



## An overview on long-term projection experiments using MIROC-ESM and an associated EMIC

M. Kawamiya (1), S. Watanabe (1), K. Tachiiri (1), T. Hajima (1), A. Ito (1), A. Yamamoto (2), H. Okajima (2), and E. Kato (3)

(1) Research Institute for Global Change / Japan Agency for Marine-earth Science and Technology, Yokohama, Japan, (2) Atmosphere-Ocean Research Institute / University of Tokyo, Kashiwa, Japan, (3) National Institute for Environmental Studies, Tukuba, Japan

The KAKUSHIN program (Innovative Program of Climate Change Projection for the 21st Century) is a 5-year research project, which started in FY 2007 and came to an end this year, dedicated to global warming projection covering uncertainty estimation and impact assessment. The targets of KAKUSHIN program include near- and long-term projection and extreme events, as in the CMIP5 protocol. In this presentation we focus on the results from the long-term projection component, which have been obtained with MIROC-ESM and JUMP-LCM: the former is a GCM-based earth system model and the latter an EMIC whose ocean part is common with MIROC-ESM.

Under the KAKUSHIN program, we have performed most of the experiment listed in the CMIP5 protocol. Analyses on the obtained results show some intriguing results that, among others, future land use scenario may have a critical impact on the global carbon cycle, and that relationship between cumulative carbon emission and temperature rise, such as climate carbon response (CCR), has a moderate dependence on emission scenarios due to ocean heat uptake. Model analysis is underway also on other aspects, and indicates a significant impact of sea-ice melting on ocean acidification over the Arctic Sea through regulation by sea-ice on air-sea CO<sub>2</sub> exchange, and a longer periodicity of Quasi-Biennial Oscillation (QBO) under global warming due to strengthened updraft.

Furthermore, uncertainty estimation on the future scenarios is going on with the help of MIROC-lite. Examination on the RCPs revealed that “negative emission (or anthropogenic carbon sink)” may, depending on the way to evaluate the uncertainty, be necessary even for achieving the RCP4.5 concentration, for which the standard emission pathways does not include any negative emission. It is also noteworthy that uncertainty for the allowable emission pathway is highly dependent on how ensemble members are weighed according to their resemblance to nature. Also, it turned out that the differences between the RCP standard emission pathways and those obtained our GCM-based ESM (MIROC-ESM) fall within the uncertainty range estimated by MIROC-lite based on the scatter range of C4MIP experiments, while MIROC-ESM’s emission pathways are at the high end of the uncertainty. It is demonstrated that EMICs can be utilized as a powerful tool for uncertainty estimation on results obtained by GCM-based ESMs.

From this FY, a new research program on global change projection called SOSEI, covering establishment of seamless prediction, geo-engineering assessment, and climate scenario development, will be launched in Japan. The new program is also outlined in the presentation.