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Is there warming in the pipeline? A multi-model analysis of the zero emission commitment from CO₂

Andrew H. MacDougall¹, Thomas L. Frölicher², Chirs D. Jones³, Joeri Rogelj⁴, H. Damon Matthews⁵, Kirsten Zickfeld⁶, and the Zero Emissions Commitment Model Intercomparison Project*

¹St. Francis Xavier University, Climate & Environment, Antigonish, Canada (amacdoug@stfx.ca)

²Climate and Environmental Physics, Physics Institute, University of Bern, Switzerland; Oeschger Centre for Climate Change Research, University of Bern, Switzerland

³Met Office Hadley Centre, Exeter, EX1 3PB, UK

⁴Grantham Institute for Climate Change and the Environment, Imperial College, London, UK; International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria

⁵Concordia University, Montreal, Canada

⁶Simon Fraser University, Burnaby, Canada

*A full list of authors appears at the end of the abstract

The Zero Emissions Commitment (ZEC) is the change in global mean temperature expected to occur following the cessation of net CO₂ emissions, and as such is a critical parameter for calculating the remaining carbon budget. The Zero Emissions Commitment Model Intercomparison Project (ZECMIP) was established to gain a better understanding of the potential magnitude and sign of ZEC, in addition to the processes that underlie this metric. Eighteen Earth system models of both full and intermediate complexity participated in ZECMIP. All models conducted an experiment where atmospheric CO₂ concentration increases exponentially until 1000 PgC has been emitted. Thereafter emissions are set to zero and models are configured to allow free evolution of atmospheric CO₂ concentration. The inter-model range of ZEC 50 years after emissions cease for the 1000 PgC experiment is -0.36 to 0.29 °C with a model ensemble mean of -0.06 °C, median of -0.05 °C and standard deviation of 0.19 °C. Models exhibit a wide variety of behaviours after emissions cease, with some models continuing to warm for decades to millennia and others cooling substantially. Analysis shows that both ocean carbon uptake and carbon uptake by the terrestrial biosphere are important for counteracting the warming effect from reduction in ocean heat uptake in the decades after emissions cease.

Overall, the most likely value of ZEC on decadal time-scales is assessed to be close to zero, consistent with prior work. However substantial continued warming for decades or centuries following cessation of emission is a feature of a minority of the assessed models and thus cannot be ruled out.

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