Thank you for your attention to the manuscript.

General:

Based on our experiments and analysis, we found a close relationship between the $\delta^{18}O_{bub}$ enclosed in the alpine glacier Tanggula and its variation (strong accumulation or melting) in the central Tibetan Plateau. It showed that the strong accumulation (deep firn) or melting (water involved ice formation) of the glacier could lead to unusual positive or negative values of the $\delta^{18}O_{bub}$. This is the first investigation of long-term series of $\delta^{18}O_{bub}$ enclosed in the Tibetan Plateau glaciers. We think it might could provide an available way to reconstruct the glacier variation and the climate change over the historical time in the third pole Tibetan Plateau.

Reply to major point comment:

At the very beginning of the introduction part, we briefly introduced the significance of the ice core air bubbles research for the climate and environment reconstruction. We think this might provide a background of the ice core air bubble research and could make it easier for more readers to understand the detail subject we mentioned next in the manuscript.

We also think these measurement and conclusion results about the variations of component and composition of air bubbles enclosed in glaciers in the polar regions could help for further understanding of what caused the variations of component and composition of air bubbles enclosed in the alpine glaciers.

Discussion about the potential influences on $\delta^{18}O_{bub}$ from processes such as firn thickness variations, melt water influences etc. is firstly introduced in the second paragraph at the introduction part. Then, further discussion was made during the analysis of the implication of the variation of δ^{18}Obub in the Tanggula ice core.

Dating of the ice core in this manuscript was based on the combination of different approaches. The upper (shallow) part of the ice core was dated by the annual counting method which was widely used for the alpine glaciers in The Tibetan Plateau. Then the dating model for the mountain glaciers which was developed by other researcher Bolzan et al. (1985) was used for the deeper part of the ice core when the annual signal in not clear. Absolute age control of the annual counting result was done by the measurement result of the β activation maximum at 1963 A.D. in the TP. Through the comparisons between these two results, we concluded that the uncertainty should be about 2 years. For deeper ice, the credibility of the dating result calculated by the Bolzan ice flow model was verified by the dating result from comparisons of ice core air content to the solar variation. More detailed and accurate description will be given in the revised draft.

The air in the ice was not extracted from the ice. On the other hand, we used an image analysis method during the describing process of the ice core physical properties. The results was used in this manuscript for the roughly dating of the ice core by compared it the solar variation, Which could help to calibrate the model calculated age. The detailed method was described in section 2.2.

The procedure for the measurements of $\delta^{18}O_{bub}$ was described in section 2.2. As the release method of the air in the ice was a mature method developed by our coauthor and was already published, so we did not describe it in this manuscript, but cited. It was an online system. And the water vapor was firstly cleaned in the cold trap after the air released. Furthermore, it was secondly cleaned by a nafion drying tube before the air component was transported into the Mat-253. The $\delta^{18}O_{bub}$ and $\delta^{17}O_{bub}$ were both measured by the Mat-253. No other isotope and elemental ratios were measured during the experiment.

The glacier flow model formula was obtained from the published article which was cited in the manuscript. So detailed method was not mentioned in our manuscript.

Reply to Intro:
Yes we agree. In our discussion part we analysis the physical and chemical influence to the variation of the $\delta^{18}O_{bub}$. More introduction of these items relevant for the manuscript will be added to the revised manuscript. The $\delta^{15}N$ wan not measured in this study.

Reply to Line 40f:
More contribution factors like the ecosystem variation to the Dole effect will be added in the revised manuscript.

Reply to Line 49ff:
Yes, we agree.

Reply to Line 64:
As the $\delta^{15}N$ was not measured for this study, the exact firn thickness was not discussed in the manuscript.

Reply to Line 95f:
we used an image analysis method during the describing process of the ice core physical properties. It is used in our manuscript for the roughly dating of the ice core by compared it the solar variation. The detailed method was described in section 2.2.

Reply to Fig.2:
Yes, we agree that uncertainty should be existed. The absolute age control of the annual counting result was done by the measurement result of the β activation maximum at 1963 A.D. in the TP. Through the result comparison, we concluded that the uncertainty should be about 2 years. For deeper ice, the dating result calculated by the Bolzan ice flow model was verified by the roughly dating result from comparison of ice core air content to the solar variation. It is possible that sometimes there was age errors for some part of the ice core, but it does not affect the result discussion in decadal or centurial scale.

Minor points:
Reply to Line 158:
Yes, we agree.

Reply to Fig.3:

The Bolzan glacier flow model formula was obtained from the published article which was cited in the manuscript. So detailed method was not mentioned in our manuscript.

Reply to Table 1:

The lab internal reference standard gas in this manuscript is the compressed ambient air which was mentioned in the section 2.2. More information will be added in the revised manuscript.

Reply to Line 206:

Yes, we agree.

Reply to Fig.4:

In our experiment we assume today's ambient air to be zero. Yes. We think the unusual variation of the δ^{18}Obub in the Tanggula ice core should be affected by other factors rather than the global climate changes. Based on our analysis we concluded that the oxygen isotope of gases in firn layer or ice could exchange with that of the melt water through a series of physical and chemical reactions caused by strong ultraviolet rays before or after the enclosure of gases into ice.

Yes, we mean during the late Holocene.

Reply to Line 215f:

As the δ^{15}N was not measured for this study, the exact firn thickness was not discussed in the manuscript. However isotopic gravity fractionation in firn has been demonstrated in other studies. It was cited in the introduction part.

Reply to Line 221f:

Yes, we think it is important. This also showed the different climatic and environmental implications of ice core gas isotopes of glaciers in the TP compared to that in the Polar regions.

Reply to Line 232f:

We will rewrite it in the revised manuscript to make it for better understanding.

Reply to Fig.5:

The reference to these data was cited from Line 264 to Line 270.

Reply to Line 309:

Yes, we agree.

Reply to Line 312:

More conclusion detail will be added in this part in the revised manuscript.