

2.3 – Regional Ocean Prediction

Improvement of Temperature and Salinity Structure through Data Assimilation and Bias Correction in a Regional Model for the East Sea

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Introduction

Global prediction models have been used to provide boundary conditions for regional ocean models. However, biases present in global models can significantly affect the accuracy of prediction within nested regional ocean models. In this study, open boundary bias correction (BC) and data assimilation (DA) were conducted using the observed temperature and salinity data to improve the simulation accuracy in the Korea Strait and the East Sea.

Data and Methods

Numerical Model

Regional Ocean Modeling System (ROMS)

Grid spacing	3 km
Vertical layer	41 sigma layers
Initial condition	HYCOM 2018/01/01
Open boundary	Daily HYCOM
Bathymetry	ETOPO5, Korbathy 30s
Atmospheric forcing	ECMWF ERA5 3 hourly
Tide	10 major constituent TPXO6
River	Nackdong, Tuman, Amur
Assimilation scheme	Ensemble Kalman Filter (EnKF)

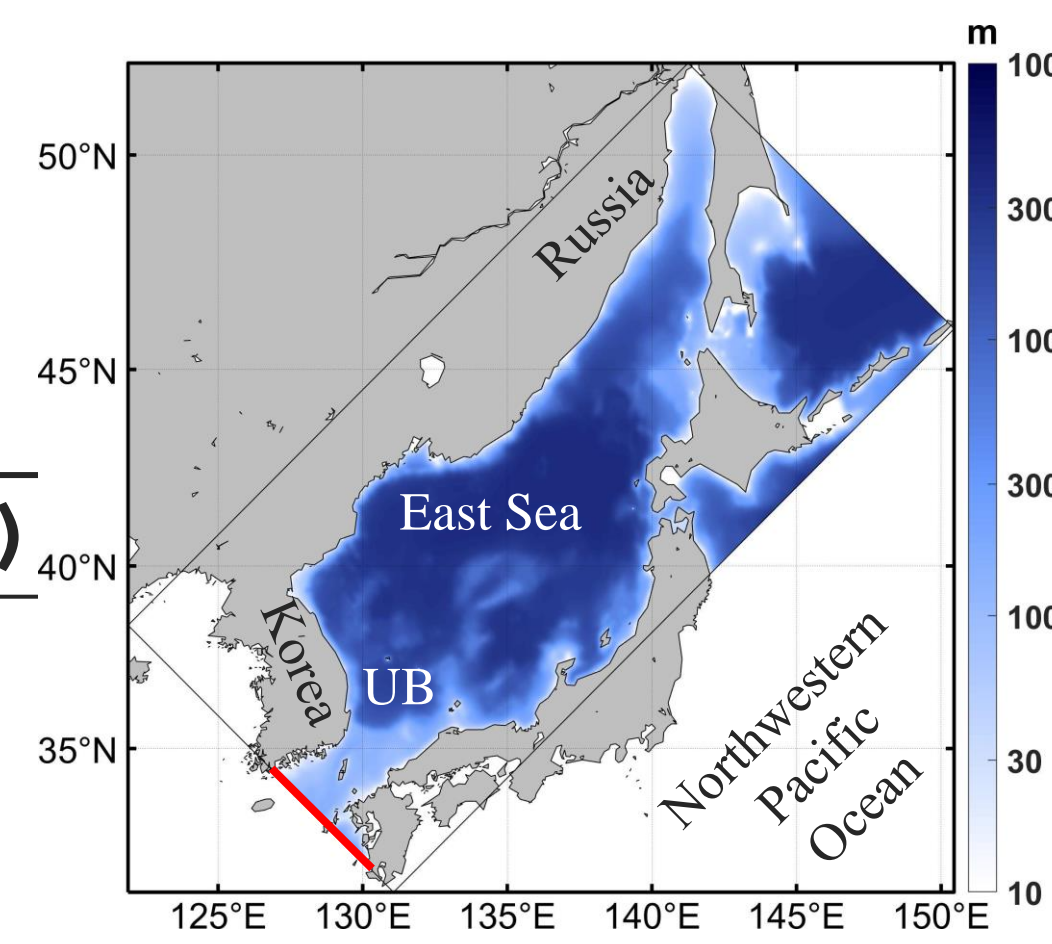


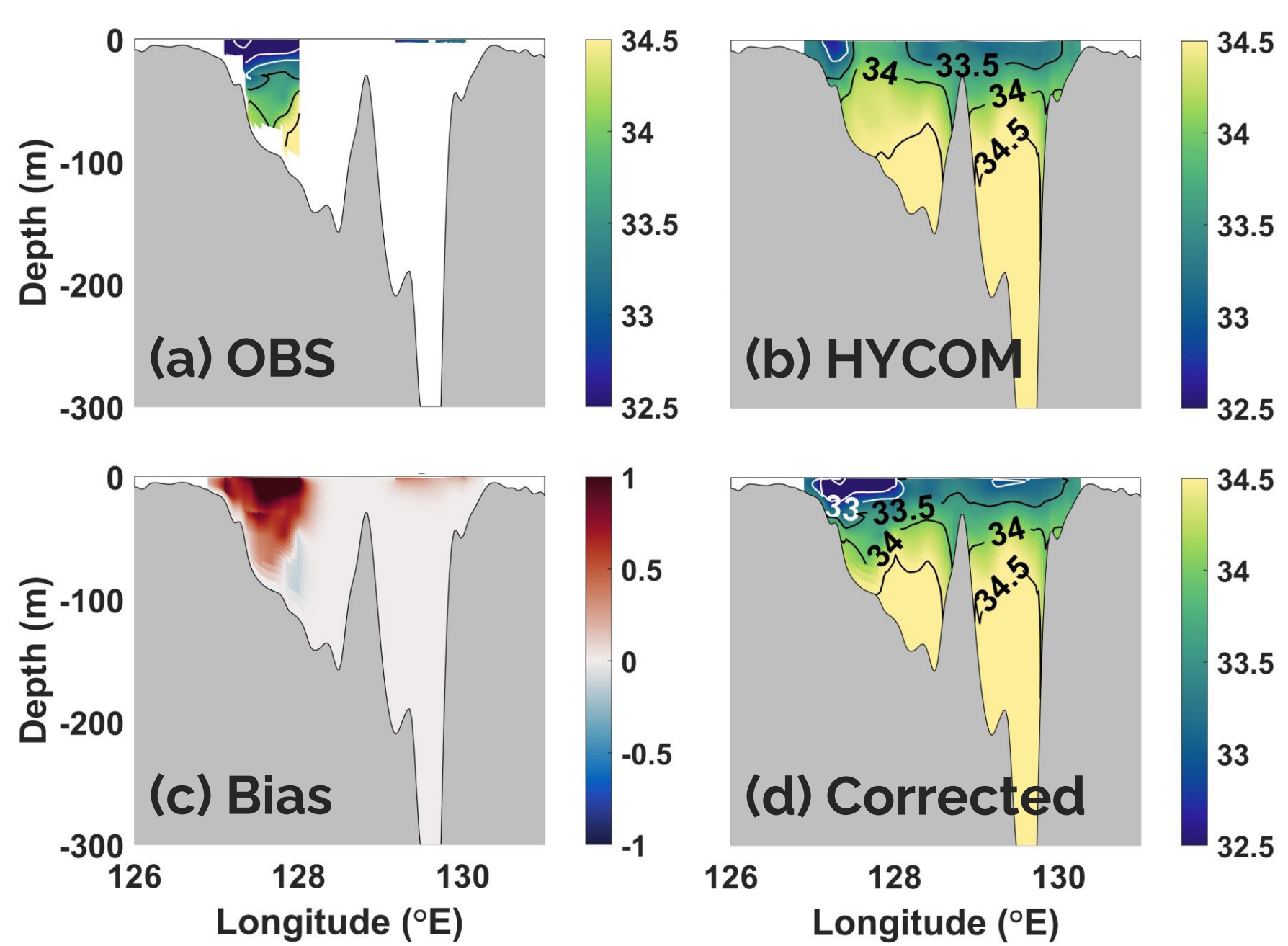
Fig. 1. The numerical model domain. Red line is the bias corrected boundary.

Experiment design

	Exp.CTRL	Exp.BC	Exp.DA	Exp.BCDA
Boundary correction	-	○	-	○
Data assimilation	-	-	○	○

Results

Bias between the observation and global model data



• HYCOM salinity was higher compared with the observation at the Korea Strait in August (Fig. 2).

Fig. 2. Salinity at the Korea Strait (red line in Fig. 1) in August 2019; (a) observation, (b) HYCOM (no bias correction), (c) bias and (d) bias corrected.

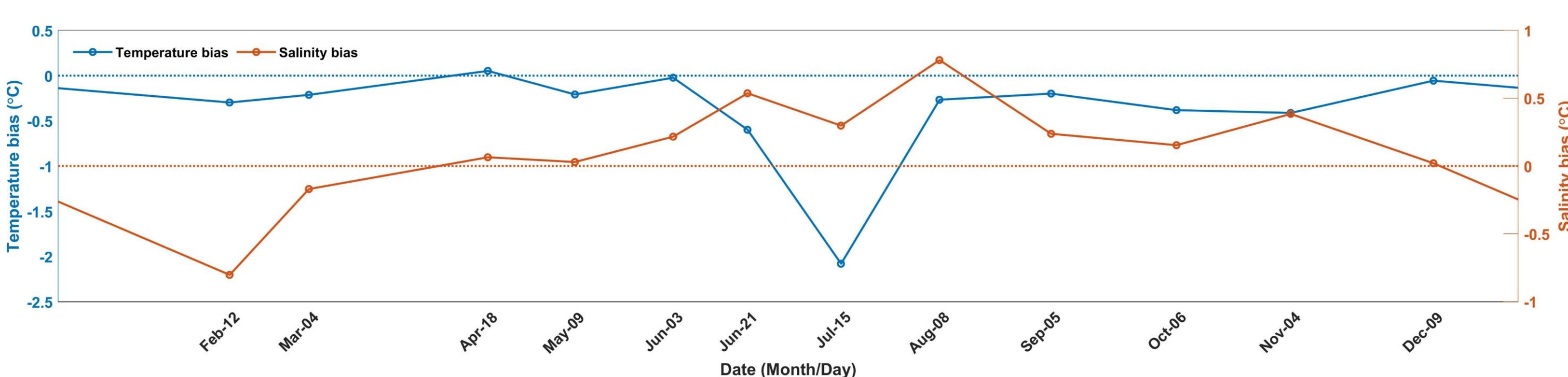


Fig. 3. Biases at the Korea Strait in 2019. Blue and orange lines indicate temperature and salinity bias, respectively.

• HYCOM salinity at the Korea Strait was lower in winter and higher in summer compared to observation, respectively (orange line in Fig. 3).

Conclusion

- To remove the bias in global prediction model, bias correction and data assimilation were applied, and evaluated its performances.
- Data assimilation effectively improved the accuracy of temperature in the interior, but could not improve it near upstream (open boundary).
- Bias correction of open boundary data enhanced the accuracy of salinity near the upstream and in the interior in summer.

Salinity distribution in August 2019

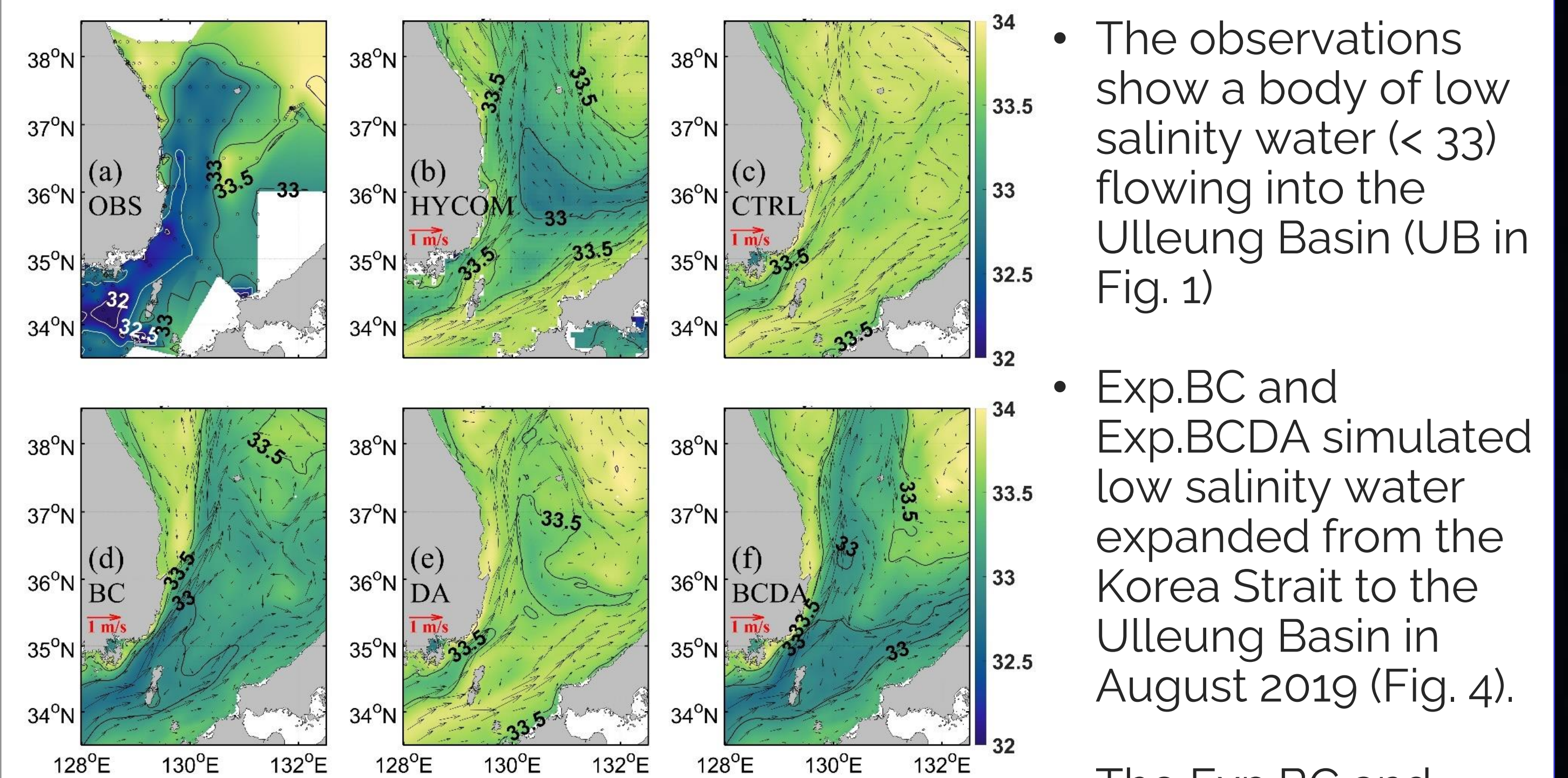


Fig. 4. Horizontal salinity distribution at the depth of 10 m in the southwest East Sea in August 2019; (a) observation, (b) HYCOM, (c) Exp.CTRL, (d) Exp.BC, (e) Exp.DA and (f) Exp.BCDA.

- The observations show a body of low salinity water (< 33) flowing into the Ulleung Basin (UB in Fig. 1)
- Exp.BC and Exp.BCDA simulated low salinity water expanded from the Korea Strait to the Ulleung Basin in August 2019 (Fig. 4).
- The Exp.BC and Exp.BCDA partially recovered the low salinity water in surface layer (Fig. 5).

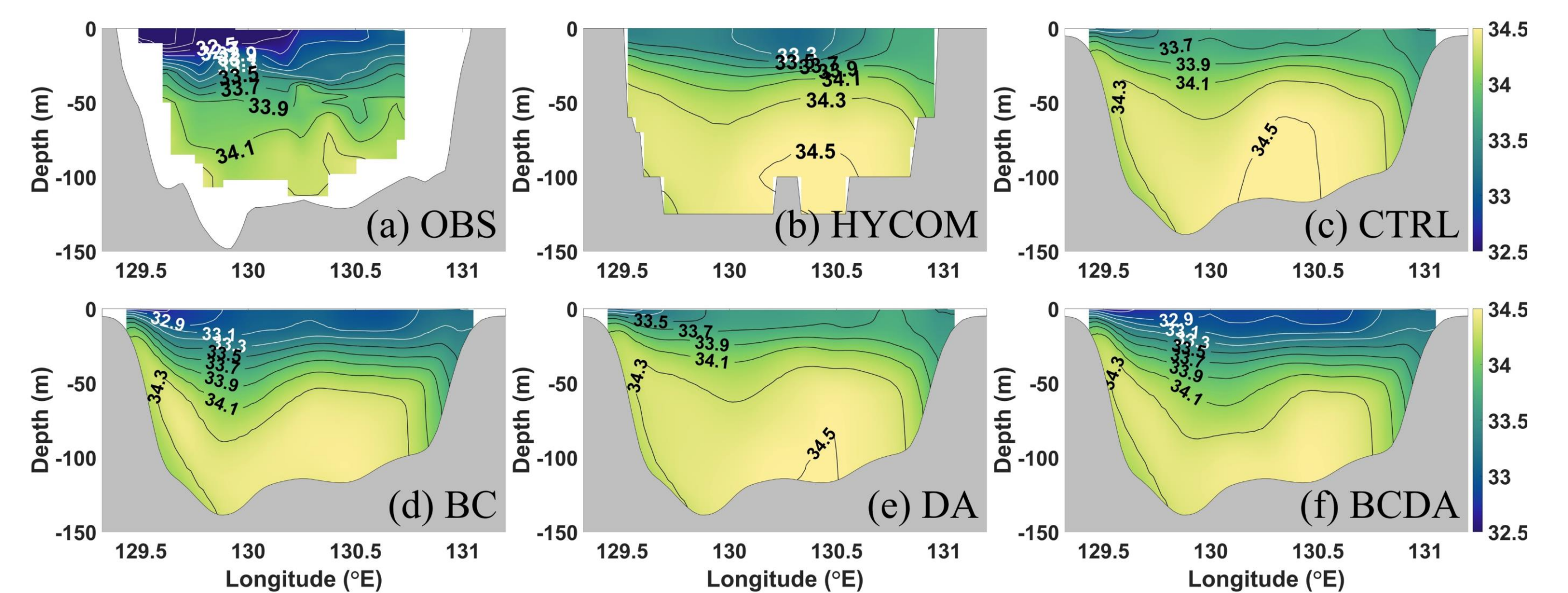
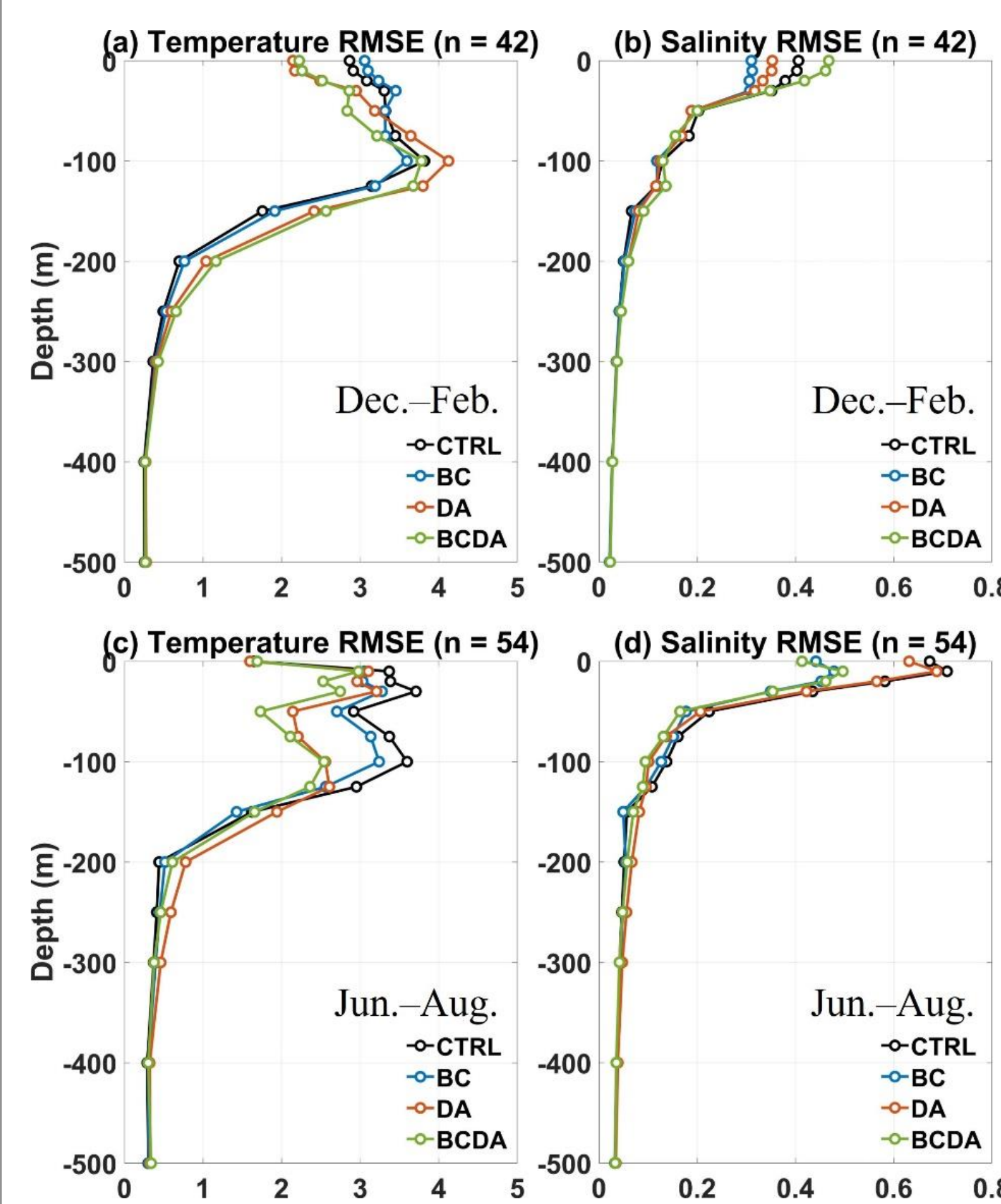


Fig. 5. Vertical salinity section across the Korea Strait in the southwest East Sea in August 2019; (a) observation, (b) HYCOM, (c) Exp.CTRL, (d) Exp.BC, (e) Exp.DA and (f) Exp.BCDA.

Decrease of RMSEs in temperature and salinity



- In salinity, bias correction improved salinity accuracy better than data assimilation, particularly, in summer (Fig. 6).
- In temperature, data assimilation enhanced the simulation performance of temperature.
- In Exp.BCDA, salinity RMSE was higher than Exp.CTRL in winter.

Fig. 6. RMSE profiles of temperature and salinity from independent dataset in (a, b) winter and (c, d) summer, respectively. n is the number of observation.