The Upgrade of GRAPES_TYM in 2015 and Its Performance and Problems

Suhong Ma , Jin Zhang

National Meteorological Center (NMC), China Meteorological Administration (CMA)

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 north-ward bias of GRAPES_TYM ; The fix of the bug in surface layer could reduce the fast spin-up of Tc vortex during 0-12h and strong positive bias for TCs with slower deepening rate. The rerun 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% (18%)/72h,28% (21%)/96h and 33% (23%）/120h. The operational results in 2015 indicate that GRAPES-TYM still has obvious northward 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 51.0m/s.

2. The Brief Introduction of GRAPES_TYM

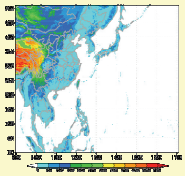
Evolution of GRAPES_TYM

2009:
Under development based on GRAPES_Meso model
2012:
Put into operational running (（0.15° /L32), forecast length 72h
2014:
Meso-SAS was applied and improvement of Vortex initialization, forecast length 120h
2015:
Model resolution increased from 0.15° /L32 to 0.12° /L50

Configurations of GRAPES_TYM

Domain
0°~51°N; 90°~171°E
Horizontal resolution
dx=dy=0.12°
Vertical coordinate
50 Terrain-following height vertical layers
Physics
RRTM longwave radiation
Dudhia shortwave radiation
WSM 6-class graupel microphysics
Meso-Simplified Arakawa-Schubert scheme
Monin-Obukhov surface-layer scheme
SLAB/thermal diffusion surface physics
YSU PBL
Run per day (initial time)
00,06,12.18UTC (4times/day)
Forecast length
120hour
First guess and LBC filed
NCEP GFS initial and forecast filed
Vortex Initialization
Relocation + bogus

Integration domain



3. Improvements in 2015

3.1 Increasing of model vertical resolution

The vertical coordinate is height-based terrain –following coordinate

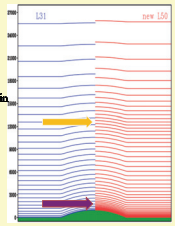
$$z = Z_T \frac{Z - Z_s(x,y)}{Z_T - Z_s(x,y)}$$

Note:

Z_T and Z_s are the height of the Model top and the height of the Terrain.

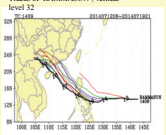
More vertical levels are placed within the boundary layer and around 200hPa.

Distribution of vertical levels

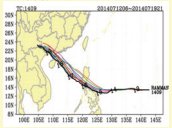


3.1.1 Influences to the tracks of RAMMASUN

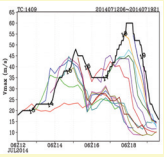
Tracks of RAMMASUN , vertical level 32



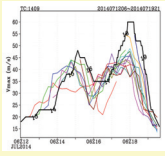
Tracks of RAMMASUN , vertical level 50



Intensity of RAMMASUN , vertical level 32



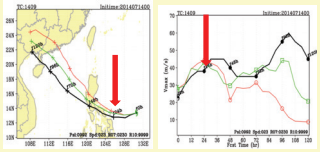
Intensity of RAMMASUN , vertical level 50



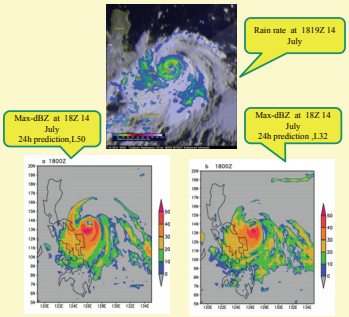
3.1.2 Influences to the structures of RAMMASUN

120h forecast initiated at 00Z 14 July 2014

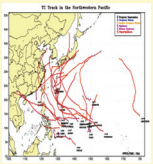
Black: best track; Green: L50; Red:L32



Structures of 24h forecasts ,initiated at 00Z 14 July 2014



3.1.3 Statistical results

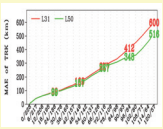


2/day (00Z and 12Z)
120h forecast
23TCs
228 samples

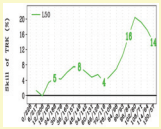
TCs in 2014

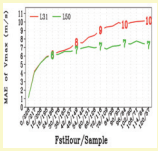
3.1.3 Statistical results

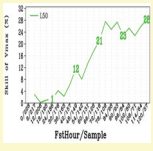
Mean errors of track and intensity



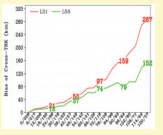
Skill



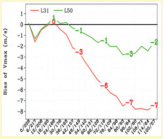




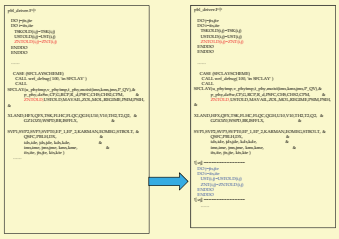
Bias of cross- track



Bias of intensity

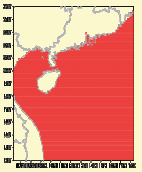


3.2 Fix of the BUG in the PBL

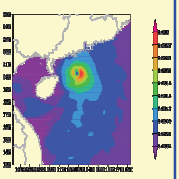


3.2 Fix of the BUG in the PBL

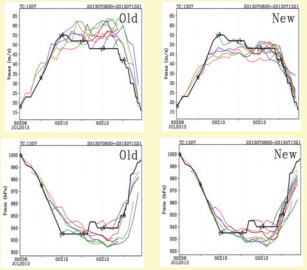
Roughness (ZNT) before BUG fixed



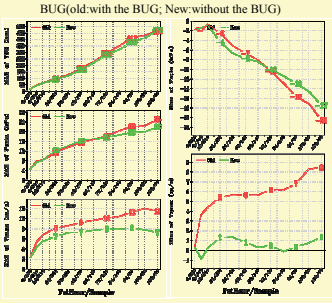
Roughness (ZNT) after BUG fixed



Case study: SOULIK(1307) intensity prediction(colored) and observation (Black)



Statistical results for 2014 TCs with fix of the BUG(old:with the BUG; New:without the BUG)



4. The upgrading of GRAPES_TYM in 2015

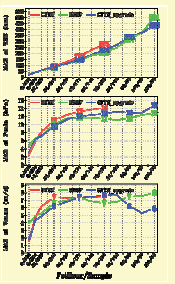
GRAPES_TYM was upgraded in 2015 including the above two main improvements, and the horizontal resolution was increased from 0.15° to 0.12°。

All the TCs in 2013 and 2014 were rerun using the upgraded version of GRAPES_TYM。The following are the statistical results for the two years.

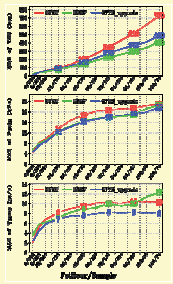
GRAPES_TYM (Operation v.s. Upgrade) performance in 2013 and 2014

verified against STI best

2013



2014

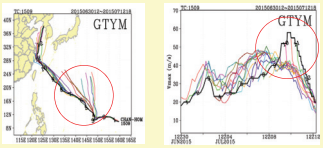


5. The problems of upgraded GRAPES_TYM

The operational results from 2015 show that the upgraded GRAPES_TYM has the following systematic errors:

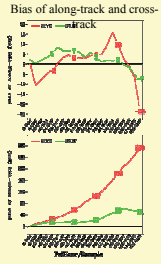
(1) North ward bias of TC tracks
(2) Negative bias for STY (super typhoon)

Typical Case for the north-ward bias of tracks and negative bias for Super intensity stage

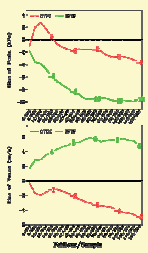


Statistical results for the whole year of 2015

Bias of along-track and cross-track



Bias of Pmin and Vmax



6. Summary

GRAPES_TYM was upgraded in 2015 including the following three aspects:

1) The vertical resolution was increased from L32 to L50
2) The horizontal resolution was increased from 0.15° to 0.12°
3) The BUG in PBL was fixed

The above improvements could reduced the northward bias of TC tracks and the large positive intensity bias.

The upgraded GRAPES_TYM still has the following system bias:

1) North-ward bias of TC tracks especially far from the land in the ocean
2) The super Typhoon (Vmax greater than 51m/s)couldn't be predicted