

The Next Generation's Storm Surge Prediction System in Japan Meteorological Agency

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Preface

- JMA routinely operates two storm surge models.
 - Japan area (to issue warning and advisory for Japan)
 - Asia area (to provide Storm Surge Watch Scheme information for Typhoon Committee members)
- JMA plans to largely upgrade the system.
 - Un-Structured Grid (USG)
 - Ensemble Prediction System (EPS)





CURRENT SYSTEM

Specifications

	Japan Area	Asia Area	
Model	2 dimensional non-linear model	2 dimensional linearalized model	
Coordinate	Lat/Lon Cartesian grid Arakawa C-Grid	Lat/Lon Cartesian grid Arakawa C-Grid	
Area	20.0N~50.0N, 117.5E~150.0E	0.0N~46.0N, 95.0E~160.0E	
Resolution	45"x30"~12'x8' (1km~16km) Adaptive Mesh Refinement (AMR)	2'x2' (~3.7km)	
Time step	4 seconds	8 seconds	
Forecast range	39 hours	72 hours	
Calculation run	8 times/day (3 hourly)	4 times/day (6 hourly)	
Initial time	00,03,06,09,12,15,18,21 UTC	00,06,12,18 UTC	
Number of prediction courses	In case of typhoons: 6 courses (Center, 4 courses on the forecast circles, model GPV) No typhoon: 1 course (model GPV)	In case of typhoons: 6 course (Center on the forecast circles, GEPS 5 courses) No typhoon: 1 course (model GPV)	
Forcing	MSM (Meso Scale Model) GPV (5km)	GSM (Global Spectral Model) GPV (0.25x0.2) GEPS (Global EPS) GPV (0.5625x0.5625)	
Typhoon bogus	Pressure profile: Fujita (1952) Gradient wind (with inflow angle 30 deg.) Asymmetric component by typhoon movement		

Both models don't include inundation, ocean wave, ocean state and river water.

気象庁 Japan Meteorological Agency

Adaptive Mesh Refinement (Japan area)

- We are interested in storm surges in coastal area, not offshore.
- Fine mesh only in coastal area
 - Number of grid < 1/10
 - Fast calculation



Typhoon course (Japan area)

- The Japan area model runs for five possible TC tracks to cover a major set of scenarios.
 - 1. Center track
 - 2. Faster track
 - 3. Rightward biased track
 - 4. Slower track
 - 5. Leftward biased track



Typhoon course (Asia area)

 The Asia area model selects five representative scenarios from GEPS (27 member) using cluster analysis (K-means method).





Problems

- Insufficient number of scenarios
- Extreme courses
- Adding ensemble members is needed for probabilistic forecast and information
- Computer resources (disk resources)



NEW SYSTEM

Un-Structured Grid

- Adopting Un-Structured Grid
 - Finite Volume Method
 - Arakawa B-grid (in general triangulation mesh)
 - ex.) FVCOM (UMASSD), FESOM2 (AWI)





Un-Structured Grid

- Resolutions depend on length from coastline.
- Resolutions along coastlines are unified.

➤GPV size is largely saved.

Number of grids



Ensemble Prediction System

- Adding ensemble members (all members from atmospheric EPS model)
- Probabilistic forecast (improvement of information for risk management)



Ensemble products









Box plot of storm tide in Chofu Blue line shows control run. Black line shows bogus calculation. Time series of probability of storm surge in Chofu

Orange (blue) bars show the probabilities of storm surge>=1m (>=50cm), respectively.





24 Aug

25 Aug

23 Aug

New specifications (plan)

	Japan Area	Asia Area	
Model	2 dimensional non-linear model		
Coordinate	Un-structured grid (B-grid)		
Area	20.0N~50.0N, 117.5E~150.0E	0.0N~46.0N, 95.0E~180.0E	
Resolution	Maximum resolution: 500m	Maximum resolution: 1min	
Time step	-	-	
Forecast range	39 hours	120 hours	
Calculation run	8 times/day (3 hourly)	4 times/day (6 hourly)	
Initial time	00,03,06,09,12,15,18,21 UTC	00,06,12,18 UTC	
Number of prediction courses	In case of typhoons: Depends on MEPS, No typhoon: 1 course (model GPV)	In case of typhoons: Depends on GEPS, No typhoon: 1 course (model GPV)	
Forcing	MSM (Meso Scale Model) GPV (5km) MEPS (Meso EPS) GPV (5km)	GSM (Global Spectral Model) GPV (0.25x0.2) GEPS (Global EPS) GPV (0.5625x0.5625)	
Typhoon bogus	Pressure profile: Fujita (1952) Gradient wind (with inflow angle 30 deg.) Asymmetric component by typhoon movement		



SUMMARY

Summary

- JMA plans to upgrade the storm surge prediction system in the next super computer system (from 2018).
- The upgrade includes introducing Unstructured Grid and Ensemble Prediction System.
- It is expected the system contribute more to risk management for not only Japan but also Asia area.



Thank you!

Ryohu-maru

Keihu-maru

PRELIMINARY SLIDE

Example of track selection



AMR vs. USG



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Calculation time

- In current super computer system (Hitachi SR16000)
 - All models are calculated in 1-node (theoretical computing performance: 980.48Gflops).
 - MPI isn't applied to development version.

Calculation time (s)

	Japan area (FT=39)	Asia area (FT=72)
Current grid	180 (AMR, max: 1km)	90 (LATLON, 2min)
Un Structure d Crid	400 (max: 1km)	430 (max: 2min)
UII-Structured Grid	1100 (max: 0.5km)	1320 (max: 1min)



Image of new system

• Main part of the two models are going to be unified and managed in common programs.

