

Clim. Past Discuss., author comment AC3
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Reply on RC2

Tançrède P. M. Leger et al.

Author comment on "A cosmogenic nuclide-derived chronology of pre-Last Glacial Cycle glaciations during MIS 8 and MIS 6 in northern Patagonia" by Tançrède P. M. Leger et al., Clim. Past Discuss., <https://doi.org/10.5194/cp-2022-32-AC3>, 2022

Firstly, thank you for taking the time to provide some comments on the manuscript.
Please find below our reply to these comments.

Reviewer:

"L70 - Could you specify the timing of the LGC for clarity?"

Author reply:

In agreement with this comment, this information was added to the first reference to the LGC in the introduction section.

Reviewer:

"L230 - This might not be relevant, but is it worth mentioning why the work took place at 3 different labs? Interlab calibration?"

Author reply:

The reason for this is purely logistical. The 6 samples that were treated at CEREGE required more purification, and a time allocation that collaborators at SUERC did not have. As I, the principal investigator, was based at CEREGE at the time, these remaining samples were sent to CEREGE so that I could work more closely on them and purify them further. For practical and financial reasons, these remaining samples were also measured at the AMS on site. On 6 other samples: quartz purification and isolation only was conducted at Edinburgh prior to being sent to SUERC for wet chemistry and AMS measurement. This is also due to financial and logistical reasons.

Please let us know by replying to this comment if you think it is relevant to add this information to the paper.

Reviewer:

"L627 - 'outwash terrace sampled features preserved braided...' please consider rewording this part for clarity"

Author reply:

In agreement with this comment: this sentence was reworded to: "At the sampling sites, the outwash terrace surface displays preserved braided meltwater channels that suggest minimal outwash surface deflation post deposition"

Reviewer:

"L880 - You may consider referencing specific parts of Fig. 8 within this text for clarity (e.g., (Fig. 8D; Darvill et al., 2016), (Fig. 8C; Denton et al., 2021)"

Author reply:

Changes were made accordingly

Reviewer:

"L894 - Is it possible that some of the temperature proxies reflect changes in or a feedback/reaction to ice volume? Shouldn't MIS 5D be the coldest part of the last glacial cycle with high seasonality and very long, colder winters?"

Author reply:

The magnitude of cooling in Antarctic ice cores during MIS 5d is in fact quite impressive, around 10 degrees C in 20 ka according to the 5 core average temperature curve (fig. 8A). Indeed this is possibly related to this special orbital configuration causing high seasonality and very long, colder winters in the southern hemisphere. However this extreme orbital configuration occurred right after a strong glacial termination, just after the Earth's climate system reached a treshold and warmed abruptly, most likely due to an internal mechanisms such as an extreme Heinrich events, shutdown of AMOC, modification of the thermohaline circulation causing southern ocean current southward migration which could trigger a CO2 outgasing positive feedback etc. We thus need to look at both the orbital configurations but also the internal mechanisms reponsible for these abrut shifts in climate. This intense cooling started from a quite warm interglacial and thus didn't result in a maximum cooling of similar intensity than during MIS6,4,2 peak coolings.

Reviewer:

"In general, how strongly can we pin the range of ages (or just the maximum age) from outwash plains to specific insolation signals, especially when we should expect a delay of several millennia between forcing and response?"

Author reply:

Given the uncertainties associated with TCN exposure dating of such old deposits, we agree that a few kyr uncertainty is unrealistic. The main findings of the paper lie more in the establishment of the timing of local glaciations that we can attribute to a certain MIS interval, and with time-window precisions that lie more in the 2 sigma standard deviation ranges (10-20 ka), which are large enough to take into account production rate uncertainties. However, while we think our oldest cobbles are the closest "estimates" of the timing of these glaciations, they may indeed still underestimate the true deposition age, and only collecting many more samples would help determine whether this intepretation is correct. With this in mind, we have decided to modify the text in the discussion and the conclusion, to make sure that we talk about the timing of these glaciations using more conservative time ranges, rather than the exposure age figures

from the oldest cobble only. When talking about the timing of these glaciations in comparison with southern hemisphere insolation parameters and other palaeoclimate proxy records, we have added to the text that this entire discussion is based on our own interpretation of the available chronological evidence, which while yielding high confidence for MIS 2 chronologies, yields rather intermediate and low levels of confidence for our MIS 6 and MIS 8 record, respectively. We have made sure to further stress that our discussion around the role of local seasonality and seasonal duration implies the assumption that such extensive PIS glaciations likely occurred during periods of maximum hemisphere-wide cooling, and thus when antarctic atmospheric temperatures reached their lowest values as well. We thus use the precision of the Antarctic ice core chronologies which display minima in local atmospheric temperatures that are included in our much larger dating uncertainty ranges, to discuss the palaeoclimate and link to insolation hypotheses. Although these assumptions yield uncertainties, we still believe that this discussion is important and contributes some new thoughts on the debate around the drivers of southern hemisphere and global glacial/interglacial cycles.