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Holocene moisture evolution across the Mongolian Plateau and its surrounding areas: A synthesis of climatic records

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ABSTRACT

Based on the review of 26 high-standard Holocene climatic reconstructions (mainly pollen-based) from the Mongolian Plateau and its surrounding areas, temporal and spatial patterns of the Holocene moisture evolution are synthesized. The regionally-averaged moisture history from the summer monsoon-influenced semi-arid belt in China (i.e., Region A) demonstrates that the moisture index curve is broadly in agreement with the synthesized East Asian Monsoon Strength curve, both following the general trend of the West Tropical Pacific SST that is in turn the delayed response to the northern hemispheric summer solar insolation. The regionally-averaged moisture indices from the winter monsoon-dominated southern Siberia including Lake Baikal area and the Altai Mountains (i.e., Region B) exhibit a general declining trends since 10.6–9.6 cal. kyr BP, being largely consistent with the trends of the annual precipitation and the warm-season temperature in the Russian Plain. The consistency might be attributable to the Holocene declining trend of the warm-season temperature in North Atlantic region. The predominant feature of the regionally-averaged moisture index from the westerlies-affected northern Xinjiang (i.e., Region C) is a persistent increasing trend since ~8 cal. kyr BP. The wetting trend of northern Xinjiang during the past 8000 years might be attributable to the increasing trend of winter insolation and to the associated increasing trend of cold-season temperature in northwestern Europe. The chronological correspondences between dry phases and warm intervals in the arid areas of the Mongolian Plateau (i.e., northern Mongolian Plateau within Mongolia and southern Mongolian Plateau within China, Region D) lend a support to the proposal that the mid-Holocene dry phase was most likely the result of mid-Holocene high warm-season temperature.

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1. Introduction

The Mongolian Plateau includes the entire country of Mongolia and the Inner Mongolian Autonomous Region of China with the Gobi in the center (Fig. 1). Its western boundary is demarcated by the Mongolian Altai Mountains and its eastern boundary by the Hinggan Mountains. The plateau touches the southern tip of the Lake Baikal basin in the north and borders the northern margin of the Chinese Loess Plateau in the south. Climatologically, the Mongolian Plateau is extremely important because it is on the pathway of southward invasion of the polar front that directly links the high-latitude climate systems with low-latitude climate systems (Aizen et al., 2001; Visbeck, 2002). The Mongolian High Pressure System, which developed over the northern part of the Mongolian Plateau and the adjacent southern Russian Siberia, is interacted with the Azores High Pressure System that dominates the summer climate of central Asia and with the East Asian Low Pressure System that controls the summer climate of eastern Asia (Lydolph, 1977; Bridgman and Oliver, 2006). Specifically, the temporal dynamics (i.e., growth and decay) of the Mongolian High Pressure System is highly dependent on the temporal dynamics (i.e., growth and decay) of the Azores High Pressure System to the west and also on the temporal dynamics (i.e., growth and decay) of the East Asian Summer Monsoon to the south (Gong et al., 2001; Bridgman and Oliver, 2006). In addition, the strength of the Mongolian High Pressure System not only depends on the pressure contrast between the Asian interiors and the subtropical Pacific Ocean, but also depends on the pressure contrasts of the Mongolian High Pressure System with the Aleutian Low Pressure System to the east and with the Icelandic Low Pressure System to the west (Lydolph, 1977; Meeker and Mayewski, 2002; Bridgman and Oliver, 2006). The Icelandic Low-associated North Atlantic Oscillation (NAO) is demonstrated to be in anti-phase with the Aleutian Low-associated North Pacific Oscillation (NPO). That is, the positive phase of the NPO in the North Pacific realm concurs with the negative phase of the NAO in the North Atlantic realm (Kim et al., 2004;

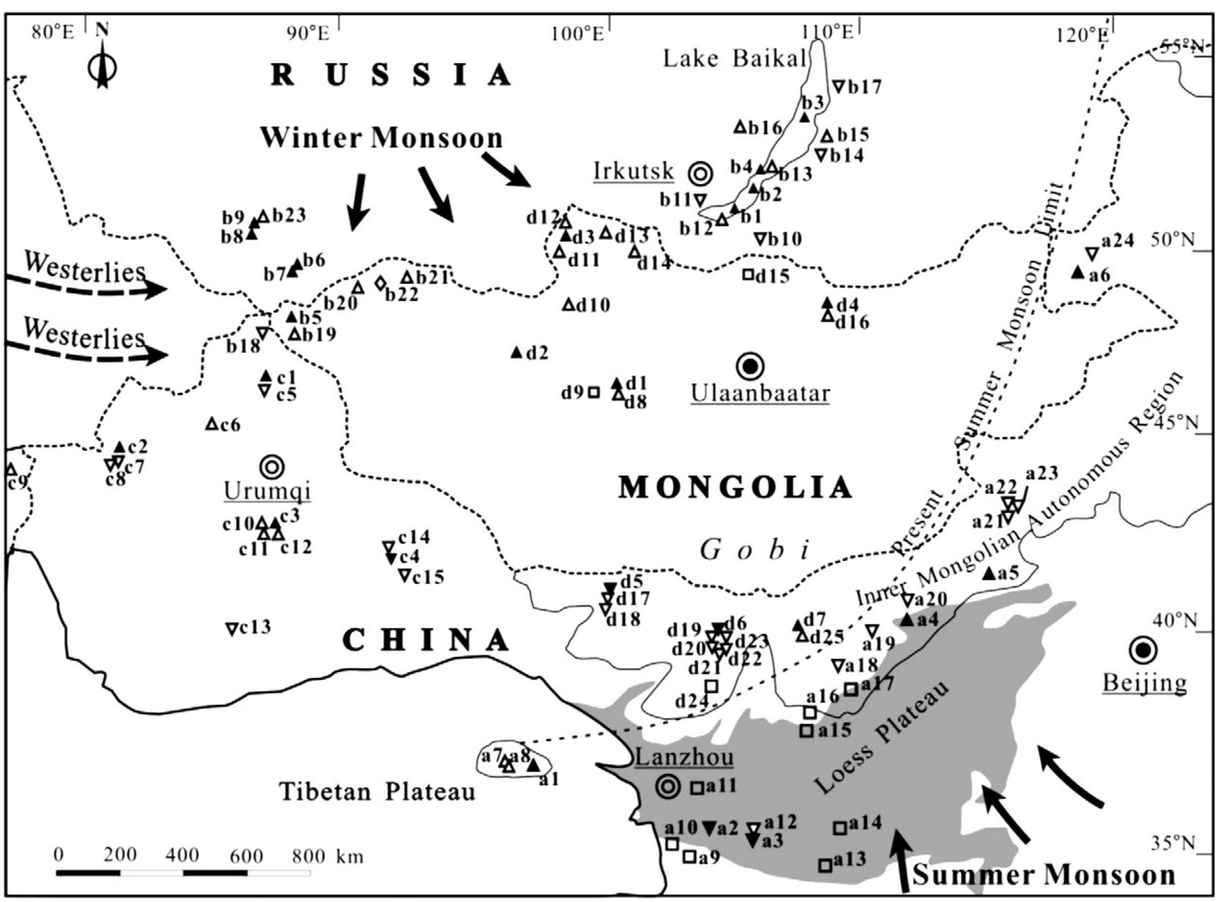

Fig. 1. Map showing the examined sites and their climatic contexts. Sites a1–a6, b1–b9, c1–c4 and d1–d7 were in-depth reviewed in this paper and the other sites were just examined for their data qualities (i.e., not in-depth reviewed). Note: ▲ Lake cores that passed quality scrutiny; ▼ exposed lacustrine section or peat section that passed quality scrutiny; △ lake core that did not pass quality scrutiny; ▽ exposed lacustrine section or peat section that did not pass quality scrutiny; □ eolian section or eolian–lacustrine complex or peat–eolian complex that did not pass quality scrutiny; and palaeolake terrace records that did not pass quality scrutiny.
The climate contexts are after Gao (1962), Lydolph (1977) and Visbeck (2002).