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Transport in an idealized three-gyre system with application to the Adriatic Sea

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Theoretical results and numerical methods from dynamical systems theory are used to study mixing and transport in an idealized three-gyre system with application to the surface flow in the Adriatic Sea. Much of the work focuses on the role of transport barriers, their dynamics and methods of their identification. Particular attention is paid to the issue of intergyre transport. The velocity field is assumed to be two-dimensional and incompressible, and composed of a steady three-gyre background flow on which a time-dependent perturbation is superimposed. Two systems of this type are considered: 1) an analytical model of the Adriatic Sea; and 2) an observationally-based altimetry-derived model of the Adriatic Sea. It is shown that a new phenomenon arises in a three-gyre system, which is not present in a two-gyre system. Due to this phenomenon, the three-gyre system has qualitatively different transport properties for small and large perturbations to the background. For a small perturbation to the steady three-gyre background flow two of the gyres exchange no fluid with the third gyre. When the perturbation strength exceeds a certain threshold, transport between all three gyres occurs. This behavior is described theoretically, illustrated using the analytic model and shown to be consistent with the observationally-based model of the Adriatic Sea.