Supplement of

Age of the Tibetan ice cores

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Two-parameter flow model (2p model)

The 2p model is based on a simple analytical expression for the decrease of the annual layer thickness $L(z)$ (m w.e.) with depth:

$$L(z) = b \left(1 - \frac{z}{H}\right)^{p+1}$$

where $z$ is depth (m w.e.), $H$ the glacier thickness (m w.e.), $b$ the annual accumulation (m w.e.) and $p$ a thinning parameter (dimensionless). The age $T(z)$ as a function of depth can be calculated when the inverse layer thickness is integrated over depth:

$$T(z) = \int \frac{dz}{L(z)} = \frac{1}{b} \int \left(1 - \frac{z}{H}\right)^{p-1}$$

Solving the integral and setting the age at the surface to be $T(0) = 0$, the final age-depth relation is obtained:

$$T(z) = \frac{H}{bp} \left[\left(1 - \frac{z}{H}\right)^p - 1\right]$$

The thinning rate (vertical strain rate) is the first derivative of the layer thickness:
The model has two degrees of freedom, the net annual accumulation rate $b$ and the thinning parameter $p$, both of which are assumed to be constant over time. This allows us to fit the model by a least squares approach through the available reference horizons if the glacier thickness $H$ is known (if drilled to the bedrock) or can be reasonably well estimated (e.g. from radar sounding). In order not to overweigh the data from the deepest horizons, the model is fitted using the logarithms of the age values (Uglietti et al., 2016).

**The Kesang stalagmite core**

The Kesang Cave is located in the Tekesi County, the western China (42°52′ N, 81°45′ E, ~2000 m a.s.l., Fig. 1). Eight samples from Kesang Cave were used to establish the Kesang $\delta^{18}O$ record with three covering the Holocene and five covering the rest of the Pleistocene portion. The Kesang stalagmite $\delta^{18}O$ records characterize a dynamic precipitation history over most of the past 500,000 years (Cheng et al., 2012).
Figure S1: Three-dimensional topography for the locations of the Chongce and the Guliya ice caps. It was constructed from the Shuttle Radar Topography Mission (SRTM) digital elevation data, available from the Consultative Group for International Agricultural Research-Consortium for Spatial Information (CGIAR-CSI) at http://srtm.csi.cgiar.org/.
Figure S2: Map showing the ice thickness of the Chongce ice cap with drilling sites.

Core 1 (133.8 m) and Core 2 (135.8 m) to bedrock and Core 3 (58.8 m) were drilled in 2012. Core 4 (216.6 m) and Core 5 (208.6 m) to bedrock were drilled in 2013. Inset picture shows the bottom section of Core 2. The ice thickness was measured by ground penetrating radar with relatively high accuracy. For instance, the thickness measured at the drilling site of the 216.6 m core is ~214 m.