Global monsoon in observations, simulations and geological records

PAGES Global Monsoon Symposium – Shanghai, China, 29-31 October 2008

PINXIAN WANG[1], BIN WANG[2] AND T. KIEFER[3]

[1]State Key Laboratory of Marine Geology, Tongji University, Shanghai, China; pxwang@online.sh.cn
[2]SOEST, University of Hawaii, Honolulu, USA; [3]PAGES International Project Office, Bern, Switzerland

Although scientific focus on monsoons can be traced back nearly 350 years, only recently have monsoons been recognized as a global system. With the application of remote sensing and other new techniques, the concept of a "global monsoon" has been introduced as a global-scale seasonal overturning of the atmosphere and the associated seasonal contrast in precipitation. The paleocommunity has not yet responded to this new trend in modern climatology. The paleo-monsoon is still being studied almost exclusively as a regional phenomenon.

To consider global monsoon changes from a geological perspective, 60 scientists from 5 continents gathered at Tongji University in Shanghai for the PAGES Global Monsoon Symposium. It was the first meeting organized by the newly established PAGES Working Group "Global Monsoon and Low-Latitude Processes: Evolution and Variability". The symposium brought together paleo- and modern climatologists, data-producers and modelers to compare monsoon records from various regional monsoon systems, to find out their similarities and differences across a range of timescales from interannual to orbital, and to unravel the mechanisms causing variations in the global monsoon system and regional deviations from the global trend.

Of the 26 oral presentations, 12 were given by modern and 14 by paleo-climatologists. The modern climatologists introduced the current understanding of "global monsoon" and its measurement (Fig. 1), advanced a new concept of "dynamic warm pool", and discussed the variations of the monsoon system over the past decades. A crucial issue that was raised was the discrimination of the global and regional components in monsoon variations. For example, global monsoon precipitation over land has declined over the past half-century (B.Wang and Ding, 2006) but the mechanisms remain elusive. Approached on a regional scale in East Asia, this change may be caused by variations in the snow cover in Tibet. However, taken from a global perspective, it could be ascribed to a global factor, such as enhanced volcanic activity. A compilation of monsoon variations from various continents will help to distinguish regional from global features, and shed light on the roles of the external forcing and internal feedback processes in determining monsoon variability on different spatial (regional and global) and temporal scales.

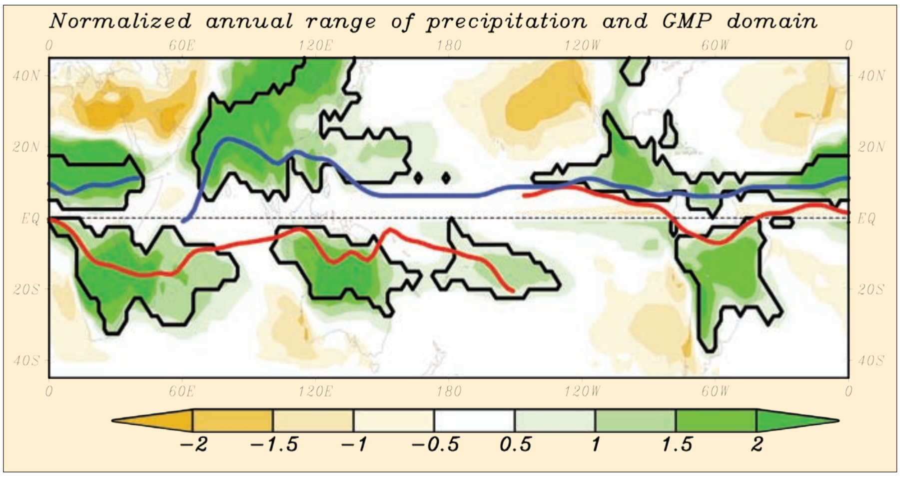

*Figure 1: The modern global monsoon precipitation (GMP) domain (outlined by the **black** curves) based on annual range (local summer minus winter mean) of precipitation normalized by annual mean precipitation (color shading). **Red** (**Blue**) line indicates the ITCZ position in Jan-Feb (July-Aug) estimated by maximum precipitation rate (B. Wang and Ding, 2008).*

One focus of the symposium was orbital cyclicity of the global monsoon during the late Quaternary. Results of data analyses and numerical modeling were presented to demonstrate the monsoon cycles in the Americas, Asia, Africa and Australia. A common feature is the prevalence of precession pacing of the monsoon variations indicative of their global nature (Fig. 2). On the other hand, the observed deviations from the common trend suggest a role played by regional conditions such as land orography and sea temperature. An outstanding example of precession cycles in monsoon precipitation is the speleothem records from South China (Y. Wang et al., 2008) but a heated debate evolved on the detailed interpretation of oxygen isotopes of speleothems as a monsoon proxy. While new evidence was presented from in situ studies of local precipitation to support the interpretation that the speleothem $\delta^{18}O$ represents changes in intensity of monsoon precipitation, variation in moisture sources was offered as an alternative interpretation that would be more consistent with other paleoenvironmental records from China. Since the $\delta^{18}O$ records of speleothems are similar to those of air bubbles in Antarctic ice cores (Y. Wang et al., 2008), the debate extended to the general nature of the oxygen isotope signal of rainwater and its use as a proxy of the global monsoon.

Many presentations were based on high-resolution records from deep sea and lake deposits displaying monsoon variations on sub-orbital timescales. Millennial-scale events discovered in monsoon records from Asia, Africa and America have been correlated to those in Greenland and the North Atlantic, yet it remains unclear whether the monsoon responds through teleconnections to high-latitude forcing, or plays a primary role in initiating and amplifying abrupt changes originating from the tropics. Disentangling this requires improved understanding of the teleconnection dynamics associated with the tropical-extratropical interaction. Another challenging issue is the negative correlation between monsoon and ENSO during the last 2 millennia. As shown by deep-sea sequences from the Indian and eastern Pacific, the monsoon intensity was weak 1-2 ka ago and enhanced during the last millennium, while the ENSO variability was intense 1-2 ka ago but has weakened since then. Thus, ENSO appears to be sensitive and variable on the same timescales as the monsoon, but to what extent one system is forced by the other, or whether they vary as an interactive system in response to common forcing, remains unclear.

The second Global Monsoon Symposium will be held in 2010, and will explore global monsoon changes across all region-

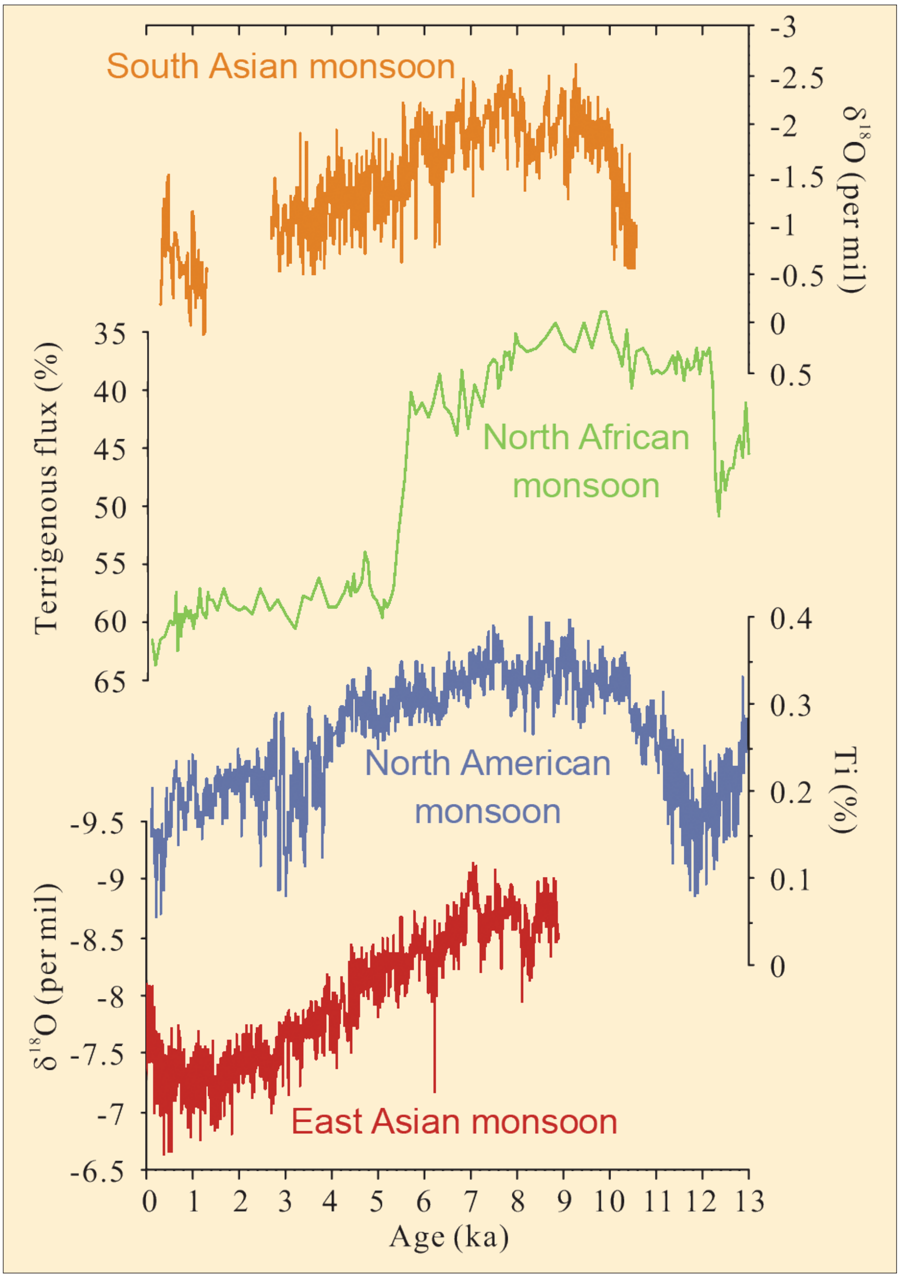

Figure 2: Global monsoon in the Holocene: The common trend in monsoon variations in the Northern Hemisphere. ***A****) South Asian monsoon: Stalagmite $\delta^{18}O$ from Qunf Cave in Southern Oman (Fleitmann et al., 2003);* ***B****) North African monsoon: Terrigenous detritus % from ODP 658, tropical Atlantic off Western Africa (deMenocal et al., 2000);* ***C****) North American monsoon: Ti% in laminated deposits from the Cariaco Basin off Venezuela (Haug et al., 2001);* ***D****) East Asian monsoon: Stalagmite $\delta^{18}O$ from Dongge Cave, South China (Y. Wang et al., 2005).*

al sub-systems over a range of timescales from interannual to orbital.

References

deMenocal, P.B., Ortiz, J., Guilderson, T., Adkins, J., Sarnthein, M., Baker, L. and Yarusinski, M., 2000: Abrupt onset and termination of the African Humid Period: Rapid climate response to gradual insolation forcing, *Quaternary Science Reviews*, **19**: 347-361.

Fleitmann, D., Burns, S.J., Mudelsee, M., Neff, U., Kramers, J., Mangini, A. and Matter, A., 2003: Holocene Forcing of the Indian Monsoon recorded in a stalagmite from Southern Oman, *Science*, **300**: 1737-1739.

Wang, B. and Ding, Q., 2006: Changes in global monsoon precipitation over the past 56 years, *Geophysical Research Letters*, **33**: L06711.

Wang, B. and Ding, Q., 2008: Global monsoon: Dominant mode of annual variation in the tropics, *Dynamics of Atmospheres and Oceans*, **44**: 165-183.

Wang, Y. et al., 2008: Millennial- and orbital-scale changes in the East Asian monsoon over the past 224,000 years, *Nature*, **451**: 1090-1093.

For full references please consult:
www.pages-igbp.org/products/newsletters/ref2009_2.html

First international cave monitoring field workshop

Gibraltar, 26 February – 1 March, 2009

David Mattey[1] and Christoph Spötl[2]

[1]Department of Earth Sciences, Royal Holloway, University of London, UK; mattey@es.rhul.ac.uk
[2]Institute for Geology and Paleontology, University of Innsbruck, Austria; christoph.spoetl@uibk.ac.at

Cave deposits (speleothems) are one of the most promising fields in paleoenvironmental research and recent studies have highlighted the potential of this terrestrial archive to provide paleoclimatic information on a range of timescales (e.g., seasonal to orbital) (see *PAGES News*, 16(3), 2008). While the accuracy and the precision of uranium-thorium chronologies of speleothems are superior to many other climate-proxy dating techniques, much has still to be learned about the way climate signals are being transmitted through the soil zone and karst aquifer to be recorded in growing stalagmites or flowstone. The key to a better process understanding—enabling the eventual calibration of climate-proxy transfer functions—are long-term observations of the relationship between weather and the chain of processes that transmit the climate signal to the speleothem. Setting up and maintaining cave monitoring programs can be a challenge given that caves may be difficult to access or located in remote regions. Several groups have now been involved in cave monitoring over recent years and have acquired considerable expertise but little of this knowledge has found its way into the international literature.

A 4-day workshop held in Gibraltar was convened to bring together for the first time the international researchers who are actively involved in monitoring caves around the world. The aim of this meeting was to share experience and