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Systematic multiproxy comparison suggests different magnitudes of glacial cooling in the tropics: Ecology or calibration?

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Knowledge of the amplitude of past climate changes is essential for the estimation of climate sensitivity to external forcing and the amount of natural climate variability. Geochemical proxies, both organic and inorganic, are routinely used to estimate past seawater temperatures. Compilation studies such as MARGO show that different proxies often result in different magnitudes of regional glacial cooling. However, these proxies are not always analyzed in the same sedimentary archives, rendering direct multiproxy comparisons challenging. Here, we compiled and compared published multiproxy (alkenone-based UK'37, archaeal tetraether-based TEX86H and Mg/Ca of foraminifera) records at single sites in the tropics and the subtropics. Among the three geochemical proxies scrutinized, the TEX86H suggests the strongest glacial cooling, which is on average twice of those inferred from the UK'37, the Mg/Ca of planktonic foraminifera and the simulations of a state-of-the-art climate model. Based on a systematic analysis of the seasonal and depth structure in the climate simulations, we ruled out different habitats (depth and season, constant over time) of proxy carriers as the sole factor causing the differences in the magnitude of glacial cooling. Notably, the downcore temporal relationship between TEX86H and UK'37 differs from the modern spatial relationship between these proxies (as observed in surface sediments data in the global ocean). Given that UK'37 and Mg/Ca derived glacial coolings agree with each other and with the model simulations, it is likely that the magnitude of glacial cooling inferred from TEX86H is overly strong, which might be caused by temporally varying habitat depth and/or seasonal production of archaea. Alternatively, the TEX86H calibration, which assumes constant depth and season in temperature, is possibly confounded by environmental factors that act to dampen the slope of the TEX86H-temperature calibration.