High Resolution Weather Forecast of CWB-GFS Nested with NCEP-RSM

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Abstract

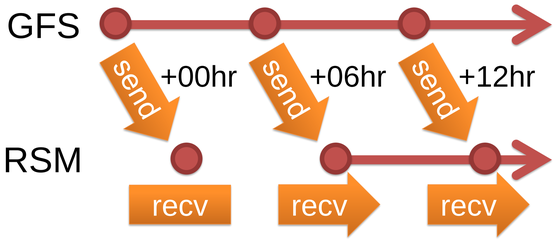
1. CWB-GFS (Central Weather Bureau Global Forecast System) is nested with NCEP-RSM (National Centers for Environmental Prediction Regional Spectral Model) through Multi-Program Multi-Data (MPMD).
2. A case of not-well-predicted recurving typhoon – Talim (2017) – shows that the nested model improves the forecast and can be more efficient via MPMD with proper distribution of computer resources.

Introduction

- Mountainous Taiwan has complicated regional circulation, which is hard to be well predicted by CWB-GFS T511 but crucial for economic loss and disaster prevention.
- To tackle this with limited computer resources, NCEP-RSM was chosen to be nested into CWB-GFS through MPMD structure efficiently.

Nested via MPMD

- The initial and base data from GFS are sent to RSM through MPI point-to-point communication and the efficiency is optimized when the waiting time for data to communicate approaches zero.



Results

- **Efficiency of MPMD** (machine: Fujitsu Fx10 at CWB)
  - GFS: T511 (~25 km), Δt = 90 s
  - RSM: 12 km, (X648, Y384, L42), Δt = 45 s

CPUs (GFS, RSM)	Wall Time (hours)	I/O (GB)
MPMD run	Fcst. 120 hr, OMP=2, 768 CPUs in total	
(192, 192)	7.5	62.7
(256, 128)	3.1	
(288, 96)	2.8	
Sequential run-GFS	Fcst. 120 hr, OMP=4, 768 CPUs in total	
192	2.5	92.0
Sequential run-RSM	Fcst. 120 hr, OMP=2, 768 CPUs in total	
384	0.9	95.7

  - With MPMD, over 17% of time and 60% of I/O are saved.
- **Case: TY Talim (2017)** - initialized at 00 UTC 11 Sep. 2017

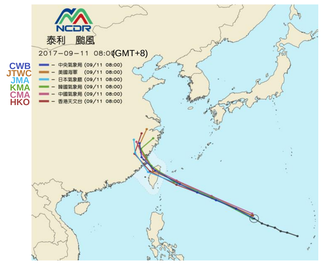


Figure 1: Forecasted tracks of Talim by six operational centers. *Adopted from National Science and Technology Center for Disaster Reduction (NCDR).*

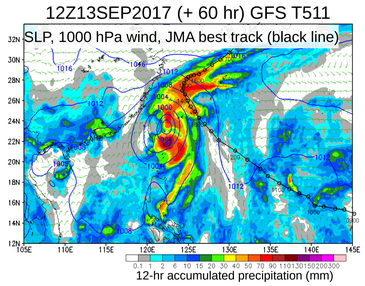


Figure 2: Forecast of GFS T511.

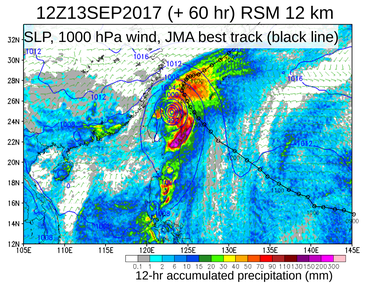


Figure 3: Forecast of RSM 12 km.

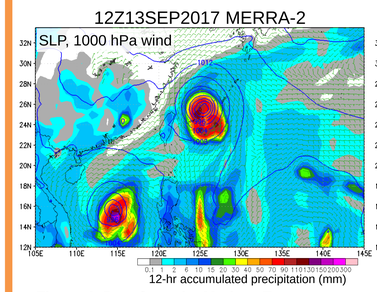


Figure 4: Data from the Modern-Era Retrospective analysis for Research and Applications version 2 (MERRA-2) reanalysis.

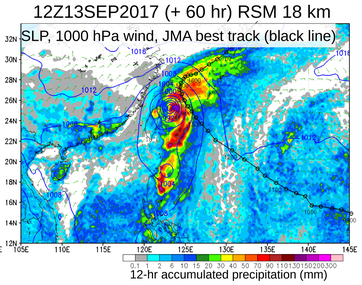


Figure 5: Forecast of RSM 18 km.

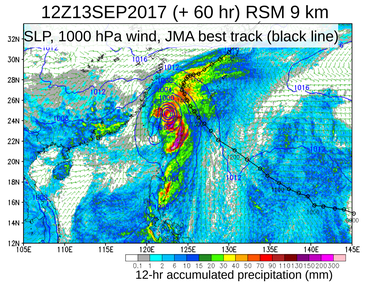


Figure 6: Forecast of RSM 9 km.

Diffusion and Truncation

- The results of the last-50-waves-truncated (not shown) run is similar to the results of the larger-diffusion run.

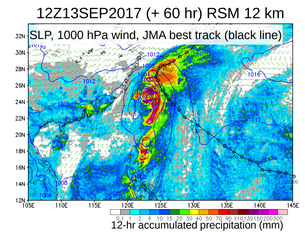


Figure 7: Forecast of RSM 12 km with 1.8 times diffusion coefficients larger than Figure 3.

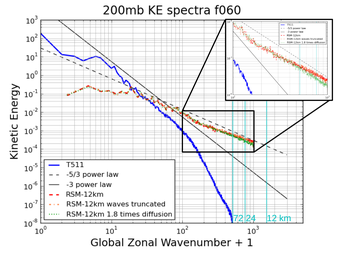


Figure 8: Kinetic Energy Spectrum of GFS T511 and RSM forecasts.

Discussion

1. MPMD improves the efficiency.
2. The nested model forecasts
   - improve the typhoon intensity and track
   - are still dominated by large scale flow of GFS and fail to capture the recurvature.
3. Diffusion and small waves truncation have similar results but a wider wavenumber range is influenced by diffusion.

Future Work

1. use semi-Lagrangian scheme to reduce Gibbs phenomenon
2. make this nested model be unified model (vertical coordinate, physics schemes, …)
3. tune the model to optimize performance

Acknowledgements

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