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The decadal variability of the Kuroshio Extension as a chaotic self-sustained internal oscillation

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A double-gyre reduced-gravity shallow water model of the Kuroshio Extension, bounded to the west by a schematic coastline and forced by a time-independent climatological wind, exhibits a fairly realistic mean jet and a low-frequency variability characterized by a chaotic bimodal oscillation between an energetic meandering state and a much weaker state with a reduced zonal penetration. These high and low energy states are found to be very similar to the "elongated" and "contracted" modes of the Kuroshio Extension as detected through in situ and altimetric measurements; moreover, the characteristic period (of around 10 years), flow patterns and transition details of a typical bimodal cycle are found to be in significant agreement with the altimeter observations presented by Qiu and Chen (2005) for the period 1992-2004. A complex dynamical mechanism supporting such internal oscillation, and involving the bimodal behavior of the Kuroshio south of Japan, is proposed and discussed. On the basis of these modeling results and of their validation with altimeter data, it is hypothesized that the observed bimodal decadal variability of the Kuroshio Extension is basically due to a self-sustained internal oscillation related to the instability of the Kuroshio south of Japan without any crucial intervention of wind-driven Sverdrup transport fluctuations and of topographic interactions, although such effects certainly play an important role in shaping the finer structure of Kuroshio Extension changes.