LETKF-based Ocean Research Analysis (LORA) version 2 for a quasi-global domain (LORA-QG)

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Abstract

Data assimilation produces accurate analysis datasets by combining numerical simulations and observations based on dynamical systems theory and statistical methods. Various assimilation approaches have been developed, including 3D-VAR, 4D-VAR, the Kalman filter, and the ensemble Kalman filter (EnKF). The authors developed an EnKF-based eddy-resolving regional ocean data assimilation system called sbPOM-LETKF (Stony Brook Parallel Ocean Model-local ensemble transform Kalman filter) and produced the ensemble ocean analysis dataset LORA (LETKF-based Ocean Research Analysis) version 1 for the western North Pacific and Maritime Continent regions covering August 2015–January 2024. However, the ocean exhibits long timescales ranging from interannual to decadal variability, and the limited spatial and temporal coverage of LORA version 1 constrains its applications.

In this study, we extend the sbPOM-LETKF system to generate an eddy-permitting ensemble ocean analysis dataset LORA version 2 for a quasi-global domain (LORA-QG) since June 2002, when the global observing system was substantially enhanced by microwave satellites and Argo profiling floats. We validate LORA-QG by comparing it with existing ocean reanalysis products that have comparable domains, horizontal resolution, and output intervals: GLORYS2V4, ORAS5, and C-GLORS.

The validation results using independent drifter buoy observations show that LORA-QG has the lowest and second lowest spatiotemporally averaged root-mean-square differences for sea-surface temperatures and currents, respectively, among the four reanalysis products. Although warm temperature biases substantially reduce accuracy in the western tropical Pacific, LORA-QG exhibits significantly higher accuracy around western boundary currents and the Antarctic Circumpolar Current. Additional validation using other independent observations confirms that LORA-QG achieves sufficient accuracy for geoscientific research.