



Towards CMIP6/PMIP4: Preparation of the Last Glacial Maximum and the Last Millennium experiments using MIROC-ES2L

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We have started preparing the Last Glacial Maximum (LGM) and Last Millennium (LM) experiments in order to contribute Coupled Model Intercomparison Project Phase 6/Paleoclimate Modelling Intercomparison Project Phase 4 (PMIP4) using an Earth System Model MIROC-ES2L. The model version for PMIP4 has horizontal resolution of T42 and vertical 40 layers for the atmosphere. The horizontal oceanic coordinates are tri-polar 360 x 256 grids with vertical 63 layers. The model is capable to calculate carbon and nitrogen cycles explicitly. We present status of the experiments and preliminary analyses.

The LGM experiment requires most of the efforts and long spin-up on performing the PMIP4 experiments because of the different land sea mask and different oceanic thermohaline circulation state from pre-industrial control (PI) (Kageyama et al. 2017). We started spin-up experiments using the physical core of MIROC-ES2L during the model development in order to gain enough integration length. As a first step, greenhouse gas levels are reduced to the LGM level from PI and integrated for 2640 years. Then, the land-sea mask has changed to one of the choices of LGM configuration in PMIP4, ICE-6G_C and integrated for 300 years. After that, the altitude difference from PI is implemented and integrated for 2000 years. Then, the difference of Earth orbit is changed to the LGM state and under integration. Global mean temperature change at 2 m height at the LGM is -3.7 degree Celsius after 5240 years integration deviated from PI. This is consistent with an estimate using multi-proxy and General Circulation Models (Annan and Hargreaves 2013). Although the general temperature drop from PI is reasonable, more cooling over the polar regions is needed compared to the ice core data (Stenni et al., 2010, Uemura et al., 2012). We keep the integration and are going to include ecosystem in land and ocean modules.

The LM experiment has integrated using the physical core of MIROC-ES2L to test the model performance following the PMIP4 protocol (Jungclaus et al. 2017). Beforehand, a control experiment forced with the condition at 850 CE was performed 200 years and the LM transient experiment was branched, and integrated for 1000 years. The Greenhouse gases, volcanos, land-use, orbital, and solar forcing are implemented following the PMIP4 protocol. We will repeat this procedure with full MIROC-ES2L after the model version and the provided forcing are fixed. The annual mean temperature at 2 m height averaged over the northern hemisphere shows the evident negative spikes after huge eruptions of volcanos. Further details will be presented.