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Comparison of Arctic and Southern Ocean sea ice between the last nine interglacials and the future

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Understanding the sea ice variability and the mechanisms involved during warm periods of the Earth is essential for a better understanding of the sea ice changes at the present and in the future. Based on simulations with the model LOVECLIM, this study investigates the sea ice variations during the last nine interglacials and focuses on the inter-comparison between interglacials as well as their differences from the present and future. Our results show that, for the double CO_2 experiment and the Shared Socioeconomic Pathway (SSP)1-2.6, SSP2-4.5 and SSP5-8.5 scenario experiments, the global, Arctic and Southern Ocean sea ice areas simulated by LOVECLIM all fall in the range of the multi-model results from CMIP 6. In addition, the results show that the annual mean Arctic sea ice variation is primarily controlled by local summer insolation, while the annual mean Southern Ocean sea ice variation is more influenced by the CO_2 concentration but the effect of local summer insolation can't be ignored. The lowest Arctic sea ice area results from the highest summer insolation at MIS-15, and the lowest Southern Ocean sea ice area at MIS-9 is explained by the highest CO_2 concentration and moderate local summer insolation. As compared to the present, the last nine interglacials all have much less sea ice in the Arctic annually and seasonally due to high summer insolation. They also have much less Arctic sea ice in summer than the double CO_2 experiment, which makes to some degree the interglacials possible analogues for the future in terms of the changes of sea ice. However, compared to the double CO_2 experiment, the interglacials all have much more sea ice in the Southern Ocean due to their much lower CO_2 concentration, which suggests the inappropriateness of considering the interglacials as analogues for the future in the Southern Ocean. Our results suggest that in the search for potential analogues of the present and future climate, the seasonal and regional climate variations should be considered.

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