"Investigating cold based summit glaciers through direct access to basal ice: A case study constraining the maximum age of Chli Titlis glacier, Switzerland" by Pascal Bohleber et al.

- Response to reviews -

Please note:

- Author's responses to the referee's comments are in blue
- Changes in the corresponding revised manuscript are highlighted in red
- All line numbers in "Changes to manuscript" refer to the new revised version
- All new references can be found in the new manuscript

Response to referee #1, B. Laabs

The manuscript describes a useful and important study of basal-ice in Chli Titlis glacier. The methods are described well and represent a preliminary investigation that the authors have already extended to other such glaciers. The manuscript is interesting and suitable for The Cryosphere. I believe it can be improved by addressing the comments provided below, which would constitute a minor revision.

We thank the referee for his comments and valuable suggestions for improving the manuscript.

Two items of importance are summarized here; the remaining comments are minor.

1. Please provide a location map of the Chli Titlis glacier and the neighboring glaciers described in the study. This will be useful for the readership that is less familiar with the study area and the regional glaciers.

   Thank you for the suggestion. We have used orthophotos, boundaries, and a DEM of Swisstopo to compile a location map as requested and include it as a separate additional figure in the revised manuscript. In choosing the dimensions of the map, we aimed for illustrating the location and exposition of the greater Titlis glacier as well as showing the local situation around the ice tunnel (smaller zoom-in).

Changes to manuscript: New Figure 1 (Location map).

2. The authors seem to waive on the reliability of the del-D data for basal ice, citing some concerns about the quality of the measurement. The data are described as a
regression with del\textsubscript{18O}, but are not illustrated. The authors should decide whether to include the data; based on the information given in version 1, the inclusion of the del-D data may not be necessary.

Our concerns regarding the reliability of the delta D data concern the measurements performed on samples of profile 1 in 2014 using the Picarro instrument due to difficulties with calibrating the instrument at that time (notably the independent set of delta 0-18 measurements performed via mass spectrometry is not concerned). Consulting with our technician the uncertainty in the absolute values of the delta D data is estimated as up to 4 permil. This also means that the slope in the co-isotopic plot would carry large uncertainty and not much could be gained from co-isotopic analysis. We therefore decided now to not include the delta D data of profile 1. For profile 2, however, the co-isotopic measurements by the Picarro instrument are considered reliable. We have now included the data and an additional plot showing the co-isotopic regression. We also explicitly state the relevant measurement uncertainty.

Changes to the manuscript:

- P6 L5-7: Added text.
- Added new Figure 4 showing co-isotopic data for profile 2.

Minor comments:

Page 1, Line 16: the term “sedimentary glaciers” is unconventional. Consider using a different term to characterize such glaciers. Perhaps you mean “stratified glacier ice”?

We have removed the word "sedimentary" and specifically explain that glaciers "archiving snow on a quasi-continuous basis" are concerned.

Page 1, Line 19: including an altitude range for “uppermost summit” glaciers?

Changed accordingly.

Page 2, Line 19: change “arrive just-in-time” to “are now available”

Changed accordingly.

Page 2, Line 23: change “offers constraining” to “limits”

Changed accordingly.

Page 2, Line 33: final sentence of paragraph is not necessary.
Removed sentence.

Top of Page 3: a location map of the study area and the glacier would be useful here.

New Figure 1 included showing a location map.

Page 3, Line 7: reword to clarify meaning of the phrase, “with an increase towards its back end”.

We have reworded the sentence to clarify.

Page 3, Line 17: insert sentence describing the “clear signs” of negative mass balance.

We have added an according sentence. P4, L22-23. To some extent, differences in surface conditions by fabric cover above the cave also become visible in the zoom-in of Figure 1.

Page 4, Line 7: change “a” to “an”

Changed accordingly.

Page 5, Line 10: change “that stem from” to “caused by”

Changed accordingly.

Top of Page 5: seems that radiocarbon dates appear too early. Move this table to a position after the “Radiocarbon dating” section.

Changed accordingly.

Page 5, Line 13: the delta D data are not shown in Figure 2 and are perhaps not necessary to discuss here.

As discussed above, we have now included a separate plot showing the delta D data of profile 2. Due to large uncertainty we decided not to further consider the delta D data of profile 1, however.

Page 6, Line 1: seems that a reference for the "systematic investigations" should be provided here, or described further if they were done in this study. In either case, please provide more information beyond that given at line 3.

Thank you for pointing this out. We have added more information and a new reference to the recently published paper by Hoffmann et al. (2017) which presents the systematic investigations into the effects of combustion temperature in micro-radiocarbon dating. The latter were not part of the study.
that we present here, but were performed as a separate investigation by Helene Hoffmann (PI).

**Changes to manuscript:** P6 L15ff: Added text and new reference (Hoffmann et al. 2017).

Page 7, Line 32: here the delta D data are implied to be more reliable than stated on page 5 (in Methods). Some statement of potential error in the delta D should be included here, as should a figure showing the regression of the delta D and delta 18O data.

As mentioned above, we now mention the large potential error for delta D in profile 1 and justify not considering this data further. We also include a plot showing the regression for profile 2.

Figure 2 caption: the statement “no distinct basal isotope was found in profile 3” is unclear. Reword the statement to clarify it.

Reworded the statement to clarify.

Page 9, Line 2: define CPO and expand on the last sentence to explain its significance.

We have added additional text and references to clarify the significance of the CPO (as far as possible).

**Changes to manuscript:** P11 L5-8: Added text and references.

Page 10, Lines 1-5: here, the reader would benefit greatly from a location map showing the study area relative to the nearby glaciers with mass balance measurements.

Added a new Figure 1 and make reference to it here.