P1.84 A DECISION TREE TO ASSESS FORECAST TRACK CONFIDENCE FOR LANDFALLING GULF OF MEXICO TROPICAL CYCLONES

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1. INTRODUCTION

When a Gulf of Mexico tropical cyclone is forecast to make landfall, it is inevitable that many critical decisions will have to be made. The goal of this study is to provide a decision tree for assessing the potential error and relative confidence of Gulf of Mexico landfall forecasts. This decision making tool is expected to aid with important pre-storm activities such as evacuation, resource or aid pre-placement, and petrochemical plant shutdowns. Track forecasts continue to improve and become more detailed with the development of digital databases; however, effective communication of forecast confidence is at least equally as important as continued improvement in order for decision makers to make well informed decisions. Evidence of this need is provided in a recent online survey that found 80% of respondents felt that an indication of forecaster confidence (forecasts in general) would be very or somewhat useful (Ryan, 2003).

2. DATA AND METHODS

Landfalling Gulf of Mexico tropical cyclones occurring during the six year period of 1998-2003 are analyzed in this study. The resulting dataset consists of 26 tropical cyclones (17 tropical storms, 9 hurricanes). Tropical depressions are included provided that they became a named storm at some point in the Gulf of Mexico. Since the goal of this study is to provide guidance to coastal decision makers, only landfall forecasts are evaluated, with landfall occurring between the forecast hours of 12 and 72. Only one inland forecast hour point from a landfall forecast is included. The result is 180 landfall forecasts available for evaluation.

Forecast track error is determined by calculating the great circle distance between the forecast location and the observed location (Powell and Aberson, 2001). Forecasts evaluated are those issued every 6 hours by the National Hurricane Center (NHC). Actual tropical cyclone positions and landfall timing and locations are determined by using the "best track" dataset from the NHC, which is available after post analysis of all available data. As a baseline value for error comparison, the latest available ten year (1993-2002) average error is utilized. This is consistent with error cones available in tracking software used by decision makers.

3. THE DECISION TREE

The decision tree (Figure 1) is an attempt to relate potential forecast track error/forecast confidence with the initial conditions of the tropical cyclone. The first consideration is the intensity of the cyclone. Previous studies have shown that model and NHC track forecasts generally improve as the intensity of the cyclone increases (Goerss, 2000). For hurricanes, a further delineation is made between category 1 and category 2 or greater. For tropical storms, a significant error difference emerged between those that moved into the Gulf and those that developed in the Gulf, with the former generally more predictable. This result is likely related to the fact that storms moving into the Gulf are often better organized, and have a history to consider when making the forecast. The next important consideration is the speed of movement. For category 2 hurricanes, moderate moving cyclones (7-12 mph) displayed the least track error. However, for category 1 hurricanes and tropical depressions, fast moving cyclones (>12 mph) exhibited the least error within their respective categories. For tropical storms, relative track error changed with the forecast hour when examining the speed of movement. Center reformation is useful as a predictor of future error for slow moving, tropical storms (<7 mph), but did not aid as a predictor for moderate or fast moving tropical storms. This result is attributed to the fact that some center reformations occur as the tropical storm is getting better organized and accelerating. The tree shows that there is a wide range of error that can be expected based on initial conditions. The greatest error can be expected from stationary, reforming, tropical storms that develop in the Gulf; whereas, the least error and highest confidence can be expected from moderate moving category 2 or greater hurricanes. In these extreme examples, average error differences are on the order of 400 km at 48 hours. Although it is acknowledged that the tree will not work for every forecast, it is believed that having an objective potential error/confidence assessment tool will aid in the decision making process for most forecasts.

4. LANDFALL TIMING AND BIASES

The majority of landfall forecasts for tropical storms and hurricanes are left (along the coast) of the actual landfall location and exhibit a late bias (tropical cyclones made landfall earlier than forecast) (Table 1). Forecasts for tropical depressions showed an early bias in the 12-36 hour period. The standard deviation of time error indicates that appropriate errors for planning purposes are on the order of 6 hours in the 12-36 hour period and 11-14 hours in the 37-72 hour period. The late bias in the 37-72 hour period is consistent with results for Gulf landfall forecasts during the 55-72 hour period for the years 1976-2000 (Powell and Aberson, 2001).

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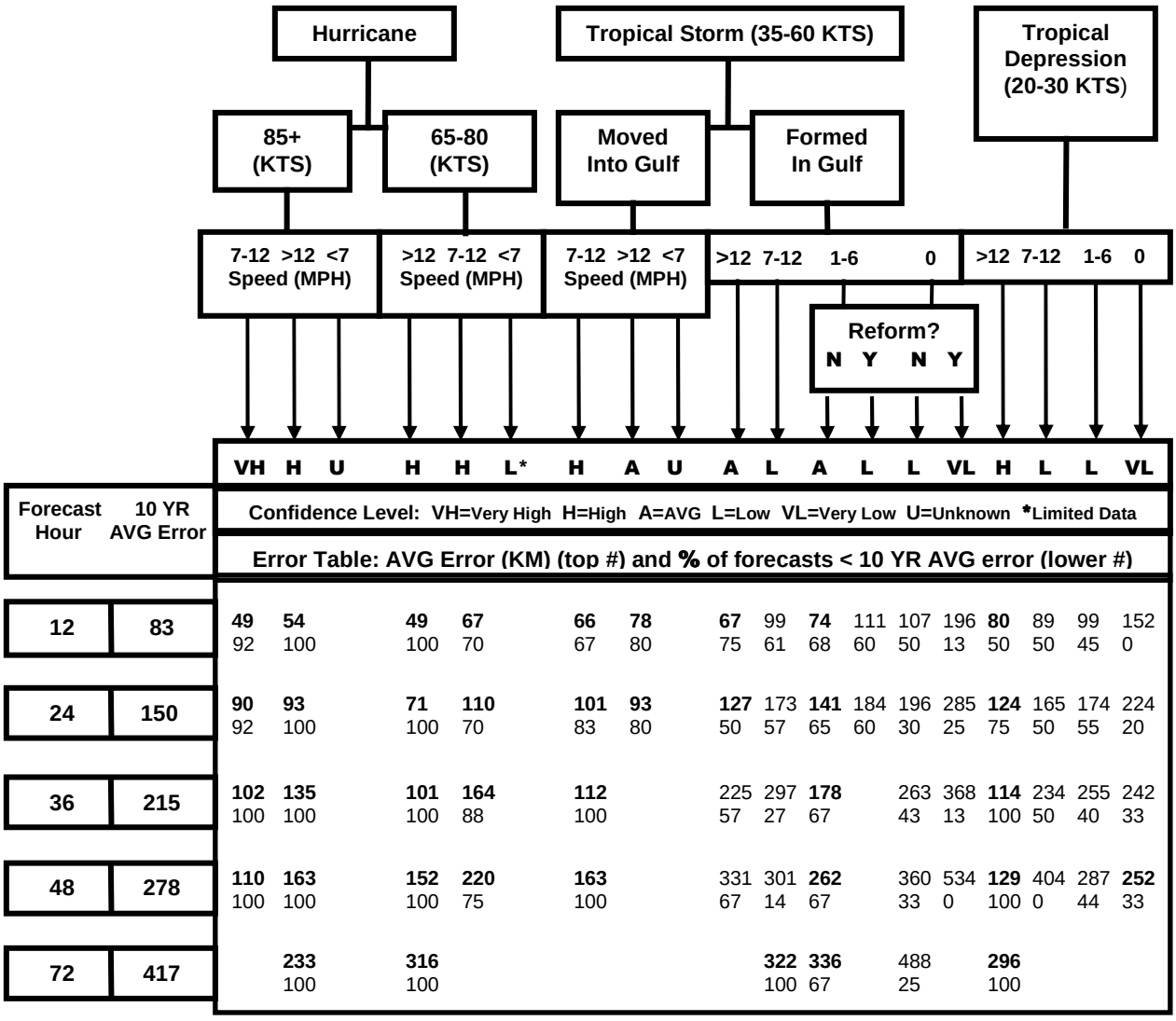

Fig. 1. The Decision Tree/Error Table. From top to bottom arrows point to confidence levels. The error table shows the average error and % of forecasts with < 93-02 (10 YR) average error for each category in the tree above. Bold numbers in the table indicate average error < 93-02 average error (available left of table by forecast hour). Unknown (U) confidence indicates that there is not sufficient data to show an average and assign a confidence.

Category	Hurricanes		Tropical Storms		Tropical Depressions	
Forecast period (h)	12-36	37-72	12-36	37-72	12-36	37-72
No. of forecasts	22	18	58	42	15	25
Left/right bias (km)	-60.1	-79.2	-30.6	-207.4	-37.9	-7
% of forecasts left	72.7	77.8	55.2	81	53.3	48
Time bias (h)	4.4	0.9	2	6.8	-9.6	4.2
ABS time error (h)	5.5	10.9	5	9.8	11.6	10
Time STD (h)	5.9	13.6	6.2	10.8	12.1	11.7

Table 1. Left/right landfall bias calculated along the coastline and time error at landfall by cyclone category and forecast period. Negative numbers indicate a left or early bias. ABS = absolute value and STD = standard deviation.

5. REFERENCES

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