



Sensitivity of carbon budgets to permafrost carbon feedbacks and non-CO₂ forcings

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The near proportionality between cumulative CO₂ emissions and change in near surface temperature can be used to define a carbon budget: a finite quantity of carbon that can be burned associated with a chosen “safe” temperature change threshold. Here we evaluate the sensitivity of this carbon budget to permafrost carbon dynamics and changes in non-CO₂ forcings. The carbon budget for 2.0°C of warming is reduced from 1320 Pg C when considering only forcing from CO₂ to 810 Pg C when considering permafrost carbon feedbacks as well as other anthropogenic contributions to climate change. We also examined net carbon budgets following an overshoot of and return to a warming target. That is, the net cumulative CO₂ emissions at the point in time a warming target is restored following artificial removal of CO₂ from the atmosphere to cool the climate back to a chosen temperature change target. These overshoot net carbon budgets are consistently smaller than the conventional carbon budgets. In other words, more carbon needs to be removed from the atmosphere to cool the system back to a chosen temperature target than the size of the original carbon budget overshoot. Overall carbon budgets persist as a robust and simple conceptual framework to relate the principle cause of climate change to the impacts of climate change.