



Current level and rate of warming determine emissions budgets under ambitious mitigation

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A number of recent studies have highlighted the importance of the present-day level of warming relative to pre-industrial in the determination of the remaining budget of carbon dioxide (CO₂) consistent with limiting warming to 1.5°C. However, discrepancies in the level of warming cannot explain all the differences between recent budget estimates. Here we show that, through simple geometry, the combination of both the level and rate of human-induced warming provides a remarkably accurate, scenario and model-independent metric of remaining emission budgets to peak warming if budgets are expressed in terms of CO₂-forcing-equivalent emissions. These in turn can predict CO₂-only budgets for comparison with previous studies if the fractional contribution of non-CO₂ forcing to total warming remains approximately constant, as is the case in several of the most ambitious mitigation scenarios. We find a best-estimate remaining budget for 1.5 of about 22 years' current emissions from mid-2017, with a 'likely' (1 standard error) range of 13-32 years, and a budget for 'likely below' 1.5 of about 18 years' emissions. These values are comparable with several recent studies using a wide range of methodologies. Our metric is transparent, model- and response-independent, and can explain how discrepancies in previous estimates arise, as well as providing a geometric link between 'Threshold Avoidance' and 'Threshold Exceedance' budgets as given in AR5. It could be used to inform the Paris stocktake progress towards an ambitious temperature stabilization goal, but is less applicable to less ambitious goals due to our reliance on a constant Transient Climate Response to cumulative carbon Emissions (TCRE). Please note that this material was already presented, in part, at the 2018 December AGU.