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Concurrent Changes to Hadley Circulation Extent and the Meridional Distribution of Tropical Cyclones

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Poleward trends in seasonal-mean latitudes of tropical cyclones (TCs) have been identified in direct observations from 1980 to present. Paleoclimate reconstructions also indicate poleward-equatorward migrations occur over centennial to millennial timescales. Hadley circulation (HC) is often both implicitly and explicitly invoked to provide various dynamical linkages to this shift, although no direct analysis of concurrent shifts in the recent period has been presented. Indeed, identified poleward trends in zonal-mean seasonal-mean latitudes of TC lifetime maximum intensity (LMI) and HC termini are of comparable magnitudes, being approximately 0.5 degrees latitude decade-1 in both hemispheres.

The observational TC record (1981-2016) and local HC diagnostics derived from divergent meridional winds (obtained by employing the Helmholtz decomposition) in ERA-Interim, JRA55 and MERRA2 are analyzed. We find coherent covariance in both long-term linear trends and detrended interannual variability. We find a significantly lower magnitude poleward trend in Northern Hemisphere TC LMI than previously reported (our estimate being approximately 0.1 degrees latitude decade-1). We also find that detrended seasonal-mean tropical cyclogenesis and LMI latitudes can share up to 35% of HC extent's interannual variability with dependencies on both hemisphere and ocean basin. Local HC intensity is only related to TC latitudes in the eastern North Pacific where it is inversely proportional to genesis and LMI locations, sharing up to 50% of their interannual variability over the period. Regressing HC diagnostics onto sea surface temperature implicates both reduced meridional temperature gradients and 'La Nina-like' zonal gradients to more a poleward HC and reduced (increased) subtropical (tropical) vertical wind shear.