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Analyzing tropical cyclone radar reflectivity patterns using GIS

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The U.S. National Climatic Data Center (NCDC) has recently made available all radar-derived data in a format that can be directly imported into a GIS. The spatial analysis of radar data obtained from landfalling tropical cyclones (TCs) can determine where heavy rainfall may occur due to the development of precipitation from the convergence of onshore winds, assess the rate at which deep convection circulates about the eye wall, and characterize the motion of the entire rain shield. The rain shield defines the area comprised of both stratiform and convective precipitation. This paper discusses several techniques employed to analyze TC radar reflectivity data obtained from the NCDC within ArcGIS.

After the radar data are imported into the GIS, the boundary of the rain shield is defined by the edge of the 20 dBZ returns. Separate polygons are then constructed using reflectivity returns in 5 dBZ increments to define their edges. The area of each polygon and the length of its perimeter are utilized to calculate a compactness ratio. The distance and bearing of the center of mass of each polygon from the storm center is used to measure rain shield symmetry. Calculating the directional distribution of each polygon's nodes provides orientation and an elongation measure. A set of observations is developed for each reflectivity level from 20 – 50 dBZ. Polygons comprised of higher values are generally too small to warrant separate analysis.

Computing these shape metrics in regular intervals allows changes in the size, shape, and rate of motion of the rain shield and embedded convective cells to be quantified. This objective quantification facilitates comparisons among TCs. The application of these techniques to a large number of landfalling TCs coupled with an analysis of actual rainfall accumulations could be utilized to improve TC rainfall models.