Long-term east-west asymmetry in monsoon rainfall on the Tibetan Plateau

XiangJun Liu1,2*, ZhongPing Lai1,3*, ChaoLu Yi1, and YanBin Lei*

1Key Laboratory of Salt Lake Resources and Chemistry, Qinghai Institute of Salt Lakes, Chinese Academy of Sciences, Xining 810008, China
2Key Laboratory of Tibetan Environment Changes and Land Surface Processes, Institute of Tibetan Plateau Research, Chinese Academy of Sciences, Beijing 100085, China
3State Key Laboratory of Loess and Quaternary Geology, Institute of Earth Environment, Chinese Academy of Sciences, Xi’an 710075, China

Hudson and Quade (2013) suggest that an early Holocene increase in the size of lakes on the Tibetan Plateau (Fig. 1A) was caused by increased precipitation. They used the area within high paleoshorelines to reconstruct paleorainfall patterns, and found that paleolake area increased approximately fourfold in the western region of the Plateau, twice as much as in the east, which mirrors the modern west-east climate differences. They concluded that the modern climate differences are a long-term feature of the Tibetan Plateau, and that the rainfall from the Indian summer monsoon increased much more than the rainfall from the East Asian summer monsoon in response to the same insolation forcing.

However, lake expansion can be explained by processes other than increased rainfall.

(1) The lake sizes may have been influenced by a change in the size of the catchment area. The supply coefficient of a lake is defined as the ratio of its catchment area (excluding the lake area) and the lake area (Fan, 1983). For a given sized lake in an arid zone, a larger catchment area (than in a humid zone) is required to maintain the same water balance, and thus a larger supply coefficient is needed. Fan (1983) found that the supply coefficient of the lakes on the Tibetan Plateau increased from south to north, generally corresponding to the modern decrease in precipitation from the south-to-north. Thus, even if the precipitation over the Tibetan Plateau increased evenly, lakes with high supply coefficients would have undergone a larger area expansion.

(2) Input of glacier meltwater could have changed the water balance during the early Holocene. The glaciated area on the Plateau may have been up to 7.5× larger during the Last Glacial Maximum than at present (Shi, 1998). Thus, high lake levels during the last deglaciation and the early Holocene could have been sustained by the influx of a large amount of glacial meltwater (Li et al., 2001). This glacial meltwater and the enhanced rainfall might have jointly triggered the high lake levels during the early Holocene, but through different mechanisms.

(3) River channel diversion can change the size of a closed lake. For instance, at present, the Kangba River flows into Garing Lake (Fig. 1B). However, abandoned river channels show that it (at least in part) once ran into the Coqen River (Fig. 1C), which eventually flows into Zharinam Lake (Fig. 1B). When the Kangba flowed into the Coqen, the volume of inflow water into Zharinam Lake was larger than after its diversion into Garing Lake, so that the level of Zharinam Lake increased, while that of Garing Lake decreased. On the Tibetan Plateau, river channel diversion is not unusual, due to the low relief of its surface. On the northeastern Tibetan Plateau, the Yuqia and Tatalin Rivers have alternatively supplied water to Lake Da Qaidam and Lake Xiao Qaidam when their flow directions changed during the late Quaternary (Madsen et al., 2013).

We argue that Hudson and Quade overlooked the potential influence of these three processes on lake-level variations in their reconstruction of early Holocene paleorainfall, and that their conclusions may not be fully justified.

ACKNOWLEDGMENTS
This research was supported by the National Natural Science Foundation of China (grants 41201014 and 41290252).

REFERENCES CITED