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Local meridional circulation changes contribute to a projected slowdown of the Indian Ocean Walker circulation

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The weakening of zonal atmospheric circulation, a widely accepted projection of climate change in response to global warming, features a weakening of the Indian Ocean Walker circulation (IWC), with an anomalous ascending motion over the western and anomalous descending motion over the eastern Indian Ocean. The projected IWC weakening has previously been attributed to slower warming in the east than the west, that is, to a positive Indian Ocean Dipole (IOD)-like warming pattern. However, such a warming pattern can also be induced by IWC weakening. As a result, the cause-and-effect relationship cannot be easily determined, and the projected change is poorly constrained and highly uncertain. Here, using a suite of coupled climate model simulations under a high-emission scenario, we find that the IWC slowdown is accompanied by not only a positive IOD-like warming pattern but also anomalous meridional circulation that is associated with anomalous descending motion over the eastern Indian Ocean. We further show that the anomalous local meridional circulation is closely linked to enhanced land-sea thermal contrast and is unlikely to result from the positive IOD-like warming pattern, suggesting that the IWC weakening is in part driven by the anomalous local meridional circulation. Our findings underscore the important role of local meridional circulation changes in modulating future IWC changes.