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Regional hydroclimate changes in Southern Europe during the inception and termination of the penultimate glacial (MIS 6)

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Glacial and interglacial transitions offer valuable insights into the Earth system response to both abrupt and gradual change and differ in timing and magnitude in response to varying orbital configurations and internal system dynamics. Here we focus on the inception and termination of the relatively underexplored penultimate glacial (MIS 6) in order to assess lacustrine responses to climate changes under differing boundary conditions. We apply a combined diatom and stable isotope approach to investigate changes in regional hydroclimate as recorded in the sediments of Lake Ioannina (NW Greece). Diatom and isotope-inferred changes in lake conditions coincided with the MIS 7/6 transition. The δ18O record suggests higher precipitation / evaporation (P/E) ratios between c. 178 and 164 ka, associated with peak insolation during MIS 6e, with episodes of planktonic diatom expansion likely reflecting the interstadials of the 6e complex. Furthermore, the close correspondence between planktonic diatom frequencies, arboreal pollen and regional sea-surface temperatures together provide strong evidence for millennial-scale oscillations in regional precipitation at times during the early–mid MIS 6. Although the isotope data suggest overall cooler and drier conditions during the mid–late MIS 6, consistent with approaching glacial maxima, variability in P/E and oscillations in planktonic and facultative planktonic diatom frequencies nevertheless show that marked changes in lake conditions persisted into late MIS 6. The diatom data suggest a complex penultimate deglaciation driven primarily by multiple oscillations in lake level. There is diachroneity in lake and terrestrial ecosystem response to warming at the onset of the last interglacial, with an abrupt increase in lake level occurring c. 2.7 ka prior to sustained forest expansion with peak precipitation. This is likely a result of direct input of snow melt and glacial meltwater transfer to the subterranean karst system in response to warming, which would cause rising regional groundwater levels. These data highlight that consideration of boundary conditions are key when interpreting the individual responses of limnetic and terrestrial lake system components to changes in regional hydroclimate.