Polar amplifications in the past warm periods obtained from MIROC 4m AOGCM

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The Earth has experienced several warm periods (e.g., early Eocene and Cretaceous), which had warm climates, comparable to global warming prediction of near future due to rising CO2 concentration in the atmosphere. Paleoclimatic proxies indicate that the common characteristics of these periods are remarkable temperature amplifications in the high-latitude and polar region (Bice et al., 2003; Huber, 2008), resulting in small equator-to-polar temperature difference. However, simulations of warm periods climate using General Circulation Models tend to underestimate the polar amplifications than those suggested from geological records. The discrepancy between proxy data and climate models is one of the greatest challenges of warm climate study. Although it is important to consider the effects of the ocean circulation and vegetation feedback to reproduce the polar amplifications in the past warm periods, there were few studies using Atmosphere-Ocean coupled General Circulation Model (AOGCM). In this study, we simulate Present Day, early Eocene, and late Cretaceous climates with different CO2 levels using AOGCM MIROC 4m, additionally full-coupled with dynamic vegetation model, and get the climatology in full equilibrium with longer than 3000 years. The simulated temperatures of early Eocene and late Cretaceous experiments are compared with surface temperature reconstructions based on paleoclimatic proxies. We also investigate the difference of physical process to polar amplification between warm periods (early Eocene and late Cretaceous) and Present Day by using an energy flux analysis. Despite using the fully coupled model with paleo-configuration, the polar amplification in this study is not enough to fully reproduce proxy-indicated polar temperatures. This result implies that we need to re-verify model-performance to the polar climate in GCMs and physical feedback process to global warming due to rising greenhouse gasses in the atmosphere.

Keywords: polar amplification , paleoclimate, AOGCM

