Mitigation of global cooling by stratospheric chemistry feedbacks in a simulation of the Last Glacial Maximum

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Numerical simulations of the Last Glacial Maximum (21 kyr B.P.) climate are performed by using an Earth System Model of the Meteorological Research Institute of the Japan Meteorological Agency to investigate the impact of stratospheric ozone profile on surface climate with reduced CO_2 condition and different orbital parameters. The contribution of the interactive ozone chemistry reveals a significant anomaly of +0.5 K (approximately 20 %) in the tropics and up to +1.6 K in high-latitudes for the annual mean zonal mean surface air temperature compared with those of the corresponding experiments with a prescribed ozone profile for preindustrial simulation of the fifth Coupled Model Intercomparison Project (CMIP5). In the tropics, this mitigation of global cooling is related to longwave radiative feedbacks as sociated with circulation-driven increase in lower stratospheric ozone and related increase in stratospheric water vapor and related decrease in cirrus clouds. The relationships are opposite signs to and consistent with those of an increased CO_2 simulation by Nowack et al. (2015). In high-latitudes, the polar amplification of mitigation of cooling is associated with the sea ice retreat that is the same sign to and consistent with our previous paleoclimate simulation in the mid-Holocene (6 kyr B.P.). Most of the LGM runs by CMIP5 models with the prescribed ozone had cold bias in sea surface temperature in the tropics when compared with geological proxy data, whereas the bias is reduced in our simulations by using interactive ozone chemistry. We recommend climate models include ozone profile and sea-ice that are consistent with CO_2 concentration.

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