SYMPOSIUM OP'24
ADVANCING OCEAN PREDICTION SCIENCE FOR SOCIETAL BENEFITS

Theme #4

1/12° Global Ocean Modeling System by the Korea Institute of Ocean Science and Technology

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Introduction

- Growing importance of high-resolution global ocean data as extreme events affecting Korea become more frequent (e.g., marine heatwaves, tropical typhoons)
- Marine environmental pollution emerging as a major concern in Korea (e.g., microplastics, radioactive substances)
- Crucial role of high-resolution global ocean models in effective particle-tracking simulations
- Development of the global ocean model (GFDL-MOM6) through collaboration between the Korea Institute of Ocean Science and Technology (KIOST) and Pukyong National University

Data & Method

- Base model: GFDL-MOM6
- Horizontal resolution: 1/12 °×1/12 ° (82°S–90°N, 180 °W–180 °E)
- Vertical resolution: 61 layers applying hybrid coordinate system (Z-star & isopycnal grid)
- Vertical mixing scheme: ePBL (Reichl and Hallberg, 2018)

Table 1. Input data for the global MOM6 model by KIOST

3D-initial fields (Temp, Salt)	Atmospheric forcing	Observation data for data assimilation		
		Sea Surface Temperature (SST)	In-situ TS profiles	Sea Surface Heights (SSH)
EN4.2.2	ECMWF-ERA5	NOAA OISSTv2	GTSPP best-copy, Argo, WOD	CMEMS Global Ocean Along-track L3

- To assimilate ocean datasets, Ensemble Optimal Interpolation is applied using the following formula (Evensen et al., 2003; Kim et al., 2015):

$$X^a = X^b + K(Y - HX^b) \qquad (1)$$

(X^a: Analysis fields; K: Kalman gain matrix; Y: Observations; HX^b: Forecast fields)

- Number of Ensemble members: 50
- Assimilation Intervals: 7 days for TS profiles, daily for SST and SSH
- Strategy of c[...] coordinate:

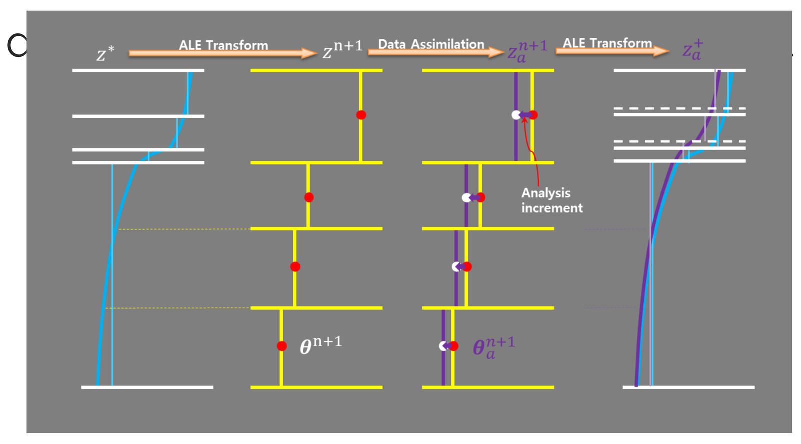

Figure 1. Schematic diagram of vertical coordinate conversion using the ALE algorithm for an ocean data assimilation system

Results

- Comparison in sensitivity tests with different observational data applied in data assimilation
- Model period: March 1–31, 2011
- Validation datasets: EN4.2.2 c14

Table 2. Sensitivity test based on differences in data assimilation

Experiments	CTR (NO_DA)	EXP1 (DA_TS)	EXP2 (DA_TSH)
Assimilated variables	-	SST, in-situ profiles	SST, in-situ profiles, SSH

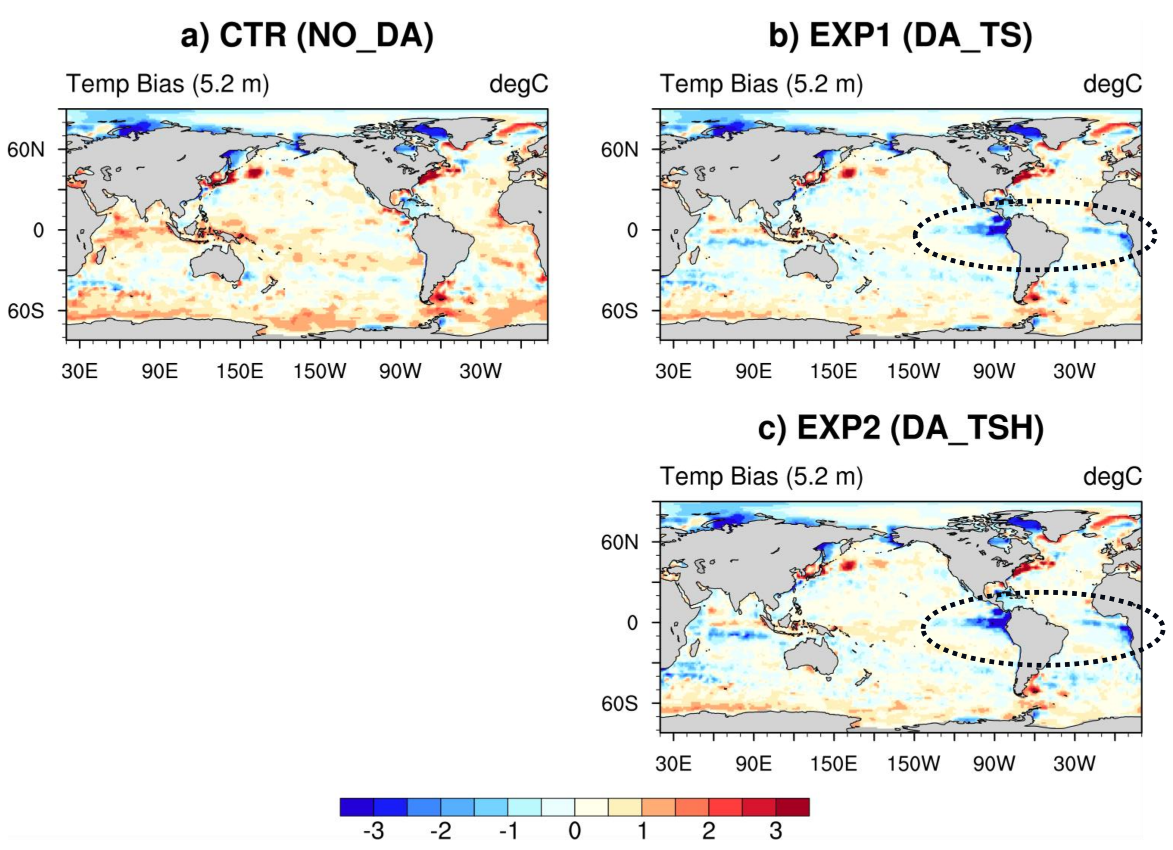

Figure 2. Surface temperature biases for each case obtained from EN4.2.2

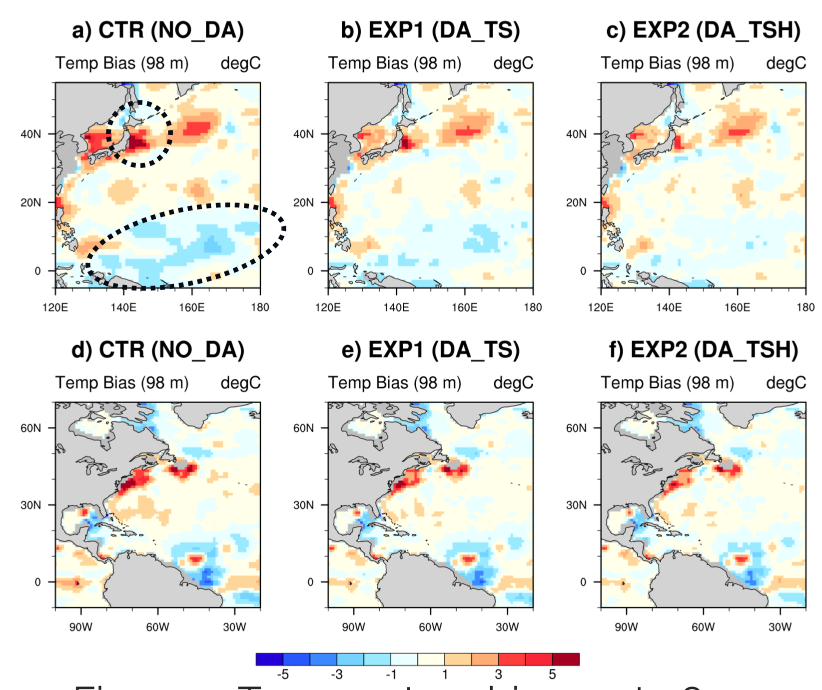

Figure 3. Temperature biases at 98 m for each case obtained from EN4.2.2

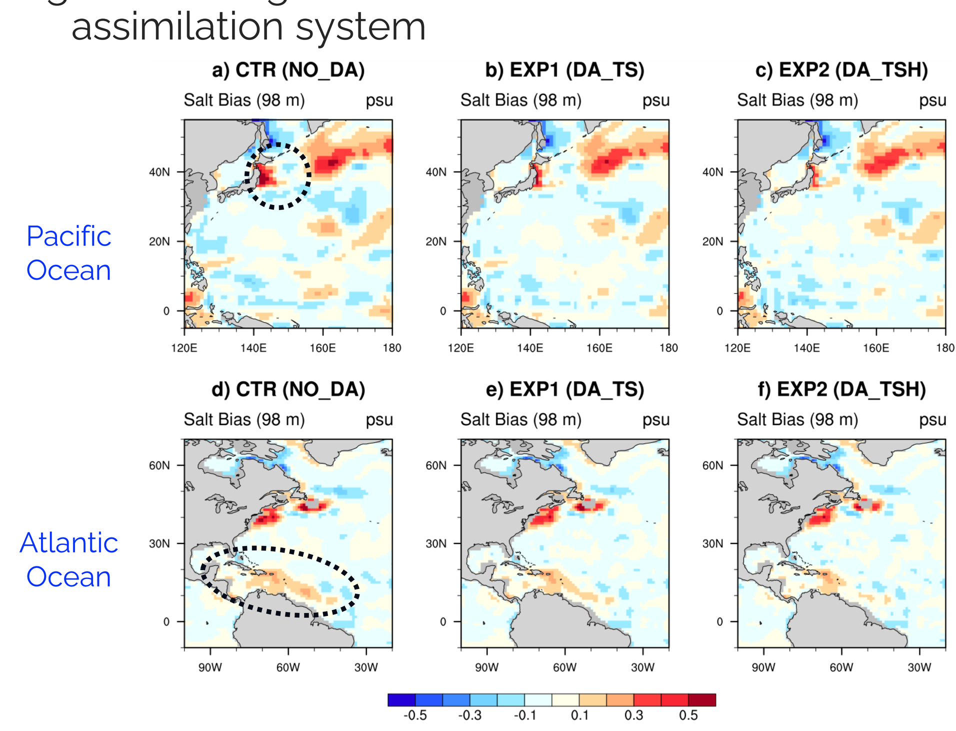

Figure 5. Salinity biases at 98 m for each case obtained from EN4.2.2

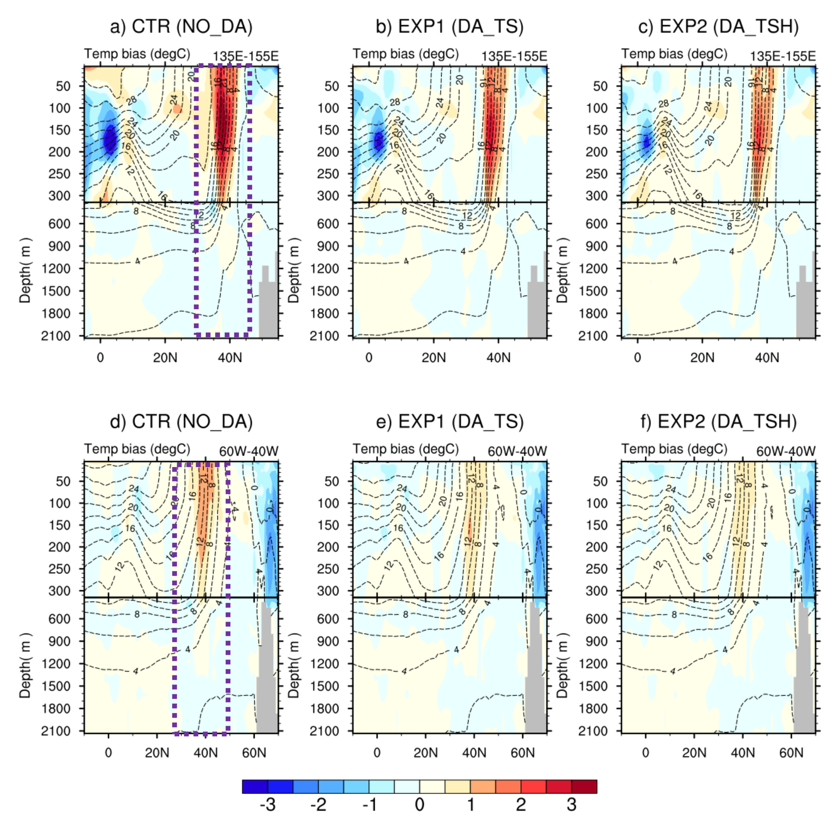

Figure 4. Vertical zonal-mean temperature (dashed line) and its bias (color) for each case obtained from EN4.2.2

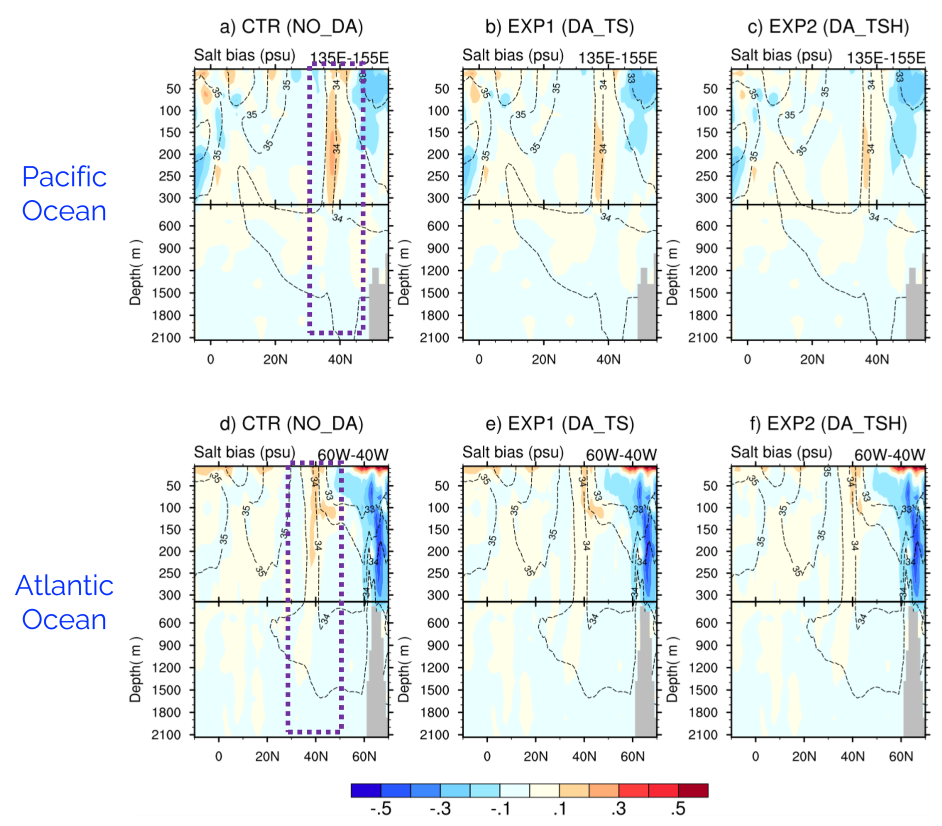

Figure 6. Vertical zonal-mean salinity (dashed line) and its bias (color) for each case obtained from EN4.2.2

Summary and Future plans

- Reduction of the dominant positive bias in CTR (NO_DA) across most global regions through data assimilation, with an associated increase in pronounced cold bias (below -2°C) in equatorial regions such as the eastern Pacific, and Atlantic Ocean (Figure 2).
- In Pacific Ocean, most effective mitigation of positive temperature and salinity biases in subsurface layers around the Kuroshio-Oyashio Mixed Water Region (140°E, 40°N), along with moderation of cold temperature bias in the equatorial region (Figures 3; Figure 4).
- In Atlantic Ocean, substantial reduction of positive temperature and salinity biases near the Gulf Stream (40°N) in EXP2 (DA_TSH), with noticeable positive biases in the CTR (NO_DA) case (Figure 4; Figure 6).
- Mitigation of warm temperature bias near 30°N (Figure 3d–e) and positive salinity bias in the Caribbean Sea (Figure 5d–e) by conducting additional data assimilation for sea surface height.
- Over 10 years of global reanalysis data (2011–2020) to be generated after model improvements (e.g., Memory usage optimization in data assimilation, improving perturbation fields)