6C.2 THE PRELIMINARY ANALYSIS OF THE DROPSONDE DATA FROM DOTSTAR AND THEIR IMPACT ON THE TYPHOON TRACK FORECASTS

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1. INTRODUCTION

Tropical cyclones (TC) generally develop in data-sparse oceanic regions. Few observations are available for depicting initial conditions of TC models, and this negatively affects the accuracy of track forecasts. In 1982, the Hurricane Research Division (HRD) began to investigate possible improvements on numerical tropical cyclone track forecasts with the assimilation of dropwindsonde observations taken in the data-sparse TC environment. The observations helped the National Centers for Environmental Prediction (NCEP) and the Geophysical Fluid Dynamics Laboratory (GFDL) hurricane model to reduce track forecast errors significantly (Burpee et al. 1996). The follow-up dropsonde data obtained from the Gulfstream-IV aircraft surveillance also shows significant impact on the hurricane track prediction (Aberson and Franklin 1999; Aberson 2003).

Considering the potential of dropwindsonde data in improving typhoon forecasts, a research project, Dropsonde Observations for Typhoon Surveillance near the Taiwan Region (DOTSTAR; Wu et al. 2004), is supported by National Science Council (NSC) of Taiwan, with strong collaboration with HRD. Typhoon surveillance missions with the Astra aircraft are conducted to improve the numerical guidance for typhoons near Taiwan during the typhoon seasons of 2003 - 2005. The GPS (Global Positioning System) dropwindsondes have been released to obtain the pressure, wind, temperature, and humidity in the environment of typhoons. The observations are ingested into the global models of the Central Weather Bureau (CWB), NCEP, and FNMOC in real time.

In this paper, the preliminary analysis on the dropsonde data and their impact on the track prediction are presented.

2. RESULTS

2.1 Distributions of the dropsondes

One mission each has been conducted for Typhoons Dujuan (Sep. 1) and Melor (Nov. 2) during the 2003 typhoon season. The observation locations and winds at 850 hPa are shown in Fig. 1. Note that a rather symmetric flight track was flown around the periphery of Dujuan, unlike in Melor, where the aircraft passed over the center of the typhoon.

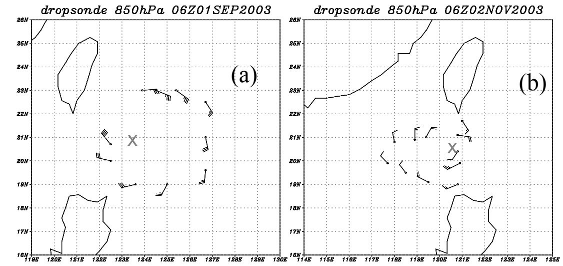

Fig. 1. The 850 hPa winds for (a) Typhoon Dujuan and (b) Typhoon Melor

2.2 Structure of the soundings

Detailed structure of Melor can be depicted along the leg when the aircraft flew directly over the center. Note that the apparent warm core exists in the center (Fig. 2), with the temperature higher than that of the surroundings by about 2~3 degrees. The axis of the maximum wind speed tilts outward with height, with the maximum wind speed of 24 m s^{-1} at 900-hPa near the 6^{th} dropsonde.

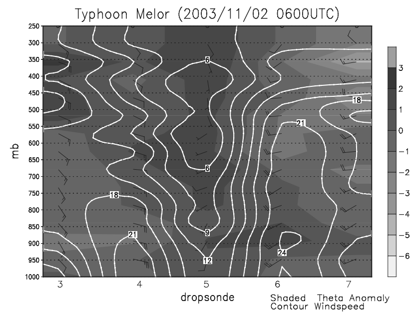

Fig. 2. The vertical profile from drop 3 to drop 7 of Typhoon Melor. The contour indicates wind speeds (m s^{-1}) and shading indicates potential temperature anomaly.

2.3 Impact of dropwindsonde data on global analysis of CWB

Due to the lack of observations around the TC, the TC structure is generally not well represented in the global analysis. In both cases of Dujuan and

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Melor, the cyclonic winds from middle to high levels are much stronger when the dropsonde are assimilated (Fig. 3). In particular, the closed circulation at higher levels associated with Dujuan is not analyzed by CWB's Global Forecasting System (GFS) (Fig.3b). After assimilating the dropsonde winds, the wind directions and wind speeds are improved distinctly (Fig. 3a).

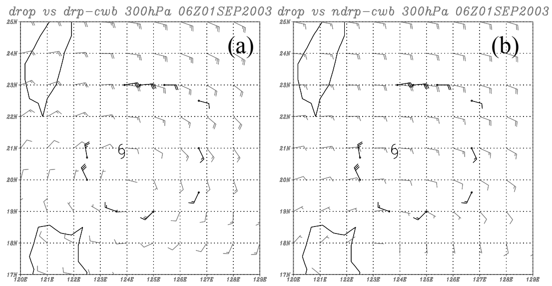

Fig.3. The initial 300-hPa wind fields of CWB's GFS (a) with assimilating dropwindsonde data and (b) without assimilating dropwindsonde data.

Figure 4a (4b) shows the differences in the initial deep-layer-mean winds of NCEP's GFS (FNMOC's NOGAPS) between the analyses with and without assimilating the dropsonde data. The regions with the largest differences are collocated well with the locations of the dropwindsondes, with the maximum value of about 3 m s^{-1} for NCEP GFS and 7 m s^{-1} for NOGAPS.

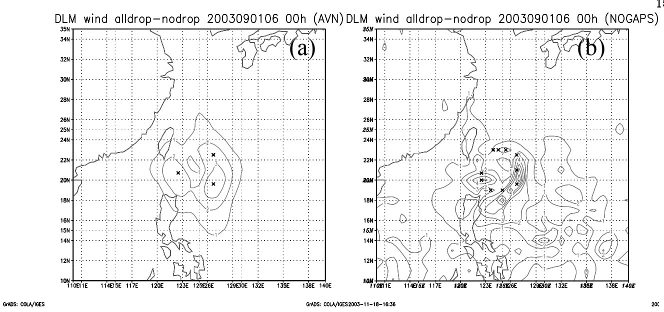

Fig.4. The differences in the model initial condition deep-layer-mean winds of (a) NCEP GFS and (b) NOGAPS.

2.4 Impact of dropwindsondes on typhoon track forecasts

Preliminary results from the comparison of the model runs of Dujuan with and without the dropwindsonde data show that GFS are improved between 32% to 81% between 6 and 30 h, and the average improvement from 6 to 48 h is 35% (Fig.5a). Note that due to some technical problems, only three dropsondes out of the 11 released dropsondes were assimilated into NCEP GFS in real time. Results from the re-run with all the dropsonde data will be shown in the conference.

The track forecasts for Typhoon Melor shows one the greatest challenges for numerical models in the typhoon season of 2003. For this case both NCEP GFS and the GFDL hurricane model forecasts show negative impact on the runs with the dropwindsonde data (Fig. 5b). Significant degradations are seen from 6 to 36 h to both NCEP GFS and GFDL hurricane model forecasts. This is in agreement with Aberson (2003), where he showed that the sampling of the entire target feature is needed to improve the forecasts, otherwise a degradation is probable. Work is still undergoing to make further evaluations on how these dropwindsonde data make such impact in the models.

The initial results of DOTSTAR show a golden opportunity for improving the track prediction of typhoons in the western North-Pacific (near Taiwan). More dropwindsondes will be released into the periphery of typhoons near Taiwan during the typhoon seasons of 2004 and 2005. As the number of observations increases, we expect to see a more statistically significant evaluation of the impact of these dropwindsondes on TC track predictions.

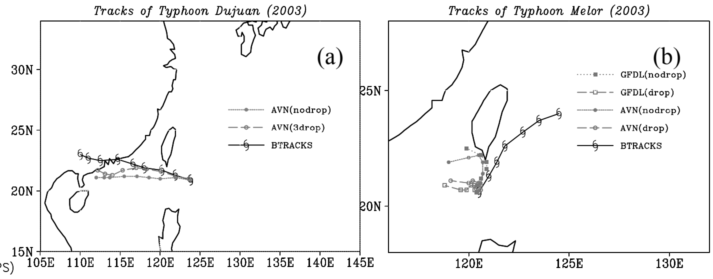

Fig.5. The best track and forecast tracks of (a) Typhoon Dujuan and (b) Typhoon Melor

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