Dear Prof. Lonnie Thompson,

Many thanks for your constructive comments. Below a point-to-point response to the comments. The comments are in black, and our response is in blue.

Comments: Hou, et al. Age of Tibetan ice cores by L.G. Thompson

The authors raise an important point about the age of the Guliya record as it is unusual in light of previous Tibetan Plateau (TP) records from the Dunde ice cap, Dasuopu Glacier (col) and Puruogangri ice cap. For their Chongce ice cores, the authors used a novel method of radiocarbon dating water-insoluble organic carbon (WIOC) particles at the microgram level from carbonaceous aerosols embedded in the glacier ice from 44 meters to 216.6 meters depth.

They import these dates into a simple two dimensional flow model to develop a time-depth profile. Questions should be raised concerning the use of such a model, given the complex flow regimes in these western Kunlun glaciers. More importantly the authors do not show any climate record derived from stable isotopes from these ice cores so that the reader can evaluate the quality and continuity of the record and how it compares to the other TP climate records (especially the 1992 Guliya record). Guliya is unusual in that it shows large and abrupt variations in $\delta^{18}O$ below ~150 m, which other TP records do not contain. Does the longest record from Chongce show similar variations?

Response: We agree that the two dimensional flow model, though widely used for establishing the ice core chronology including the Dunde (Thompson et al., 1989) and the Puruogangri (Thompon et al., 2006) ice cores, is too simple to account for the complex flow regimes close to the glacier bedrock. We will therefore remove the extrapolation from the oldest (and deepest) ^{14}C data point to the bedrock. Otherwise, we simply used the flow model to fit the dating points for obtaining a continuous age-depth scale. We agree that independent evidence such as the stable isotopes from these ice cores would be helpful to support the dating. We just finished the measurement of stable isotopes of the Chongce 135.8 m Core 2 and the 58.8 m Core 3 and they suggest Holocene origin in agreement with our dating. We are preparing the corresponding manuscript and therefore cannot post these $\delta^{18}O$ profiles here and make them public at this moment. Nevertheless, we will provide a copy of these $\delta^{18}O$ profiles for the review purpose only.

Another concern about the Chongce record is geophysical in nature. In 1991 Chinese scientists published a Quaternary Glacial Distribution Map of the TP. According to this map, the terminal moraines around the Guliya ice cap are very close to their maximum position during the last two glaciations. However, this is not the case for the Chongce ice cap located just ~30 km to the west. Chongce shows the greatest variations in ice extent of any of the ice caps in this region. In addition, the Chongce glacier, which flows from the Chongce ice cap, surged between 1992 and 2014 while the Guliya ice cap remained static (Yasuda and Furuya, 2015; Fig. 3). Therefore, it might be inaccurate to assume that the timescale developed for the Chongce cores should reflect that of Guliya. In light of the evidence indicating the instability of the Chongce's ice flow, the longest core drilled in the deepest section of a valley glacier which flows through a bedrock trough (fig. S2) is very unlikely to be an optimal site for retrieving an undisturbed paleoclimate record. In light of the geophysical considerations discussed above it would be premature to conclude that these results invalidate the much longer Guliya timescale.

Response: Thank you for bringing to our attention of Yasuda and Furuya's work on the dynamics of surge-type glaciers in West Kunlun Shan. From Fig. 3 of their paper, it is clear that the surged area is confined within the Chongce glacier (Fig. 1). Using topographical maps, Shuttle Radar Topography Mission (SRTM) and Landsat data, we have examined the area changes of glaciers on the Western Kunlun Mountain (including the Chongce and Guliya ice caps) since the 1970s (Fig. 1. Wang, Y., Hou, S., Huai, B., An, W., Pang, H., Liu, Y.: Glacier anomaly over the Western Kunlun Mountains, northwestern Tibetan Plateau, since the 1970s, *J. Glaciol.*, 3rd revision). For the whole area, change of the glacier area reveals insignificant shrinkage by 0.07 ± 0.1% yr^{-1} from the 1970s to 2016. The Chongce glacier retreated between 1977 and 1990, and advanced from 1990 to 2011 (period of surge), then remained stable until 2016. In contrast, the Chongce ice cap remained static from the 1977 to 2016 (Fig. 1), confirming the stability of the ice cap where our ice cores were recovered. Moreover, we observed similar mass changes of surge-type and non-surge-type glaciers over the Western Kunlun Mountains, suggesting that the flow instabilities seem to have little effect on the glacier-wide mass balance. Similar mass budgets for surging and non-surging glaciers have also been reported in the Pamirs and Karakoram (Gardelle et al., 2013). Based on the estimate of elevation changes over the West Kunlun Mountain by Lin et al. (2017) and Zhou et al. (2018) (Figs 3 and 4), it is reasonable that Chongce ice cap is in balance between 1973 and 2014. Therefore, the impact of surge over the Chongce glacier is minimal, if any, on the stratigraphy of the Chongce ice cap, especially in its accumulation zone where our Chongce ice cores were drilled.

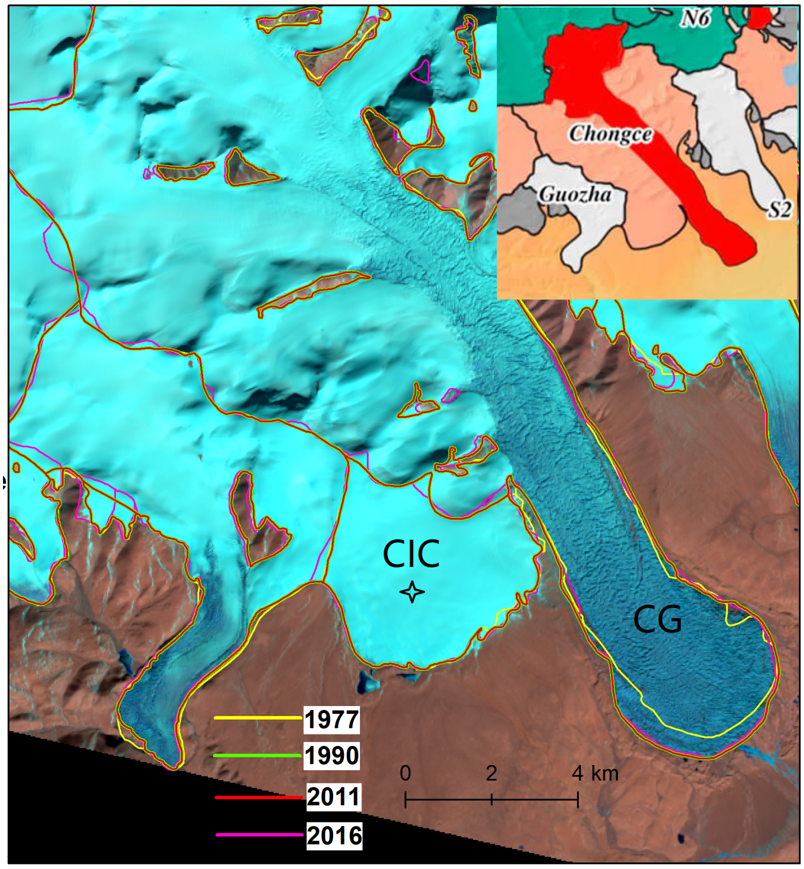

Fig.1. Map showing the Chongce Ice Cap (CIC) and the Chongce Glacier (CG), with the terminus positions at different time. The star shows the position of the drilling site of the Chongce Cores 2 and 3, which might be an optimal site for retrieving an undisturbed paleoclimate record. The inset is from Fig. 3 of Yasuda and Furuya (2015) with the red area showing the surged area confined within the Chongce glacier. Terminus positions are determined from Landsat images as shown in Fig. 2.

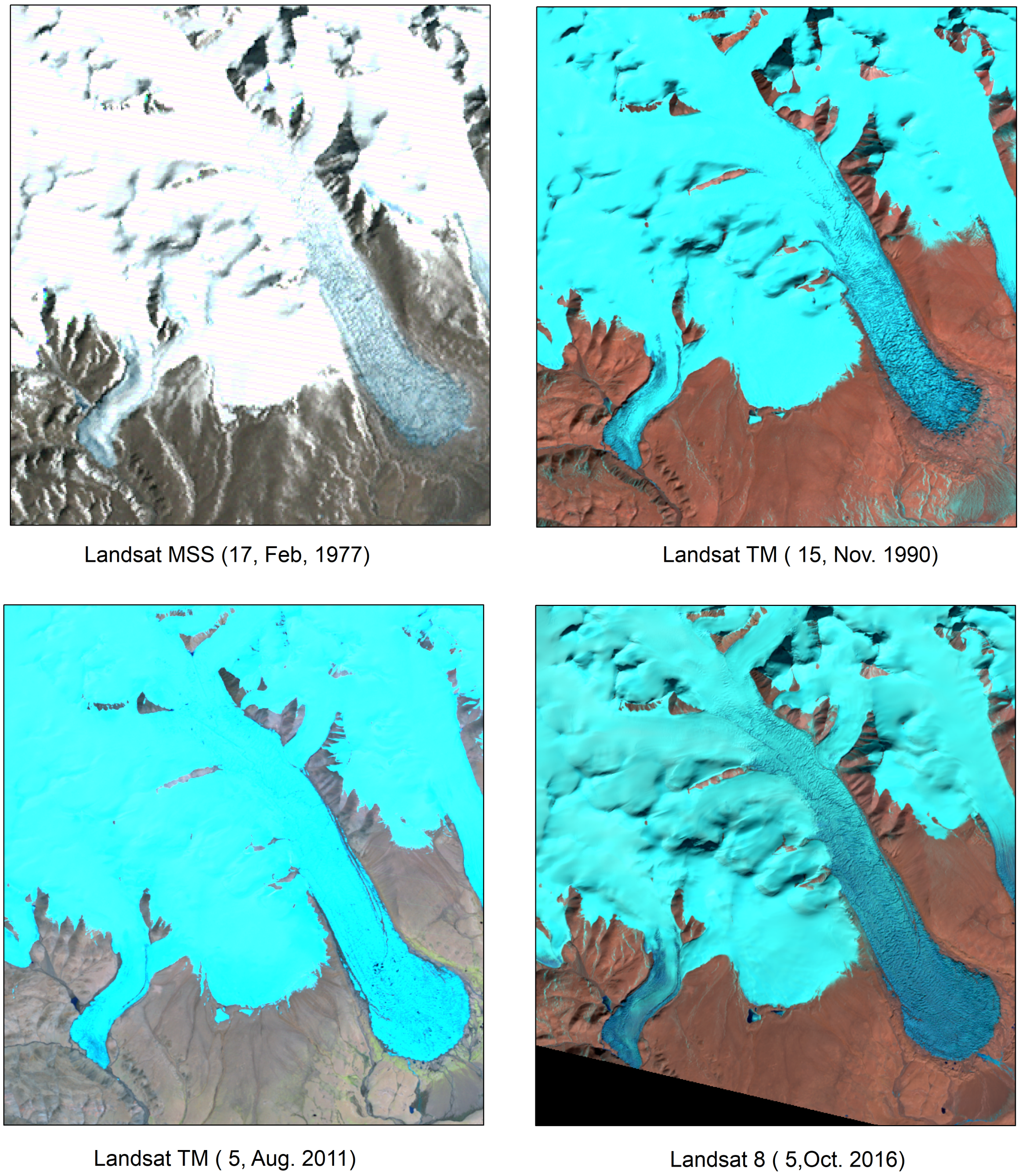

Fig. 2. Data for Chongce glacier and ice cap terminus position assessment. They are co-registered to the topographical maps and the accuracy of co-registration is about 20 m (slightly more than half of one pixel of Landsat images)

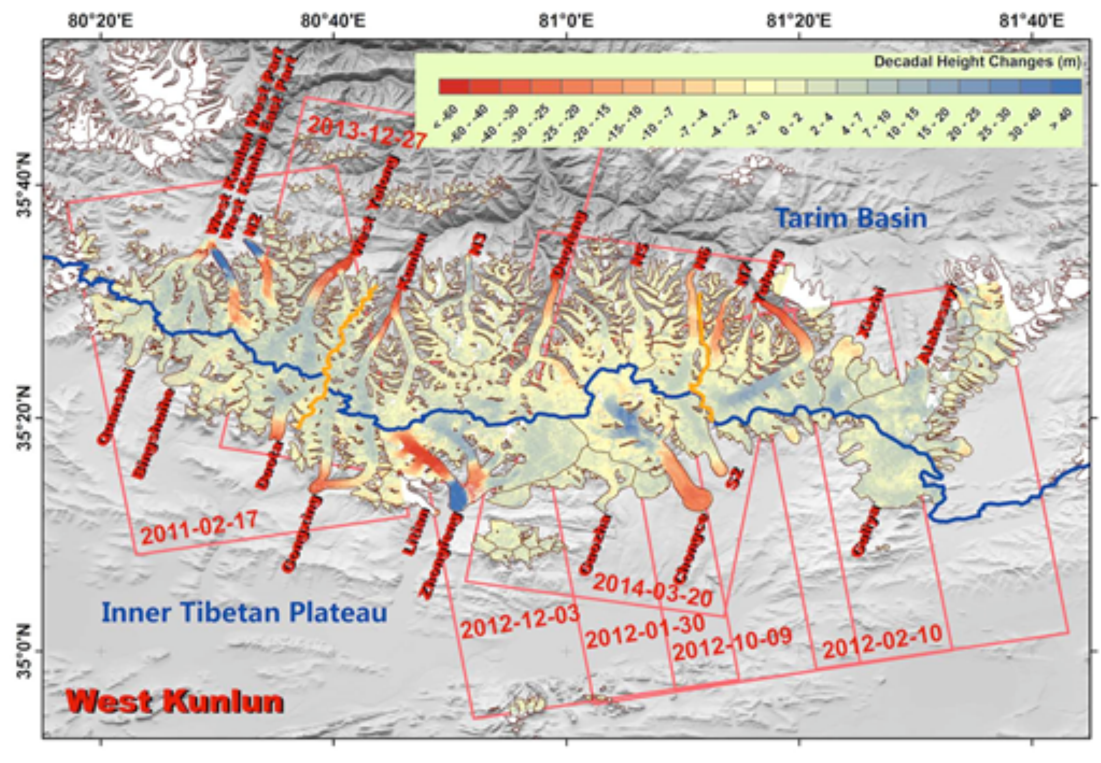

Fig.3. Glacier height changes from 2000 to the 2010s from Lin et al. (2017)

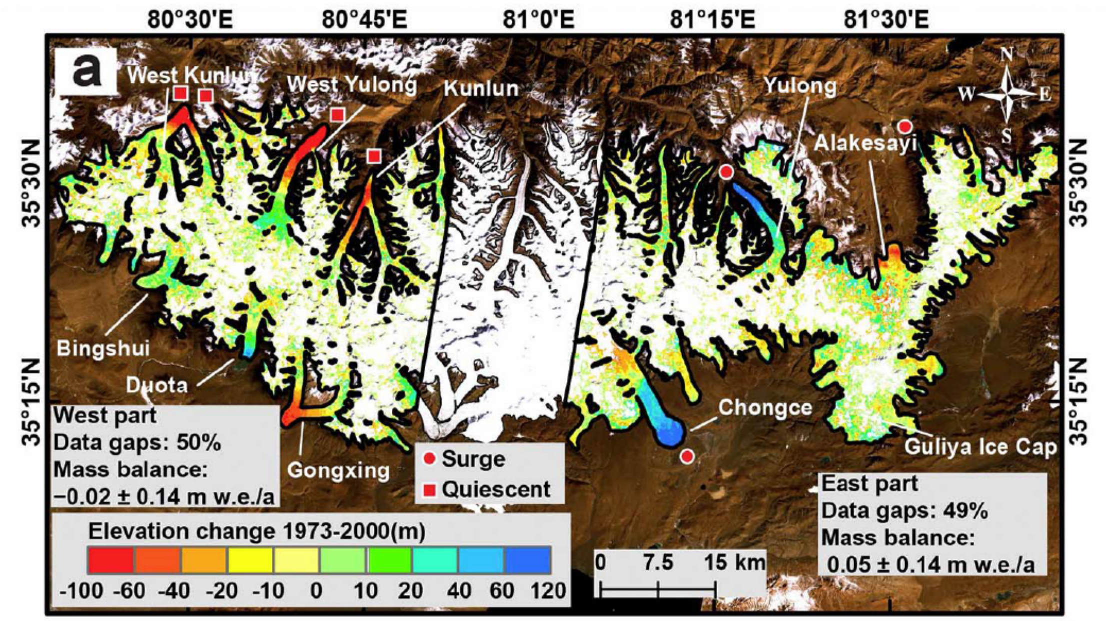

Fig.4. Glacier elevation change from 1973 to 2010 from Zhou et al. (2018)

Although the 1991 Quaternary Glacial Distribution Map of the TP (Li and Li, 1991) can provide valuable information about the quaternary glacier variation on the TP, its spatial resolution (1:3 000 000) may be insufficient to delineate the variation features of a specific glacier or ice cap. Later, Jiao et al. (2000) studied the evolution of glaciers in the West Kunlun Mountains during the past 32 ka (Fig.5). It is clear that the Chongce glacier advanced much during the LGM, while the terminal moraines in front of the Chongce ice cap are very close to their maximum position during the LGM, similar to those around the Guliya ice cap, confirming the stability of the Chongce ice cap since the LGM.

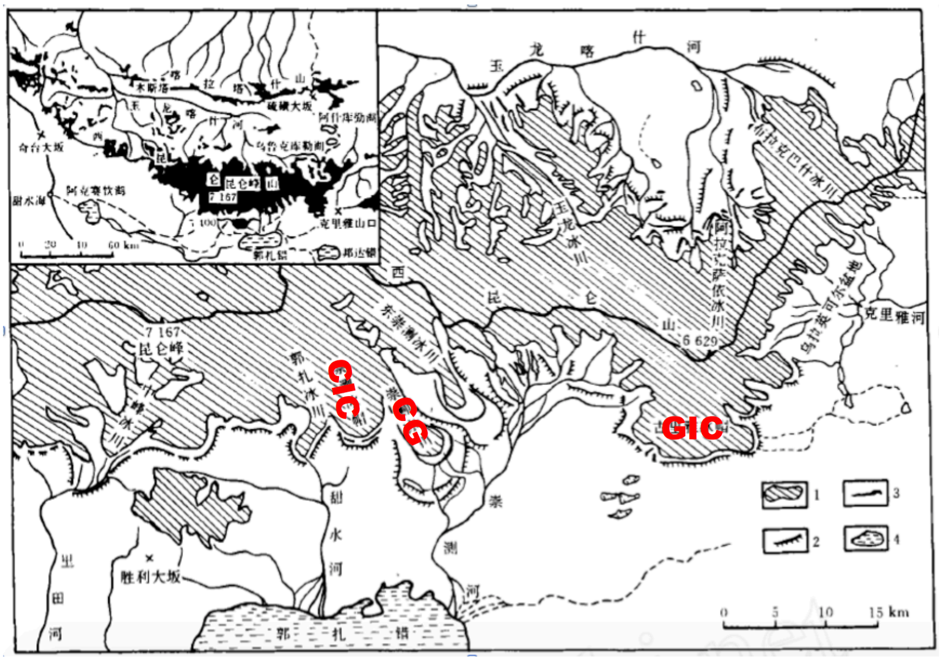

Fig.5. Map showing the glacier distribution and the lower limit of the LGM in the West Kunlun Mountains (Jiao et al., 2000). CIC: Chongce Ice Cap, CG: Chongce Glacier, GIC: Guliya Ice Cap. 1: present glacier, 2: terminal moraine during the LGM, 3: terminal moraine during the Neoglaciation, 4. lakes

Note that the location shown for the 1992 Guliya core in Fig. S1 is incorrect. This should be corrected.

Response: We used the coordinates (35°17’ N, 81°29’ E) published in Thompson et al. (1997) for the location of the 1992 Guliya core. We would be happy to make a correction if more accurate coordinates are provided.

We strongly agree with the authors that more effort is necessary to explore multiple dating techniques to confirm the ages of the TP glaciers, including those from Chongce and Guliya. The Western Kunlun region, located at the intersection of the regions dominated by the westerlies and the SW Monsoon, is climatologically complex and the interactions of multiple air masses makes stable isotope interpretation challenging. Multiple aerosol sources also complicate the reconstruction of the paleo-environmental records preserved in these ice fields.

Response: We fully agree with this comment. Thanks to the new analytical techniques, we should have more opportunities to decipher the complexity of the Tibetan ice core records.

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