PERFORMANCE OF THE TYPHOON FORECAST SYSTEM IN TAIWAN IN 1998

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Abstract

The Typhoon Forecast System (TFS) developed in the Central Weather Bureau in Taiwan is a limited-area forecast system dedicated for the prediction of tropical cyclones in the western Pacific. Since the starting of the operation run in 1994, the TFS has provided useful guidance to the forecasters on duty. Continuous effort has been made to improve the performance of the system and the yearly averaged 48h forecast distance error of TFS is reduced from 421km in 1994 to 264km in 1997. Recent improvements of the system, including insertion of the beta-gyre, bogussing of multiple cyclones and extension of the forecast range to 72h, will be reported.

Keywords : beta-gyre, bogussing

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1. INTRODUCTION

Located just to the southwestern edge of the Pacific subtropical high-pressure system, Taiwan is threaten by on the average 3 to 4 typhoons each year. Typhoons bring much needed rainfall to the island during the summer season, but cause great amount of damage. Accurate forecast of typhoon to mitigate the damage is one of the most challenging tasks at the Central Weather Bureau(CWB) of Taiwan. The first 3D dynamic typhoon track forecast model TFS was installed in 1989(Peng et al. 1993, 1995). This report describes recent performance made by the forecast system.

2. THE FORECAST SYSTEM

The TFS is based on a multivariate optimal interpolation(MVOI) assimilation system and a hydrostatic limited-area primitive equation model that is only exercised when tropical storms initiate or move in the vicinity of the island. The initial guesses during cold-starts and the boundary conditions are provided from the CWB's operational global forecast system(GFS).

The horizontal resolution of the TFS is 45km with 20 σ-levels in the vertical. Parameterized physics include the modified Kuo convection scheme, grid scale condensation, the TKE-ε planetary boundary layer, similarity surface layer. And the Harshvardhan's short-wave and long-wave radiation.

Due to the lack of conventional observations over the ocean, it is necessary for the TFS to have a somewhat elaborated initialization of typhoons or tropical storm to allow a better representation of the inner core structure. The special initialization procedure includes a filtering of the initial guess field around the storms(Kurihara et al. 1995), a placement of Rankine vortex of the proper size and strength, and the addition of a beta gyre as generated by a barotropic model. These steps are followed by the MVOI assimilation.

3. SYSTEM PERFORMANCE

The yearly average TFS position errors from 1994 to 1997 are depicted in Fig 1.

There is a continue improvement of skill as a result of modifications and upgrades as described in Chen et al.(1997). There is no doubt that annual climate variations could contribute to the system performance as measure by mean position errors. In fact, the trend of improvement is broken in the 1998 typhoon season. For the 9 typhoons that TFS had predicted so far this year, the average 48-h forecast position error is as large as 429km. Accordingly, very large 48-h position errors of CWB's equivalent barotropic model at 688 km and the CLIPER at 602 km are also noted.

The 1998 season is by no means average. Many tropical cyclones are weak with their steering flow are difficult to determine. For example, typhoon Rex had a very oscillatory track(Fig. 2) that TFS failed to capture, as did other numerical guidance.

Most of the time, Rex located in the saddle position between two mid-latitude high-pressure systems. In post analysis, it appears that the north-south movement of Rex was associated with the strengthening and weakening of the Pacific subtropical high and a dry line extending back and forth from west to east into the trough north of the storm center. Both the TFS and GFS failed to forecast accurately such change on the synoptic scale. The movement of typhoon Todd also seemed to have been affected by the build-up of the Pacific subtropical high as it veered toward west from a typical clockwise track as the high-pressure system strengthened(Fig. 3).

Post season rerunning of these cases will be performed to determine the exact impact of the variability of the subtropical high. These tests will also help to diagnose the steering level and whether the vertical structure of the model allowed a proper interaction of the storm and the steering flow.

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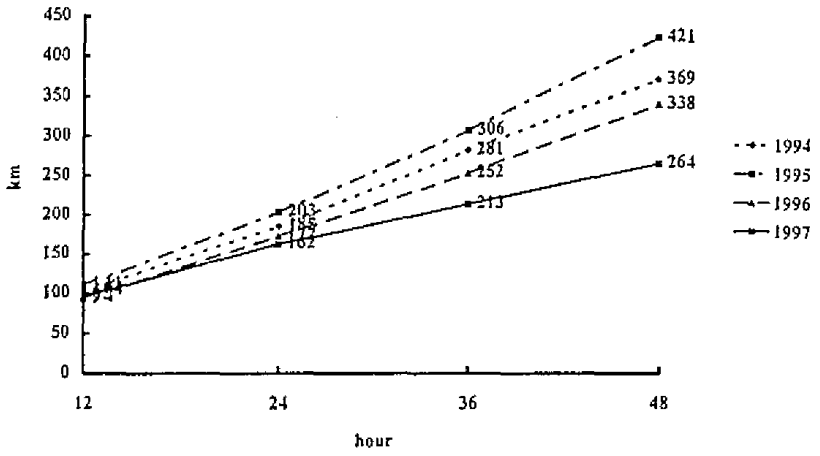

Figure 1. Yearly average of the forecast distance errors of TFS from 1994 to 1997

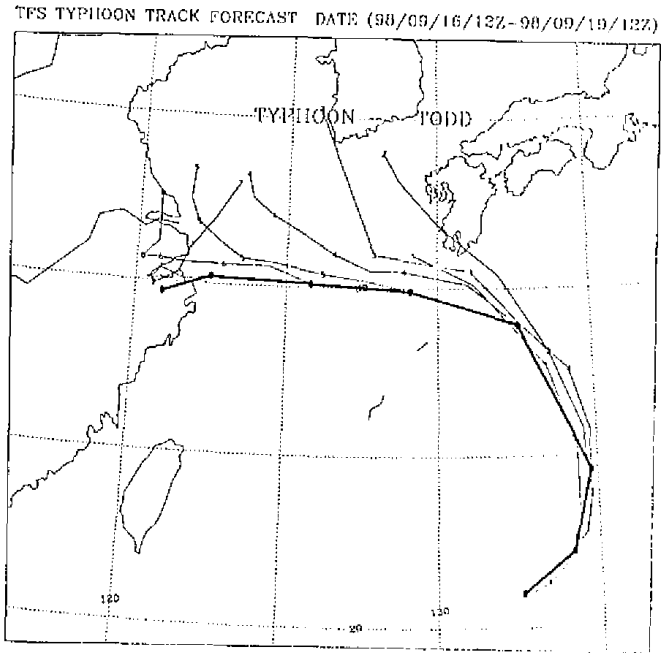

Figure 3. As in Fig.2 except it is for typhoon Todd.

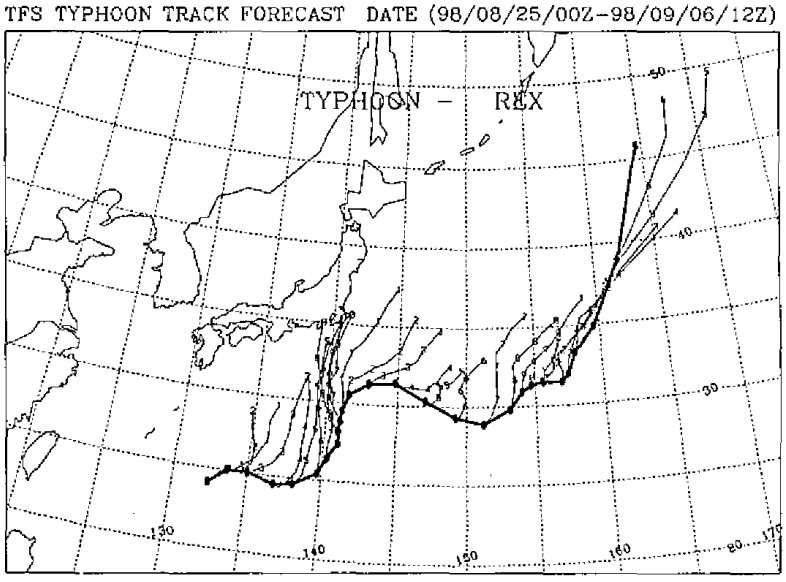

Figure 2. Best track and forecast tracks from TFS for typhoon Rex in1998.