Article:
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Supplementary Information

1. *Modification of carbon and oxygen isotopes by continuous light*

Yang et al., (2009) suggested that hydrogen and carbon isotope fractionations in plants could be significantly affected by growth under continuous light, analogous to plant growth at very high latitudes under a polar light regime. Here, we discuss the potential impact of growth under continuous light on the measured isotope ratios in fossil *Nothofagus*.

Our reconstruction of $\delta^{18}O_{precip}$ from ancient tree ring cellulose suggests that during a period of warming and Neogene ice sheet retreat, Antarctic $\delta^{18}O_{precip}$ was significantly enriched (~12‰) relative to modern precipitation over the continent. Part of this enrichment could be due to the continuous light regime experienced by the plant during the growing season. While no data exists for $\delta^{18}O$, an enrichment in $\delta^{2}H$ of 15-40‰ has been documented in plant species grown in continuous light experiments (Yang et al., 2009); using an equilibrium fractionation factor of 8‰ to convert between $\delta^{18}O$ and $\delta^{2}H$, this would imply an enrichment of 2-5‰ in oxygen isotope space.

This decrease in discrimination against the heavier isotope is believed to be caused by enhanced water loss during a 24 hr transpiration cycle. However, it must be emphasised that while the light regime may have been similar, the fossil *Nothofagus* plants in this study grew under very different conditions to those used in the growth experiments. During the late Neogene, the Antarctic interior was covered by a tundra shrub; low summer temperatures (~5°C), low precipitation rates and high wind stress mean that photosynthetic and transpiration rates would have been significantly lower during the growth season, evidenced by the extremely narrow growth rings of the fossil *Nothofagus* (Francis and Hill, 1996). In contrast, deciduous conifers in the experiments of Yang et al. (2009) were grown at much higher temperatures and lower water stress. This would considerably reduce the transpiration rate for Antarctic plants versus those used in the growth experiment,

decreasing water loss, and consequentially reducing any potential leaf water isotope enrichment. We therefore conclude that the majority of the enrichment signal in our ancient $\delta^{18}O_{precip}$ reconstruction is caused by changes in the hydrological cycle, not in plant isotope fractionation. The same study also recorded more negative values in plant $\delta^{13}C$ in plants grown under continuous light relative to those grown under diurnal light, due to increased internal CO_2 concentrations (Jagels and Day, 2004; Smith et al., 1976; Yang et al., 2009).

Supplementary Figures

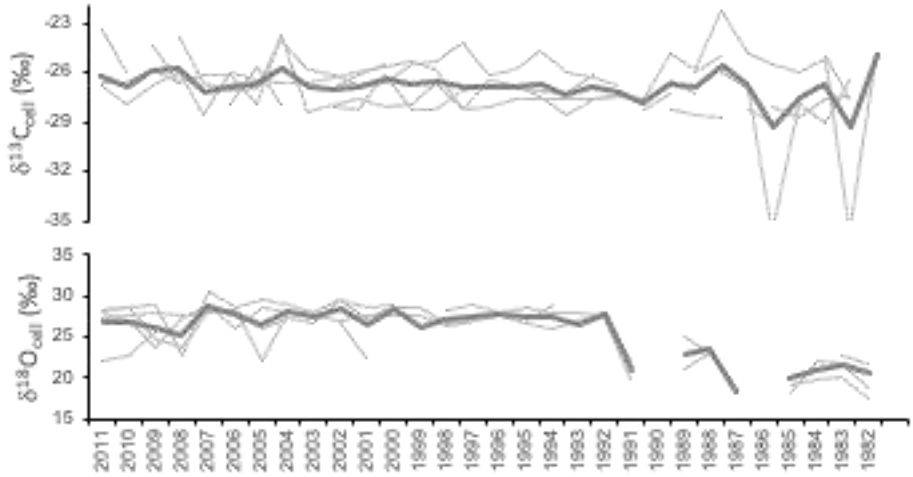

Figure S1. Chronologies for $\delta^{13}C_{cell}$ and $\delta^{18}O_{cell}$ shown for site 3. EPS for $\delta^{18}O$ is 0.87, EPS for $\delta^{13}C$ is 0.67.