

Application of the MM5 model in storm track prediction in Vietnam

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Abstract: The MM5 model, a limited-area, nonhydrostatic, terrain-following sigma-coordinate model, version 3, was combined with TC-LAPS bogus module to predict the storm tracks for some test cases of hurricanes effected Vietnam during 2003 tropical storm season. The study cases include Hurricane Koni (07/2003), Hurricane Krovanh (08/2003) and Hurricane Nepartak (11/2003). Comparing with the forecast result from the intact MM5 model which uses no TC-bogus or MM5-TC bogus, the forecast result shows that storm track errors are remarkably decreases when MM5 is combined with TC-LAPS bogus module in all prediction periods, from 12 to 72 hours.

1. INTRODUCTION

Institute of Meteorology and Hydrology, Vietnam has recently improved the MM5 model for Vietnam conditions. There are many researches and work are carried out such as dynamic and physic structure of the MM5 model, four-dimensional data-assimilation capability, physics parameterization, nonhydrostatic dynamics, multiple-nest technology. Many net-grid domains and resolutions are first selected and tested find the most suitable domain and resolution. The various physic options are also tested to find the best options for Vietnam region conditions. The MM5 model is then run for several test cases for hurricanes in 2003 storm season with three different options of TC-bogus schemes including no-bogus scheme, MM5 bogus scheme (Low-Nam, S., and C. Davis, 2001), and TC-LAPS bogus scheme.

Some results from application of MM5 model with the **TC-LAPS TC-bogus** module for **Typhoon** forecasting in 2003 are shown and discussed in the next section of this report. The results show that the combination model is suggested to apply for purposes of Typhoon research and forecast in Vietnam.

2. METHODOLOGY

a. Atmospheric model

The numerical model used in this study is the Penn State/NCAR non-hydrostatic model MM5 (Grell et al. 1994) Version 3.6. That is a three-dimensional, limited-area, primitive-equation, nested-grid model with a terrain following sigma vertical coordinate. Physics Library is used for the parameterization of physical processes as: The Burk-Thompson is used in the boundary layer parameterizations Thompson (1989); Convective parameterization was handled by the Gell scheme (See Grell et al., 1994); Stratiform condensation (cloud microphysical) schemes are given by Reisner et al. (1998)... The initial condition is provided by the analysis field of the National Center for Environmental-USA.

b. Synthetic storm vortex

Normally, a tropical cyclone analyzed in the NCEP global analysis tends to be too large and too weak because of the limitation in the horizontal resolution. In contrast, the fine mesh of the Meso model is capable of representing tropical cyclone vortices more realistically. To solve this problem, a synthetic TC vortex (bogus) is inserted into those fields at initial time. The vortex construction follows Davidson et al. (1993), Davidson and Weber et al. (2000). The vortex is constructed using key observational data from the Japan Meteorological Agency best track and operational forecast advisory archives. Control parameters for the vortex include: (a) the minimum central sea level pressure, (b) The current location of the storm and its position 6 and 12 h earlier, and (c) the radius of the outermost closed isobar that is assumed to coincide approximately with the radius of gale-force winds- used to define the size of the storm.

3. CASE STUDY RESULTS

a. Hurricane Koni

Koni formed as a tropical depression (TD) north of the Palau Islands at 00UTC 15 July 2003. It moved to the west and changed the direction to the west-northwest around 06UTC 16 July. It reached the southeastern edge of Samar Island around 00UTC 17 July and crossed the middle of Philippines at TD intensity on that day. Shortly after it entered South China Sea, it became a tropical storm (TS) north of Palawan Island at 06UTC 18 July. It changed its direction to the northwest around 18UTC 18 July and upgraded into a severe tropical storm (STS) over the middle of South China Sea at 00UTC 20 July. After it changed the direction to the west-northwest around 12UTC 20 July, it reached its peak intensity with a maximum sustained wind of 60kt southeast of Hainan Island at 18UTC on that day. With gradual weakening, it reached the southeastern coast of Hainan Island around 12UTC 21 July. It downgraded into TS over Hainan Island at 18UTC 21 July and entered Gulf of Tongking. After it landed on the coast of northern Vietnam around 08UTC 22 July, it downgraded into TD over the northern Laos at 18UTC on that day. It dissipated over the same region at 00UTC 23 July. Figure 3.1 shows the best track and forecast of Koni at forecast different dates 00UTC 18, 19, and 20 July, 2003.

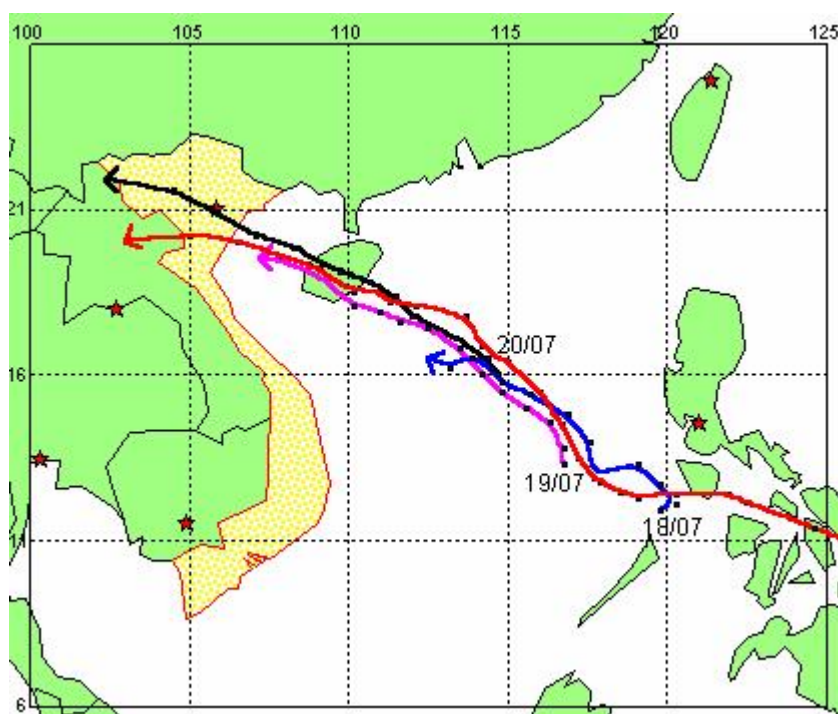


Fig 3.1 The best track and forecast of Koni at 00UTC 18, 19, and 20 July, 2003

Table 3.1 Mean 12-72 h forecast tracks errors of Koni by different cases

Model	Forecast Period (h)					
	12	24	36	48	60	72
NOBG	125.55	98.66	140.15	162.11	144.63	141.9
MM5BG	52.55	126.64	139.88	138.71	212.48	235.04
MM5-TCLAPBG	88.32	72.77	84.69	83.53	116	173.95

b. Hurricane Krovanh

Krovanh formed as a tropical depression (TD) west of Pompei Island at 18UTC 13 August 2003. It moved west-northwestwards and changed the direction to the northwest over the sea south of Guam

around 18UTC 16 August. Keeping TD intensity, it changed the direction to the west-southwest over the sea west-southwest of Okinotorishima at 12UTC 19 August. It became a tropical storm (TS) far south of Minamidaiojima at 12UTC 20 August and developed into a severe tropical storm (STS) northeast of Luzon Island at 06UTC on the following day. It developed into a typhoon and reached its peak intensity with a maximum sustained wind of 65kt east of Luzon Island at 00UTC 22 August, then it crossed the Island on that day. After it temporarily weakened to TS over the western coast of Luzon Island at 18UTC 22, it developed into a STS west of the Island at 00UTC on the following day and gradually changed the direction to the west-northwest. It developed into a typhoon and reached the second peak intensity with a maximum sustained wind of 65kt over South China Sea at 18UTC 24 August. After it passed Leizhou Banda around 00UTC 25 August, it landed on the northern coast of Vietnam at STS intensity around 12UTC on that day. It downgraded into a TS at 00 UTC 26 August and further downgraded into a TD over the northern part of Vietnam at 06UTC on that day. It dissipated over the northern part of Vietnam at 18UTC 26 August. Figure 3.2 shows the best track and forecast of Krovanh at forecast different dates 00UTC 21, 22, and 23 August, 2003.

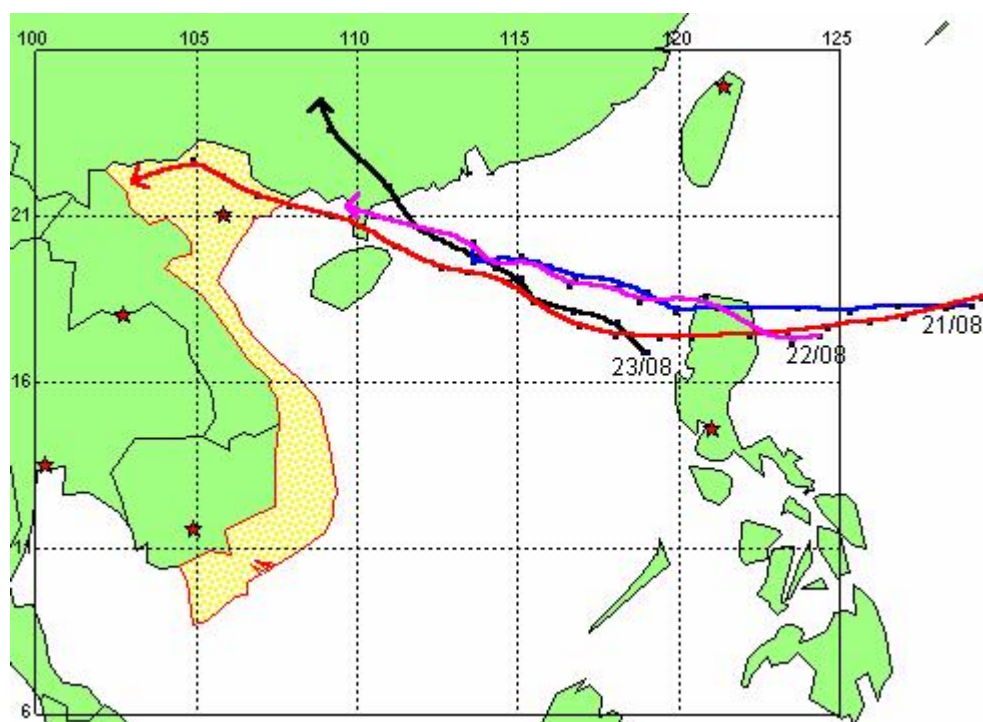


Fig 3.2 The best track and forecast of **Krovanh** at 00UTC 21, 22, and 23 August, 2003

Table 3.2 Mean 12-72 h forecast tracks errors of Krovanh and compared with different cases (Km)

Model	Forecast Period (h)					
	12	24	36	48	60	72
NOBG	115.7	178.94	130.93	205.46	225.56	290.8
MM5BG	113.57	175.37	197.96	221.5	215.27	239.75
MM5-TCLAPBG	74	122.74	133.04	130.33	194.05	215.68

c. *Hurricane Nepartak*

Nepartak formed as a tropical depression (TD) over the sea northeast of Yap Island at 18UTC 11 November 2003. After moving toward west for about a day, it developed into a tropical storm (TS) over the sea east of the Philippines at 18UTC 12 November. Developing slowly, it moved toward west and made landfall on the Philippines at around 16UTC 13 November. After it crossed over the Philippines, it turned gradually to west-northwest and reached Typhoon intensity and its peak intensity with a maximum

sustained wind of 65kt over the sea southeast of Hainan Island at 18UTC 16 November. It turned gradually to the north and went into Gulf of Tongking and weakened into a tropical depression at 06UTC 19 November. The tropical depression dissipated over the Gulf of Tongking at 18UTC 19 November. Figure 3.3 shows the best track and forecast of Nepartak at forecast different dates 00UTC 14, 15, 16, and 17 November, 2003.

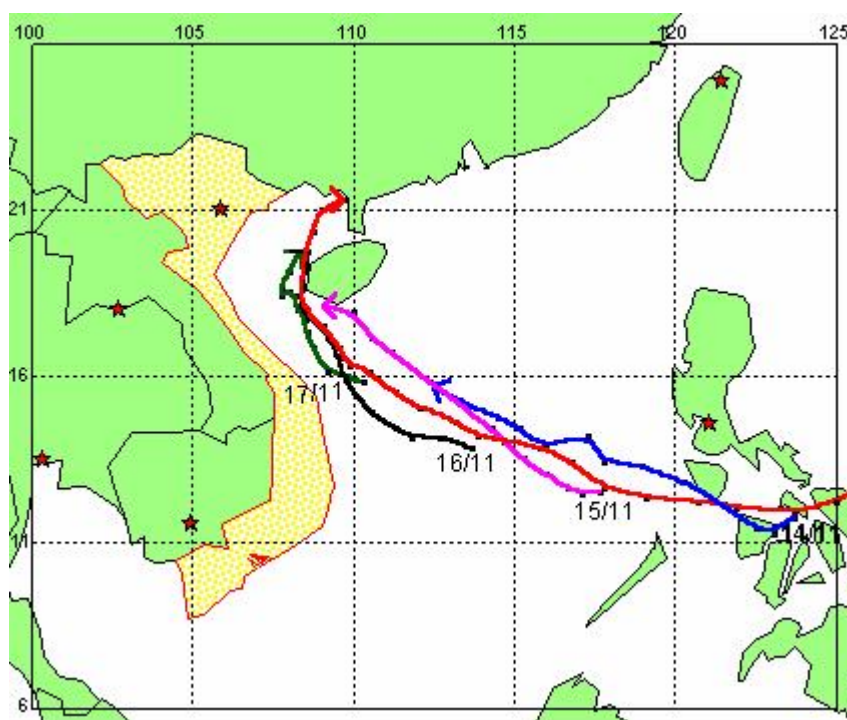


Fig 3.3 The best track and forecast of **Nepartak** 00UTC on 14, 15, 16, and 17 November, 2003

Table 3.3 Mean 12-72 h forecast tracks errors of Nepartak by different cases

Model	Forecast Period (h)					
	12	24	36	48	60	72
NOBG	179.42	124.81	215.4	236.49	355.13	454.81
MM5BG	121.06	167.32	220.1	307.08	377.19	444.27
MM5-TCLAPBG	142.93	152.12	177.64	187.19	217.54	143.23

4. Summary and conclusion

The initialization scheme of TC_LAPS was inserted into MM5 model. Comparing with the forecast result from the intact MM5 model which uses no TC-bogus (NOBG) or MM5-TC bogus (MM5BG) (see in table 3.1÷table 3.3), the forecast result shows that storm track errors are remarkably decreases when MM5 is combined with TC-LAPS bogus module in all prediction periods, from 12 to 72 hours. Especially, with the hurricane that has complex track as hurricane Nepartack, both the MM5BG method and NOBG did not perfect this hurricane. But when the MM5-TCLAPBG method is used, then the forecast error deceases very much. However, to having exactly conclusion about advantage of the MM5-TCLAP method, we need to have many experiments. The above result is only firstly research in improve typhoon forecast ability by numerical model in Vietnam.

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