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Global bifurcations in a double-gyre model of the Kuroshio Extension

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A double-gyre reduced-gravity shallow water model of the Kuroshio Extension forced by a time-independent climatological wind exhibits a decadal chaotic bimodal oscillation between an energetic meandering state and a much weaker state with a reduced zonal penetration of the jet. Such self-sustained internal oscillation is found to be in significant agreement with the low-frequency variability of the Kuroshio Extension as revealed by altimeter observations, and is interpreted in the framework of dynamical systems theory as a homoclinic orbit in phase space resulted by a global bifurcation associated with the reconnection of the stable and unstable manifolds of the saddle fixed point corresponding to the weak jet state. Besides the large amplitude relaxation oscillation just mentioned, two small amplitude chaotic oscillatory modes (one with a small and the other with an intermediate mean kinetic energy) have also been identified for slightly different values of the lateral eddy viscosity and forcing amplitude. The chaotic transitions observed between these three modes of variability are conjectured to be due to heteroclinic connections.