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Role of clouds on the Southern Ocean sea surface temperature bias and its impact on the LGM AMOC

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Antarctic and Southern Ocean are key regions for the climate system. A precise simulation of these regions in climate models are necessary to improve our understandings of the climate system, confidence of the future climate predictions and performances of paleoclimate simulations. However, most climate models suffer from warm sea surface temperature biases over the Southern Ocean in the simulations of modern climate (warm SST bias). Previous studies suggest that the warm SST bias is associated with an overestimation of a downward short wave radiation at the sea surface, which is partly related to an underestimation of supercooled cloud water in the model. In this study, by improving the representation of supercooled cloud water in MIROC4m AOGCM based on satellite data, we aim to improve the warm SST bias. We also assess the impact of improvements in the warm SST bias on the modern climate and a simulation of the Last Glacial Maximum. Model simulations show a reduction in the downward short wave radiation at the Southern Ocean in response to the modification in the supercooled cloud water. As a result, the warm SST bias at the Southern Ocean is also improved. The simulation of the Last Glacial Maximum with the improved MIROC4m AOGCM also shows improvements in sea ice cover over the Southern Ocean and the deep ocean circulation compared to reconstruction data. Therefore, this study clarifies the importance clouds over the Southern Ocean in simulating both the modern and paleo climate.