SYMPOSIUM OP'24
ADVANCING OCEAN PREDICTION SCIENCE FOR SOCIETAL BENEFITS

Theme 2.3

Forecast Skill Assessment of Surface Currents Using Drifter Trajectories in the Northwest Pacific

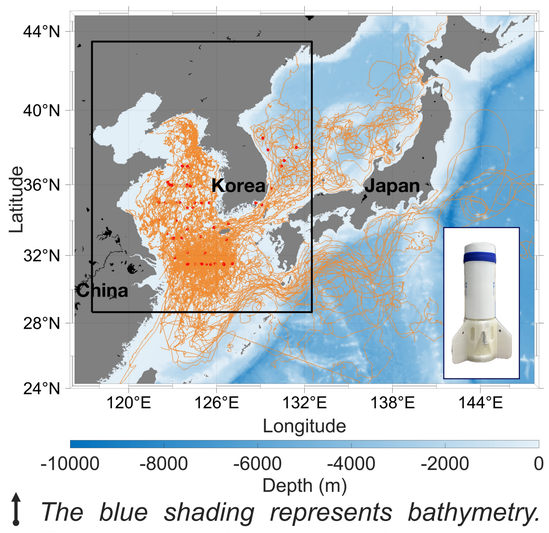
Sang-Hun Jeong, Jin-Yong Choi, Jung-Woon Choi, Deok-Su Kim and Jaeil Kwon

Introduction

Korea's coastline exhibits remarkable complexity, generating intense tidal currents driven by significant tidal fluctuations. These coastal regions feature intricate current patterns influenced by both topographic features and oceanic forcing. Recognizing the need for accurate marine prediction systems, KIOST (Korea Institute of Ocean Science and Technology) developed Coastal-KOOS (Korea Operational Oceanographic System), implementing sophisticated ocean circulation prediction models for enhanced forecasting and disaster response capabilities. Our methodology focused on a rigorous validation approach, transforming Lagrangian drifter trajectories into Eulerian velocities and cross-referencing these with fixed-point observational data to establish measurement accuracy. Through comparative analysis between model-predicted and drifter-derived velocities, we systematically identified the spatial distribution of the model's predictive strengths and limitations across different coastal regions.

Data and Methods

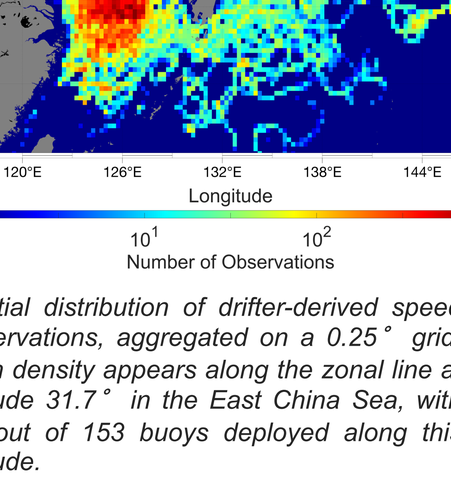
1. Study Area, Drifter Trajectories and Model Domain



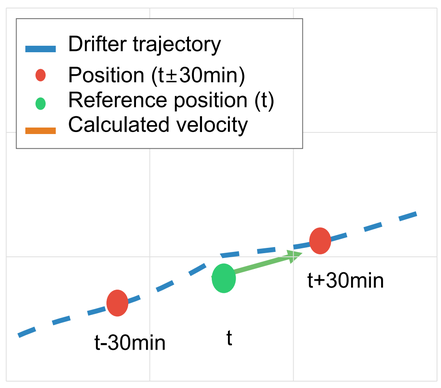
The blue shading represents bathymetry. Red dots indicate deployment points, while the orange lines show drifter trajectories. The black line outlines the MOHID model domain. The drifter height is 25 cm, and it remains nearly fully submerged in the water.

2. Overview of Drifter Deployment and Model Description

- Total deployments : 153
- Periods : 2020 ~ 2024, saved every 10 minites
- GPS accuracy : 10 cm to 1 m
- Equipped with small drogues
- Current Forecast System : Coastal-KOOS based on MOHID, MOM5, WRF and SWAN
- Model : MOHID Level 2 (resolution 2 km / 40 layers)

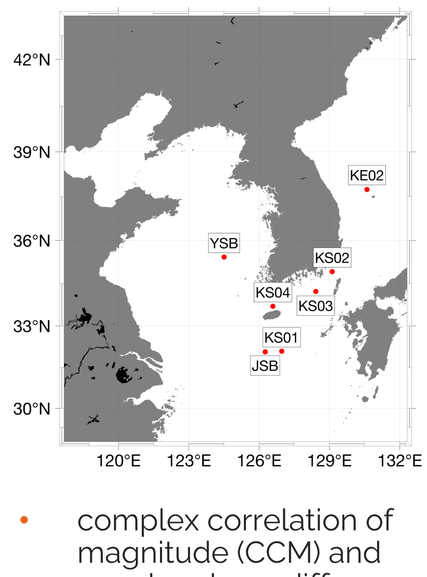


3. Transforming Lagrangian instruments to Eulerian products



- Velocity is calculated based on distances on the WGS84 ellipsoid, using latitude and longitude positions 30 minutes before and after each hour
- Central difference scheme used for eastward and northward velocity calculation (unit : m/s)
- Data points excluded if t±30min positions unavailable

4. Fixed Observation Site and Skill Metrics



- complex correlation of magnitude (CCM) and angular phase difference (CCP)

$$\rho = \frac{\langle V_p \times V_o' \rangle}{\langle V_p \times V_p' \rangle \langle V_o \times V_o' \rangle}, V = u + iv$$

$$|\rho| = \sqrt{[Re(\rho)]^2 [Im(\rho)]^2}$$

$$\theta = \tan^{-1}\left[\frac{Im(\rho)}{Re(\rho)}\right]$$

Results and Discussion

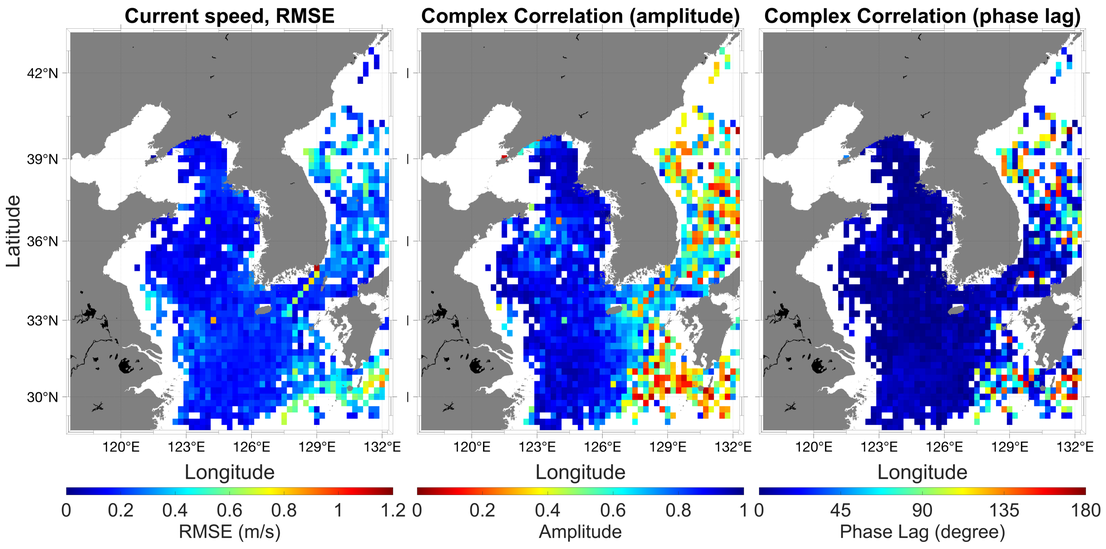
1. Surface Current Speed Statistics: Comparison between Drifters, Fixed Observations, and MOHID

	Obs-Drifter	Obs-MOHID	Drifter-MOHID
n	53	152368	147844
RMSE	0.25	0.22	0.22
Corr.	0.74	0.58	0.77
CCM	0.71	0.69	0.78
CCP	-11.6	-7.7	-3.5

Extracted Eulerian velocities of drifters located within 6 km of observation (53 points). Stokes drift and wind effects are not accounted for in the drifter-derived speed. Fixed observations were collected by KIOST and KHOA from 2020 to 2024

2. Spatial Skill Assessment of MOHID Using Drifter-derived Speed

Spatial distribution of drifter-derived speed observations, aggregated on a 0.25° grid. High density appears along the zonal line at latitude 31.7° in the East China Sea, with 91 out of 153 buoys deployed along this latitude.



- The MOHID model effectively predicts tidal current-dominated areas, consistent with its operational objectives.
- High RMSE values appear in regions influenced by the Kuroshio and Tsushima Currents and the East/Japan Sea, reflecting strong currents and model prediction accuracy, with similarly elevated RMSE along the Chinese coast.
- CCR is high in the Yellow Sea and East China Sea, with slightly lower values in the central Yellow Sea due to weaker mean currents. CCR and CCP along the Chinese coast and Tsushima Current paths indicate that MOHID accurately predicts current direction and pathway but shows lower accuracy for current magnitude.
- Data assimilation of variables like temperature and sea surface height is likely needed to improve predictions of eddy activity in the Kuroshio region and the East/Japan Sea

KOREA INSTITUTE OF OCEAN SCIENCE & TECHNOLOGY
Sang-Hun Jeong, Marine Natural Disaster Research Department, Korea Institute of Ocean Science and Technology, Busan 49111, Republic of Korea. jsh5481@kiost.ac.kr

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