Modeling a modern-like pCO₂ Warm period with two versions of IPSL AOGCM

Ning Tan¹, Camille Contoux², Gilles Ramstein², Yong Sun³, Christophe Dumas², Pierre Sepulchre², and Zhengtang Guo¹
¹Key Laboratory of Cenozoic Geology and Environment, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing 100029, China
²Laboratoire des Sciences du Climat et de l'Environnement, LSCE/IPSL, CEA-CNRS-UVSQ, Université Paris-Saclay, 91191 Gif-sur-Yvette, France
³State Key Laboratory of Numerical Modelling for Atmospheric Sciences and Geophysical Fluid Dynamics, Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing 100029, China

The mid-Piacenzian warm period (3.264 to 3.025 Ma) is the most recent geological period with present-like atmospheric pCO₂. A specific interglacial (Marine Isotope Stage KM5c, MIS KM5c; 3.205 Ma) has been selected for the PlioMIP 2 phase (PlioMIP 2). We carried out a series of experiments according to the design of PlioMIP 2 with two versions of IPSL atmosphere-ocean coupled general circulation model (AOGCM): IPSL-CM5A and IPSL-CM5A2. Our results show that the simulated MIS KM5c climate presents enhanced warming at mid- to high latitudes when compared to the PlioMIP 1, resulting from the enhanced Atlantic Meridional Overturning Circulation caused by the high-latitude seaway changes. The sensitivity experiments, conducted with IPSL-CM5A2, show that, apart from the pCO₂, both modified orography and reduced ice sheets contribute substantially to mid- to high latitude warming in MIS KM5c. When considering the pCO₂ uncertainties (+/−50 ppmv) during the Pliocene, the response of the modeled mean annual surface air temperature to changes to pCO₂ (+/−50 ppmv) is not symmetric, which is likely due to the nonlinear response of the cryosphere (snow cover and sea ice extent).