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A strategy for optimal drifter deployment using Lagrangian data assimilation

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We present a new approach to the design of an observing system for data as positions along individual trajectories of Lagrangian instruments. Such Lagrangian data may exhibit highly nonlinear and chaotic behavior of the flow field. If assimilated correctly, however, they can significantly help to improve data assimilation systems because they contain time-integrated information of the velocity field. We employ the Lagrangian data assimilation (LaDA) method based on the ensemble Kalman filter that uses an augmented state representation. This augmentation in LaDA affords a direct assimilation of Lagrangian data into the model state variables by eliminating the need for any conventionally used approximation. It also naturally lends itself to the use of dynamical systems theory in the design of a comprehensive observing system.

Our strategy for optimal drifter deployment is to first construct a flow template through the analysis of Lagrangian dynamics. This template cannot be obtained correctly from an analysis of the instantaneous Eulerian velocity or streamfunction field. Our strategy is then to deploy the drifters according to the flow template and targeted Lagrangian structures. This strategy is tested using the shallow-water ocean model. By judicious choice of deployment location and timing based on the flow template, our strategy efficiently estimates both the basin-scale circulation and the local coherent structures. It also estimates the minimum number of drifters required for the optimal drifter deployment of Lagrangian instruments.