11A.6 EVALUATION OF CAUSES OF LARGE 96-H AND 120-H TRACK ERRORS IN THE WESTERN NORTH PACIFIC

Kathryn A. Payne, Ryan M. Kehoe, Mark A. Boothe, and Russell L. Elsberry
Naval Postgraduate School, Monterey California

1. INTRODUCTION

Since the Joint Typhoon Warning Center (JTWC) began official 120-h forecasts in 2002, average track errors at five days have plateaued at approximately 300 n mi (Table 1). Previous experience at JTWC has demonstrated that consensus track forecasting works best when four or more skillful dynamical models tracks are available. Whereas JTWC has ten track forecasts to 72 h, at longer intervals only four dynamical track forecasts are available to form a consensus track (CONU): United Kingdom Met Office (UKMO), NCEP Global Forecast System (GFS), Navy Operational Global Atmospheric Prediction System (NOGAPS), and U.S. Navy version of the Geophysical Fluid Dynamics Laboratory Model (GFDN.) Kehoe (2005) showed that JTWC track errors at 120 h during 2004 were highly correlated with CONU errors. If CONU includes one or more erroneous tracks, the 96-h and 120-h forecasts can be seriously degraded.

Table 1. Average track errors (n mi) of JTWC forecasts. Data were obtained from the JTWC error statistics on their website and from Jeffries and Fukada (2002.)

JTWC FORECAST ERRORS (n mi) BY YEAR			
Year	72 h	96 h	120 h
2000	208	231	325
2001	180	289	419
2002	162	225	280
2003	186	242	304
2004	173	218	296
2005	159	234	311

The percentages of 120-h track forecasts with large errors (>500 n mi.) during the 2005 western North Pacific season were: GFS, 23%; UKMO, 18%; NOGAPS, 24%; and GFDN, 31%. Proper identification and removal of a track forecast displaying an error mechanism could form a selective consensus that will be more accurate than the (non-selective) consensus, CONU. Kehoe (2005) previously examined large NOGAPS and GFDN tropical cyclone track forecast errors in the western North Pacific for the 2004 typhoon season. Error mechanisms are described by conceptual models (Carr and Elsberry 2000 a, b) that are related to known tropical cyclone motion processes being misrepresented in the dynamical fields.

In this research, large track errors during the 2005 typhoon season by NOGAPS, GFDN, UKMO, and GFS are examined. Characteristics and symptoms of the erroneous forecasts tracks and models fields are documented and illustrative case studies are presented. For this preprint, only the large NOGAPS and GFDN track errors will be discussed, and for the GFDN only the 0600 UTC and 1800 UTC forecast fields are available for error mechanism analysis. By the time of the conference, the GFDN 00 UTC and 12 UTC, UKMO, and GFS track errors will be analyzed.

2. PRELIMINARY RESULTS

A homogenous comparison of average 120-h forecast errors for the 2005 western North Pacific season is given in Fig. 1. The usefulness of consensus track forecasting is evident at 72 h. Whereas the four dynamical models that are also used for longer forecasts have 72-h errors on the order of 175-200 n mi, when these four model tracks are combined with six other models, the CONU 72-h error during 2005 was about 125 n mi (Fig. 1). Since the JTWC errors are essentially the same as for CONU, the JTWC has surpassed the long-standing 150 n mi goal at 72 h.

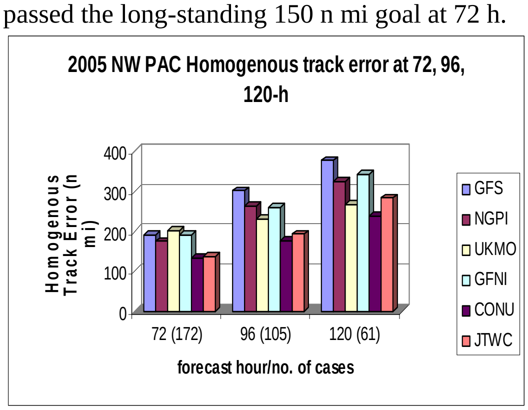

Fig. 1. Homogenous track error comparison for 2005 season for the various models, the consensus (CONU), and JTWC (calculated from JTWC aids and best-track files).

Notice that the 96-h and 120-h track errors increase significantly, and the variability among the four model tracks also increases, relative to the 72-h track errors. Whereas the GFS (UKMO) model had the superior (poorer) performance at 96 h and 120 h during 2004 (not shown), the GFS (UKMO) had the poorest (superior) performance during 2005. Another conclusion to be drawn from Fig. 1 is that the JTWC did not improve upon the CONU at 96 h and 120 h during 2005. For these reasons, it is desirable to study the sources of these track errors by the various models and to give guidance to the JTWC forecaster as when to use or not use the model track.

In this retrospective study, all cases of large track errors are examined. Following the procedures established by Carr and Elsberry (2000 a,b) and Kehoe (2005), conceptual models of the sources of large errors are matched to each case. The Post-analysis Function of the Systematic Approach to Forecasting Aid (SAFA) is used to display the model tracks and fields, knowing which model(s) has (have) a large error. It is a separate question whether the forecasters can detect these errors in real time. That is why the guidance in SAFA is to only form a selective consensus when the forecaster is confident that the track is erroneous.

a. GFDN

In a preponderance of cases with a large error at 96 h or 120 h, an excessive (E) midlatitude anticyclogenesis (E-MAG) mechanism took place in which the GFDN built a false anticyclone at 700 mb in central China to the east of the Tibetan plateau. As time progressed, the anticyclone extended over the Korean Peninsula and toward the northern Sea of Japan. As the false Tibetan anticyclone built, it additionally propagated energy along a wave train with a low to the northeast, and a perturbation on the Pacific subtropical anticyclone (PSA) that shifted it to the east. While the false anticyclone was not always evident at 500 mb, the 500 mb PSA was also shifted to the east.

While E-MAG was assigned as the primary error mechanism in 17 cases, the false Tibetan anticyclone led to large track errors in four ways: (i) false steering of the TC on the southeastern periphery of the false anticyclone (E-MAG, six cases), (ii) false steering of the TC caused by a merger of the false anticyclone and the PSA (E-MAG, seven cases), (iii) insufficient development the short wave trough that actually affected the TC (insufficient (I) midlatitude cyclogenesis (I-MCG, one case)), and (iv) incorrect steering of the TC due to the false eastward displacement of the PSA (insufficient midlatitude anticyclogenesis (I-MAG), three cases).

Review of some 2004 forecast fields studied by Kehoe (2005) indicated that the false Tibetan anticyclone feature was also present in multiple cases during the 2004 season, although E-MAG was named by Kehoe as a primary mechanism in only nine large error cases. However, I-MCG (known as secondary error mechanism due to the presence of the false Tibetan anticyclone) was named as an error mechanism in 46 cases during 2004.

b. NOGAPS

Examination of the NOGAPS forecasts that had large 120-h track errors revealed two-sided errors, in which MCG and MAG occurred insufficiently (I) in some cases and excessively (E) in other cases (Table 2). In contrast, Kehoe (2005) found a majority of midlatitude large-error cases involved I-MCG. While E-MCG appears to be the most common error mechanism (21 cases), 11 of these cases occurred in the same TC.

Midlatitude error mechanisms dominated over tropical error mechanisms. One notable tendency in NOGAPS, which occurred in two TCs, was to spin-up a false cyclone (E-MCG) in the vicinity of the remnants of a decaying secondary circulation, which could be either another TC or a midlatitude circulation. The TC then interacted with the false circulation in such a way as to create a large track error.

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Table 2. Error mechanisms for NOGAPS and GFDN occurring at 96 h and/or 120 h during the 2005 western North Pacific season. A large error that occurs at both 96 h and 120 h is counted only once. *The first (second) number listed is the number of times the phenomenon occurred excessively (insufficiently).

2005 96-h and 120-h Error Mechanisms

Phenomenon name	*Acronym*	*No. of NOGAPS forecasts**	*No. of GFDN forecasts**
Large Errors Due to Tropical Influences			
Direct Cyclone Interaction (tropical)	DCI	2-0	3-0
Ridge Modification By TC	RMT	1-0	0-0
Large Errors due to Midlatitude Influences			
Direct Cyclone Interaction (midlatitude)	DCI-m	1-0	0-0
Response to vertical wind shear	RVS	6-0	0-0
Midlatitude cyclogenesis	MCG	21-9	1-3
Midlatitude cyclolysis	MCL	4-0	0-1
Midlatitude anticyclogenesis	MAG	7-5	17-0
Midlatitude anticyclolysis	MAL	0-0	2-0
Other		0	1
Fields not available		4	6
Total forecasts		60	34

*The first (second) number listed is the number of times the phenomenon occurred excessively (insufficiently)