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A continuous, high-resolution and multi-proxy reconstruction of terrestrial climatic variability (ca. 50 ka to Present) in mid-latitude New Zealand

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The last ca. 50 ka of environmental variability across mid-latitude New Zealand is recorded by the lacustrine sediments in a maar crater lake, Lake Pupuke (36˚47.25'S, 175˚46.25'E). A series of marked climatic events have been discerned from a mix of physical, geochemical and biological proxy environmental data. A combined tephro- and radiocarbon chronology is used to improve the timings and duration of marked climatic events from MIS 3.5 to Present within mid-latitude New Zealand.

Lake Pupuke is a eutrophic freshwater lake situated in the Auckland Volcanic Field (AVF). The site offers a rare long-term (ca. 50 ka) terrestrial record of continuous palaeoclimate through to the present. Moreover, Auckland is situated at the ecotonal boundary of cooler wetter conditions to the South and drier, warmer conditions to the North. The AVF is also exposed to distal and local ashfall enabling detailed chronologies to be constructed from the lake sediment records. This and the paucity of high-resolution ($<$ 1000 yr interval) continuous records of terrestrial environments during much of the Last Glacial Coldest Period (LGCP) enhance the value of sedimentary records from Auckland's crater maars.

Fifteen 3.0 m long overlapping sediment cores were collected using a UWITEC piston percussion coring system mounted on a floating drilling platform in the central pelagic of Lake Pupuke. The cores have been described for a range of index properties alongside magnetic susceptibility and elemental profiles (ITRAX automated XRF/X-ray density core scanner) prior to construction of a composite sediment core series of 14.20 m in length. A detailed sediment chronology comprising 17 ^{14}C and 11 tephra isochrons has been created for the composite record spanning the interval MIS 3.5 to present. A mixed effect regression model was used to enable 95% confidence interval estimates of ages to be determined through to MIS 3.5 (μ 95% variability = $\pm$ 1130 yrs). Sediment samples have been processed at 1-15 cm (ca. 34-506 yr) resolution for a range of environmental proxies (e.g., grain size, XRF geochemistry [ITRAX], total elemental concentrations [C, N, S], bulk stable isotopes [δ^{13}C, δ^{15}N], stable isotope compound specific analyses, diatom taxonomy and stable isotope analyses [δ^{18}O, δ^{30}Si]).

Multi-proxy palaeoenvironmental data identify and offer insights into the timing and nature of limnological and environmental change induced by the onset of MIS 1, onset and termination of MIS 2 and the termination of MIS 3. Combined these records imply the presence of fluctuating lake level and changes in stratification as main drivers behind the observed changes in palaeolimnology. The Last Glacial Coldest Period is particularly apparent in bulk stable isotope and total organic carbon signatures which comprise an average of -19.73 $\pm$ 2.79 ‰ and 10.26 $\pm$ 2.10 % respectively whilst their Holocene equivalents are -23.7 $\pm$ 1.73 ‰ and 16.93 $\pm$ 3.69 % respectively. Enriched δ^{13}C values likely resulted from pCO$_2$ reduction during the LGCP whilst reduced TOC reflects coincident falls in productivity. Other near recent events are also presented, in particular substantive changes to nutrient cycling, community structure and mixing coincident with a change in terrestrial flora ca. 6.0-8.0 cal. kyr BP and a marked interval of lacustrine change between 12-15.0 cal. ka BP.