Dear Referee,

Many thanks for the constructive comments. Below I have made a point-to-point response to the comments. The comments are in black, and our response is in blue. I hope that the response can be acceptable.

Sincerely yours,

Hou Shugui

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comments by Anonymous Referee #1

The manuscript by Zhang et al. provides interesting and new data which justify publication in The Cryosphere. It is relatively well structured and well written. However, English wording is partly not sufficient and some language editing will be required (for example in lines 15: ".... interpretation this information....", "....highland over the world....", line 21 "its sounding regions.").

We have accordingly revised these sentences.

Lines 14-15: We revised this sentence as:

A precise chronology is the essential first step for a reliable interpretation of the ice core records.

Lines 15-16: We revised this sentence as:

The Tibetan Plateau, sometimes called "the Roof of the World", is the world's highest and largest plateau with an average elevation exceeding 4000 m above sea level (a.s.l.) and an area of 2.5 Million square kilometers.

Lines 20-21: Following Cheng et al. GRL 2012, we revised this sentence as:

During the past two decades, the Guliya ice core record has been widely used as a benchmark for correlating regional climate variables in the Westerlies region of the central Asia and the northern Tibetan Plateau.

There are three major deficiencies which need to be addressed before publication:

1) The implications of the Kesang Cave record for the reliability of the Guliya ice core chronology are barely touched in the manuscript. The issue is mentioned but not explained in detail. Unexperienced readers will not understand the point. So, why is Kesang Cave and also the new study supporting the opinion that the Guliya ice core chronology is not correct. What is the evidence from Kesang Cave? This is not explained in sufficient way.

Yes we include a short introduction about the records of the Kesang Cave and the Guliya ice core in the Supplement in order to make the communication as concise as possible.

The Guliya ice core and the Kesang Cave core

In 1992, a 308.6 m ice core to bedrock was recovered from the Guliya ice cap located at 35°17'N, 81°29'E on the northwest Tibetan Plateau (Figure 1). The drilling site is at an elevation of 6200 m a.s.l. Top 266 m of the core was dated to a period spanning 110 ka, and ice below 290 m depth was suggested to be more than 500 ka old due to ^{36}Cl-dead in the ice (Thompson et al., 1997). Three Guliya interstadials (Stages 3, 5a, and 5c) are marked by increases in $\delta^{18}O$ values similar to that of the Holocene and Eemian (~124 ka ago) (Thompson et al., 1997).

The Kesang Cave is located in the Tekesi County,western China (42°52′ N, 81°45′ E, elevation ~2000 m a.s.l.) (Figure 1). Eight samples from the Kesang Cave were collected to establish the Kesang $\delta^{18}O$ record with three covering the Holocene and five covering the rest of the Pleistocene portion. Cheng et al. (2012) obtained precise ages (~150 dates), all in stratigraphic order within errors, using a ^{230}Th dating technique in the University of Minnesota. The stalagmite $\delta^{18}O$ variations largely reflect changes in the $\delta^{18}O$ of meteoric precipitation (Cheng et al., 2012).

To reconcile the difference in the $\delta^{18}O$ variations between the Guliya and the Kesang records, Cheng et al. (2012) suggested that the Guliya record needs to be younger about a factor of two.

2) The authors state that the Chongce ice cap is not older than 42 ka. They also argue that this age is much younger than those assumed for the lower parts of the Guliya ice cores. However, what are the paleoclimatic implications of their findings for the Chongce ice cap? Are the new data evidence for an ice-free region in the Chongce region in Marine Isotope Stage (MIS) 3? If so, what are the implications for the snow and ice accumulation rate at Chongce since the establishment of the ice cap sometime in MIS 3 or later? What does the statement that

Chongce subglacial sediments are much younger than Guliya basal ice imply? Are the two ice caps comparable in terms of altitude, exposure, underlying relief, etc.?).

We have thought seriously about these constructive comments.

The luminescence dating of the basal sediment of the Chongce ice cap provides an upper limit of 42 ± 4 ka. This might imply that the ice age at the bottom of the drilling site should be younger than this upper limit, although we do not know the exact age of the bottom ice at the drilling site. The new data does not imply for an ice-free region in the Chongce region in Marine Isotope Stage (MIS) 3, but for an ice-free condition at and below the elevation of the bottom at the drilling site during a (or more) warm period (or periods) since the upper limit age (e.g., MIS3, the Bølling-Allerød period, Holocene Climate Optimum). Given the surface elevation of the Chongce drilling site of 6100 m a.s.l. and the ice core length of 216.6 m, the elevation at the bottom of the Chongce drilling site should be 5883.4 m a.s.l. As to the Guliya ice core, the surface elevation of the drilling site of 6200 m a.s.l. and the ice core length of 308.6 m result in an elevation at the bottom of the Guliya drilling site to be 5891.4 m a.s.l., suggesting that the age of the bottom ice at the Chongce and the Guliya drilling sites might be comparable. Thus our new data can not support the previously suggested age of more than 500 ka old at the Guliya ice core bottom (Thompson et al., 1997).

We will clarify this information in the revision.

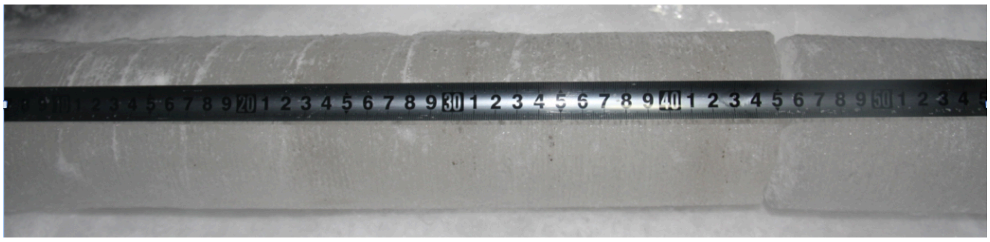
3) The authors state that the bottom sediments beneath Chongce ice cap are a combination of sediment and ice. What is the evidence that the base of the ice cap was actually reached? Are the sediments possibly representing a higher concentration of sediments within the ice but not necessarily basal sediments? The authors do not state that bedrock was drilled.

We have several pieces of evidences that the base of the ice cap might be actually reached.

① The bottom sediment is consisted of particles with wide range of size, including a high fraction of coarse particles. We had roughly measured the size distribution of a bottom sediment sample, with the results as shown in the table below. These coarse particles can not be an eolian origin. Moreover, the mountains surrounding the ice core drilling sites are snow and ice covered, thus eliminating the possibility that these coarse particles are from the surrounding high mountains. Therefore, these coarse particles should be scoured from the bed ground beneath the glacier, implying that the base of the ice cap might be actually reached.

size (μ m)	< 150	150 - 900	900 - 2000	> 2000
quality (g)	4.0	4.28	3.97	9.68
percent (%)	18.2	19.5	18.1	44.1

② Due to the limit of luminescence test, we can not take a photo the bottom section of the Core 4, but the high particle content (~70%) of the bottom sediment of Core 4 suggests a similar condition as shown by the inset photo of Figure S1. Though dust layers are frequently observed along the Core 4, they are much weaker than the bottom section. The photo below with typical dust layers along the core, when compared to the inset photo of Figure S1, makes clear the uniqueness of the bottom sediment section.

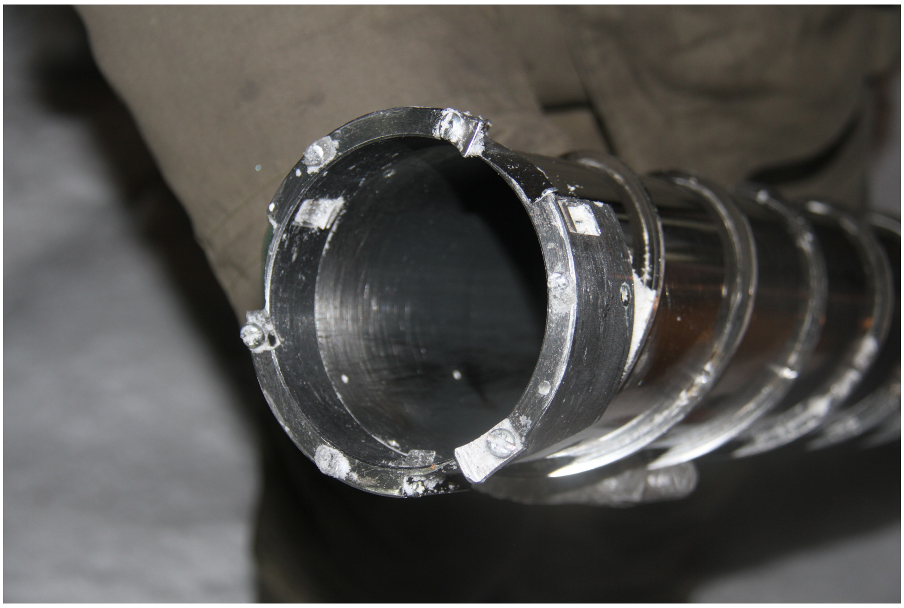


A 18. 7 m ice core drilled at the summit (6530 m a.s.l.) of the Chongce ice cap in 1992 gives a maximum dust mass concentration of 955 mg kg^{-1} (Li et al., 2006). This provides a general impression of dust layers along the Chongce ice cores, which is ~3 orders of magnitude lower than the bottom sediment, confirming the uniqueness of the bottom sediment section.

Li Y., Yang Y., Han J., Xie Z., M. Nakawo, K. Goto-Azuma. Persistent decrease of dust burden for about 100 years over middle-upper Troposphere of the southern Taklimakan Desert , China. J. Glaciol. Geocryol., 28(6), 873-878, 2006. (in Chinese with English abstract)

③ Radio sounding gives an ice thickness of ~ 214 m at the drilling site, which is very close to our ice core length of 216.6 m.

④ We drilled the ice cores by using an electromechanical drill in a dry hole. Unfortunately, this kind electromechanical drill is not designed to penetrate into bedrock. But when the cutters of the drill reached the bedrock, a unique vibrating movement can be felt through the cable by our experienced engineer, who has experience of drilling ice cores for >20 years. Below I attach a photo of the cutters after the last run of drilling, showing the blade fractures that were caused by the high-speed spinning cutters bounced from the bedrock.



Minor comments:

Are lines 9-14 on page 2 relevant? They could be removed.

This gives basic information about the Chongce ice cores. For the convenience of the readers, we think it better to keep this information.

Page 2, line 26: ice or water content? make clear

The total bottom sediment including ice is 1431.7 g. We first took a small portion of the sediment (13.4 g) for measuring ice content, which is determined by weighting the mass before and after drying, resulting in ~30% ice (water equivalent) content.

Page 3, line 20: what is "obvious"?

We have revised this sentence to make it clear.

Samples with IRSL (infrared stimulated luminescence) vs. blue OSL signal ratios over 10% of unity would be re-treated with fluosilicic acid again until the ratio was within 10% of unity.

Page 3, line 20: what are the dots in the unit here?

We have revised it as "IRSL (infrared stimulated luminescence) vs. blue OSL signal ratios".

Page 4, line 9: What is the result if the first case is assumed? Explain the age result for this scenario too.

The OSL dating results of the coarse grain (90-150μm) quartz are shown below. Water content is assigned an absolute uncertainty of ±7%. The slightly older ages of the coarse grains in comparison to the fine grain quartz may imply that the former were more affected by the local scoured particles that were partly bleached. Another disadvantage for the coarse grain aliquots is that their medium and slow components accounts for a significant part of the natural OSL signal.

Sample	U (ppm)		Th (ppm)		K (%)		Water content	D_e	Dose rate	Age
	Gamma[1]	NAA	Gamma	NAA	Gamma	NAA	(%)	(Gy)	(Gy/ka)	(ka)
CCICE	3.66±0.15	3.45±0.12	11.21±0.42	11.40±0.32	3.52±0.10	3.48±0.08	0	238±51	5.25±0.45	45 ±11
CCICE	3.66±0.15	3.45±0.12	11.21±0.42	11.40±0.32	3.52±0.10	3.48±0.08	30	238±51	3.85±0.24	62 ±14

Page 4, lines 11-12: how is the study of Takeuchi et al. related with the new study here?

Takeuchi et al. (2014) reported radiocarbon dating of organic soil from the bottom of an 86.87 m ice core drilled at the top of the Grigoriev Ice Cap (41°58'33" N, 77°54'48" E. Fig. 1) in the Tien Shan Mountains, showing that the age of the soil is 12 656 -12 434 cal years before present. This age is apparently younger than our luminescence dating, suggesting that our upper limit age may be over estimated because potentially additional sources of radiation were not considered for calculating the dose rate.

Page 6, line 17: abbreviation should be probably "Geochron."

Revised accordingly.

Page 7, line 7: no issue numbers

Revised accordingly.

Page 7, line 30: no capitalized letters if not for names or at beginning of sentence

Revised accordingly.