Necessary AND Sufficient Conditions for Tropical Cyclogenesis

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During the Atlantic hurricane season of 2010, unprecedented coverage of potential tropical cyclogenesis events was possible due to the combined observational resources of NOAA, NSF, and NASA, and a commitment on the part of the lead scientists in the tri-agency program to collaborate closely. As a result, several low-level vorticity maxima were probed by aircraft at least twice daily, often following similar patterns for the wind-finding dropsondes several hours apart, in a concerted attempt to document large scale to mesoscale events during periods when the forecast consensus was that intensification was possible, and on occasion, likely. At the same time, a combination of satellite observations and remote sensing data from aircraft made it possible to document the existence and evolution of deep convection and mesoscale convective systems. The critical scientific question is whether cyclogenesis is inevitable, given favorable large scale conditions over a warm ocean with minimal vertical wind shear. Wang, Dunkerton, and Montgomery have formalized this idea, and popularized it as the "pouch" hypothesis. This paper begins the process of examining the reasons for the long delay in the genesis of Karl, and comments on some properties of the meso-convective events that may delay or inhibit tropical cyclone formation, despite larger scale conditions being favorable.