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# Simulating the climate impact of Large Igneous Provinces: A mid-Miocene case-study

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Large Igneous Provinces (LIPs) can result in significant degassing of mantle-derived $CO_2$ into the ocean-atmosphere system, but only the largest LIPs are considered to have had a significant impact on global climate. However, some smaller LIPs also coincide with times of global warmth and carbon cycle perturbations. Here we use biogeochemical box models to investigate the possibility of one such minor LIP, the Columbia River Basalts (CRB), warming climate during the mid-Miocene. An advantage of studying this fairly recent event is the more rigorous model-data comparison made possible by the relative wealth of palaeorecords. Comparing our model results to reconstructions of mid-Miocene carbonate compensation depth, benthic foraminifera $\delta$13C and $pCO_2$ suggests an emissions scenario of 2000-4000 Pg C between $\sim$16.2 and 15.8 Ma fits the palaeorecords best, though additional mechanisms are required to match the CCD reconstruction after this. This emission range is nearly an order of magnitude greater than estimates for extrusive basalt degassing alone, but is within the estimated range when including degassing from intrusive and underplated material or the potential incorporation of pyroxenite-rich oceanic crust into the CRB's magma supply. When including these extra $CO_2$ sources we conclude that the CRB could have played a significant role in the mid-Miocene Climatic Optimum if the additional emissions actually occurred. This can be extrapolated to other LIPs and we consider whether they could have also had a greater impact than currently accepted.