An update on paleoclimate data-model comparisons for the Southwest Pacific

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New multi-proxy records of sea and land temperature variation from late Paleocene to early Eocene, eastern South Island, New Zealand indicate that both sea floor and sea surface temperatures (SFTs and SSTs) increased by ~10°C from late Paleocene to early Eocene times. Late Paleocene (58–59 Ma) TEX_{86}-derived SSTs for Canterbury Basin and Campbell Plateau range from 18 to 23°C, consistent with coeval TEX_{86} records from the south Tasman Sea, and indicative of a warm temperate climate for the region at this time. Campbell Plateau SFTs of 7–9°C are deduced from benthic foraminiferal Mg/Ca ratios. At this upper bathyal site, this temperature range is equivalent to the present-day Deep Western Boundary Current, and suggests that an equivalent southern-sourced cool water flow existed in the Paleocene, prior to the development of a circumpolar current.

In contrast to this temperate Paleocene climate, our multi-proxy studies (TEX_{86}, Mg/Ca, $\delta^{18}O$) indicate that the early Eocene of southeast New Zealand experienced truly tropical conditions. SST peaked at ~30°C during the Paleocene Eocene Thermal Maximum and the Early Eocene Climatic Optimum, decreasing only by ~2°C in the later early Eocene (48–46 Ma). SFT peaked at 17–20°C at 50 Ma and declined to 13–16°C by 48 Ma. A cooling step at 48.5 Ma corresponds to intensification in corrosive bottom water flow over the Campbell Plateau, as evident from the disappearance of the planktic-benthic $\delta^{18}O$ offset at DSDP site 277. The SST estimates are consistent with coeval TEX_{86}-derived SSTs from the southwest Tasman Sea.

Both global and regional climate models under high CO_2 conditions (2240 ppm CO_2, NCAR CCSM3; 1200 ppm CO_2, HadRM3p) suggest warm temperate conditions for New Zealand (SSTs of 15–20°C), which is consistent with Paleocene and later Eocene temperature estimates but not with early Eocene SST estimates. These models are also consistent with the results of physiognomic analysis (CLAMP) of leaf fossil assemblages from eastern South Island, which indicate cool temperate conditions for the Paleocene (mean annual air temperature [MAAT] of 10–12°C) and marginally subtropical conditions for the early Eocene (MAAT of 18–22°C). Other paleontological data, such as occurrences of the mangrove palm *Nypa* and the larger benthic foraminifera *Asteroclina* are consistent with warm subtropical conditions (but not warm tropical) in the early Eocene.

We suggest that the combined effects of salinity, seasonality and stratification result in a warm bias in the SST and SFT estimates derived from $\delta^{18}O$, Mg/Ca and TEX_{86} in these southwest Pacific records. We outline some ways to correct for this bias.