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Climate of the Past Discussions

Interactive comment on "Isotopic and lithologic variations of one precisely dated stalagmite across the Medieval/LIA period from Heilong Cave, Central China" *by* Y. F. Cui et al.

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General comments: This manuscript presents a multi-proxy analysis of the Monsoon over China from a single stalagmite sample. The record shows a distinct change in the relationship between local ariditiy proxies (i.e. d13C) and large scale hydro proxies (i.e. d18O) at the transition between the LIA and MWP. This changed relationship reflects a change in atmospheric circulation where d18O went from being closely related to local precip amount to being influenced by moisture source changes that were not inherently tied to precip amount. The study is a really nice complement to a number of modeling studies, which have highlighted the problem with assuming d18O over China is related to local climate. The method could be applied elsewhere on Chinese Stalags to identify periods where d18O is a good local proxy and when it is not. The writing is relatively clear, the interpretations are smartly conservative and while the paleoclimate data is not ground-breaking it is an important step forward in assessing how to analyze the growing body of d18O data from China. I wish the authors had embraced the modeling work of Dayem, Pausata and LeGrande etc: : :and placed this current study in the context of the modeling of d18O over China.

Response: We thank the referee for his/her thoughtful comments, and these comments are of great help in revising this manuscript. The interpretation of Chinese stalagmite δ18O signal becomes a hotly focus in the paleoclimate studies (Cheng et al., 2009; Maher 2008, Clemens et al., 2008, 2010; Dayem et al., 2010; Pausata et al., 2011). The referee provides an important suggestion that the modeling work of δ18O from the published papers should be taken into consideration in our revised manuscript.

Specific comments:

Pg. 1276 > > Ln 2: to explore multiple speleothem?

Response: to explore multiple proxies

> Ln 5: dates are precise

Response: ensure Th-230 dates precisely

> Ln 15: index from historical

Response: change “by” to “from”

> Ln 21: What is “the Mei-Yu”?

Response: The seasonality of present-day precipitation in eastern China varies from south to north (Wang and Lin 2002). This south to north progression of high precipitation rates follows the path of the Mei-Yu front, a warm, humid, and convective subtropical frontal system that is related to the subtropical high pressure system over the

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western Pacific Ocean(Zhou et al., 2004 and references therein). The front stretches northeast to southwest over southeast China, extends as far west as ∼105°E and as far north ∼35° N (Zhou et al., 2004).

> Ln 24: intensively studied?

Response: change “concerned” to “studied”.

> > Pg. 1277 > > Ln 2: oscillation involved

Response: delete “has”

>Ln 10: made using

Response: delete “in”

> Ln 15: well constrained dating,

Response: We did the change.

> Ln 17: applied as a

Response: We did the change.

> Ln20: “indicate a coherent monsoon pattern, with an increase. . .”

Response: We did the change.

> Ln 26: “test the relationship between”

Response: change “of” to “between”.

> > Pg.1278 > > Ln 7: “by the highly seasonal variations of the water excess”. . .what is “water excess”?

Response: change “water excess” to “seepage water”

> Ln 17: “The relative humidity inside is close to 100 %.” How as this assessed?

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Response: This is the instrumental data by humidometer.

> Ln 18: “monsoon”

Response: “monsoons” changes to “monsoon”

> Ln 19: “Mean annual precipitation between 1000mm and 1500mm shows a significant seasonal variation.” How does mean annual precip “show” significant seasonal variation?

Response: We did the changes. The highly seasonal climate of the study area is dominated by the East Asian monsoon system. The mean annual meteoric precipitation changes between 1000 mm and 1500 mm.

> Ln 20: Summer and winter monsoons only account for 55% of precip?

Response: The instrumental data of past 44 years from Yichang station near Heilong cave show that the mean precipitation amount in spring and autumn accounts for 25% and 20% of total annual precipitation, respectively.

> > Pg 1280 > Ln 11: develop a chronology for the stalagmite

Response: We did the change.

> > Pg. 1281 > > Ln 2: “The amplitude seems larger during the interval of 0_73mm (mainly covering the LIA, approximately 1.3 ‰ than the other part.” Changes in amplitude could be quantified as opposed to just noted ad hoc.

Response: The maximum amplitude during LIA is larger than that in MWP by approximately 0.13‰

> Ln 12-15: In light of the numerous criticisms that now abound with respect isotopic controls of precip over China, some more consideration is warranted here.

Response: Instrumental data from southeastern China show that summer monsoon rainfall contributes significantly to the annual mean, with distinctly lower rainfall δ18O than during other seasons. Therefore, a changing ratio of low rainfall δ18O (transmitted by summer monsoon) was often invoked to explain the cave isotopic data (Wang et al., 2001), which is related to changes in the amount of summer monsoon precipitation or “summer monsoon intensity” (Cheng et al., 2006, 2009; Cai et al., 2010). However, annual and rainy season precipitation totals over China have correlation length scales of ~500 km, shorter than the distance between caves, the records from which share similar variations in δ18O values. In some degree, the instrumental data and simulation studies do not support the idea that variations in stalagmite δ18O values are caused by changes in precipitation amount (Dayem et al., 2010, LeGrande and Schmidt 2009). Dayem et al. (2010) suggested that complex processes should contribute to variations in Chinese stalagmite δ18O values, i.e. different source regions of the precipitation, different pathways between the moisture sources and the cave sites, a different mix of processes involving condensation and evaporation within the atmosphere, or different types of precipitation. Recently, Pausata et al., (2011) proposed that Chinese stalagmite δ18O is controlled by changes in the Indian monsoon during a simulated Heinrich event, rather than by East Asian summer monsoon. Johnson (2011) also claimed that Chinese speleothem δ18O does not reflect regional East Asian monsoon strength. Wang and Chen (2012) analyzed the water vapor sources for the precipitation and the factors influencing the summer atmospheric moisture over southeastern China, and suggested that the Chinese stalagmite δ18O can record the signals from the middle and high latitude Eurasia-Atlantic climate, including the regional East Asian monsoon and remote Indian monsoon. Cheng et al. (2012) reviewed speleothem records from both hemispheres and suggested that δ18O signal might record the Global-Paleo-Monsoon characteristics that are analogous to modern scenario. Therefore, the climatic interpretation of δ18O records remains a subject of considerable debate. In our studies, the changing relationship between the regional δ18O signal and the local environmental proxies (δ13C, gray level and Sr) suggested that δ18O variations might be related to local precipitation amount in a special scenario when the summer rainfall and its δ18O was dominated by a single moisture source.

This speculation, to some extent, is analogous to the condition in India (Sinha et al. 2005, 2007). As the referee suggested, the modeling work is of great help to understand the relationship between rainfall and the associated isotopic composition, and should be fully considered to interpret the stalagmite δ18O records in China.

>Ln 24: Could c13 reflect natural secessional trends in forest that may or may not be intimately tied to climate. Things like fire, which may be stochastic?

Response: Actually, in our study region where vegetation type is predominantly C3 forest, the influence of vegetation on stalagmite δ13C primarily reflects changes in the density of vegetative cover and biomass. The δ13C changes show a significant periodicity of $\sim$90 years, so some stochastic events like fire can be excluded.

> > Pg 1282 > > Ln 25: “summit”, is perhaps not best word choice here.

Response: change “summit” to “coldest period”

> > Pg 1284: > > Ln 1: I am very familiar with the manifestation of Active and Break patterns over India but less so over China. Could this be shown with a figure? Such as maps of precip anomalies over China during active and break periods?

Response: The spatial pattern of summer rainfall anomalies in the eastern China monsoon region showed an opposite variations between the Yellow River Valley (North China) and the mid-low Yangtze River Valley, which is associated with the northern march of summer monsoon boundary. The spatial rainfall patterns were mainly controlled by the interaction between the ITCZ and the Subtropical Convergence Zone (Zhang and Tao, 1998; Ge et al., 2008), with weak (intense) tropic monsoon intensity corresponding to an intense (weak) subtropical monsoon. Therefore, the active and break patterns over tropic monsoon system (such as Indian monsoon) were probably opposite to the active and break patterns in subtropical monsoon system (such as Mei-Yu front) on decadal-centennial scale (Fig. 1).

Ln 11: “remarkable resemblance”, this is somewhat subjective until supported by cor-

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relation statistics.

Response: The original expression might not be subjective because the correlation between them is not high enough. So we now change "remarkable resemblance" to "is similar to".

> Ln 18: The monsoon is also dominated by land surface processes and local convective development. Yes, related to the ITCZ but not exclusively as implied.

Response: This is an excellent comment. Numerous studies show that the Asian summer monsoon is mainly controlled by the ITCZ, but not exclusively (e.g. Chao and Chen, 2001; Gadgil, 2003).

> > Pg. 1285: > > Ln 7: Would be worth doing cross spectra and/or cross wavelet between d18O and d13C. Notably to document if the spectral power and or phasing changes across the LIA/MWP transition.

Response: It is a good suggestion. Spectral analyses on the δ18O and δ13C records show a significant peak at $\sim$100 years and $\sim$90 years over the LIA, respectively, and no stable cycles in MWP. Indeed, the cross spectra result shows a common 90-year quasi-periodicity in LIA, but not in MWP (Fig. 2). The phasing changes of the quasi-periodicity are also consistent in LIA (Fig. 2).

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Discussion Paper

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Fig. 1. Decadal means of the specific humidity transports in July for a 1968-1978 and b 1979-1998 in the lower troposphere. The northernmost boundary of the summer monsoon is highlighted with red lines. The green arrows indicate the western end of the ridge of the Western Pacific subtropical high. Fig. 1a shows strong (active) tropic monsoon intensity and weak (break) subtropical monsoon intensity. Fig. 1b shows weak (break) tropic monsoon intensity and strong (active) subtropical monsoon intensity. (Fig 1 was cited from Qian et al., 2007)

Fig 2. Cross spectra analysis between the δ18O and δ13C records.

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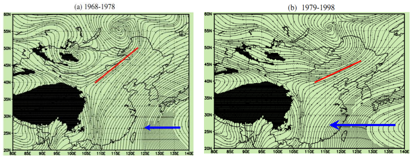

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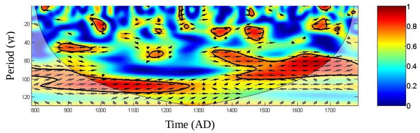

Fig. 2. Cross spectra analysis between the δ18O and δ13C records.