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Understanding the dynamic of poleward shifting of atmospheric and oceanic circulation using aqua-planet model simulations

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Growing evidence suggests that the oceanic and atmospheric circulation experiences a systematic poleward shift under climate change. However, due to the complexity of climate system, such as, the coupling between the ocean and the atmosphere, natural climate variability and land-sea distribution, the dynamical mechanism of such shift is still not fully understood. Here, using an idealized partially coupled ocean and atmosphere aqua-planet model, we explore the mechanism of the shifting oceanic and atmospheric circulation. We find that, in contrast to the rising GHG concentration, the subtropical ocean warming plays a dominant role in driving the shift in the circulation system. More specifically, due to background ocean dynamics, a relatively faster warming over the subtropical ocean drives a poleward shift in the atmospheric circulation. The shift in the atmospheric circulation in turn drives a shift in the oceanic circulation. Our simulations, despite being idealized, capture the main features of observed climate changes, for example, the enhanced subtropical ocean warming, poleward shift of the patterns of near-surface wind, sea level pressure, cloud, precipitation, storm tracks and large-scale ocean circulation, implying that global warming not only raises the temperature, but also systematically shifts the climate zones.