SYMPOSIUM OP'24

ADVANCING OCEAN PREDICTION SCIENCE FOR SOCIETAL BENEFITS

Theme 2.3

Summer advection of warm surface water from the East China Sea to the southern coast of Korea

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1. Introduction

- In the southwestern coastal region of Korea, abrupt surface temperature rise occured in summer 2017. Especially, temperature rise more than 9°C was observed by the temperature data logger in the offshore of the southwestern region from July 25 to August 4 (Fig 3a; Kim et al., 2022).
- The objective of this study is to identify the cause of abrupt surface water temperature rise in the southwestern coastal region of Korea using an ocean circulation model.

2. Methods

- Regional Ocean Modeling System (ROMS)
- Horizontal grid spacing: 1/100°
- Vertical grid: 41 sigma layers
- Bathymetry: Korbathy30s dataset
- Open boundary: 1/12° Mercator Ocean global reanalysis
- Atmospheric forcing: ERA-interim reanalysis datasets
- Tidal forcing: Topex/Poseidon version 6

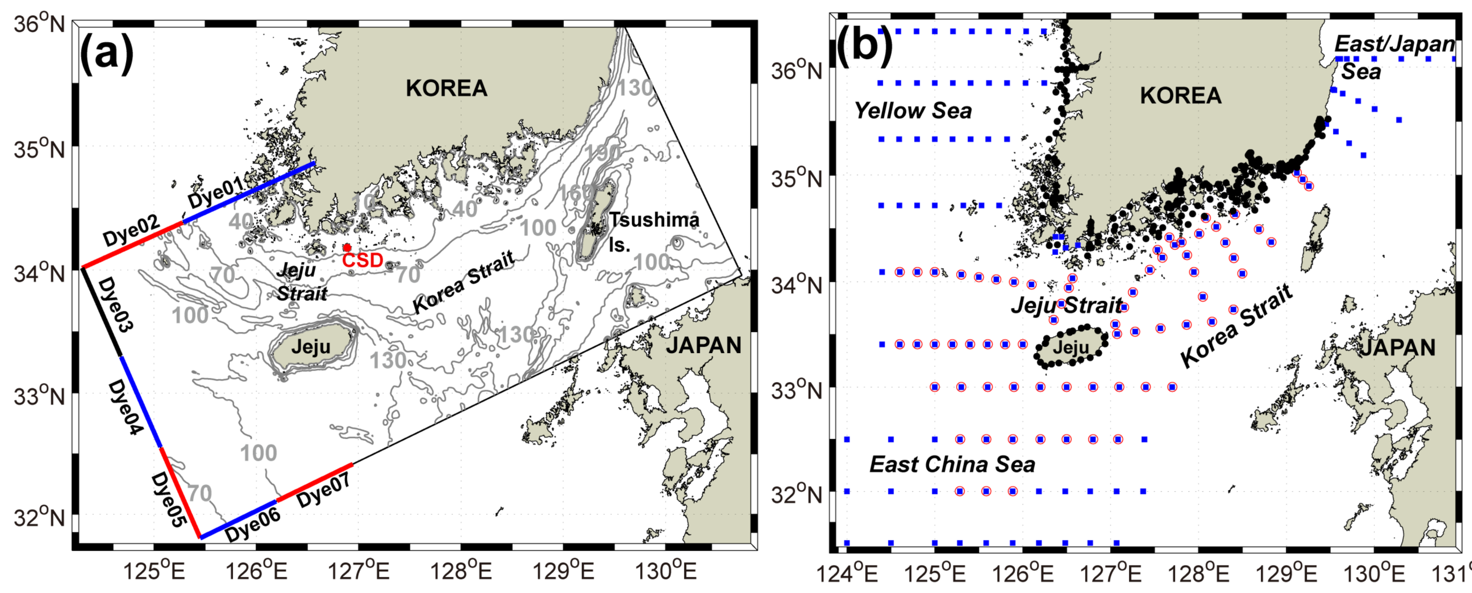

Fig.1. (a) Model domain and bathymetry (gray contours). Passive tracers (dye) were released at the open boundary from segments Dye01 to Dye07. Red dot indicate Cheongsando (CSD). For model validation, hydrography data from stations with pink circle in (b) are used to plot temperature-salinity diagram in Fig. 2.

3. Results

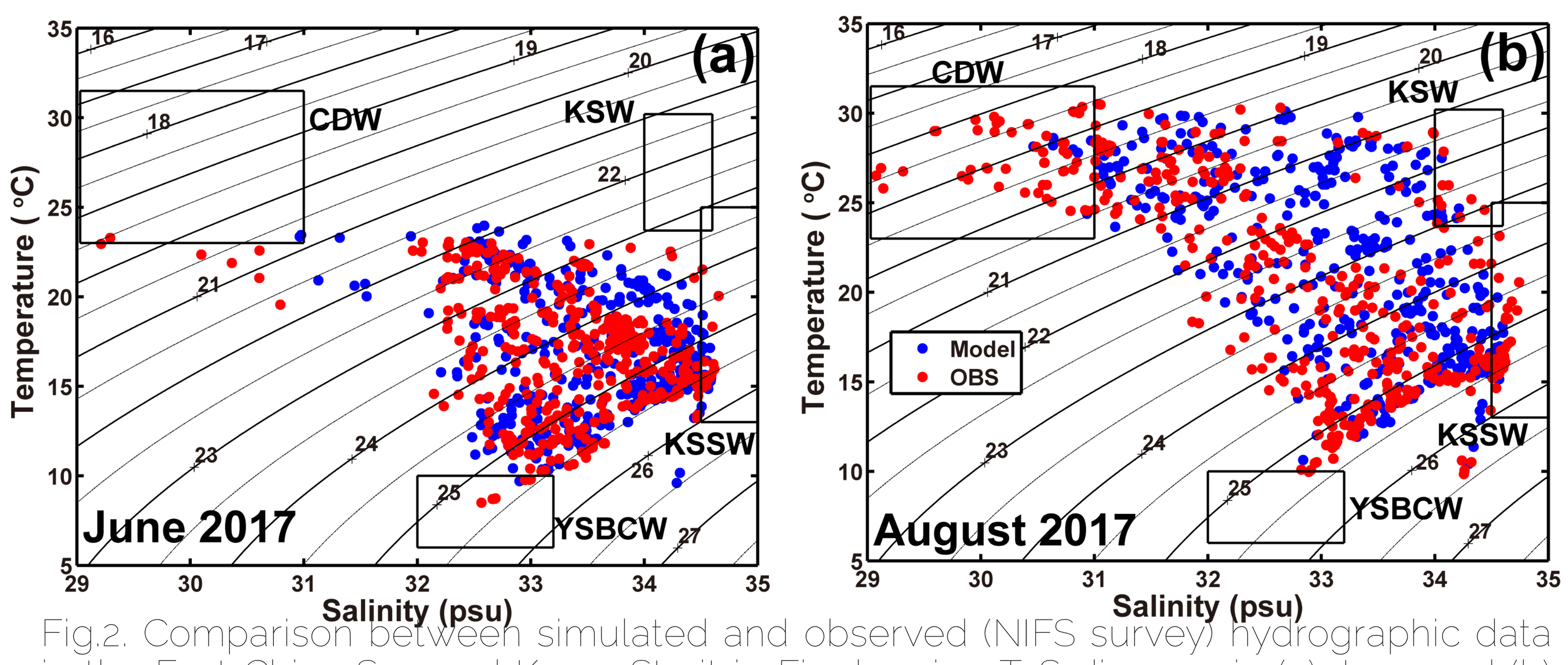

Fig.2. Comparison between simulated and observed (NIFS survey) hydrographic data in the East China Sea and Korea Strait in Fig.1b using T-S diagram in (a) June and (b) August 2017. Red and blue dots represent the observed and simulated water types, respectively. The CDW, KSW, KSSW and YSBCW indicate the Changjiang Diluted Water (Kim et al., 2020), Kuroshio Surface Water, Kuroshio Subsurface Water (Qi et al., 2014) and Yellow Sea Bottom Cold Water (Hur et al., 1999), respectively.

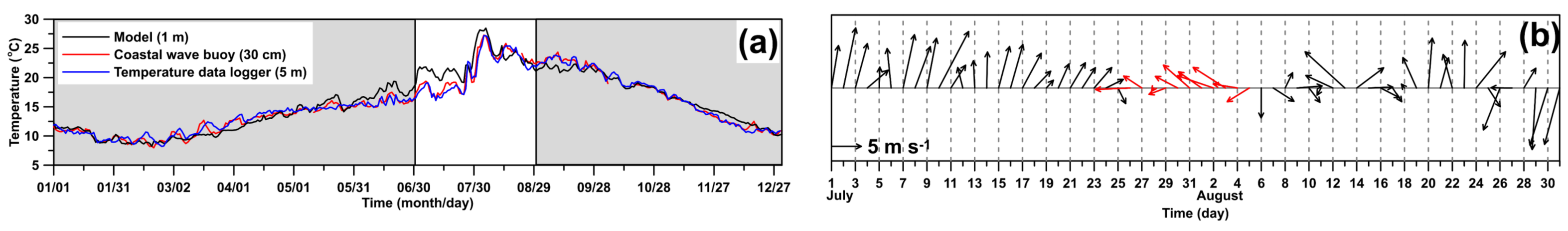

Fig.3. Time series of (a) the daily mean sea surface temperature from model (black line), Buoy (red line), and data logger (blue lone) at CSD and (b) the spatial mean ECMWF wind vectors in the southwestern region of Korea (124-128°E, 33-35°N) from July 1 to August 31, 2017. Red vectors represent the easterly winds during the abrupt surface temperature rise event.

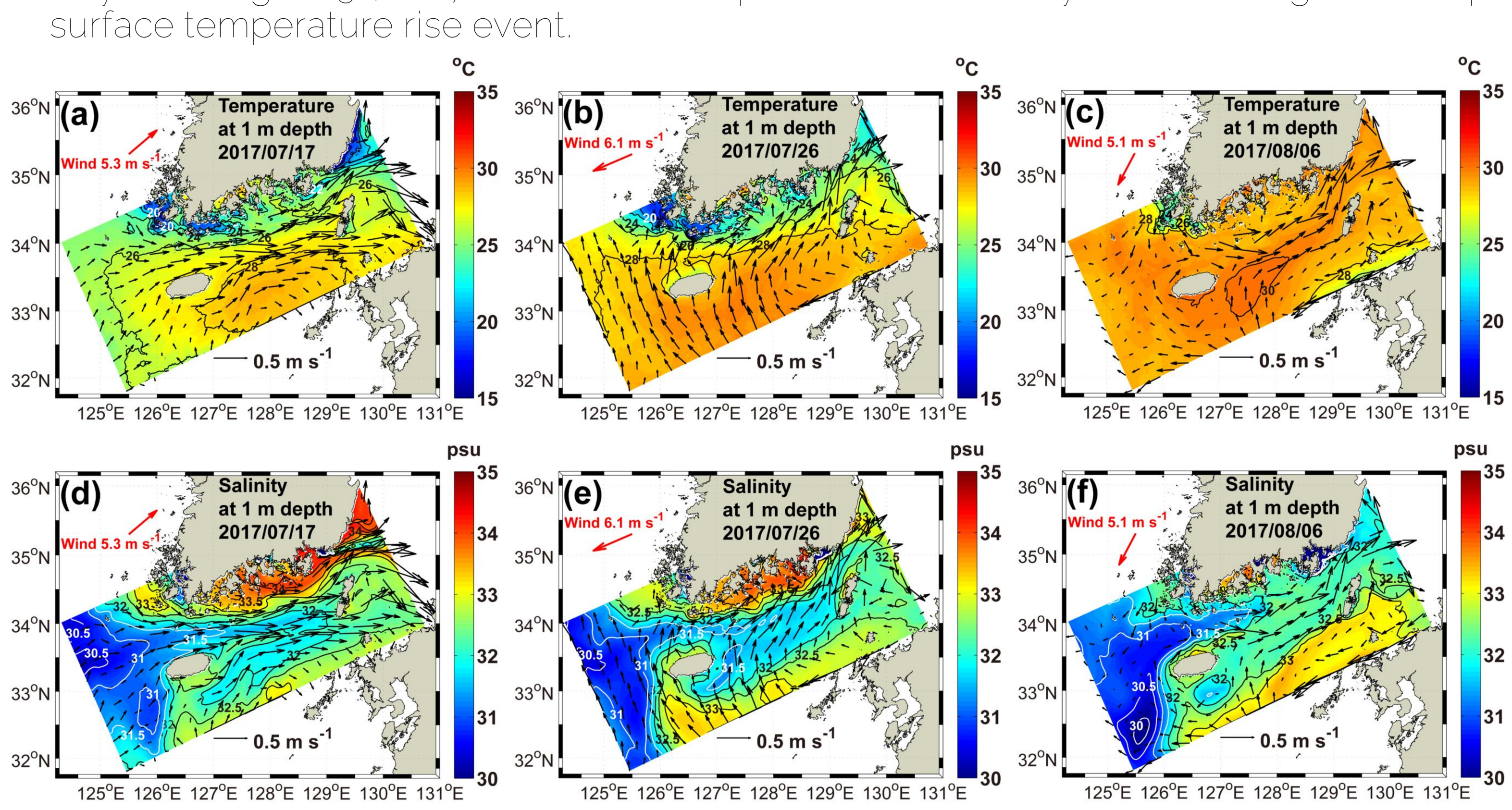

Fig.4. Horizontal distribution of the simulated surface temperature (upper panel) and salinity (bottom panel) with current vectors on (a and d) July 17, (b and e) 26, and (c and f) August 6, 2017. The red vectors indicate the spatial mean ECMWF wind in the model domain.

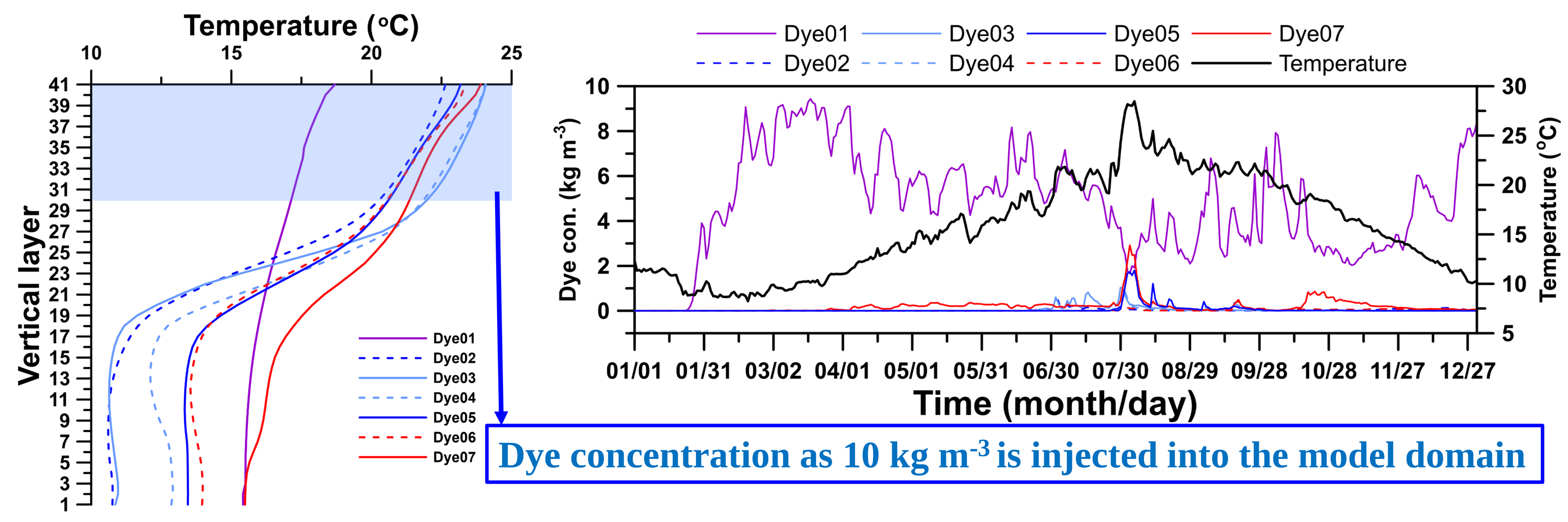

Fig.5. (a) Vertical profile of the spatial and temporal mean temperature in each dye release region in Fig.1a.The light blue area from layer 30 to 31 indicates the vertical dye release layer in the model for all dye release regions except Dye01, where the entire vertical column was used. (b) Time series of dye concentrations and temperature at a depth of 1 m at CSD.

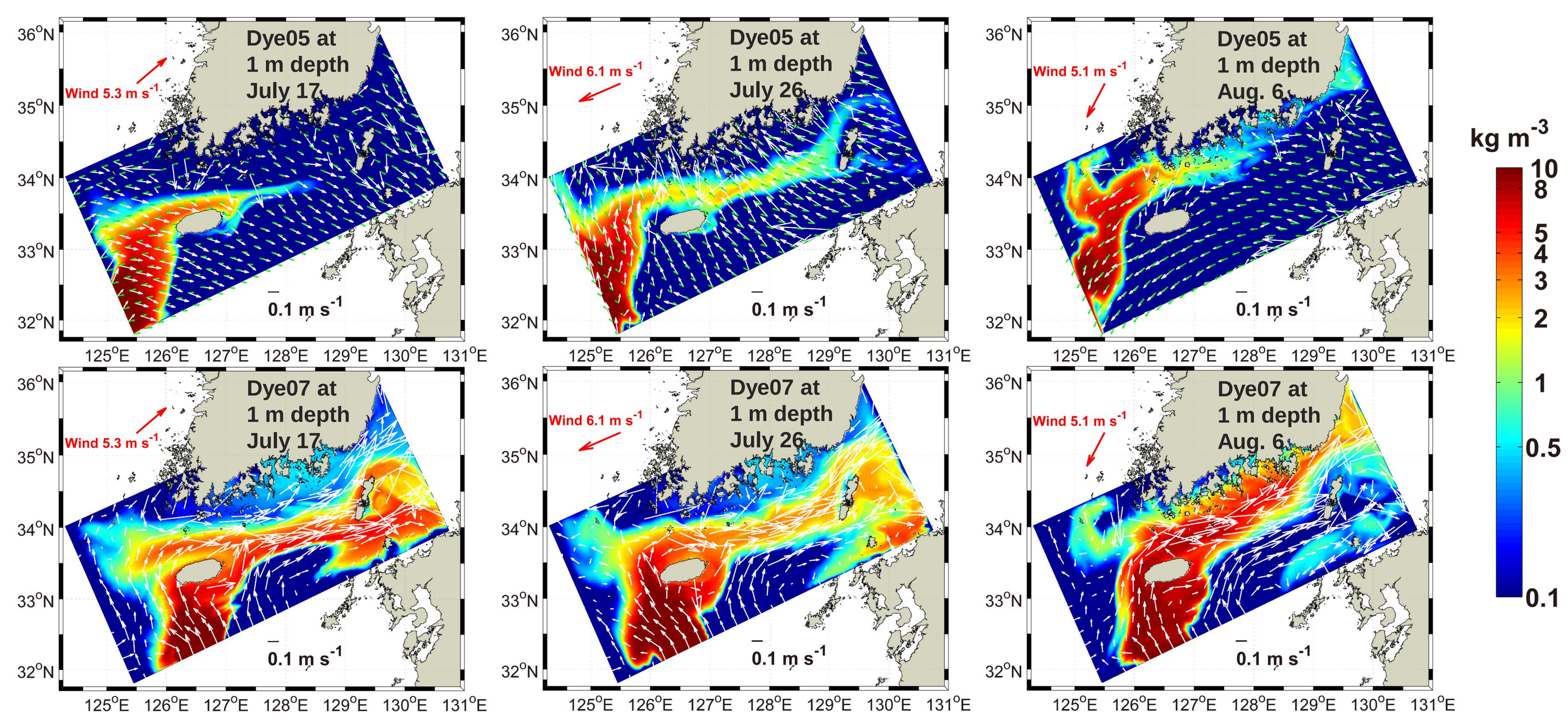

Fig.6. Horizontal distribution of Dye05 (upper panel) and Dye07 (bottom panel) concentrations with ageostrophic (white vectors in the upper panels), theoretical Ekman (green vectors in the upper panels), and geostrophic (white vectors in the bottom panels) currents at 1 m depth on (a and d) July 17, (b and e) July 26, and (c and f) August 6. The red vectors are equal to those in Fig. 4. The colorbar of dye concentration is in log scale.

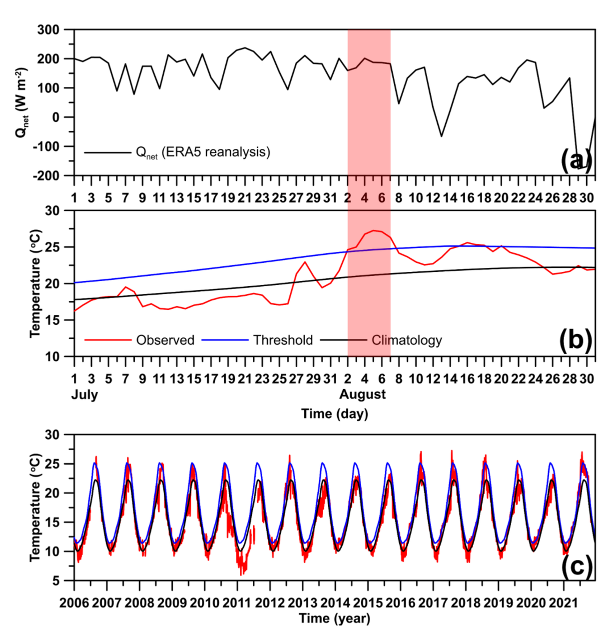

Fig.7. Time series of the (a) net surface heat flux (Q_{net}), (b) daily water temperature at a depth of 5 m from July 1 to August 31, 2017 (red line) and the daily threshold for a marine heatwave event (blue line), climatological mean (black line) temperature calculated using observed data at CSD from 2006 to 2021. (c) Daily time series of the observed (red line), threshold (blue line), and climatological mean seasonal (black line) temperature from 2005 to 2021.

4. Conclusions

- When the easterly wind blew, abruptly temperature rises in the simulated and observed time-varying temperature during summer (Fig. 3).
- When the northwesterly wind blew, surface flows changed to the northward currents, surface temperature and salinity became warmer and fresher in the southwestern region of Korea on August 6 through July 26 (Fig. 4).
- During the abrupt surface temperature rise event, Dye05 and Dye07 (i.e. surface warm and less-saline water in Fig. 4) were transported by the northward ageostrophic currents from the Jeju Strait to the southwestern coastal region of Korea (Fig. 6).
- Marine heatwave diagosed by the definition of Hobday et al. (2016) at CSD was caused by the coastward Ekman transport of the warm and less-saline water originating from the East China Sea in the summer of 2017 (Figs. 6 and 7).