Korea Meteorological Administration
Numerical Modeling Center

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01 INTRODUCTION

- According to the IPCC AR6, global warming has contributed to long-term ocean warming, resulting in stronger typhoons and more frequent extreme storm surges.
- The Korean Peninsula, particularly along its western and southern coasts characterized by complex bathymetry and pronounced tidal variations, is especially susceptible to flooding and inundation.
- To mitigate these risks, the Korea Meteorological Administration (KMA) currently operates high-resolution storm surge forecasting systems based on NEMO v3.6 with grid resolutions of 8 km (Regional Tide/Storm surge Model/RTSM) and 1 km (Coastal Tide/Storm Surge Model/CTSM).
- In this study, a nested grid-based storm surge forecasting model is developed with the AGRIF module to achieve high resolution and accuracy, and its performance is evaluated.

02 METHOD

Costal Tide/Storm Surge Model (CTSM)

Base model	NEMO (ver. 3.6)
Domain	123°E – 133°E, 31°N – 43.5°N
Resolution	1/120° × 1/120° (1201 × 1501)
Initial condition	12hr previous forecast
Boundary condition	Regional Tide/Storm surge Model
Atmospheric forcing	Korean Integrated Model (KIM)-GDPS (10 m wind, MSLP)
Prediction & Start time	72hr (00, 12 UTC)

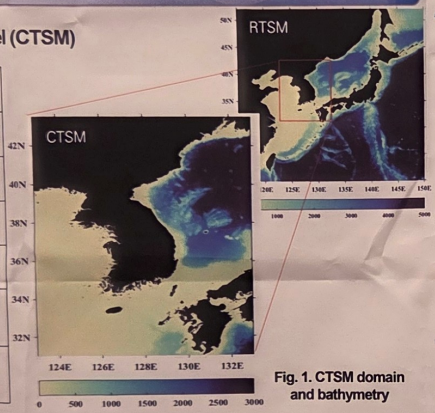

Fig. 1. CTSM domain and bathymetry

Nested grid-based high-resolution Tide/storm Surge Model (NTSM)

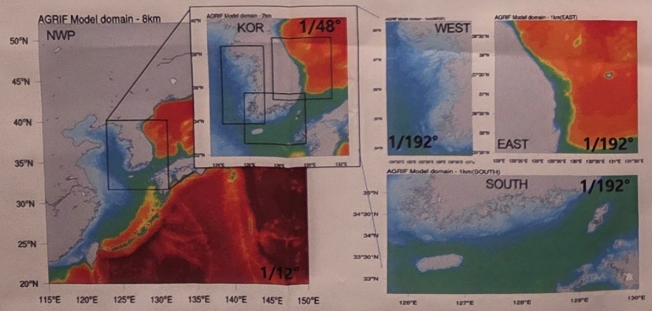

Fig. 2. High-resolution model domains for each nested region.

	NWP	KOR	WEST	SOUTH	EAST
Spatial resolutions	1/12°≈ 8 km (420×386)	1/48°≈ 2km (440×400)	1/192°≈ 500m (568×888)	1/192°≈ 500m (848×532)	1/192°≈ 500m (716×668)
Area	115.0~150.0°E, 20.0~52.0°N	123.2~132.4°E 31.6~40.0°N	124.2~127.15°E 33.7~38.4°N	125.6~130.0°E 32.6~35.4°N	127.9~131.6°E 35.4~38.9°N
Vertical level	10 (sigma – SH94)				
Atmospheric Forcing	Korean Integrated Model (KIM)-GDPS (10 m wind, MSLP)				
Lateral Open boundary	-	NWP	KOR		
Tidal	TPXO 8				

Model validation

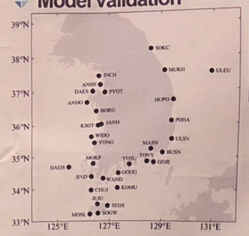

Fig. 3. Locations of 32 tidal gauge Stations along the coast of Korea.

Experiment Period	Date
Summer	2024.08 – 2024.09
Typhoon JONGDARI	2024.08.19 – 2024.08.22
Tropical Depression	2024.09.18 – 2024.09.21

- The predictive performance of the storm surge model is evaluated using observed sea level data from the summer of 2024 and a typhoon case, with Root Mean Square Error (RMSE) calculated.
- Time series analysis during the typhoon case is conducted to assess the model's ability to reproduce the observed surge heights.

Surge prediction system	
	➢ Observed surge height : Observed sea level – harmonic tide prediction ➢ Model surge height : Forced(10m, MSLP) model run – tide only model run ➢ Sea level prediction : Model surge height + harmonic tide prediction

03 RESULT

RMSE for Model Surge height against observation data

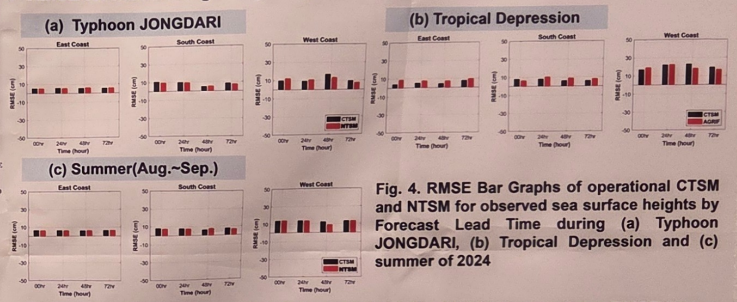

Fig. 4. RMSE Bar Graphs of operational CTSM and NTSM for observed sea surface heights by Forecast Lead Time during (a) Typhoon JONGDARI, (b) Tropical Depression and (c) summer of 2024

- For the Typhoon and the summer season in 2024, the NTSM shows a lower RMSE than CTSM, confirming its better representation. But the RMSE of NTSM for the Tropical Depression is relatively higher than CTSM in the East and South coasts.

Typhoon 'JONGDARI'(2409)

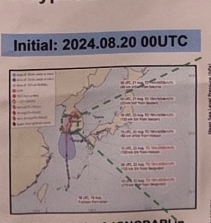

Fig. 5. Track of JONGDARI in 2024

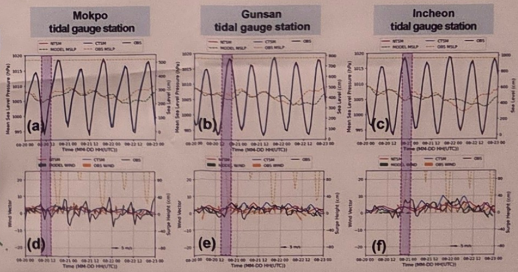

Fig. 6. Sea level (a–c) and surge heights (d–f) of observation and models during Typhoon JONGDARI. In panels (a–c), the solid lines represent sea level and dashed lines indicate mean sea level pressure. The gold dashed line denotes the storm surge warning threshold. In panels (d–f), the solid lines represent surge heights, and the gold dashed line indicates the difference between the warning threshold and the harmonic tide prediction. Purple shades indicate the time when the typhoon is approaching.

- In the case of the typhoon, model surge height has been slightly increased. But the variation of model surge height is not well simulated compare to observation.
- In Mokpo, the model's surge height was less dynamic compared to the observed surge height. Because tide-surge interaction of this station is remarkable, the models failed to accurately reproduce surge height.
- In Gunsan and Incheon, the models simulated the storm surge relatively well, and the NTSM surge heights are more similar to the observations than those of CTSM

04 CONCLUSION

- We develop a nested grid-based storm surge forecasting model using the AGRIF module, with domains ranging from the Northwest Pacific to the Korean coasts. We validated it through case studies during the summer and a typhoon event in 2024, and compared the