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A subtropical North Pole during the late Paleocene - early Eocene

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The warm global temperatures during the late Paleocene and early Eocene are associated with elevated greenhouse gas concentrations. Superimposed on this period of gradual climate warming, several periods of widespread massive greenhouse gas warming occurred, of which the most extreme happened at the Paleocene-Eocene boundary approximately 55 million years ago. Surface temperature evolution of low- to mid latitudes have been reasonably well documented across this Paleocene-Eocene thermal maximum (PETM), but to fully assess pole-to-equator gradients and potential polar amplification of greenhouse warming during the PETM, polar records are required. Here we identify the PETM in a recently recovered (Arctic Coring Expedition, IODP Leg 302, August-September 2004) marine sedimentary sequence deposited near the North Pole and examine the pattern of Arctic climate change during this extreme climate anomaly. We show that during the PETM the tropical dinoflagellate *Apectodinium* inhabited the Arctic Ocean, when (TEX_{86}-derived, in this case likely reflecting summer-) surface temperatures rose from 18ºC to over 23ºC. Concomitantly, sea level rose and photic zone euxinia developed. Arctic surface temperatures before, during and after the PETM were at least 10˚C warmer than predicted by paleoclimate model simulations with 2000 ppmv CO_2. Moreover, our data confirm previously-noted sig-

nificantly reduced pole-to-equator temperature gradients that cannot be reproduced by the current generation of fully coupled climate models. This suggests that feedback mechanisms that are unimplemented in the models, in conjunction with elevated greenhouse gas concentrations, played a crucial role in the polar-amplified warmth of early Paleogene climates. Finally, our results show that the pole-to-equator temperature gradient remained similar during the PETM, suggesting that the mechanism that caused early Paleogene reduced gradients was largely saturated at this event.