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Impact of cumulative emissions of carbon dioxide: the trillionth tonne

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The equilibrium warming response to stabilisation of atmospheric greenhouse gas concentrations remains highly uncertain, impeding agreement on stabilisation targets to avoid dangerous anthropogenic climate change. Similar problems apply to the carbon cycle: observed carbon dioxide emissions and concentrations provide only a weak constraint on the response to stable or declining emissions. Using ensemble simulations based on two simple climate-carbon-cycle models constrained by observations and by results from more comprehensive models, we show that the ratio between the peak carbon-dioxide-induced warming and the total carbon dioxide released over the entire "anthropocene" is better constrained by quantities that we can observe and remarkably constant over a broad range of emission profiles. Hence policy targets limiting cumulative emissions of long-lived greenhouse gases are more robust to scientific uncertainty than emission-rate or concentration targets: total emissions of one trillion tonnes of carbon-equivalent over 1750-2500 (about half of which has already been emitted) results in a most likely peak carbon-dioxide-induced warming of 2oC above pre-industrial, with a 5-95% uncertainty range of 1.3-3.9oC.