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Investigation on mechanisms controlling export production at the LGM with an biogeochemical ocean model

A. Oka (1), A. Abe-Ouchi (1,2), M. Chikamoto (2), and T. Ide (1)

(1) Atmosphere and Ocean Research Institute, The University of Tokyo, Japan (akira@aori.u-tokyo.ac.jp), (2) JAMSTEC, Japan

Using a biogeochemical ocean model that includes the iron cycle, we carry out preindustrial (control, CTL) and glacial (Last Glacial Maximum, LGM) climate simulations and investigate difference in export production (EP) between CTL and LGM. The model successfully reproduces general trends of a paleoclimate reconstruction of EP at the LGM except over the Atlantic Ocean. By conducting a series of sensitivity simulations, we investigate the mechanism controlling EP at the LGM in each basin. In the Southern Ocean, the model successfully reproduces the dipole pattern of the paleo reconstruction: the higher-latitude decrease and lower-latitude increase of EP. It is found that the lower-latitude increase of EP comes from iron fertilization effects by enhanced dust deposition, while the higher-latitude decrease of EP is caused by the reduction of surface shortwave due to spreading of sea ice there. We also find that increased dust input in other basins remotely affects EP in the Southern Ocean. In the Atlantic Ocean where the model fails to reproduce the paleo reconstruction, it is demonstrated that the response of EP in the Atlantic Ocean is strongly affected by distribution of iron limitation in a control climate. It is implied that the accurate evaluation of iron limitation in the present ocean is critical for evaluating changes in EP and associated reduction of atmospheric CO_2 concentration at the LGM.