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Dynamical mechanism of the poleward intensification of the Southern Hemispheric Westerlies due to sea ice extent change

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Paleoclimate data shows a good correlation between the concentration of CO_2 and atmospheric temperature in the geological timescale. Many studies compare the Last Glacial Maximum (LGM) and the Pre-Industrial era (PI), to understand the coupling processes. A popular mechanism explaining this coupling process is a modulation of the ocean circulation and related CO_2 emission over the Southern Ocean due to atmospheric westerly. The atmospheric westerly plays an important role in driving ocean circulation; however, the related processes are not fully understood for the LGM period.

In this study, we examine physical processes determining the characteristics of the atmospheric westerly focusing on the Southern Ocean. Atmospheric states for LGM and PI are reproduced using a coupled earth system model with different sea ice conditions. A poleward intensification of the Southern Hemispheric Westerlies is observed for the LGM experiment. A comparison to PI shows that the meridional temperature gradient largely determines this intensification, and the enhanced meridional gradient is observed due to decreased heat flux from the subantarctic ocean in the LGM experiment. This result suggests that the Antarctic sea ice is a crucial component for understanding the Southern Hemispheric Westerly.