Assimilation of temperature and salinity profile data into the Norwegian Climate Prediction Model

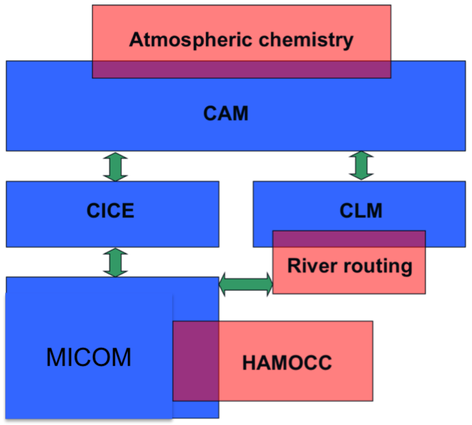
Yiguo Wang, Francois Counillon, Laurent Bertino, Ingo Bethke, Marc Bocquet, Noel Keenlyside and Mao-lin Shen
Correspondence to Yiguo Wang, Nansen Environmental and Remote Sensing Center, Bergen, Norway. E-mail: yiguo.wang@nersc.no

Contribution

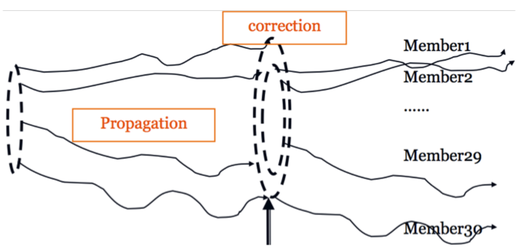
Assimilating temperature and salinity profile data is promising to constrain the ocean component of Earth system models for the purpose of seasonal-to-dedacal climate predictions. However, assimilating temperature and salinity profiles that are measured in standard depth coordinate (z-coordinate) into isopycnic coordinate ocean models that are discretised by water density is challenging. The study compares two data assimilation schemes in NorCPM: converting observations to the model coordinate (Xie and Zhu, 2010) and interpolating model state to observation coordinate.

NorCPM = NorESM+EnKF

Earth System model (NorESM)

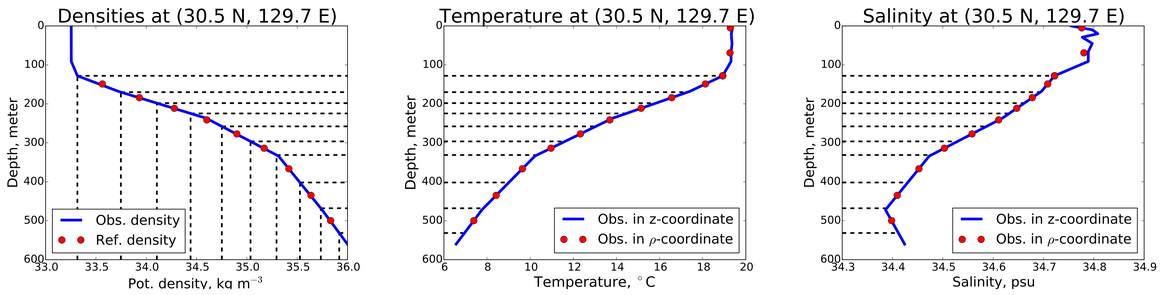


Data assimilation (EnKF)



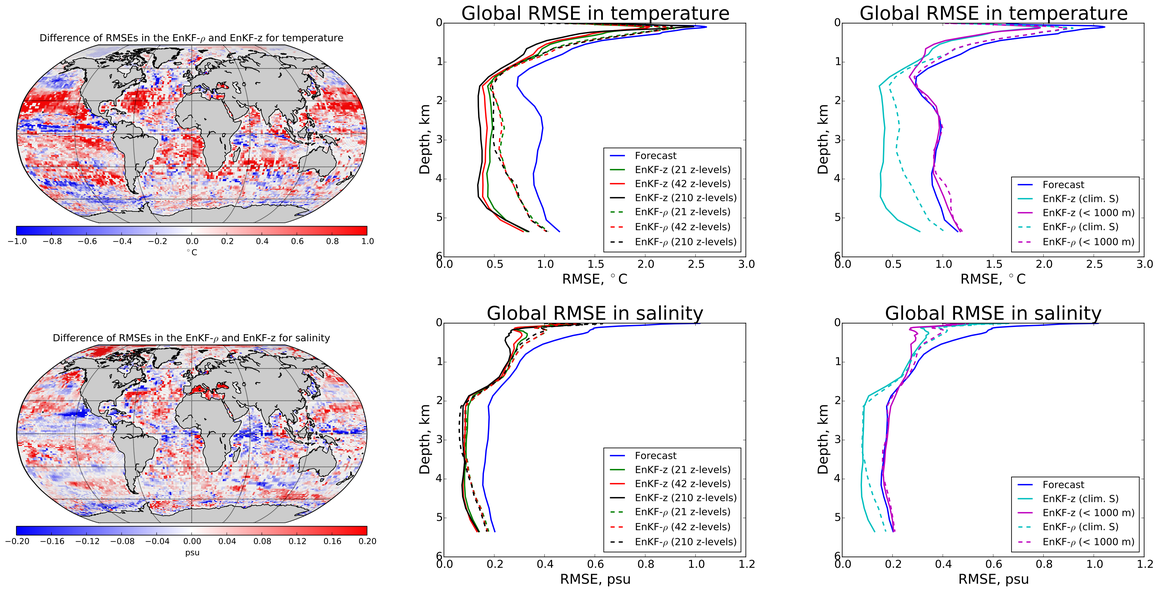
In the study, the atmosphere component CAM4 has a resolution of F19 (about 2 degree), and the ocean component MICOM and sea-ice component CICE4 have a resolution of 2 degree on a tripolar grid.

Observations from EN4 dataset



Observing System Simulation Experiments

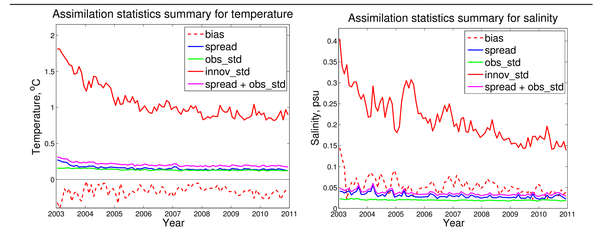
- **Forecast**: 30 NorESM members (53 ρ-levels) in 1980-01
- **Truth**: EN4 objective analysis in 1980-01 (Good et al., 2013)
- **Observations**: truth + white noise (Levitus et al., 1994a, b)
- **Mimic datasets**: different observed vertical resolution, inhomogeneous sampling (e.g. upper 1000 meter observations only), or lack of salinity measurements
- **EnKF-z**: assimilating T and S in z-level
- **EnKF-ρ**: assimilating T, S in ρ-coordinate and **synthetic** layer thickness



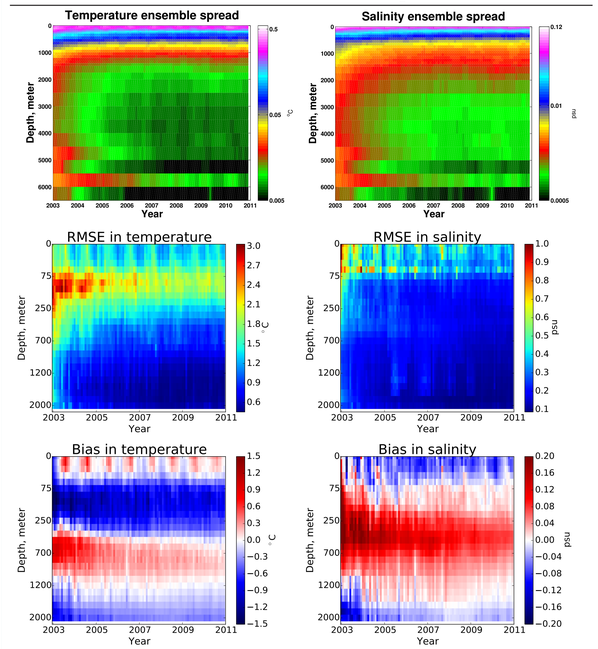
Conclusions: EnKF-z outperforms EnKF-ρ for different dataset. The main reason is that converting z-level observations into isopycnic coordinate introduces high uncertainties.

EnKF-z in real framework

Global assim statistics

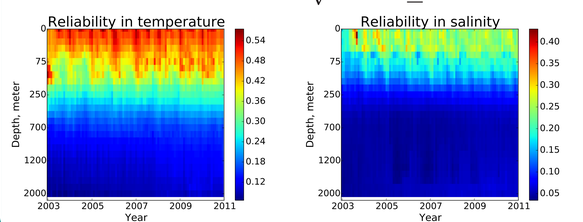


Assim statistics in depth



Assim reliability

$$\text{Reliability} = \frac{\sqrt{\text{obs\_var}+\text{mod\_var}}}{\sqrt{\text{innov\_var}}}$$



Future work

Simultaneously assimilating different datasets, e.g. SST, SSH, T & S profiles and sea ice.