

Dear Dr. Marie Dumont:

Thanks a lot for your letter concerning our manuscript (ID: egosphere-2022-552). I'd like to provide some detailed changes in the results, discussion, and conclusion performed in the manuscript in response to the main concern of the reviewer.

In the method section, we added some information about the dataset and the method to preprocess the ice core data. After the preprocessing, temporal uncertainties of ice properties in each year were reduced. In the revised manuscript, about half of the text in Section 2.1 was newly provided.

In the result section, all figures (Figures 2-8) have been updated. On the one hand, the data after preprocessing are not the same as the original version. On the other hand, the color of lines was adapted to avoid indistinction for color-blind readers. Analyses in this section were also revised accordingly. The treatment of uncertainty was supplied as a part of all analyses done in the manuscript. About 40% of analyses in Sections 3.1, 3.2, and 3.3 was revised. After the analysis of variance, we found that the variation in the top layer of ice between years was statistically insignificant. Meanwhile, the interannual variations in the interior layer were significant. These were also the main changes in the conclusion.

Section 4.2 of the discussion was almost completely rewritten (three pages). Figure 11 was also remade. We discussed the potential spatial and temporal variability in ice cores in response to the main concern of the reviewer. We found that the shortwave radiation in the study years was nearly constant (99.4 ± 6 W). Furthermore, variation in melting days of ice sampling sites between years was statistically insignificant (ANOVA, $P > 0.2$). Previous observations also demonstrated that ice surface melt was relatively stable in August (e.g. Perovich et al., 2003; Nicolaus et al., 2021). Therefore, we think the effects of temporal variations on the ice surface were relatively small and can be ignored. As for the ice interior layer, its variations were significant. Previous observations have reported that properties of the interior layer were nearly constant in the melt season (e.g. Light et al., 2008; Frantz et al., 2019). So, the variations in the ice interior layer did not result from the temporal variability.

The spatial differences in ice cores have been provided in the original manuscript. In the last version, we found there were no clear changes in the optical properties of the top layer in different latitude zones. Furthermore, the scattering coefficient of the ice interior layer from the low-latitude zone was relatively small. The reviewer believed these were "useful, justifiable results". Combined with the analysis in Section 3.2, we found the top layer of ice cores has no significant temporal, spatial, or interannual

variations, and the variations in the interior layer consisted of interannual and spatial variations. Then, we further quantitatively discussed the effects of spatial variations on the whole variations of the interior layer through the propagation law of variation ($\text{whole variations}^2 = \text{interannual variations}^2 + \text{spatial variations}^2$). Some ice cores in 2014 and 2016 were sampled in the low-latitude zone. All ice cores in 2008, 2012, and 2014 were sampled in mid- or high-latitude zones. According to the differences between ice cores from different years (Figure 3) and different latitude zones (Figure 10), we correct the scattering coefficient of the interior layer in 2014 from 176 m^{-1} to 182 m^{-1} . That's to say, the interannual variations were larger than the whole variations by 6 m^{-1} . The value of 2016 was also corrected accordingly. Then, variations between the corrected scattering coefficient of the interior layer could be regarded as the result of the interannual factors.

In the revised conclusion, we emphasized that there are no statistically significant spatial, temporal, and interannual variations in the ice top layer. Meanwhile, variations in the interior layer were significant and mostly resulted from the different ice ages.

We hope these descriptions of changes performed in the manuscript are helpful for you to proceed with a decision on the manuscript. Thanks a lot.