THE FIELDS INSTITUTE
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ABSTRACTS 1.2

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Enstrophy Minimization, Entropy Maximization, and Mixing Processes in Hurricanes

The eyes of hurricanes are often observed to be nearly circular, but they are occasionally observed to take on distinctly polygonal shapes. The shapes range from triangles to hexagons. Other observations implicate the existence of intense meso-vortices within or near the eye region. Is there a relation between polygonal eyewalls and hurricane meso-vortices? Are these phenomena just curiosities of the hurricane's inner-core circulation, or are they snapshots of an intrinsic mixing process within or near the eye which serves to determine the circulation and thermal structure of the eye? As a first step towards understanding the asymmetric vorticity dynamics of the hurricane's eye and eyewall region, we examine these issues within the framework of an unforced barotropic nondivergent model. Polygonal eyewalls are shown to form as a result of barotropic instability near the radius of maximum winds. Simulations with a high resolution pseudospectral numerical model are presented to follow the instabilities into their nonlinear regime. When the instabilities grow to finite amplitude, the vorticity of the eyewall region pools into discrete areas, creating the appearance of polygonal eyewalls. The circulations associated with these pools of vorticity suggest a connection to hurricane meso-vortices. At later times the vorticity is ultimately rearranged into a nearly monopolar circular vortex. While the evolution of the fine-scale vorticity field is sensitive to the initial condition, the macroscopic end-states are found to be similar. In fact, the gross characteristics of the numerically simulated end- states are predicted analytically using a generalization of the minimum enstrophy hypothesis. In an effort to remove some of the weaknesses of the minimum enstrophy approach, a maximum entropy argument developed previously for rectilinear shear flows is extended to the vortex problem, and end-state solutions are obtained. A related talk, extending these ideas to the more general case of a divergent fluid, will be given by Scott Fulton in this Minisymposium.