**Author comments:**
*We thank the reviewer for taking the time review the manuscript and provide thoughtful and constructive feedback. Reviewer comments and suggestions have been addressed; please see the below replies in blue italicized text.*

**Reply to RC1 (Tobias Erhardt):**

Harlan et al. present a description of the measurement setup for the MBS CFA record and the associated uncertainties. Overall I found the manuscript to be complete, well written and very readable!

*We thank the reviewer for the thoughtful feedback.*

I only have some minor remarks that the authors should address before publication:

The most important one is a potential issue with the relative delay estimation between the two parameters (Section 4.4): The authors determine the signal delays using the maximum of the derivative during the transition into the standard measurements. This approach is certainly valid, but a small detail is missing from the discussion: The influence of the signal smoothing on this way of determining the relative signal delays. For higher signal smoothing the maximum of the derivative will occur systematically later as the derivative will have its maximum at approximately halve the signal amplitude. This will introduce a slight systematic overestimation of the signal delay for parameters with larger smoothing relative to parameters with less signal smoothing. I would encourage the authors to add a few sentences in this regard.

*We thank the reviewer for bringing this up - we agree that this is an important point and well raised. We chose this method due to its ability to be applied to each run in a systematic way but agree that (as with all approaches) there is a certain degree of bias dependent on signal smoothing inherent to this method. We will add something along the lines of the following text at end of section 4.4 to address this:*

*"Other choices for delay calculations could have been to use the start of the rise or even the end of the rise, however due to smoothing can be hard to reliably identify, whereas the maximum of the derivative of the increase is easily and systematically identified. However, we recognize that this can introduce a minor offset between methods that are highly smoothed in comparison to those that have faster response times."*

The second is the description of the differences between the 2018 and 2019 setups. Judging from the flow diagrams in Figure 3, the systems were quite different with respect to the parameters presented here. I would suggest the authors expand this section significantly to delineate all the differences also in terms of procedures.

*We agree that more detail could be warranted by other CFA users/readers, especially with regards to run procedures. The most meaningful differences in the two system setups are described in the manuscript, namely the depth registration types i.e. the difference between using an encoder and a laser. We see the point raised that the two instruments/methods could influence the final depths slightly differently, however these effect of these differences on the final dataset are likely very minor. Some of the potential differences between the two methods include the shorter "dead time" with the laser vs the cable encoder, which must be fully removed and replaced during frame changeover. Additionally, while the 55 cm piece lengths used in the 2018 campaign introduce more potential contamination at breaks, they make absolute depths more certain, as the top depths are known at every 55 cm rather than every meter. We will add a few more lines regarding that in the section titled "Depth scale".*

*Besides these depth differences, the systems were not in fact too different in the end (i.e. delay time to the conductivity measurement was in both systems 15 seconds (stated in section 4.4). Calibrations and processing of calibrations were made based on the same concentration and dilution of standards, following the same calibration data processing method. In section sampling resolution we explain how the different melt-rates influenced the resolution "These melt-rates produce a direct sampling resolution (independent of smoothing due to response time) of 0.58 and 0.68 mm, respectively"*

*We will add text to the methods sections specifically delineating the elements of the systems and procedures that were the same and/or different, elaborating on the system diagrams in Figure 3.*

Specific remarks:

L 123: "temperamental" is an odd choice of words. To avoid personification maybe describe in terms of noise sensitivity

*We will update the text with more appropriate terms such as 'inconsistent' or 'erratic'.*

Section 3.0.2: See comment above.

Section 4.4: See comment above.

Section 5.0.1: Explain target meltrate especially in light of the density change downcore.

*While we present here the melt-rate throughout each measurement campaign, during the 2018 campaign (top ~95 m), the melt-rate did in fact decrease as the firn/ice density increased downcore. We will elaborate further on this in section 5.0.1 to provide more clarity on how the melt-rate was adapted to the density changes.*

Section 6.1: What makes the pH measurements more sensitive to the pressure fluctuations than the Na channel? From my understanding both are absorption spectroscopic methods and are thus more sensitive to mixing ratio fluctuations than the fluorescence detection.

*Indeed both absorption methods are more sensitive than fluorescence methods. The acid method however is even more sensitive than the sodium method, because rather than being a "true" absorption method it relies on pH dye changes using a combination of two dyes to cover the full range of pH expected in ice core waters One could thus think of it as a double "absorption" function, the dyes are each most efficient at one wavelength, but do impact each others max wavelength. The method is optimized and described in Kjær et al. (2016) so we refer to that for more details. Because the method is very sensitive to the dye to sample ratio, small flow changes (i.e. squeezing and wear of pump tubing, which naturally happens over time, as well as pressure changes and temperature changes) influence the method more than the also sensitive Na+ method. In the Na+ method, the issue (more so than exact mixing of reagent and standards) seems to be due to wear out of the IMER column over time, causing a slower drift. We refer to Kaufmann et al. (2008) for more information on that method.*

Section 6.5: Please explain the filtering approach detailed enough so that others are able to replicate the same thing, if needed. This will also help to judge the imprint of the filter on the final dataset in terms of its frequency content.

*We state in section 6.5 that the filtering approach was "applying a filter that applies a threshold cutoff to the differential of the signal (due to the characteristics of these features)." We agree that this could use more detailed elaboration. Text will be added to the manuscript which more explicitly describes the method of data filtering, stating text along the lines of the following:*

*"The passage of air bubbles through the detectors results in a signal characterized by a significantly steeper increase (and subsequent decrease) in the signal voltage than anything produced by variability in the ice core sample. Because of this characteristic peak shape, we are able to define for the differential of the dataset, a threshold, values above which we use to define "bubble spikes" in the data, which can be safely removed from the dataset."*

***References:***

*Kaufmann, P., Federer, U., Hutterli, M. A., Bigler, M., Schüpbach, S., Ruth, U., Schmitt, J., and Stocker, T. F.: An improved continuous flow analysis system for high-resolution field measurements on ice cores, Environmental Science & Technology, 42, 8044–8050,https://doi.org/10.1021/es8007722, 2008.*

*Kjær, H. A., Vallelonga, P., Svensson, A., Elleskov L. Kristensen, M., Tibuleac, C., Winstrup, M., and Kipfstuhl, S.: An Optical Dye Method for Continuous Determination of Acidity in Ice Cores, Environmental Science & Technology, 50, 10 485–10 493,https://doi.org/10.1021/acs.est.6b00026, pMID: 27580680, 2016.*