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The effect of extratropical surface heat fluxes on the ITCZ in different ocean basins

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We present a suite of coupled climate simulations in which tectonic changes of the extratropical ocean circulation and surface heat fluxes determine the annual mean location of the ITCZ in all ocean basins. We use a course-resolution coupled general circulation model with simplified atmospheric physics, flat surface topography and various three-basin geometries.

Idealized configurations of the world's basins, all with westward slanted eastern tropical coastline, have the ITCZ south of the equator in all basins due to the dominant deep-water source and ocean heat release in the southern hemisphere as long as there is no circumpolar flow. Once the Drake Passage is open, only the ITCZ in the Atlantic moves north of the equator due to the lowering of the main pycnocline, and the transition of both the deep-water source and the strongest ocean heat release in the basin to the northern hemisphere.

Asia repels the annual mean maximum of the tropical precipitation south of the equator in the Indian Ocean because even a subdued release of the extratropical ocean heat in the basin is more influential than the surface heat flux out of the south and central Asia land mass. More specifically, when we extend the northern edge of Indian Ocean into mid and high latitudes, the annual mean ITCZ moves northward over the equator in configurations with and without the Indonesian throughflow. In our model, the strong ocean heat release in the Kuroshio extension region is crucial for the location of the mean ITCZ north of the equator in Pacific basin.

Our coupled simulations demonstrate the dependence of the main tropical circulation and precipitation, particularly the Hadley circulation and the ITCZ location on the extratropical land mass distribution and the oceanic meridional overturning circulation. These results aim to contribute to a more encompassing dynamical picture of the mean tropical climate in different regions around the globe that is controlled by the superposition of local processes (forced by top and bottom boundaries) and remote processes (forced by lateral boundaries influenced by the atmospheric bridge and the oceanic tunnel).