Why can wind delay the shedding of Loop Current eddies?

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Abstract

We first show that wind in the Gulf of Mexico can delay the shedding of Loop current eddies. We analyze a time-dependent three-dimensional numerical experiment forced by a spatially and temporally constant westward wind stress within the Gulf, compare it with an otherwise identical no-wind run, and confirm the result with reduced-gravity experiments. We show that the wind produces westward transports over the northern and southern shelves of the Gulf, convergence in the west and a returned (i.e. eastward) upper-layer flow over the deep central basin towards the Loop Current. We then use Pichevin and Nof's (1997) and Nof's (2005) theory to explain that the returned flow constitutes a zonal momentum flux that delays eddy-shedding. Mass-balance analysis shows that wind also forces larger Loop Current and rings (because the delayed shedding allows more mass to be accumulated in them) and produces more efficient mass exchange between the Gulf and the Caribbean Sea. Finally, it is shown that eddies alone (without wind stress curl) can force a boundary current and downward flow in the western Gulf, and a corresponding deep flow from western to eastern Gulf.