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Tropical Cyclone Signatures in Atmospheric Convective Available Potential Energy

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Tropical cyclones play an important role in the climate system providing transports of energy and water vapor, forcing the ocean, and also affecting mid-latitude circulation phenomena. Tropical cyclone tracks experience strong interannual variability and in addition, longer term trend-like changes in all ocean basins. Analysis of recent historical data reveal a poleward shift in the locations of tropical cyclone tracks in both the Northern and Southern Hemispheres (Kossin et al. 2014, Nature, 509, 349-352). The physical consequences of these alterations are largely unconstrained. For example, the increasing encroachment of tropical cyclone activity into the extra-tropical environment presents a novel and still poorly understood paradigm for tropical-extratropical interactions. In this respect, the role that the atmospheric convective available potential energy (CAPE) plays in the dynamics of tropical cyclones is highly interesting.

The two characteristic global-scale spatial patterns in CAPE are identified using EOF analysis. The first pattern shows an abundance of CAPE in the centre of the Pacific and corresponds to the El Nino Southern Oscillation. The second one is capturing positive CAPE anomalies in the oceanic tropics and negative anomalies over equatorial Africa. Associated with these buoyancy patterns, alterations in tropical cyclone activity occur in all basins forming both zonal and meridional patterns. Atmospheric buoyancy is the trigger for deep convection, and subsequently cyclone genesis. This is the mechanism of impact upon location at the start of cyclone tracks. It is found to have less impact upon where cyclones subsequently move, whether or not they undergo extratropical transition and when and where they experience lysis. It is shown that CAPE plays a critical role in the general circulation in the tropics which in turn is the larger steering context for embedded systems within the Walker and Hadley cells. So this lack of ‘latter life’ impact posits an interesting start for further theoretical and physical consideration.