



## **The effect of non-CO<sub>2</sub> forcing scenario uncertainty on the 1.5°C carbon budgets**

H. Damon Matthews and Nadine Mengis

Concordia University, Geography, Planning and Environment, Montreal, Canada (damon.matthews@concordia.ca)

Estimates of the 1.5°C carbon budget vary widely among recent studies. One key contribution to this range is the non-CO<sub>2</sub> climate forcing scenario uncertainty. To increase our understanding of historical non-CO<sub>2</sub> climate forcing, we have partitioned observed forcing into contributions from 1) fossil fuel combustion (FFC), 2) land-use change (LUC) and agricultural activities, and 3) other human activities. We find that there is currently a net negative non-CO<sub>2</sub> forcing from FFC mainly due to the co-emission of aerosols, and a net positive non-CO<sub>2</sub> climate forcing from LUC and agricultural activities. Using the results of this analysis, we designed idealized ambitious mitigation scenarios in which we scaled non-CO<sub>2</sub> forcing to remain consistent with decreasing FFC CO<sub>2</sub> emissions. We diagnosed 1.5°C carbon budgets from a set of model simulations using a prescribed 1.5°C temperature stabilization trajectory, and compared the budgets from our idealized scenarios to those resulting from the default RCP scenarios, as well as from a scenario in which we assumed proportionality between future CO<sub>2</sub> and non-CO<sub>2</sub> forcing. We find a large range of carbon budget estimates across scenarios, with the largest budget emerging from the scenario with proportional CO<sub>2</sub> and non-CO<sub>2</sub> forcing. Furthermore, our idealized scenarios, in which the non-CO<sub>2</sub> forcing is consistent with model-diagnosed FFC CO<sub>2</sub> emissions, produced carbon budgets that are smaller than the corresponding default RCP scenarios. Our results suggests that ambitious mitigation scenarios will likely be characterized by an increasing contribution of non-CO<sub>2</sub> forcing, and that an assumption of continued proportionality between CO<sub>2</sub> and non-CO<sub>2</sub> forcing would lead to an overestimate of the remaining carbon budget required to avoid low-temperature targets. Maintaining such proportionality (and the resulting larger carbon budget) would require mitigation of non-CO<sub>2</sub> emissions from agriculture and other non-FFC sources at a rate that is substantially faster than is found in the standard RCP scenarios.