Hydroclimatic variability during the last deglaciation based on biogenic silica records from Lake Suigetsu, Japan

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Hydroclimatic variability during the last deglaciation (ca. 17-10 ka) was characterized by repeated and pronounced climate fluctuations as the Earth system shifted from glacial to interglacial conditions, including the Bølling–Allerød (B–A) warming period. Lake Suigetsu. located in central Japan, preserves annually laminated (varved) sediments and serves as a reference archive for radiocarbon calibration, enabling high-precision paleoclimate reconstructions at decadal timescales. Pollen-based temperature reconstructions indicate that an abrupt warming at Lake Suigetsu began around 15 ka, approximately 200 years earlier than in Greenland. Immediately following this warming in Suigetsu, light-colored event layers occurred frequently, which have been interpreted as evidence for an increased frequency of extreme flood events—called the “Stormy Two Centuries”, yet precipitation variability during this period remains poorly constrained.

In this study, we conducted centimeter-scale (~10-year resolution) analyses of biogenic silica (BSi) content and flux to evaluate hydrological and climatic changes during the terminal phase of the last deglacial period. BSi contents were quantified using slab-based XRF scanning, FTIR, as well as alkaline digestion, with dissolved Si and Al measured by ICP–AES. To calculate BSi fluxes, dry bulk density was measured continuously at 1-cm intervals. The age model was established based on varve chronology and the IntCal20 radiocarbon calibration curve.

Our results show that the BSi flux did not immediately increase with the local pollen-inferred warming (15.0 ka). This observation suggests that rising local air temperature alone may not have been the primary driver of the silica supply. Instead, a notable rise in BSi occurred at around 14.8 ka, temporally coinciding with the onset of the Bølling-Allerød interstadial in Greenland and the intensification of the Asian Monsoon recorded in Chinese speleothems. The temporal relation supports that the increase in BSi as a potential signal of intensified precipitation and hydrological cycling associated with the northward migration of the ITCZ and Westerlies. These findings imply that the hydrological system in central Japan was sensitive to global atmospheric circulation patterns during the deglaciation.

Keywords: Chronological correlation, Last deglaciation, climate change, East Asian monsoon, FTIR, lake sediments

