Comparison of 4DVAR and LETKF in Assimilating Satellite Sea Surface Temperature in the Chesapeake Bay Operational Forecasting System Bin Zhang¹, Matt Hoffman², Lyon Lanerolle³, Chris Brown^{1,4}

1. CICS/ESSIC/UMD 2. SMS/RIT 3. NOS/NOAA 4. NESDIS/STAR/SCSB/NOAA

- Temperature and salinity are critical in understanding the coastal • ocean and ecosystems, yet difficult to forecast synoptically.
- NOAA's operational Chesapeake Bay Operational Forecasting System (CBOFS) forecasts T/S, but would benefit from the assimilation of satellite-derived SST.
- Several data assimilation techniques available; evaluate whether 4D-VAR (Moore et al., 2011) or LETKF (Hunt et al. 2007) is better for assimilating SST retrievals into CBOFS
- Satellite SST retrievals have previously been assimilated into • hydrodynamic models, but not operationally by NOAA

Overall Goal:

- Determine whether 4DVAR or LETKF should be used when assimilating VIIRS SST, together with other available observations, into CBOFS.
- Quantify the improvement of retrievals from VIIRS vs AVHRR SST.

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4DVAR and LETKF Application to CBOFS

- CBOFS is updated with latest ROMS with advanced 4DVAR scheme.
- 4DVAR and LETKF has been setup respectively at CICS/UMD and RIT with CBOFS. Initial comparison has been made.
- AVHRR and VIIRS SST are being assimilated with more than one month sequential run using 4DVAR. Both bias and STD are reduced.
- Assimilation of 3D Temperature and salinity observations has also been done successfully with 4DVAR.





One month Sequential Run of I4DVAR with AVHRR SST

 Approximately, 4DVAR uses 15 inner loops, and LETKF uses 20 ensemble members, the time cost is about 6.5hrs vs 1.5 hrs for 6 hour window using 96 CPUs.



Analysis of SST using LETKF and I4DVAR, respectively, using the same VIIRS SST as obs and same initialization.





Using 4DVAR ROMS and LETKF

- 4DVAR with CBOFS is integrated with Regional Ocean Modeling System (ROMS). The DA system an be used beyond Chesapeake Bay model for various regional ocean modeling/forecasting system.
- The successful application of 4DVAR/LETKF can reduce future workload in designing a similar DA system for different area.
- 4DVAR in ROMS comes with powerful analysis tools, such as adjoint sensitivity analysis, optimal observation system design, which can be applied to different ocean processes and area.
- Several 4DVAR scheme in ROMS can be selected to correct not only initial conditions, but also forcing and open boundary conditions.
- LETKF costs relatively less, depending on the ensembles selected, and can be easily applied to other ocean models, not only ROMS.









