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Moderate pCO_2 concentrations during MMCO indicated by fossil plants

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The mid-Miocene climatic optimum (MMCO, ∼17–14.5 Ma) is the youngest of several transient warm periods superimposed on the pattern of long-term cooling through the Cenozoic. As the most recent period of sustained global warming, the MMCO forms an important analogue for the ongoing ('Anthropocene') climate change; however, this period remains noticeably understudied relative to other Cenozoic greenhouse intervals. As a deep-time analogue, the MMCO has the advantage of being relatively similar to our modern (and projected future) world, both in terms of plate configurations and biota. Arguably, therefore, the MMCO is our best case study for understanding both how the climate system functions during global warming and the ecological implications of future climate change. Several important questions remain unanswered regarding the drivers of and biotic responses to this warming. During the middle Miocene, climates 4–8 °C warmer than today were accompanied by atmospheric pCO_2 levels that were low or, at best only moderately elevated – too low to explain MMCO warmth, implying either that climate sensitivity was higher during the Miocene, or that our climate models—the same ones we use for future predictions—lack crucial feedbacks. Here we present new pCO_2 results, based on stomatal densities of fossil leaves from the conservation Lagerstätte flora preserved in the Clarkia Formation in Idaho, USA. New robust chronology indicates that the sediments were deposited at peek MMCO warming (16–15.9 Ma). Based on the stomatal densities of numerous leaves of multiple species belonging to Betula, Quercus and Lauraceae, using several methods of pCO_2 reconstruction, we consistently find pCO_2 at $\sim$ 500 ppm. These results confirm the previous findings of moderately elevated pCO_2 during MMCO. Either proxies consistently underestimate pCO_2 during MMCO, or climate sensitivity was highly elevated during this time.