IMPROVEMENT OF TYPHOON WRF (TWRF) MODEL FOR TYPHOON PREDICTION AT TAIWAN

Der-Song Chen[1] Ling-Feng Hsiao[2] Tien-Chiang Yeh[1] Yong-Run Guo[3]
Kang-Ning Huang[1] Chin-Tzu Fong[1] Jing-Shan Hong[1] Ying-Hwa Kuo[3]

[1]Central Weather Bureau
[2] Taiwan Typhoon and Flood Research Institute
[3]National Center for Atmospheric Research

[*]corresponding author: song@rdc.cwb.gov.tw

Typhoons caused the most serious weather related disaster at Taiwan. The associated rainfall of typhoons is also one of the most important water resources in Taiwan. The numerical prediction models provide necessary guidance on typhoon track forecast. However, for a numerical model to predict accurate rainfall and wind field are still a highly challenging task. In addition, the two major factors that lead to challenge on typhoon forecasting in the vicinity of Taiwan are resulted from the lack of observational data over the Northwest Pacific Ocean and the significant interaction between typhoon circulation and Taiwan Central Mountain Range. Accurate initial state with accurate representation of interactions that occur throughout the troposphere on a variety of scales for a regional model on accurate modeling of typhoon motion is the key element for its success. In order to provide subjective guidance for the forecast team in the Central Weather Bureau (CWB) on typhoon track and precipitation, the numerical typhoon model is needed for more accurate typhoon predictions

More recently, the community model such as Weather Research and Forecasting (WRF) modeling system is widely applied to tropical cyclone forecast. A version of WRF model, called TWRF (Typhoon WRF) in the Central Weather Bureau, was developed from 2010. The TWRF model uses a terrain-following, hydrostatic-pressure vertical coordinate with the model top being a constant pressure surface. The configuration is based on version 3.1.1 in 45/15/5 km grid spacing. There are 45 vertical levels with higher resolution assigned in the planetary boundary layer. The model physics employed includes the Goddard microphysics scheme (Tao et al. 2003), the Kain-Fritsch cumulus parameterization scheme (Kain and Fritsch 1990), and Yonsei University (YSU) planetary boundary layer scheme (Hong et al. 2006). More detailed descriptions of the WRF model can be obtained from Skamarock et al. (2008). The TWRF system also including the typhoon relocation and bogus initialization scheme (Hsiao et al. 2010), partial cycling approach, outer loops in WRF 3DVAR system are used to examine the ability on the typhoon prediction. The ultimate aim is the construction of real-time forecasting of typhoon track and structure prior to and affecting Taiwan, to improve the typhoon warnings and provide local officials with the comprehensive information in the hardest hit areas as soon as possible. The detail performance of TWRF during 2010 typhoon season and the improvement strategies in the near future will be discussed in this paper.

There are two typhoons Fanapi and Megi hit Taiwan in 2010, the forecast tracks of TWRF for these two typhoons are shown in fig.1 and the 24/48/72 hours average track forecast errors are 96/185/254 km respectively. Although TWRF had indicated satisfied track prediction skill, but there are still some forecast bias like 1.) too active cyclone genesis, 2.) warm anomaly under 500hPa had found in TWRF. The default Kain-Fritsch trigger has undesirable characteristics especially in weakly-forced situations as those found in the tropics. Ma and Tan (2009) proposed a new Kain-Fritsch trigger scheme to enhance the character of precipitation and intensity of tropical cyclones. We had tried this new Kain-Fritsch trigger scheme in the TWRF. Figure 2 are the forecast results of Fanapi, Megi and the 24/48/72 hr averaged track forecast errors are 88/144/197 km, respectively. Overall, not only the track forecast skill but also the bias that mentioned above had been improved. The detailed will be present in the conference.

References

Hong, S.-Y., and Y. Noh, and J. Dudhia, 2006: A new vertical diffusion package with an explicit treatment of entrainment processes. *Mon. Wea. Rev.*, **134**, 2318–2341.

Hsiao, L. F., C.-S. Liou, T.-C. Yeh, Y.-R. Guo, D.-S. Chen, K.-N. Huang, C.-T. Terng, J.-H. Chen, 2010: A vortex relocation scheme for tropical cyclone initialization in advanced research WRF. *Mea. Wea. Rev.*, **138**, 3298–3315.

Kain, J. S., and J. M. Fritsch, 1990: A one-dimensional entraining/detraining plume model and its application in convective parameterization. *J. Atmos. Sci.*, **47**, 2784–2802.

Ma, L. M. and Z. M. Tan, 2009: Improving the behavior of the cumulus parameterization for tropical cyclone prediction: Convection trigger. *Atmos. Res.*, **92**, 190-211.

Skamarock, W. C., J. B. Klemp, J. Dudhia, D. O. Gill, D. M. Barker, M. G. Duda, X.-Y. Huang, W. Wang, and J. G. Powers, 2008: A description of the Advanced Research WRF version 3. NCAR Tech. Note TN-475ı STR, 113 pp.

Tao, W.-K., J. Simpson, D. Baker, S. Braun, M.-D. Chou, B. Ferrier, D. Johnson, A. Khain, S. Lang, B. Lynn, C.-L. Shie, D. Starr, C.-H. Sui, Y. Wang, and P. Wetzel, 2003: Microphysics, radiation and surface processes in the Goddard Cumulus Ensemble (GCE) model. *Meteor. Atmos. Phys.*, **82**, 97–137.

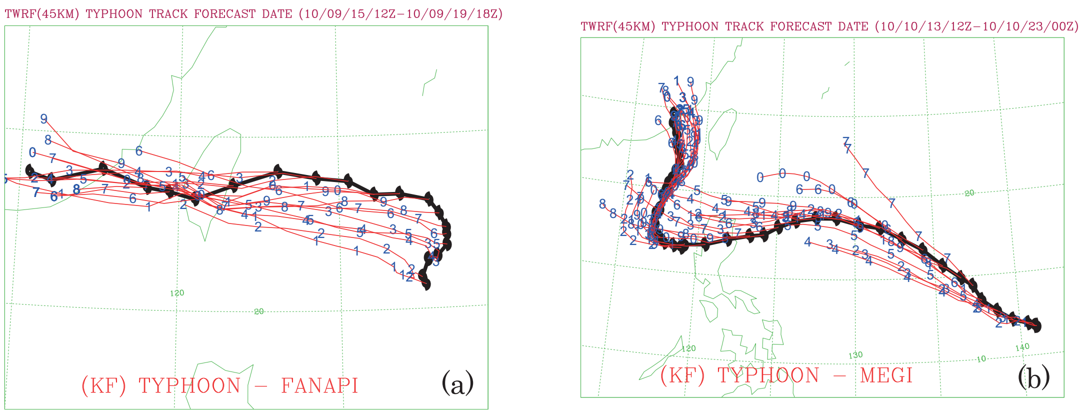

Fig. 1 The forecast tracks of TWRF for typhoon FANAPI (a) and MEGI (b).

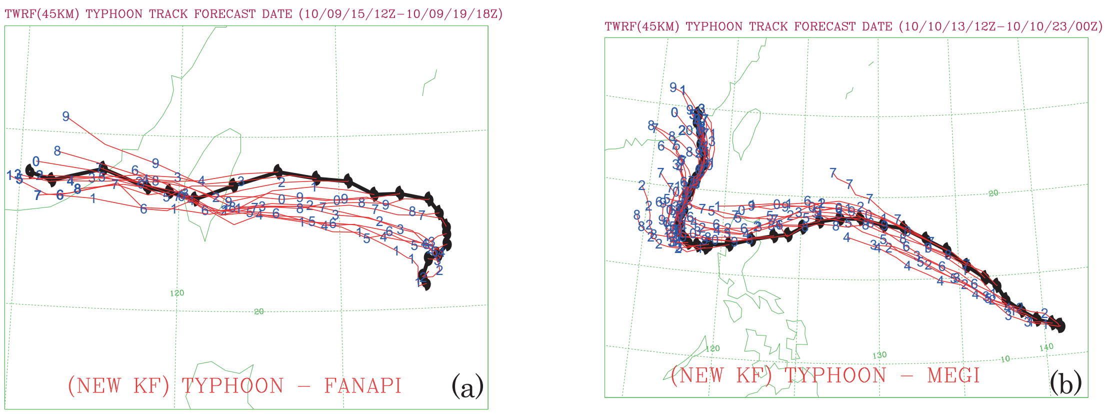

Fig. 2 The forecast tracks of TWRF with the new trigger Kain-Fritsch for typhoon FANAPI (a) and MEGI (b).