Regional Ocean Data Assimilation using the Local Ensemble Transform Kalman Filter (LETKF) with the Navy Coastal Ocean Model.

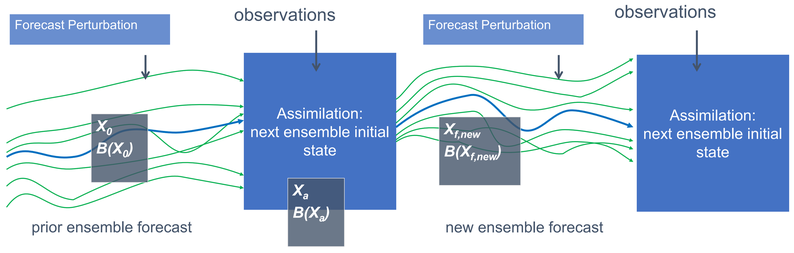
Clark Rowley[1], Patrick Hogan[1], Stephen Penny[2], Prasad Thoppil[1], Ole Martin Smedstad[3]
[1]Oceanography Division, U.S. Naval Research Laboratory, Stennis Space Center, MS
[2]Department of Atmospheric and Oceanic Science, University of Maryland, College Park, MD
[3]Perspecta, Stennis Space Center, MS

Abstract

A globally relocatable regional ocean nowcast/forecast system developed at the Naval Research Laboratory is modified to use the Local Ensemble Transform Kalman Filter (LETKF) for data assimilation.

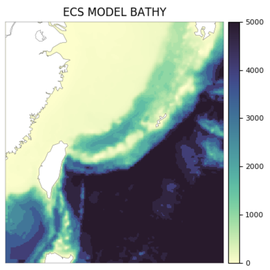
The system in current operational use is designed to support rapid implementation of new regional forecast domains. The forecast system consists of core ocean data analysis and forecast modules, software for domain configuration, surface and boundary condition forcing processing, and job control, and global databases for ocean climatology, bathymetry, tides, and river locations and transports. The operational analysis component is the Navy Coupled Ocean Data Assimilation (NCODA) system, that performs 3DVar analyses of temperature, salinity, geopotential, and vector velocity using remotely-sensed SST, SSH, and sea ice concentration, and in situ observations of temperature, salinity, and currents from ships, buoys, XBTs, CTDs, profiling floats, and autonomous gliders. The forecast component is the Navy Coastal Ocean Model (NCOM). The system supports one-way nesting and multiple model update methods.

We present initial results using the LETKF with the NCOM/NCODA forecast system in a regional model in comparison with a perturbed-observation ensemble.

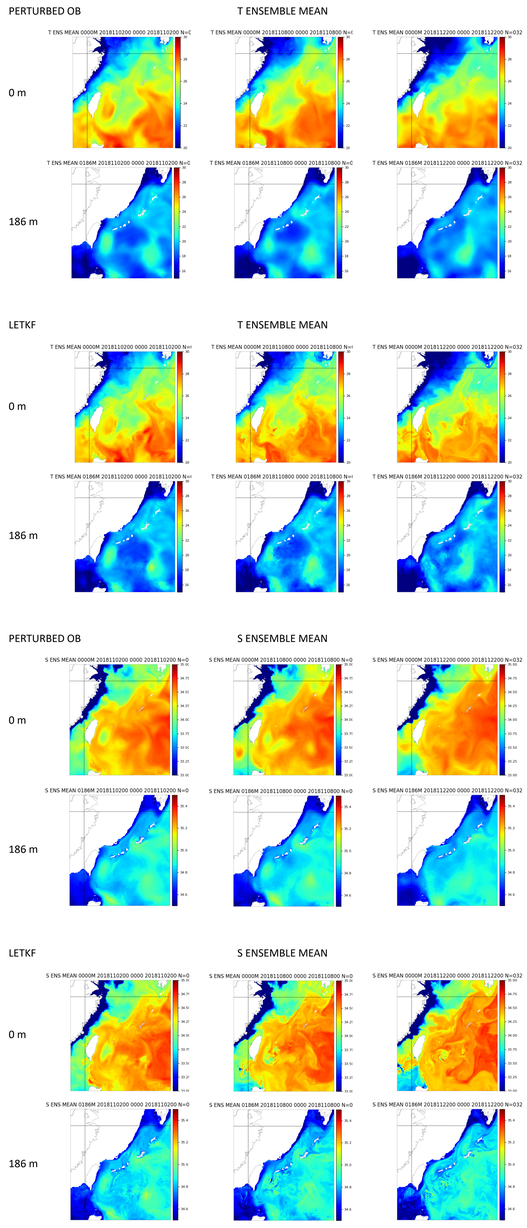


Model configuration

Navy Coastal Ocean Model (NCOM)
6 km horizontal resolution
49 temperature levels
HYCOM boundary conditions
COAMPS surface forcing
36-h forecasts initialized
01 Oct 2018

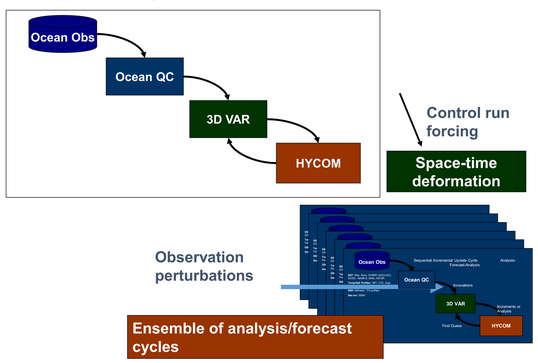


Bathymetry for the NCOM configuration used in these experiments.



Perturbed Observation Ensemble Update

Houtekamer and Mitchell, 1998



Results

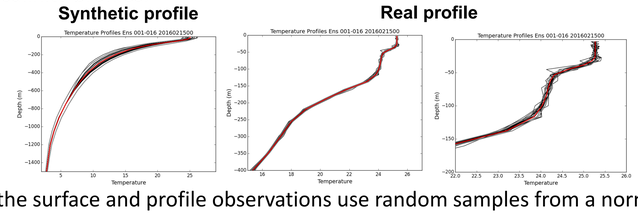
We compare the ensemble mean and ensemble perturbation standard deviation for T/S at 0 m and 186 m depths for the perturbed-observation and LETKF ensembles. The comparisons are made at 1 d, 7 d, and 21 d after the LETKF is initialized from the perturbed-ob forecast.

Preliminary results show that in this regional system the assimilation is constraining the ocean model but additional inflation will be required to maintain the appropriate initial condition spread.

Summary

We have implemented the Local Ensemble Transform Kalman Filter (LETKF) as a data assimilation and ensemble generation method with the Navy Coastal Ocean Model.

NCODA performs a 3DVar analysis of temperature, salinity, geopotential, and vector velocity using remotely-sensed SST, SSH, and sea ice concentration, plus in situ observations of temperature, salinity, and currents from ships, buoys, XBTs, CTDs, profiling floats, and autonomous gliders. Sea surface height is assimilated through synthetic temperature and salinity profiles.



Perturbations to the surface and profile observations use random samples from a normal distribution scaled by the observation error standard deviation, which combines instrument and representation error. Perturbations to synthetic profiles are generated by supplying perturbed surface inputs to the synthetic profile system.