The response of the climate to changes in the orbital parameters

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Whereas paleoclimatic records consist with Milankovitch theory (Hays et al., 1976), the response of the climate to changes in the orbital parameters (eccentricity, precession and obliquity) is poorly understood. Abe-Ouchi et al. (2013), using comprehensive climate and ice-sheet model (IcIES-MIROC), proposed that 100,000-year glacial cycles in last 400,000 years can be explained by the response of the climate to change in the insolation. It is a mystery that termination 1, the deglaciation from last glacial maximum (LGM; ~20,000 years ago) to present, and termination 5, the deglaciation from marine isotope stage (MIS) 12 to MIS11 (~400,000 years ago), were accompanied with climate changes as large as termination 2 in spiite of the fact that eccentricity was relatively small (relatively small summer insolation change) during termination 1 and 5, while it was large (large summer insolation change) during termination 2 (400,000 years problem). To consider this problem, we analyze the role of the orbital parameters for the climate changes during the terminations by examining the response of the climate to changes in the various orbital parameters. Here, using MIROC-LPJ (O'ishi and Abe-Ouchi, 2011), the sensitivity experiments combined various orbital parameters show that the changes in surface temperature are not always linear to the changes in insolation, furthermore, the large obliquity with winter solstice make the temperature higher than the small obliquity with summer solstice when eccentricity is relatively small. It suggests that the surface temperature during termination 5 with higher obliquity can be higher without increasing carbon dioxide contents, even if the insolation was weaker. In this presentation, we discuss these sensitivity experiments in detail. We will also examine the snapshot experiments in 2,000 years intervals with only changing orbital parameters during termination 1 and 5 by MIROC-LPJ.

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