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Geodesic Theory of Transport Barriers in Unsteady Flows GEORGE HALLER, McGill University, FRANCESCO BERON-VERA, University of Miami — We introduce a unified approach to detecting finite-time Lagrangian transport barriers in two-dimensional unsteady flows with general time dependence. Seeking transport barriers as least deforming material lines, we obtain a variational formulation for such barriers. This variational problem turns out to be well-posed only for three types of transport barriers: hyperbolic barriers (generalized stable and unstable manifolds), elliptic barriers (generalized KAM curves or eddy boundaries), and parabolic barriers (generalized shear jets). Such barriers then coincide with minimal geodesics under an appropriate metric induced by the Cauchy-Green strain tensor on the initial configuration of the flow. The geodesics are obtained as a solution of an ordinary differential equation, and hence are available in a smooth, parametrized form. We show how these new results reveal previously unknown transport barriers in complex model flows and geophysical data sets.

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