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Chemical Analyses of Fossil Trees Indicate Above-Freezing Wintertime Temperatures in the Arctic 45 to 55 Million Years Ago

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Abstract

The global average temperature has been increasing across the last century as a result of rising CO_2 levels in Earth's atmosphere. Warming, however, has not been even across the planet, with greater warming observed across the Arctic compared with lower latitudes. Here we test the hypothesis that enhanced Arctic warming (termed, "Arctic amplification") is a common feature of rising atmospheric CO_2 levels by investigating published stable carbon and oxygen isotope data measured on Eocene-aged fossil wood (45 to 55 million years old) collected from Arctic Canada. This time period was characterized by elevated atmospheric CO_2 levels and ice-free conditions in both the Arctic and Antarctic, and represents an opportunity to study of the effect of elevated CO_2 on temperature. We calculate that Arctic forests thrived under average July and January temperatures of 20 to 22° and -2 to 6 ^{o}C, respectively. These temperatures are 20 to 30 ^{o}C warmer than present day, and are consistent with the hypothesis for Arctic amplification under elevated CO_2. These data represent the first quantitative estimates for seasonal temperature in the Arctic during the Eocene using fossil wood, and demonstrate that above-freezing year-round temperatures are possible in the Arctic under sustained periods of elevated CO_2.