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Indo-Pacific warm pool expansion modulates MJO lifecycle

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The Madden–Julian Oscillation (MJO) is the most dominant mode of intraseasonal variability in the tropics, characterized by an eastward propagating zonal circulation pattern and rain bands. MJO is very crucial phenomenon due to its interactions with other timescales of ocean-atmosphere like El Niño Southern Oscillation, tropical cyclones, monsoons, and the extreme rainfall events all across the globe. MJO events travel almost half of the globe along the tropical oceans, majorly over the Indo-Pacific Warm Pool (IPWP) region. This IPWP region has been warming during the twentieth and early twenty-first centuries in response to increased anthropogenic emissions of greenhouse gases and is projected to warm further. However, the impact of the warming of the IPWP region on the MJO life cycle is largely unknown. Here we show that rapid warming over the IPWP region during 1981–2018 has significantly changed the MJO life cycle, with its residence time decreasing over the Indian Ocean by 3–4 days, and increasing over the Indo-Pacific Maritime Continent by 5–6 days. We find that these changes in the MJO life cycle are associated with a twofold expansion of the Indo-Pacific warm pool. The warm pool has been expanding on average by 2.3×10^5 km² per year during 1900–2018 and at an accelerated average rate of 4×10^5 km² per year during 1981–2018. The accelerated warm pool expansion has increased moisture in the lower and middle troposphere over IPWP and thereby increased the gradient of lower-middle tropospheric moisture between the Indian Ocean and western Pacific. This zonal gradient of moisture between the Indian Ocean and west Pacific and the increased subsidence over the Indian ocean due to increased convective duration of MJO over maritime continent are likely the reasons behind the changing lifecycle of MJO.