

Southern Hemisphere zonal-mean circulation changes from Last Glacial Maximum (LGM) to Future Climate

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The recent studies have shown that the westerly jet and Hadley-cell (HC) edge in the Southern Hemisphere (SH) have systematically shifted poleward during the last few decades. These trends are qualitatively well reproduced by climate model simulations, and further projected to continue in future climate. However, it is unclear whether same relationship holds in paleoclimate when global surface air temperature was much colder than the present climate. To better understand zonal-mean circulation change in a wide range of climate states, this study compares the westerly jet and HC edge in the Last Glacial Maximum (LGM), Pre-Industrial (PI), and Extended Concentration Pathway 4.5 (ECP4.5) conditions by analyzing coupled model simulations archived for the Paleoclimate Modelling Intercomparison Project phase 3 (PMIP3) and the Coupled Model Intercomparison Project phase 5 (CMIP5). A total of 9 models for LGM and 11 models for ECP4.5 conditions are analyzed focusing on the SH zonal-mean circulation changes. In all models, HC edge systematically shifts poleward from LGM to PI then to ECP4.5 conditions. However, jet latitude exhibits non-robust changes. Although all models show a poleward shift of westerly jet from PI to ECP conditions as in HC edge change, only one third of the models show a poleward jet shift from LGM to PI conditions. Other models show either no change or even an equatorward jet shift. By integrating a dynamic core GCM with an imposed tropical upper-tropospheric cooling, it is confirmed that the HC edge and jet position may move in different direction in response to LGM-like forcing. It is particularly shown that vertical structure of eddy momentum flux change plays a crucial role in determining the relationship between HC edge and jet latitude changes.

Key words: LGM, CMIP5, PMIP3, Hadley cell, eddy-driven jet

References

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