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Climate Simulations to Carbon Neutral with Improved Minimal Complexity Earth Simulator

Jiewei Chen^{1,2}, Huijuan Cui¹, and Yangyang Xu³

¹Key Laboratory of Land Surface Pattern and Simulation, Institute of Geographical Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing, China (chenjw.17b@igsnr.ac.cn, cuihj@igsnr.ac.cn)

²University of Chinese Academy of Sciences, Beijing, China (chenjw.17b@igsnr.ac.cn)

³Department of Atmospheric Sciences, College of Geosciences, Texas A&M University, College Station, USA (yangyang.xu@tamu.edu)

The Paris Agreement stated a goal to keep global warming to well below 2°C, preferably to 1.5°C above preindustrial levels. To further ensure the implementation of the Paris Agreement, recently, many countries have proposed to achieve carbon neutral between 2050-2070. In this study, we produce a set of carbon neutral scenarios and examined their climate responses using the minimal complexity earth simulator (MiCES). First of all, parameter sensitivity analysis is applied to optimize the parameters for the model using a multi-parameter sensitivity analysis method and output measurement method, which turns out that the 7 parameters related to heat and carbon transferred are most sensitive among all 37 parameters. Uncertainties of the key parameters are further constrained by observed emission and temperature within their uncertainty range, providing reference bounds of parameters with 95% confidence intervals. Then we design ideal emission scenarios with China's carbon emission peak at 2024, 2027, 2030 and carbon neutral in 2050, 2055, 2060, 2065, 2070 and extrapolated to world's emission. With improved key parameters' value, we simulated climate responses to carbon neutral scenarios. We found that the Paris goal of limiting temperature increase to 1.5°C above pre-industrial levels will require either negative carbon emission or all greenhouse gases neutral during this century, and the carbon neutral before 2060 proposed by Chinese government will contribute to limiting global temperature increase with the 2°C level.