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Advective mixing in a nondivergent barotropic hurricane model

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Abstract. This paper studies Lagrangian mixing in a two-dimensional barotropic model for hurricane-like vortices. Since such flows show high shearing in the radial direction, particle separation across shear-lines is diagnosed through a Lagrangian field, referred to as *R*-field, that measures trajectory separation orthogonal to the Lagrangian velocity. The shear-lines are identified with the level-contours of another Lagrangian field, referred to as *S*-field, that measures the average shear-strength along a trajectory. Other fields used for model diagnostics are the Lagrangian field of finite-time Lyapunov exponents (*FTLE*-field), the Eulerian *Q*-field, and the angular velocity field. Because of the high shearing, the *FTLE*-field is not a suitable indicator for advective mixing, and in particular does not exhibit ridges marking the location of finite-time stable and unstable manifolds. The *FTLE*-field is similar in structure to the radial derivative of the angular velocity. In contrast, persisting ridges and valleys can be clearly recognized in the *R*-field, and their propagation speed indicates that transport across shear-lines is caused by Rossby waves. A radial mixing rate derived from the *R*-field gives a time-dependent measure of flux across the shear-lines. On the other hand, a measured mixing rate across the shear-lines, which counts trajectory crossings, confirms the results from the *R*-field mixing rate, and shows high mixing in the eyewall region after the formation of a polygonal eyewall, which continues until the vortex breaks down. The location of the *R*-field ridges elucidates the role of radial mixing for the interaction and breakdown of the mesovortices shown by the model.

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