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Stabilizing climate requires zero emissions

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Stabilizing climate change as been a key international policy goal since the publication of the United Nations Framework Convention on Climate Change in 1992. Since that time, scientific and policy literature concerning climate change mitigation has been centered around stabilizing concentrations of greenhouse gases in the atmosphere. However, stabilizing global climate within a human timescale requires decreasing, rather than stabilized, greenhouse gas levels. In this study, we demonstrate that climate stabilization, at any level, requires that carbon emissions be reduced to zero. We show first that a single pulse of carbon into the atmosphere increases globally averaged surface temperature by a fixed amount that remains constant for up to 500 years. Following an emissions pulse, the decrease of CO_2 levels in the atmosphere is matched by a decrease in the effectiveness of ocean heat uptake, with the result that surface temperatures remain unchanged at an elevated value. We show that this same effect is achieved if a comparable amount of carbon is emitted over the next several decades. Every tonne of carbon emitted leads to an increment of warming that persists for several centuries, even in the absence of additional emissions. The corollary to this result it that to hold climate constant at a given global temperature requires zero future carbon emissions. Using a novel technique to specify a desired climate trajectory into a global climate model, we show that this result holds across a range of future rates of temperature change as well as for stabilization levels from 1 to 4 degrees above pre-industrial. To prevent further climate change, we must eliminate future CO_2 emissions; any emissions that occur in years to come will commit us to some amount of irreversible climate warming.