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Climate of the Past
Discussions

Interactive comment on "Centennial-scale monsoon changes since the last deglaciation linked to solar activities and North Atlantic cooling" *by* Xingxing Liu et al.

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1.Line 154-158: The authors said that grain size and magnetic susceptibility have been widely used as proxies for EAWM and EASM, respectively. Based on the fact that Zr/Rb and Rb/Sr ratios are highly consistent with grain size and magnetic susceptibility in the same sequence, the authors deduced that Zr/Rb and Rb/Sr ratios also can represent EAWM and EASM. If so, why don't you use grain size and magnetic susceptibility in this study? What are the advantages of Zr/Rb and Rb/Sr ratios ?

Reply: The split cores were scanned every 5-mm using an Avaatech XRF core scanner. After core scanning, sub-samples were taken at contiguous 1-cm intervals for grain size

and magnetic susceptibility analyses. The higher resolution of XRF scanning will be better for us to obtain "Centennial to millennial-scale monsoon changes".

2. In this study, the authors suggested that coarser particles in the sequence can be used as an indicator of stronger EAWM. However, it should be noteworthy that the dryland expanded southward during weak EASM periods. In this condition, coarse particles also could be transported to the study site even under a weak EAWM condition. Previous study suggested the advance-retreat cycles of desert is a dominant factor of grain-size, rather than winter monsoon (Ding et al., 1999). How do you corroborate that your EAWM proxy is reliable ? Ding, Z.L., Sun, J.M., Rutter, N.W., et al., 1999. Changes in sand content of loess deposits along a North–South transect of the Chinese Loess Plateau and the implications for desert variations. Quaternary Research, 52, 56-62.

Reply: Thanks for this comment. We agree with the reviewer's point that the advance-retreat cycles of desert can influence the grain size, especially on the sand content (>63 μm) of loess deposits (Ding et al., 1999). Due to gravity effect, sand particles can be transported only a limited distance. At the DDW section, the sand content varies between about 0% and 10.5% in paleosol units and between about 0% and 19.6% in loess (see below). Such low sand content in both paleosol and loess suggests that the location of the desert margin has a potential influence on the grain size of DDW section. Furthermore, the gradient of grain-size change on the Loess Plateau was not constant, which show stronger gradient in cold periods and weaker gradient in warm periods. This phenomenon can only be explained by different wind intensities during different climatic periods. In other words, if the variations in grain sizes would be determined by shifting deflation zones, these gradients should be constant in each climate, which is not the case (Nugteren and Vandenberghe, 2004).

3. Line 180-192: I'm not convinced that EASM changes recorded by DDW are consistent with the Lake Qinghai summer monsoon index (SMI) and the δ18O record from Dongge Cave stalagmites. First of all, records from Lake Qinghai and Dongge Cave

show a large fluctuation form YD to early Holocene, but the variation of Rb/Sr ratio is smooth. Secondly, Rb/Sr ratio of DDW indicate that EASM during the middle and late Holocene is stronger than early Holocene, which is opposite with the records from Lake Qinghai and Dongge Cave. Thirdly, the highest Rb/Sr ratio occurred during the middle Holocene, indicating a mid-Holocene EASM maximum. But both Lake Qinghai and Dongge Cave records show an early-Holocene EASM maximum. In fact, the result of mid-Holocene EASM maximum is consistent with a well-dated, pollen-based precipitation reconstruction from Lake Gonghai (Chen et al., 2015). The pollen record from Lake Gonghai has a resolution of âĹij20 yr, which is sufficient to reveal centennial-scale summer monsoon changes. I recommend the authors to add this record for comparison in Fig. 3. By the way, although δ18O records from stalagmites have attracted extensive attention in paleoclimate studies due to their precise age controls, the interpretation of speleothem δ18O in China remains controversial (e.g., Liu et al., 2015). Especially in recent years, more and more evidences indicated that that cave speleothem δ18O records in China cannot be used as a reliable proxy of EASM rainfall. The authors should notice this issue when using stalagmite δ18O record. Chen, F.H., Xu, Q.H., Chen, J.H., et al., 2015. East Asian summer monsoon precipitation variability since the last deglaciation. Scientific Reports, 5, 11186. Liu, J.B., Chen, J.H., Zhang, X.J., et al., 2015. Holocene East Asian summer monsoon records in northern China and their inconsistency with Chinese stalagmite δ18O records. Earth Science Reviews, 148, 194-208.

Reply: Thanks for this comment. In the revision, we added the record of precipitation reconstruction from Lake Gonghai in Fig. 2 and related discussions (See below).

Orbital trend of EASM intensity from DDW generally resembles the Pollen-based annual precipitation (PANN) reconstructed from Gonghai Lake (Fig.2D, Chen et al., 2015; Liu et al., 2015, 2017), indicate a mid-Holocene climatic optimum (Liu et al., 2015). This suggests that ASM intensity not only follows changes in insolation inferred from the Lake Qinghai summer monsoon index (SMI) (Fig. 2E) (An et al., 2012) and stalagmite δ18O records in eastern China (Fig. 2F) (Dykoski et al., 2005; Wang et al., 2005), but was also strongly moderated by the internal feedback processes such as continuous freshwater input into the North Atlantic caused by the remnant melting Laurentide ice sheet (Chen et al., 2015). In addition to this, asynchronous changes among these proxies are due to varied sensitivity of these proxies and archives to changes in the monsoon intensity (Caley et al., 2014).

Compared with other summer monsoon proxy records in China, the centennial-scale EASM changes at DDW are consistent with the PANN reconstructed from Gonghai Lake (Fig.2D, Chen et al., 2015; Liu et al., 2015, 2017) and SMI from Lake Qinghai (Fig. 2E) (An et al., 2012). Almost all the weak summer monsoon intervals, within dating errors, appear to coincide with major changes in the PANN reconstruction and SMI. It is worth noting that 8.2 ka event was not significant in the Gonghai (Fig. 2D) and Qinghai Lake (Fig. 3E). This could be ascribed to age model discrepancies, or the variable sensitivity of different proxies to changes in monsoon intensity (Chen et al., 2015).However, there are some discrepancies between Rb/Sr ratio of DDW and the and δ18O record from Dongge Cave stalagmites in eastern China (Fig.2F, Dykoski et al., 2005; Wang et al., 2005). This discrepancy might attribute to the controversial paleoclimatic significance of δ18O records from caves in southern China, or the North-South differences for the monsoon intensity (Caley et al., 2014; Tan, 2014; Liu et al., 2015; Chen et al., 2016). Therefore, the weak EASM intervals existing in all these three different regions (CLP, northeast of Tibetan Plateau and eastern China) may have recorded centennial EASM variability since the last deglaciation.

4. The spectral results reveal that HSG, Zr/Rb and Rb/Sr records both display a prominent periodicity at 1.27 kyr during the late Holocene. Then the authors suggested that North Atlantic cooling were the major forcing of EAM system. However, in Figure 4, âUs14C, Zr/Rb and Rb/Sr also have a prominent periodicity at âĹij0.7 kyr, which indicated that solar activity could also contribute to EAM during the late Holocene. But it seems that periodicity of âĹij0.7 kyr is missed during explanation.

Reply: Thanks for this comment. Actually the second dominant periodicities (red line, see below) are not the same in the HSG, Zr/Rb and âŰ§14C spectrum, and it's not evident in the Rb/Sr spectrum (Fig. 3). This indicate that solar activities is not the direct cause of centennial summer monsoon variability. Compare to the ealry Holocene, there is a decrease of summer insolation and the small-amplitude fluctuations of solar activities during the late Holocene (Berger, 1978). This is probably why it play a less important role in EAM system during the late Holocene.

Specific comments:

1.Line 81-82: Source of climatic information of Qin'an Country is unclear. The authors should cite related references.

Reply: Meteorological data come from the national daily dataset of surface weather profile provided by the National Meteorological Data Center, http://data.cma.cn/data/.

2.Line 125: It would be better if the authors give the interpretation of "x" and "y" in the regression equation (y=1.1465x+1.2546).

Reply: x is the depth in m, y is the calculated age (cal ka BP)

3. I noticed that the 12 radiocarbon ages have a good linear correlation with depth (R2=0.9921). It means that accumulation rate was consistent whether during strong EAWM or weak EAWM. Usually, strong EAWM would result in a higher accumulation. Why is accumulation rate consistent? Did the episodic erosion affect it (e.g., Stevens et al., 2018)? Stevens, T., Buylaert, J.P., Thiel, C., et al., 2018. Ice-volume-forced erosion of the Chinese Loess Plateau global Quaternary stratotype site. Nature Communications, 9, 983.

Reply: We agree with the reviewer's point that the sedimentation rate is related to the EAWM intensity. However, DDW is a terrace sequence dominated by aeolian input, the supply of sediment for these deposits on terraces is comparatively abundant in the basin. These deposits are mainly transported by wind from short-distance sources

(Liu et al., 2018). So the dust input are continuous whether EAWM is strong or weak. Furthermore, the grain-size distribution of DDW samples are different from those typical aeolian sediments on CLP. The values of mean grain size also exhibit large fluctuations.

4. Line 133: A space character before "μm" should be added. 5. Line 134: The space character between "μ" and "m" should be deleted. 6. Line 194, 222 and 253: "Zr/Br" should be "Zr/Rb". 7. The authors should add "δ" before "18O" in whole manuscript. 8. The reference style should be consistent. For example, in Line 292, "2.1-2.49" is incorrect. In Line 297, "24:" should be "24,".

Reply: All corrected.

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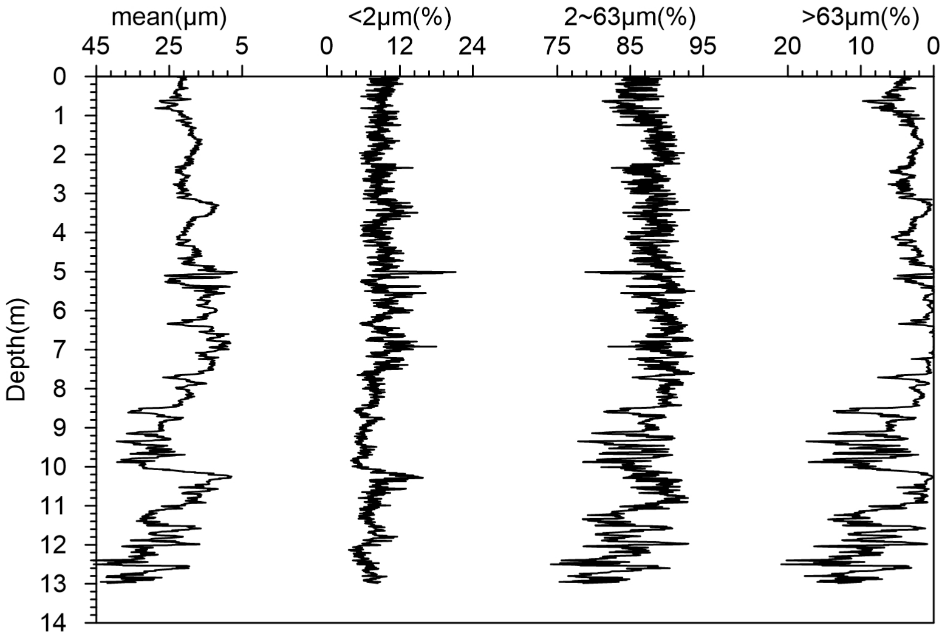

Fig. 1. Down-core variations of mean grain size and contents of three size fractions (ïijlJ2 μm, 2∼63 μm and ïijđ63μm) of the DDW core

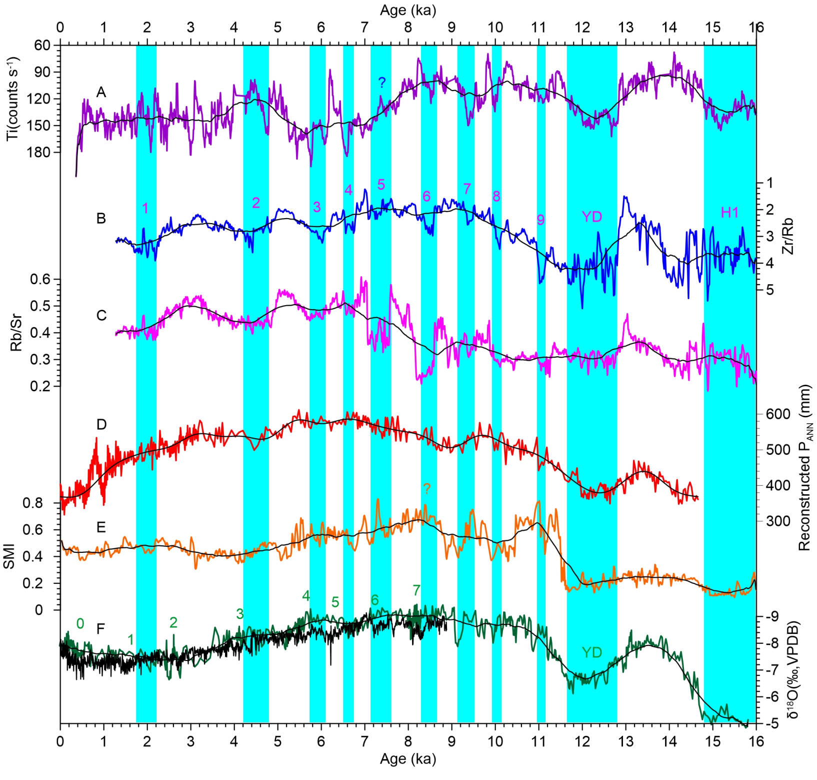

Fig. 2. Comparisons of DDW records and other paleoclimatic records.

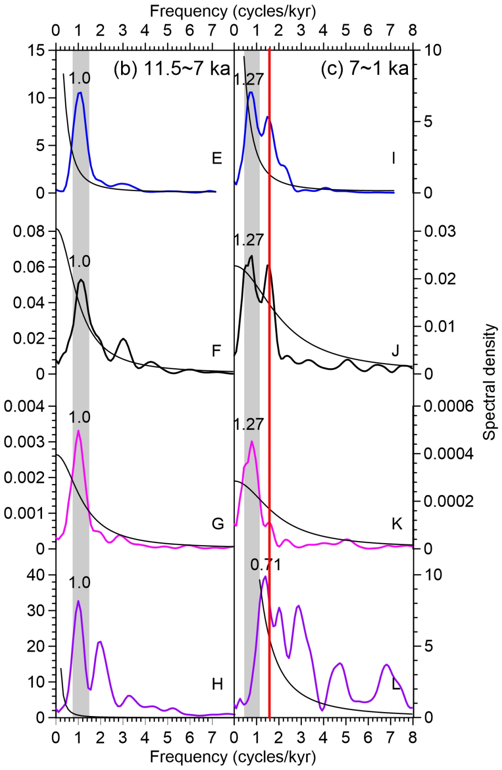

Fig. 3. The spectra results of the proxy records during the early (b) and late Holocene (c).