

EGU2020-11278

<https://doi.org/10.5194/egusphere-egu2020-11278>

EGU General Assembly 2020

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A new framework for understanding and quantifying uncertainties in the remaining carbon budget

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The remaining carbon budget quantifies the allowable future CO₂ emissions to keep global mean warming below a desired level. Carbon budget estimates are subject to uncertainty in the Transient Climate Response to Cumulative CO₂ Emissions (TCRE), which measures the warming resulting from a given total amount of CO₂ emitted. Moreover, other sources of uncertainty linked to non-CO₂ emissions have been shown to also strongly affect estimates of the remaining carbon budget. Here we present a new framework that estimates the TCRE using geophysical constraints derived from observations, and integrates the effect of geophysical and socioeconomic pathway uncertainties on the distribution of the remaining carbon budget. We estimate a median TCRE of 0.40 °C and likely range of 0.3 to 0.5 °C (17-83%) per 1000 GtCO₂ emitted. Our 1.5 °C remaining carbon budget has a median value of 710 GtCO₂ from 2020 onwards, with a range of 470 to 960 GtCO₂, (for a 67% to 33% chance of not exceeding the target). Uncertainty in the amount of current warming from non-CO₂ forcing is the dominant geophysical contributor to the spread in both the TCRE and remaining carbon budget estimates. The remaining carbon budget distribution is also strongly affected by current and future mitigation decisions, where the range of non-CO₂ forcing across scenarios has the potential to increase or decrease the median 1.5 °C remaining carbon budget by 740 GtCO₂.