletscher's forefield (central Swiss Alps)" by Irene Schimmelpfennig et al., Clim. Past Discuss., <https://doi.org/10.5194/cp-2021-110-RC1>, 2021

This study builds upon previous published work at Steingletscher and Rhone glacier in the European Alps, adding paired ^{10}Be - and ^{14}C -derived apparent exposure durations from some key locations in the Steingletscher forefield.

The paper makes a significant new contribution to understanding the long-term history of glaciers in the European Alps, especially during past warm periods, and is well-suited to publication in COP. I find this to be an elegant study, shared in a well presented paper, and I don't have any major concerns or suggestions (which is unusual). The paper's introduction does a nice job setting up why the current approach is needed to fill in gaps in Holocene mountain glacier history. Methods and results are presented in good detail. I am not a cosmogenic isotope researcher, but am familiar with the study's methods and the study design (selection of sampling sites for ^{14}C , inclusion of the outboard deglacial site to confirm erosional resetting of the cosmo clock, etc) seems strong. I am less able to rigorously evaluate the quantitative approach to modeling the two isotopes, but can say that the assumptions they apply seem solid and grounded in a diversity of available glacial geologic/geochronological evidence from past work. Section 3, notably 3.3, provides key summary background on the methodological approach. (I do suggest adding one conceptual figure to help broaden the reach of the paper; see my detailed comments below.) The figures in this manuscript are clear and informative, providing detailed information about the study sites and results.

Minor comments (those most substantive are **ed):

The Abstract could use some tweaks to be more precise and impactful. Specifically:

- Instead of "we apply a new approach" would it be more clear to describe this as an emerging or increasingly popular approach? Current wording made me think this study was the first such use of its ^{10}Be - ^{14}C approach.

- Please clarify what is meant by "the predominant occurrence of glacier advances until the end of the Little Ice Age"

- The statement that "This implies that at least the summer climate of the HTM was warmer than that of the end of the 20th century for several millennia" requires that these glaciers have been roughly in equilibrium with climate of the late 20th Century rather than lagging far behind. I doubt this issue would have a big enough effect to nullify the quoted statement, but suggest discussing the assumptions of this conclusion more fully somewhere in the paper text to better support this somewhat provocative statement in the abstract.

Line 130 the word "century" is missing

Line 212 could be clarified, instead of "inboard of any of the Holocene glacier advances," how about "inboard of all Holocene moraines"? since evidence of some Holocene advances inboard of the moraines has been erased/covered.

**The conceptual model laid out in lines 220-233 is central to the paper, and well explained here – but things get complicated and hard to visualize when we get to section 3.5 and Figure 5b. An added conceptual figure illustrating the various relevant, hypothetical trajectories of the two isotopes would be very helpful in making this paper more meaningful for non-cosmo readers.

Section 3.6. May be worth mentioning the typical size of change from the recalibration? I assume recalibration was undertaken to be thoroughly accurate but made only a small difference that doesn't affect conclusions.

Lines ~465-469: Isn't it very likely that in the Joerin study some periods of retracted ice are simply not represented by discovered ^{14}C -dateable deposits? That possibility is acknowledged in line 472 ("might also be.... lacking organic material from unknown retreat periods at the radiocarbon-dated sites") but it's not made to sound particularly likely, thus the need for the explanation about relative glacier size in lines 468-469. An "absence of evidence is not evidence of absence" scenario seems likely – but I don't know the Joerin study and may very well be missing something. Just clarify in the text.

Line 474: do not capitalize chironomid

Line 491: clarify "steady ANNUAL warming". Interesting point about the Greenland N/Ar annual temp reconstruction contrasting with models showing annual warming through the Holocene.

Line 495: Cool point about widespread glacier advances ~3 ka but a lack of independent proxy evidence for temporary cooling to drive those advances. This seems like an interesting question/issue for glacial geologists and paleoclimatologists focused on the Holocene to ponder some more. Very very tenuously there may be hints of a corresponding climate event in the midge record in figure 6d?

**Line 500: "glaciers across the Alps were smaller than their modern extents for most of the Holocene" I think the take-home from this sentence would be even stronger if you put a timeframe on it. eg We find that Steingletscher was smaller than its present size for x-x kyrs in total throughout the Holocene, and given its expanded size throughout much of the past 3000 years, first shrank smaller than present no later than x ka. Likewise, line 503 could be more precise than "for several millennia of the HTM." (how many millennia and which ones?)