General Comments

The authors reviewed the *state-of-the-art* hydroclimatic reconstructions, hydroclimatic modeling, and the comparison between the proxy-based reconstructions and model outputs of the last two millennia. They further reviewed the possibility to assess future hydroclimatic risks based on the past hydroclimatic reconstructions. In general, this paper merits in detailed and impersonal reviews/comments on both the advantages and uncertainties of proxy-based hydroclimatic reconstructions and model outputs, and it is clearly helpful to the readers to refresh their knowledge and understanding, and important to evaluate the fidelity of the climatic reconstruction, modeling outputs, and further prediction. I think a large number of audiences would be interested in the topics presented in this paper. Therefore I would be glad to suggest a publication of this paper on Climate of the Past.

The following specific points are for the authors' further consideration.

Specific comments

1. **Interpretation of the proxy indices**

   The authors listed both the advantages and uncertainties of the proxy indices. This is very important! More examples may be clearer to the readers. For example, variations in $\delta^{18}O$ of corals are widely used to reconstruct sea surface temperature (SST). However, variable factors may influence the reliability of the $\delta^{18}O_{coral}$-based temperature reconstruction, such as the coral numbers, water depth, variable temperatures and sea water $\delta^{18}O$ values in different micro-environments, etc. One widely cited application is the reconstruction of SST based on $\delta^{18}O_{coral}$ over the central tropical Pacific Ocean (Cobb et al., 2003); it indicated a La Niña-like condition and an El Niño-like condition during the medieval period and little ice age (LIA), respectively, and such a SST pattern has been widely used in model simulations. However, increasing recent studies suggested a possibly inverse SST pattern to that inferred from $\delta^{18}O_{coral}$, i.e., an El Niño-like condition and a La Niña-like condition during the medieval period and LIA, respectively (see details in Xu et al., 2016). Providing the latter stands, a large number of model outputs perhaps need to be refreshed.

   The recent years have witnessed an even more critical condition when interpreting the climatic significance of $\delta^{18}O$ in speleothem on decadal/multi-decadal to centennial timescales during the late Holocene. Sometimes, hydroclimatic changes inferred from different stalagmites even from a same cave are different. For example, the hydroclimatic conditions inferred from mud-layers in a stalagmite from KNI-5, northern Australia, are much different with those inferred from stalagmite $\delta^{18}O$ values from the same cave (see Fig. S9 in Denniston et al., 2015). Another example may be the differences between the late Holocene $\delta^{18}O$ series extracted from different stalagmites in Keshang Cave, northwestern China (Fig. 1). Variations in $\delta^{18}O$ were ascribed to changes in precipitation by Cheng et al. (2012). While Cai et al. (2017) gave more complicated interpretations; they ascribed the variations in $\delta^{18}O$ of the last ~2,000 years to temperature variations while those before were ascribed to changes in precipitation, leaving the readers a dilemma which one could be used to indicate the regional climatic changes.

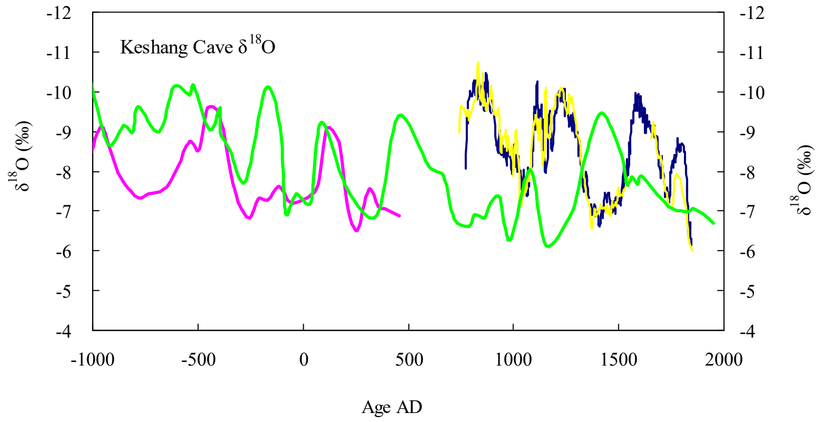

Fig.1. Comparison between late Holocene stalagmite $\delta^{18}O$ series from Keshang Cave, northwestern China (redrawn from Cheng et al., 2012 and Cai et al., 2017). The Green curve was developed by Cheng et al. (2012), and the pink, yellow, and blue curves were developed by Cai et al. (2017).

Closed-basin lake level changes are unique because they are first order recorders of past rainfall amounts (Verschuren et al., 2000; Xu et al., 2016; Goldsmith et al., 2017), and could provide a potential better way to reconstruct the past changes in precipitation after proper calibration of the evaporation. Similar methods can also be applied to reconstruct the past riverine runoff intensity, and to assess possible extreme flood risks based on the paleo- hydrological scenarios.

2. Hydroclimatic contrasts between different regions

Temperature variations are broadly synchronous between different regions due to the common large scale forcing, like solar forcing and volcanic aerosol forcing. However, unlike temperature, precipitations are influenced by variable factors, including atmospheric circulation, topography, underlying surface settings, etc. Hydroclimate, as a balance between precipitation and evaporation, could be more variable between different regions. Although orbital scale hydroclimatic trends have been reported to be similar between different regions, multi-decadal to centennial hydroclimatic changes are considerably different between different regions (e.g., Diaz et al., 2011; Graham et al., 2011; Xu et al., 2016). For example, increasing lines of evidence show late Holocene hydroclimatic contrasts between East Asian summer monsoon regions and Indian summer monsoon regions (see Xu et al., 2016 for details), and similar hydroclimatic contrasts have also been reported between the westerly-dominated Asian central arid zone and Asian monsoon areas (Chen et al., 2015). However, such hydroclimatic contrasts are not well reproduced by climatic modeling. More words about the hydroclimatic contrasts between different regions may help the readers, especially the policy-makers, to fully understand the features in hydroclimatic changes.

3. **Hydroclimatic forcings**

The influences of volcanic eruption on temperature were well reviewed in this paper. As the earth climates are influenced by variable factors, equal reviews of the role of solar forcing on temperatures and precipitations during the past ~2,000 years may further consummate this review paper.

References mentioned in this comment

1. Cai, Y. J., Chiang, J. C. H., Breitenbach, S. F. M., et al., 2017. Holocene moisture changes in western China, Central Asia, inferred from stalagmites. Quaternary Science Reviews, 158, 15-28.
2. Chen, J. H., Chen, F. H., Feng, S., et al., 2015. Hydroclimatic changes in China and surroundings during the Medieval Climate Anomaly and Little Ice Age: spatial patterns and possible mechanisms. Quaternary Science Reviews, 107, 98-111.
3. Cheng, H., Zhang, P. Z., Spötl, C., et al., 2012. The climatic cyclicity in semiarid-arid central Asia over the past 500,000 years. Geophysical Research Letters, 39, doi:10.1029/2011GL050202.
4. Cobb, K. M., Charles, C. D., Cheng. H., et al., 2003. El Niño/Southern Oscillation and tropical Pacific climate during the last millennium. Nature, 424, 271-276.
5. Denniston, R. F., Villarini, G., Gonzales, A. N., et al., 2015. Extreme rainfall activity in the Australian tropics reflects changes in the El Niño/Southern Oscillation over the last two millennia. PNAS, 112(15), 4576-81. doi: 10.1073/pnas.1422270112.
6. Diaz, H. F., Trigo, R., Hughes, M. K., et al., 2011. Spatial and temporal characteristics of climate in medieval times revisited. Bull. Am. Meteorol. Soc., 92, 1487-1500.
7. Goldsmith, Y., Broecker, W. S., Xu, H., et al., 2017. Northward extent of East Asian monsoon covaries with intensity on orbital and millennial timescales. PNAS, 114 (8), 1817-1821.
8. Graham, N. E., Ammann, C.M., Fleitmann, D., et al., 2011. Support for global climate reorganization during the "Medieval Climate Anomaly". Clim. Dynam., 37, 1217-1245.
9. Verschuren, D., Laird, K. R., Cumming, B. F., 2000. Rainfall and drought in equatorial east Africa during the past 1,100 years. Nature, 403, 410-414.
10. Xu, H., Lan, J., Sheng, E., et al., 2016. Hydroclimatic contrasts over Asian monsoon areas and linkages to tropical Pacific SSTs. Scientific Reports, 6, 33177; doi: 10.1038/srep33177.