Typhoon Prediction in Korea Operational Oceanographic System using the Hurricane WRF Model

Other advances in numerical ocean modelling

Theme 3 – Splinter D | 08 May 2019

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Typhoon over Western North Pacific

Typhoon landfall in Korea

- About 3.1 typhoons per year affect Korea
- Causing extensive damages, mainly summer
- Typhoon Maemi induces lots of damages

![Typhoon track map](image)

Monthly typhoon tracks

![Damage](image)

Damage caused by landfall typhoon Maemi in 2003
Experimental case: typhoon Chaba (2016.10.05)

- 7 killed, 4 missing, 500 million USD
- Widespread damage across the southern regions of Korea
- Strongest typhoon to hit Korea in Oct.
Typhoon prediction for Ocean prediction system

Atmospheric forcing during typhoon in ocean modeling

- Wave, Storm surge modelling in KOOS
- Holland parametric wind model (Holland, 1980), WRF has been used in storm surge modelling as atmospheric forcing

![Pressure field generated using Holland model](image1)

![Simulated surge height using Holland and WRF wind field during typhoon Sanba](image2)
Typhoon intensity validation

- TC models validated based on various analysis methods
- HWRF shows the highest performance in predicting the intensity of strong TCs

RI validation in WNP

- RI (rapid intensity change) forecasts is one of the highest priorities for TC forecast
- HWRF well capture the RI compared to other models

Tallapragada and Kieu (2014)
HWRF v4.0a version

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<th>Domain 1</th>
<th>Domain 2</th>
<th>Domain 3</th>
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<tbody>
<tr>
<td><strong>Horizontal resolution</strong></td>
<td>13.5km</td>
<td>4.5km</td>
<td>1.5km</td>
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<td><strong>Horizontal dimension</strong></td>
<td>390 x 780</td>
<td>268 x 538</td>
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<td><strong>Vertical Levels</strong></td>
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<td>75</td>
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<td><strong>Cumulus parameterization</strong></td>
<td>Scale-Aware Simplified Arakawa-Schubert(SASAS) scheme</td>
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<td><strong>Surface-layer</strong></td>
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<td>HWRF surface-layer scheme</td>
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<td><strong>Land surface</strong></td>
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<td>Noah LSM</td>
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<td><strong>PBL</strong></td>
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<td>HWRF PBL scheme</td>
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<td><strong>Radiation</strong></td>
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<td>RRTMG</td>
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Moving nests of HWRF (Chaba case)

Total layer composite reflectivity - Deep convection (Shading - dBZ)

D01

D02

D03

13.5km

4.5km

1.5km
HWRF Typhoon prediction system

- Typhoon warning (SYNDAT-tc Vital)
  - WRF-NMM Pre-processing
    - Vortex improvement & relocation
    - HWRF - Atmos (WRF-NMM)
  - POM Pre-processing
    - NCEP coupler
    - HWRF-Ocean (POM)
    - Post-processing (UPP)
    - Vortex Tracking
Results

- Including WRF model, most atmospheric models fail to predict landfall of Chaba before 48hrs
- WRF model underestimates intensity
- Initial time: 12UTC 3 OCT 2016
  (-36 h landfall)
Results

- Simulated central pressure compared to the Obs.
- HWRF overestimate buoy Obs.
- HWRF regenerated pressure well compared to WRF
- Peak time was delayed in WRF
HWRF application: Storm surge

- The storm surge height during typhoon were estimated using the Delft3D-FM model.
- Minimum pressure peak time was delayed in WRF.

Comparison of pressure field:

(a) WRF
(b) HWRF

Graphs showing pressure changes at Yeosu and Masan

Delft 3D Domain and bathymetry
HWRF application: Storm surge

- WRF model
  - WRF: -17cm in Yeosu, -50cm in Masan
  - HWRF: -9cm in Yeosu, +16cm in Masan
Summary & Discussion

- Accurate wind and pressure forecasts are essential for ocean forecast during the typhoon
- Previous studies show HWRF outperform others in WNP
- HWRF shows better performance in track and intensity than WRF simulating typhoon Chaba
- In typhoon Chaba case, Storm surge simulation results using HWRF atmospheric forcing showed better performance in two stations
- It is preliminary result to improve ocean prediction accuracy during typhoon as a part of KOOS
References

Korea Meteorological Administration(KMA), 2011 : Typhoon White Book


Thank you
On going study: HWRF operation test (Soulik)

SOULIK (2018082200)

- Binary interaction with typhoon Cimaron
- Moving speed reduced before landfall
On going study : HWRF operation test (Kong-Rey)

- Typhoon intensity overestimated before landfall
- HWRF overestimation bias
Track and Intensity performance (Chaba case)
Simulation of Chaba(1618) with HWRF

Total layer composite reflectivity (Shading-dB)