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DEVELOPMENT OF A WIND-RADII CLIPER MODEL

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1.0 INTRODUCTION

In addition to tropical cyclone center position and intensity estimates and forecasts, the Tropical Prediction Center/National Hurricane Center (TPC/NHC) is tasked with providing an estimate of the size of the tropical cyclone wind field, expressed as a set of wind radii for 34, 50, and 64 kt winds, and forecasting these radii to 36 h (all radii) and to 72 h (34 and 50 kt radii). The forecasts are produced every 6 h. The wind radii are used by the maritime community in assessing the size of a tropical cyclone (ship routing and risk avoidance) and by emergency managers in estimating the arrival of gale force winds in coastal areas - the time when most outdoor preparations must cease due to safety concerns. There is a need for forecast guidance specifically directed to this requirement. A statistical benchmark will also aid in assessing the skill of the official forecasts and other models as they become available.

In order to assist in these tasks, a tropical cyclone wind radii model has been developed for the Atlantic basin. This statistical model produces an explicit forecast of 34, 50, and 64 kt wind radii to 72 h. The statistical framework for tropical cyclone models utilizing climatology and persistence (hence the CLIPER designation) was described by Neumann (1972).

2.0 DATA

The developmental data set (1963-2002) is formed from the operational (currently 3 h after synoptic time) estimates of the wind radii, as a 'best-track' for these data has not yet been formulated. The operational forecasts are not used. The data set has been assembled from quantities found in the operational product archive maintained by TPC. Processing the entire 40 yr data set yields a significant number of cases (Table 1).

3.0 TECHNIQUE

The approach used here is to derive an equation, through linear multiple regression, for each wind threshold radius, in each quadrant, at each forecast interval. The final model is thus a system of 60 equations (4 quadrants X 3 radii X 5 forecasts).

The basic predictor set is composed of position (previous, current, and forecast), intensity (previous, current, and forecast), initial radii, storm speed, bearing and Julian date, and products and cross-products of these quantities. This results in 1081 possible predictors.

Table 1. Number of cases (1963-2002)

	34 kt	50 kt	64 kt
12 h	6682	3522	2096
24 h	5871	3336	2038
36 h	4816	2912	1895
48 h	4311	2653	1768
72 h	2964	1923	1216

It should be noted that prior to running the screening regression, radii are assigned a storm-relative quadrant. The radii as they appear in the operational products are given by compass direction (NE, SE, SW, NW). It was felt that a clearer derivation would be obtained by first stratifying the data in a storm-relative framework. That is, the direction of storm motion is used to determine which quadrant (NE, SE, SW, or NW) best represents the storm-relative left-front quadrant, for example. The results of this procedure, averaged over the data set, appear in Fig. 1.

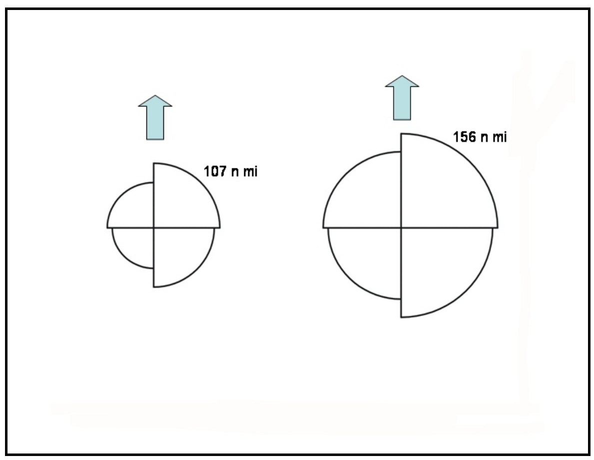

Figure 1. Average 34 kt radii for tropical storms (left) and hurricanes (right) derived from the dependent data set under consideration. Direction of motion toward top of page.

Having assembled the dependent data set, a screening regression is used to determine the predictors providing the greatest reduction of variance. All of the equations are significant at the 95% level using a traditional F-test criteria (Draper and Smith, 1966),

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Table 2. Errors - dependent data set (n mi)			
		mean	median
12 h	34 kt	23	15
	50 kt	16	11
	64 kt	11	8
24 h	34 kt	28	21
	50 kt	19	14
	64 kt	13	9
36 h	34 kt	31	24
	50 kt	21	15
	64 kt	14	10
48 h	34 kt	32	25
	50 kt	22	16
	64 kt	14	11
72 h	34 kt	36	27
	50 kt	23	18
	64 kt	15	11

Table 3. Mean errors (n mi) 2003				
		official	Radii-CLIPER	no. of cases
12h	34 kt	17	21	230
	50 kt	11	14	167
	64 kt	6	9	112
24h	34 kt	23	25	207
	50 kt	14	16	159
	64 kt	9	11	108
36 h	34 kt	26	26	185
	50 kt	17	17	140
	64 kt	11	10	101
48 h	34 kt	30	29	173
	50 kt	19	17	137
	64 kt	-	10	100
72 h	34 kt	36	32	143
	50 kt	23	18	124
	64 kt	-	12	89

after accounting for serial correlation. Beyond this, they also appear to be significant using the more rigorous equivalent F-test postulated by Neumann et al. (1977). This equivalent F-test accounts for the large number of predictors typically used in this and other meteorological applications.

4.0 RESULTS

Results from the dependent data set (Table 2) are encouraging, in that mean errors appear to progress in an orderly fashion. The true test however is running on independent data, as provided by the 2003 hurricane season (Table 3). The season was active (16 named systems, 7 hurricanes) with broad geographic distribution. It is interesting to note that while the average official errors are smaller at 12 h and 24 h, the skill of the model appears to be equal to the official forecast at 36 h, and better beyond. It is also worth noting that individual model forecasts (not shown) exhibit appropriate wind asymmetries. In addition, individual sets of forecasts (12h through 72h) evolve in a smooth fashion, without discontinuities.

5.0 CONCLUSIONS

A wind-radii CLIPER model has been developed for the Atlantic basin. The results on independent data (the 2003 Hurricane season) demonstrate a well-behaved model that increases in skill (relative to the official forecast) with time, and appears to offer smaller average errors than the official forecast beyond 36 h. The model also adequately describes the asymmetries in the tropical cyclone wind field. A similar methodology is being used to develop an eastern Pacific version.

6.0 ACKNOWLEDGMENT

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REFERENCES

Draper, N.R. and H. Smith, 1966: *Applied Regression Analysis*. John Wiley and Sons, 407 pp.

Neumann, C. J., 1972: An alternate to the Hurran tropical cyclone forecast system. NOAA Tech. Memo. NWS SR-62, National Oceanic and Atmospheric Administration, U.S. Dept. of Commerce, Washington D.C. 23 pp.

Neumann,C.J., M.B. Lawrence and E.L. Caso, 1977: Monte Carlo significance testing as applied to statistical tropical cyclone prediction models. *J. Appl. Met.,* **16**, 1165-1174.