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Would atmospheric CO_2 concentration continue to increase if anthropogenic CO_2 emissions were to suddenly cease?

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If anthropogenic CO_2 emissions were to suddenly cease, the evolution of atmospheric CO_2 concentration would depend on the magnitude and sign of natural carbon sources and sinks. Previous experiments using Earth system models have indicated that overall carbon sinks dominate, such that upon cessation of anthropogenic emissions atmospheric CO_2 levels begin to drop. However, these models have typically neglected the permafrost carbon pool. Here an iterative method is used with the permafrost carbon version of the University of Victoria Earth System Climate Model to determine whether atmospheric CO_2 increases or decreases after cessation of anthropogenic CO_2 emissions (given a constant, post cessation, concentration of non-CO_2 greenhouse gasses). It is found that non-CO_2 greenhouse gas concentrations with a radiative forcing of approximately 0.6 Wm^{-2} (relative to pre-industrial forcing) induces a near balance in CO_2 emissions from the terrestrial biosphere and uptake of CO_2 by the oceans, no matter when emissions cease during the 21st century. The present-day radiative forcing from non-CO_2 greenhouse gasses ($0.95Wm^{-2}$) is above the level required to balance the atmospheric carbon pool. Simulations indefinitely maintaining present-day levels of non-CO_2 greenhouse gas forcing after carbon emissions cease result in an 11– 22 ppmv further increase in atmospheric CO_2 concentration over a period of 300–400 years. These model experiments suggest that if anthropogenic CO_2 emissions were to cease tomorrow, that CO_2 would continue to build up in the atmosphere. However, CO_2 concentrations are simulated to increase slowly after the cessation of anthropogenic CO_2 emissions and therefore the consequences of being in such a regime are relatively mild.