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Climate, carbon cycle, and earth system response to representative concentration pathway scenarios in MIROC-ESM

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Earth system models (ESMs) have been developed to understand the mechanisms of long-term climate change with carbon cycle feedbacks. In this study, past simulations (1850-2005) and projection experiments (2006 to 2100) were conducted using an ESM named "MIROC-ESM", forced by four representative concentration pathway (RCP) scenarios that describe how anthropogenic forcing such as greenhouse gases (GHGs), aerosols, and land-use will develop in the future. The purposes of this study are to display the basic results from projections with RCPs and MIROC-ESM and explore the mechanisms of the Earth system differently responding to the scenarios. Temperature rise from 1850 ranged from 2.4 K in the RCP2.6 scenario to 6.2 K in the RCP8.5 scenario. Climate response to the increase of atmospheric carbon showed large variation among scenarios, strongly affected by ocean heat uptake efficiency as well as anthropogenic forcing. Large variation among scenarios was also found in carbon cycle sensitivity measured by cumulative airborne fraction. This variation in carbon cycle sensitivity may be attributable to the dependence of concentration-carbon feedback on the rate of atmospheric CO_2 increase, suggested by analytical solutions and biogeochemically / radiatively uncoupled simulations. The earth system would show a similar response to emitted carbon during the 21st century if the difference of ocean heat uptake efficiency and variation of radiative forcing from non-CO_2 anthropogenic agents among scenarios were small.