DROUGHTS AND FLOODING RAINS:
A FINE-RESOLUTION RECONSTRUCTION OF CLIMATIC VARIABILITY IN WESTERN VICTORIA, AUSTRALIA, OVER THE LAST 1500 YEARS.

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For my family;

Megan, Freya and Evie.

The centre of my universe, around which everything else revolves.

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DECLARATION

This work contains no material which has been accepted for the award of any other degree or diploma in any other university or other tertiary institution and, to the best knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

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ABSTRACT

The purpose of this study was to reconstruct climatic change of the last two millennia in western Victoria using fossil diatoms as the primary proxy. Due to their short life span and sensitivity to changing water chemistry, diatoms are ideal for reconstructing short-term changes in suitable environments. The primary aim of the project was to redress a paucity of highly-resolved climate studies from the Australian mainland and represents one of the first sub-decadally resolved studies of its kind in this regard. Sediments from two crater lakes were examined from the volcanic province of western Victoria. The study region is influenced by *El Niño*-Southern Oscillation (ENSO), the Indian Ocean Dipole and the Southern Annular Mode and is currently experiencing the most severe and prolonged drought since instrumental records began (Murphy and Timbal, 2008; Ummenhofer *et al*., 2009).

The two study lakes – Lake Elingamite and Lake Surprise – have differing morphology and catchment history and lie approximately 100 km apart. Lake Elingamite is a broad, currently shallow (maximum depth = 3.4 m), oligosaline (3470 µS/cm) maar lake which shows evidence of significant catchment and lake disturbance since European settlement in the region. A 178 cm core was retrieved from this lake, representing a *ca.* 1500 year record. Lake Surprise is one of only two "true crater lakes" in the western Victorian volcanic province (Timms, 1975). It is fresh (220 µS/cm) with a maximum depth of 12 m and has a more complex morphometry than Lake Elingamite. It is located within a National Park and does not have the same degree of catchment disturbance as Lake Elingamite. Two cores were retrieved from Lake Surprise, a frozen spade core of the most recent sediments and a hammer-driven piston core of the older sediments. The combination of both cores provide a 344 cm record of the last *ca*. 1425 years. Cores from both lakes were sampled contiguously for fossil diatom analysis.

In order to quantitatively reconstruct palaeo-conductivity fluctuations from the study sites, a diatom-conductivity transfer function was developed with an intentionally short conductivity gradient, using only sites with a conductivity < 22,000 µS/cm in the modern calibration set (min: 81 µS/cm; max: 21,540 µS/cm; SD: 5592.7 µS/cm). The resulting model is robust, with a jack-knifed r^2 of 0.89 and an RMSEP of 0.238 log µS/cm (equating to 9.8% of gradient length), which compares favourably to other diatom-conductivity or salinity transfer functions. At a sample-specific level, reconstruction

confidence was tested by squared-chord distance using the modern analogue technique tool.

The Lake Surprise diatom-inferred (DI) conductivity record shows a good coherence with the Palmer Drought Severity Index developed for south-eastern Australia for the 20th Century (Ummenhofer *et al*., 2009), confirming the lake's climatic sensitivity. Comparisons between DI conductivity and instrumental climate data were not possible for Lake Elingamite due to the degree of recent lake and catchment disturbance. Importantly, the climate signal evident in the full Lake Surprise record is replicated in the Lake Elingamite record, indicating that the lakes are reflecting a common, regional-scale, climate forcing.

Lake Surprise proved to be the more sensitive of the lakes and, in places where the DI reconstruction has poor modern analogues, the interpretation is supported by the Lake Elingamite record. Results show a strong centennial-scale agreement with a reconstruction of *El Niño* events from Ecuador (Moy *et al.*, 2002), confirming the influence of ENSO on the climate of the study region. At decadal-scale, the DI conductivity record provides a history of drought frequency, intensity and duration enabling the current drought to be viewed in an historical perspective for the first time. Results demonstrate that, while the current drought is unusual in terms of its severity and duration, it is not unprecedented. At centennial-scale, evidence is presented of extended periods of dry and wet climates, including a prolonged humid period prior to European settlement in the study region.

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I always enjoy reading the acknowledgement section of theses. More often than not they are written without the constraints of academic language and as such, provide a glimpse into the 'goings-on' behind the project. Therefore, in keeping with this tradition, I shall henceforth disband with the use of academic discourse for the next page or so.

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