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The impact of the Madden-Julian oscillation on the Antarctic sea ice and the related dynamic mechanism

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The sea ice variability plays an important role in the thermal interaction between atmosphere and ocean, the Earth surface albedo, and the local ecosystems. Many previous studies have found that the sea ice variability can be caused by atmospheric modes, such as the El Niño-Southern Oscillation (ENSO), Southern Annular Mode (SAM), and Atlantic Multidecadal oscillation (AMO), on the various time scales. During the austral winter, the Antarctic sea ice shows considerable melting and freezing on the intraseasonal time scale. However, no studies have explored atmospheric forcing modulating the sea ice variation. In this study, we reveal that the Madden-Julian oscillation, which is the most dominant atmospheric mode of intraseasonal variability in the tropics, induces the Antarctic sea ice variation. The MJO convection moves northeastward, while the Antarctic sea ice anomaly exhibits an eastward moving structure with respect to the MJO evolution. The dynamic mechanism is accounted for by the tropical-extratropical teleconnection by the propagating Rossby waves. Even though the MJO convection exists over the equator and the Northern Hemisphere, the Rossby wave response propagates into the Southern Hemisphere and reaches the high latitude. The MJO-induced circulation anomalies lead to anomalous meridional temperature advection, causing the Antarctic sea ice to melt and freeze. The time difference between meridional wind and sea ice anomalies is $\sim$5 days.