

Future directions of Earth system modeling: outcome of the discussion forum under TOUGOU program

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The TOUGOU program, a research project on climate change funded by MEXT, started in FY2017 and reaches its final year in FY2021. Team MIROC, consisting of major Japanese climate modeling institutions including JAMSTEC, AORI (University of Tokyo), and NIES, has developed an Earth system model MIROC-ES2L under the TOUGOU program. The model has been used to conduct the CMIP6 experiment, and the output data has been distributed through ESGF. Intriguing results have been obtained, such as the improved reproducibility of the ocean sub-surface layer in the equatorial Pacific, which leads to a drastic improvement in the relationship between El Niño and sea surface CO₂ fluxes when temperature and salinity are assimilated. Based on these results, the TOUGOU program scientists are now discussing how they should develop Earth System Science research after the TOUGOU program. One of the important directions is the comprehensive projection of global environmental change that considers factors other than climate change, as suggested by the "Planetary Boundary" concept. Also, to contribute to the Global Stocktake (GST), decadal-scale projection of the carbon cycle should be promoted to clarify the changes in the carbon balance in the recent and future years. A more precise evaluation of the carbon budget required for limiting global warming would also be an essential input to GST. Furthermore, the impact of climate mitigation policies on the global environment through, among others, land-use change can be assessed using a model that combines a socioeconomic model and an Earth system model, considering the interaction between social change and global environmental change.

Keywords: Earth system modeling, Carbon budget, Decadal Prediction, Planetary boundary, IPCC, Climate change