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Lobe Dynamics in Hurricanes

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The classical theory of *lobe dynamics* describes transport across a homoclinic trajectory in the flow of a periodically perturbed dynamical system. The flow during a single period of the perturbation defines a discrete flow map called the Poincaré map. Hyperbolic fixed points of the Poincaré map exhibit stable and unstable manifolds whose intersections define lobes and the *homoclinic tangle* of chaotic dynamics. This elegant theory exists only for two-dimensional flows with periodic or quasi-periodic time-dependence. We demonstrate that Lagrangian Coherent Structures (LCS) provide an effective method for visualizing lobe dynamics in continuous flows with arbitrary time-dependence in both two and three dimensions. This method applied to reanalysis flow data for hurricanes indicates that transport in the synoptic scale flow is dominated by lobe dynamics. Furthermore, visualization of the LCS near the eyewall reveals the Lagrangian transport structures responsible for the process of eyewall replacement, a process that has been widely identified in the hurricane forecasting community as the principal mechanism for fluctuations in hurricane intensity. In collaboration with Jerrold Marsden, Caltech.