Examining of tropical cyclone structure and intensification with the Extended Flight Level Dataset (FLIGHT+) from 1999 to 2012

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Abstract:

A comprehensive examination of tropical cyclone (TC) kinematic and thermodynamic structure in the Atlantic basin is created from the Extended Flight Level Dataset (FLIGHT+) for Tropical Cyclones (Version 1.0). In situ data collected at the 700 hPa flight level by NOAA WP-3D and USAF WC-130 aircraft from 1999 to 2012 were analyzed. 241 flights consisting of 1545 total radial legs were stratified by TC intensity and 12 hour intensity change. A matrix of composite structures was then calculated for hurricanes (Categories 1 and 2 on the Saffir-Simpson scale) and major hurricanes (Categories 3 and above) that were intensifying [intensity increase ≥ 10 kt (12 h)^{-1}], steady-state [intensity change between ± 5 kt (12 h)^{-1}], and weakening [intensity decrease ≤ -10 kt (12 h)^{-1}]. Additional considerations to the age of TCs and a previous or future 12 h intensity change are given as well.

Axisymmetric radial composites reveal that intensifying TCs had statistically significant structural differences from TCs that were steady-state or weakening, but that these differences also depended on the current intensity of the TC. Intensifying TCs were characterized by steep tangential wind gradients radially inward of the RMW that contributed to a ring-like structure of vorticity and inertial stability. Furthermore, intensifying TCs possessed the lowest absolute angular momentum compared to steady-state and weakening TCs. The composites indicated more tangential wind structural differences inside the RMW for hurricanes compared to major hurricanes. Thermodynamic structures showed fewer differences than the kinematic structures in general, but intensifying TCs were found to have higher moisture content outside the RMW overall.