Abstract View

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Tracking Nonlinear Solutions with Simulated Altimetric Data in a Shallow-Water Model*

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ABSTRACT

Low-frequency variability of western boundary currents (WBCs) is pervasive in both observations and numerical models of the oceans. Because advection is of the essence in WBCs, nonlinearities are thought to be important in causing their variability. In numerical models, this variability can be distorted by our incomplete knowledge of the system's dynamics, manifested in model errors. A reduced-gravity shallow-water model is used to study the interaction of model error with nonlinearity. Here our focus is on a purely periodic solution and a weakly aperiodic one.

For the periodic case, the noise-corrupted system loses its periodicity due to nonlinear processes. For the aperiodic case, the intermittent occurrences of two relatively persistent states—a straight jet with high total energy and a meandering one with low total energy—in the perturbed model are almost out of phase with the unperturbed one. For both cases, the simulation errors are trapped in the WBC region, where the nonlinear dynamics is most vigorous.

Satellite altimeters measure sea surface height globally in space and almost synoptically in time. They provide an opportunity to track WBC variability through its pronounced sea surface signature. By assimilating simulated Geosat data into the stochastically perturbed model with the improved optimal interpolation method, the authors can faithfully track the periodic behavior that had been lost and capture the correct occurrences of two relatively persistent patterns for the aperiodic case. The simulation errors accumulating in the WBC region are suppressed, thus improving the system's predictability. The domain-averaged rms errors reach a statistical equilibrium below the observational error level.

Comparison experiments using simulated Geosat and TOPEX/POSEIDON tracks show that spatially dense sampling yields lower rms errors than temporally frequent sampling for the present model. A criterion defining spatial oversampling—that is, diminishing returns—is also addressed.