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Climate Restoration via Zero Emissions Stabilization: Examination using Earth System Models

NOHARA, Daisuke[1*] ; WATANABE, Shingo[2] ; TACHIIRI, Kaoru[2] ; HAJIMA, Tomohiro[2] ; OKAJIMA, Hideki[2] ; TSUTSUI, Junichi[1] ; MATSUNO, Taroh[2]

[1]Central Research Institute of Electric Power Industry, [2]Japan Agency for Marine-Earth Science and Technology

Zero-emissions stabilization is a newly proposed concept that targets reduction of CO_2 emissions to zero in a distant future, after which the atmospheric CO_2 concentration is reduced by a natural atmospharic CO_2 removal process, eventually allowing the atmosphere to reach an equilibrated stable state. The zero-emissions pathway, Z650, has been designed based on this concept as a flexible alternative toward a climate stabilization target. It allows cumulative emissions of 650 GtC during the 21st century and aims to attain zero emissions in the middle of the 22nd century. To confirm the decreases in CO_2 concentrations and temperature that would be achieved with the Z650 pathway, long-term climate and carbon cycle projections have been conducted up to the year 2300 by emission-driven experiment using the Earth system models, CESM1 and MIROC-ESM. Both the models show gradual decreases in the atmospheric CO2 concentration subsequent to the occurrence of temporal peaks of the concentration due to oceanic and terrestrial CO_2 uptakes. The models also project decreases in the globally averaged surface air temperature after the peak temperature increase. These results imply that the climate is eventually stabilized from a temporal warming state to less warmed under the zero emissions with the Z650 pathway. However, the experiments show considerably different increases in the peak concentration and temperature values, which are attributable to the different carbon and climate sensitivities.