The Upgrade of GRAPES_TYM in 2015 and Its Performance and Problems

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1. Abstract
The regional typhoon model GRAPES_TYM was upgraded in June 2015. The changes include the two aspects: (1) increasing model vertical and horizontal resolution from 15km/L31 to 12km/L50; (2) Fix one bug in the surface layer program in the calculation of roughness length. The increasing of model resolution could improve the track and intensity forecast especially could reduce the large northward bias of GRAPES_TYM. The fix of the bug in surface layer could reduce the fast spin-up of Ty vortex during 0-12h and strong positive bias for TCs with slower deepening rate. The renn results for 2013-2014 show that the upgrade of GRAPES_TYM could reduce the track (intensity) errors by 8% (17%)/24h, 17% (20%)/48h, 20% (16%)/72h,23%/96h and 33% (23%) /120h. The operational results in 2015 indicate that GRAPES_TYM still has obvious northern bias for TC tracks especially for the TCs during their TD and TS stage; For TC intensity, the upgraded GRAPES_TYM couldn’t produce Super Typhoon (maximum wind speed greater than 51 m/s).

2. The Brief Introduction of GRAPES_TYM

2.1 Evolution of GRAPES_TYM
- 2000: Under development based on GRAPES_Meso model
- 2012: Put into operational running (< 0.15°/L50), forecast length 72h
- 2014: Mean-SAS was applied and improvement of vortex initialization, forecast length 120h
- Model resolution increased from 0.15°/L32 to 0.12°/L50

2.2 Configurations of GRAPES_TYM
- Domain: 40°-105°N, 80°-175°E
- Horizontal resolution: 12km/60L50
- Vertical coordinate: S/terrain-following height vertical layers
- Physical parameterization:
  - RRTM longwave radiation
  - Dudla shortwave radiation
  - WSM6-class graupel microphysics
  - Mass-Simplified Arakawa-Schubert scheme
  - Martin/Shubin surface-layer scheme
  - SLAB thermal diffusion surface physics
  - WRF, PBL, 3-layer shallow convection
- Convective parameterization process
  - 0-0.825 of 8h (8km/day)
  - Convective length: 20km
- Treatment of SST and OIC filed
- NCEP/NCAR initial and forecast filled vortex initialization
- Relaxation: 8h

3. Improvements in 2015

3.1 Increasing of model vertical resolution
- The vertical resolution was increased from 0.15° to 0.12°
- All the TCs in 2013 and 2014 were run using the upgraded version of GRAPES_TYM. The following are the statistical results for the two years:

4. The upgrading of GRAPES_TYM in 2015

GRAPES_TYM was upgraded in 2015 including the above two main improvements, and the horizontal resolution was increased from 0.15° to 0.12°.
- All the TCs in 2013 and 2014 were run using the upgraded version of GRAPES_TYM. The following are the statistical results for the two years:

5. The problems of upgraded GRAPES_TYM

The operational results from 2013 show that the upgraded GRAPES_TYM has the following systematic errors:
- Northward bias of TC tracks
- Negative bias for STV (super typhoon)

6. Summary
GRAPES_TYM was upgraded in 2015 including the following three aspects:
- The vertical resolution was increased from L32 to L50
- The horizontal resolution was increased from 0.15° to 0.12°
- The Bug in WRF was fixed
- The above improvements could reduce the northward bias of TC tracks and the large positive intensity bias.
- The upgraded GRAPES_TYM still has the following system bias:
  - Northward bias of TC tracks especially far from the land in the north
  - The super Typhoon (Vmax greater than 51 m/s) couldn’t be predicted.