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A Complex Network approach for studying Tropical Cyclones

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Complex network theory provides a powerful framework to study the collective dynamics of the interacting units that constitute a complex system. Functional climate network analysis has been widely applied to study the evolution of climate phenomena such as the South American Monsoon and El Niño which occur over seasonal to (inter-)annual time scales. In this work, we use an evolving climate network approach for the study of tropical cyclones (TCs), which are highly localized extreme weather phenomena occurring over very short time scales (typically 3-10 days). We construct time-evolving climate networks of overlapping short-length (10-14 days) time windows using ERA5 reanalysis mean sea level pressure. We focus on studying the dynamics of the cyclones in the North Indian Ocean and the tropical Atlantic Ocean TC basins. We compute topological measures such as degree centrality as well as the local and global clustering coefficients for successive networks during the cyclone season. We find that, during a TC, the network undergoes a characteristic spatial reorganization in a way that localized structures with high clustering and low degree emerge along the TC track. We also compare the spatial scales involved in the regional weather system in the absence and presence of a TC, within the time span of the network. Our results show that weather variability at daily time scales, and in particular tropical cyclones, can be captured effectively by evolving climate networks.