Coastal Engineering Technical Note

ESTIMATES OF HURRICANE WINDS FOR THE EAST AND GULF COASTS OF THE UNITED STATES

PURPOSE: To describe a method of estimating hurricane wind speeds for given return periods for the East and Gulf coasts of the United States.

BACKGROUND: Extreme hurricane wind speeds can not be predicted by extrapolating annual wind speed distributions. Also, most locations have insufficient historical hurricane data to predict hurricane wind speed distributions. Therefore, Batts, et. al. (1980) estimated hurricane winds indirectly from statistical distributions of hurricane climatological characteristics and a mathematical model of the hurricane wind speed field. The mathematical model relates the climatological characteristics to the maximum wind speeds. The model takes into account the position of the storm center relative to the point of interest, storm decay, wind speed reduction over land due to friction, and the effects of time averaging.

To estimate the probabilities of occurrence of hurricane wind speeds, Batts, et. al., (1980) assumed one thousand hurricanes hit the area adjoining each of 56 coastal sites. The sites are spaced at 50 nautical mile intervals along the U.S. East and Gulf coasts (Figure 1). The climatological data for each hurricane were determined from the respective statistical distributions by Monte Carlo simulation (random sampling). The climatological data were used as input to the mathematical model which gave the fastest-mile wind speed at 10m (33 ft) above ground over open terrain at the coastline and at 200 km (124 miles) inland for each hurricane. The model assumes a straight shoreline and constant overland surface roughness. A more detailed model should be used to include the effects of a complex shoreline or inland features. The maximum wind speeds for each of the one thousand hurricanes at each site were combined to estimate the probability distribution of occurrence of hurricane wind speeds at the site for the coastline and for 200 km (124 miles) inland (Figures 2 and 3). Table 1 is a tabulation of the results in Figures 2 and 3.

Several sources of error are possible in the procedure used to construct Figures 2 and 3.

1. Sampling error due to the limited data base on hurricane events (75 to 100 years of record) and the limited number of events simulated (1000).

2. Statistical modeling error due to choosing imperfect probability distributions to fit to the climatological data.

3. Observation error due to imperfect measuring or recording of the climatological characteristics.

4. Physical modeling errors due to the imperfect representation of the relationships between wind speed and climatological characteristics.

Most errors are estimated to be small, but errors increase as the return period increases. Also, the mathematical model used is less accurate at sites north of Cape Hatteras, NC (mile post 2200 and greater). The results for these sites should be used with caution.

PROCEDURE:

1. Find the milepost along the coast nearest the point of interest (Figure 1).

2. Determine the estimated value of fastest-mile hurricane wind speeds at 10 m (33 ft) above ground over open terrain for sites along the coast (Figure 2 or Table 1) or for sites 200 km (124 miles) inland (Figure 3 or Table 1). Fastest-mile wind speeds at distances less than 200 km (124 miles) inland can be interpolated between these values.

3. Consider estimates north of Cape Hatteras with caution.

SAMPLE PROBLEM:

1. Estimate the fastest-mile hurricane wind speed at the coast for a 25 year return period for Fort Myers, Florida (mile post 1300).

   from Figure 2 or Table 1,

   estimated fastest-mile hurricane wind speed = 95 mph

2. Estimate the fastest-mile hurricane wind speed at 100 km (62 miles) inland for a 25 year return period for Fort Myers, Florida.

from sample problem 1., wind speed = 95 mph at the coast

from Figure 3 or Table 1, hurricane wind speed = 84 mph at 200 km (124 miles) inland

$$\frac{100\ \text{km}-0\ \text{km}}{200\ \text{km}-0\ \text{km}} = \frac{\text{ws}-95\ \text{mph}}{84\ \text{mph}-95\ \text{mph}}$$

$$.5(-11\ \text{mph}) = \text{ws}-95\ \text{mph}$$

$$-5\ \text{mph} = \text{ws}-95\ \text{mph}$$

$$\text{ws} = 90\text{mph}$$

estimated fastest-mile hurricane wind speed = 90 mph

Fastest-mile wind speeds must be converted to time-dependent wind speeds for wave modeling. The procedure for this conversion is in the Shore Protection Manual (1984).

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REFERENCES:

Batts, Martin E., et. al. 1980. "Hurricane Wind Speeds in the United States," National Bureau of Standards Building Science Series 124, US Government Printing Office, Washington, D.C.

Shore Protection Manual. 1984. 4th ed., 2 vols, US Army Engineer Waterways Experiment Station, Coastal Engineering Research enter, US Government Printing office, Washington, D.C.

TABLE 1. ESTIMATED MAXIMUM HURRICANE WIND SPEED (MPH)

RETURN PERIOD

STA	AT THE COAST					AT 200 KM INLAND				
	10	25	50	100	2000	10	25	50	100	2000
150	59	85	98	107	140	39	63	78	89	127
200	59	84	97	106	140	39	63	77	88	124
250	61	84	96	106	138	42	63	75	84	115
300	62	83	95	104	136	46	70	81	91	119
350	63	84	95	104	134	51	72	84	93	121
400	62	81	92	101	133	48	69	81	92	123
450	61	80	91	101	133	46	64	77	89	120
500	59	78	90	100	133	48	66	78	90	119
550	61	80	92	102	132	53	77	88	100	128
600	60	78	90	100	130	59	78	91	100	130
650	61	80	91	100	130	61	80	92	100	130
700	62	81	91	100	132	58	76	86	95	124
750	64	82	92	102	136	53	70	80	89	113
800	65	81	91	101	134	50	66	77	84	110
850	63	80	91	100	136	48	68	78	86	121
900	62	78	88	96	129	49	67	77	85	128
950	61	78	86	93	122	50	67	76	85	128
1000	59	76	84	90	117	47	61	69	76	107
1050	60	76	84	90	115	44	58	66	73	95
1100	61	77	87	93	125	40	56	65	74	102
1150	62	79	89	98	133	46	63	72	84	115
1200	66	84	95	103	138	51	70	81	92	128
1250	73	90	100	108	137	59	80	92	101	136
1300	78	95	104	111	137	66	84	96	104	136
1350	79	96	104	111	139	73	89	100	108	136
1400	80	97	106	113	140	76	92	103	111	139
1450	81	96	105	113	141	77	94	104	113	138
1500	79	93	103	111	139	73	92	101	110	138
1550	74	90	100	109	136	72	91	100	108	136
1600	70	89	99	107	132	64	83	95	105	132
1650	66	85	95	103	126	53	72	84	95	124
1700	62	82	90	98	117	44	61	72	82	116
1750	57	77	85	92	114	36	54	66	74	111
1800	56	76	85	92	117	35	50	62	74	110
1850	56	76	88	98	130	34	50	58	73	103
1900	60	81	93	104	140	40	59	70	82	114
1950	64	87	96	105	139	47	66	77	87	115
2000	64	85	96	106	136	55	75	85	94	121
2050	68	86	96	105	136	58	77	87	95	122
2100	70	84	98	106	136	63	83	93	101	134
2150	71	88	99	107	136	66	85	95	103	136
2200	70	87	97	105	134	69	87	98	105	134
2250	64	81	91	99	132	63	82	92	98	124
2300	58	75	86	95	128	57	74	85	93	121
2350	51	69	81	92	127	47	66	77	87	125
2400	48	65	78	91	125	40	61	77	87	125
2450	47	65	79	91	130	32	54	68	82	129
2500	49	72	87	98	136	31	52	69	83	120
2550	51	77	92	101	138	32	61	76	90	130
2600	53	81	95	104	140	37	70	84	96	133
2650	55	82	95	105	141	42	74	87	98	134
2700	54	80	93	104	139	41	76	89	99	132
2750	50	74	88	99	137	35	74	89	100	133
2800	46	69	82	96	133	26	66	81	92	127
2850	42	62	77	87	132	22	53	71	86	121
2900	39	59	71	85	128	21	46	66	83	117

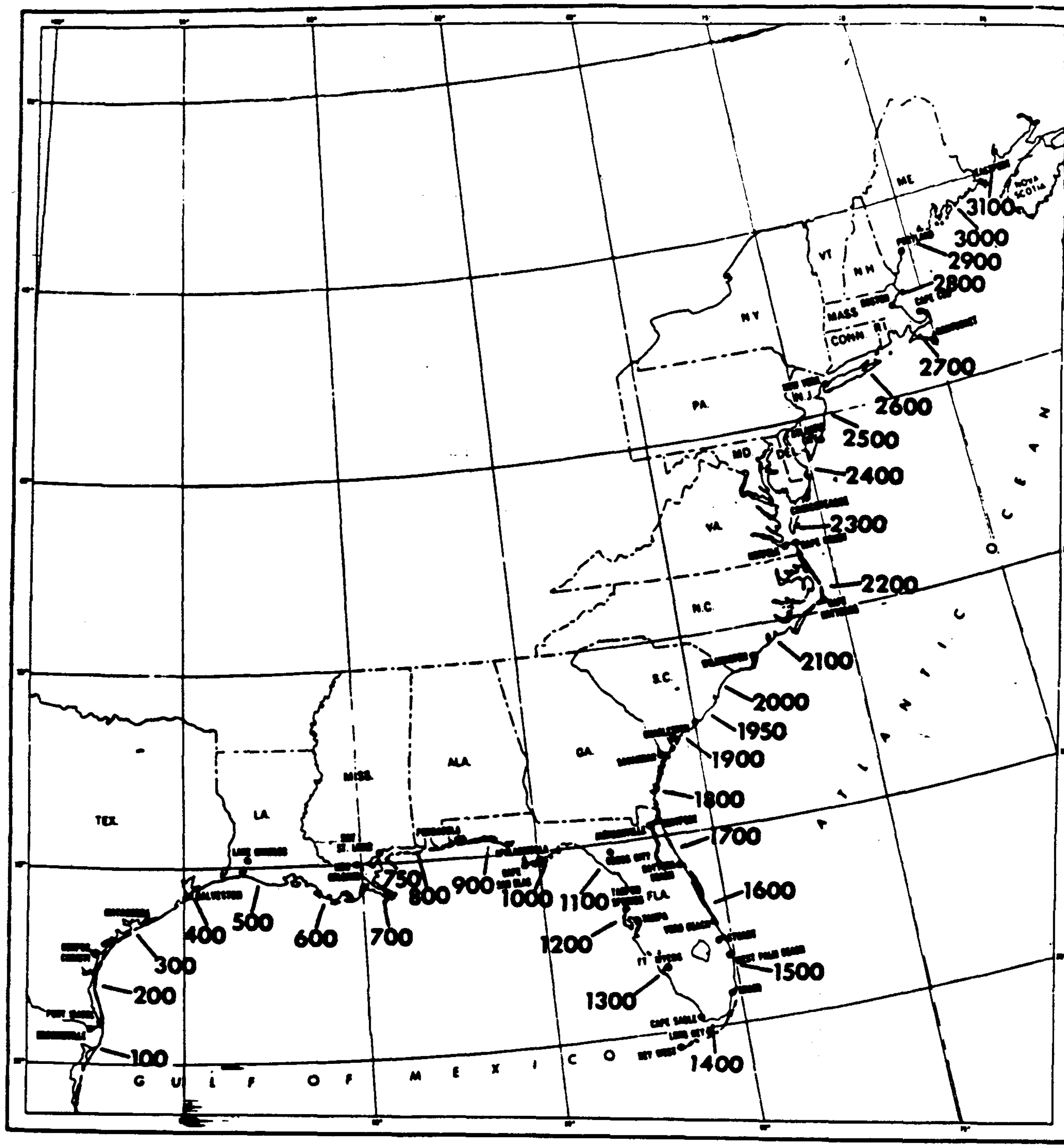

Figure 1. Locator map with coastal distance intervals marked in nautical miles (1 n. mi. ≈ 1.9 km) [5].
(Batts, et. al.,1980)

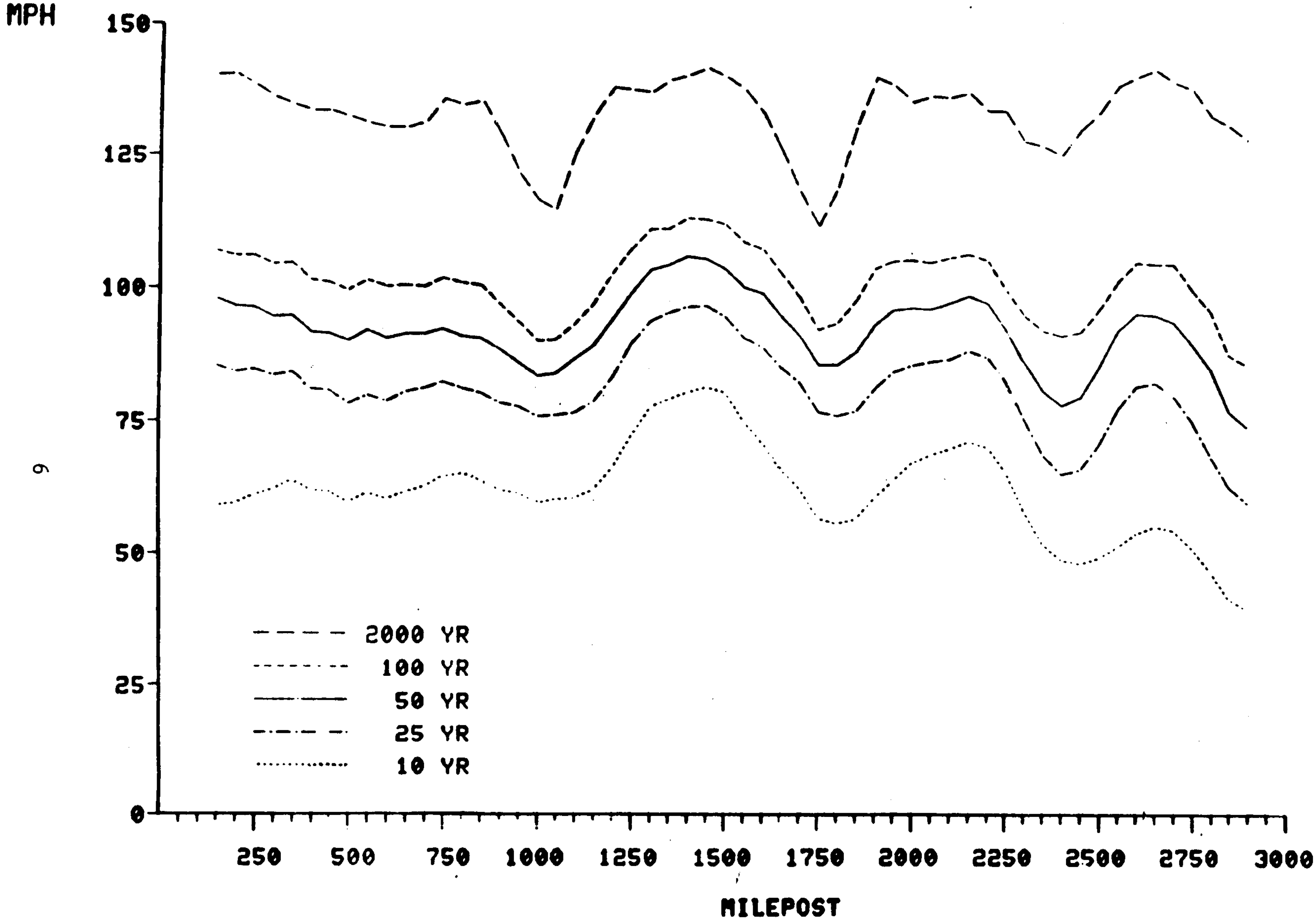

Figure 2. Estimated fastest-mile hurricane wind speeds blowing from any direction at 10 m above ground in open terrain near the coastline, for various mean recurrence intervals (1 mph = 0.47 m/s). (Battes, et. al., 1980)

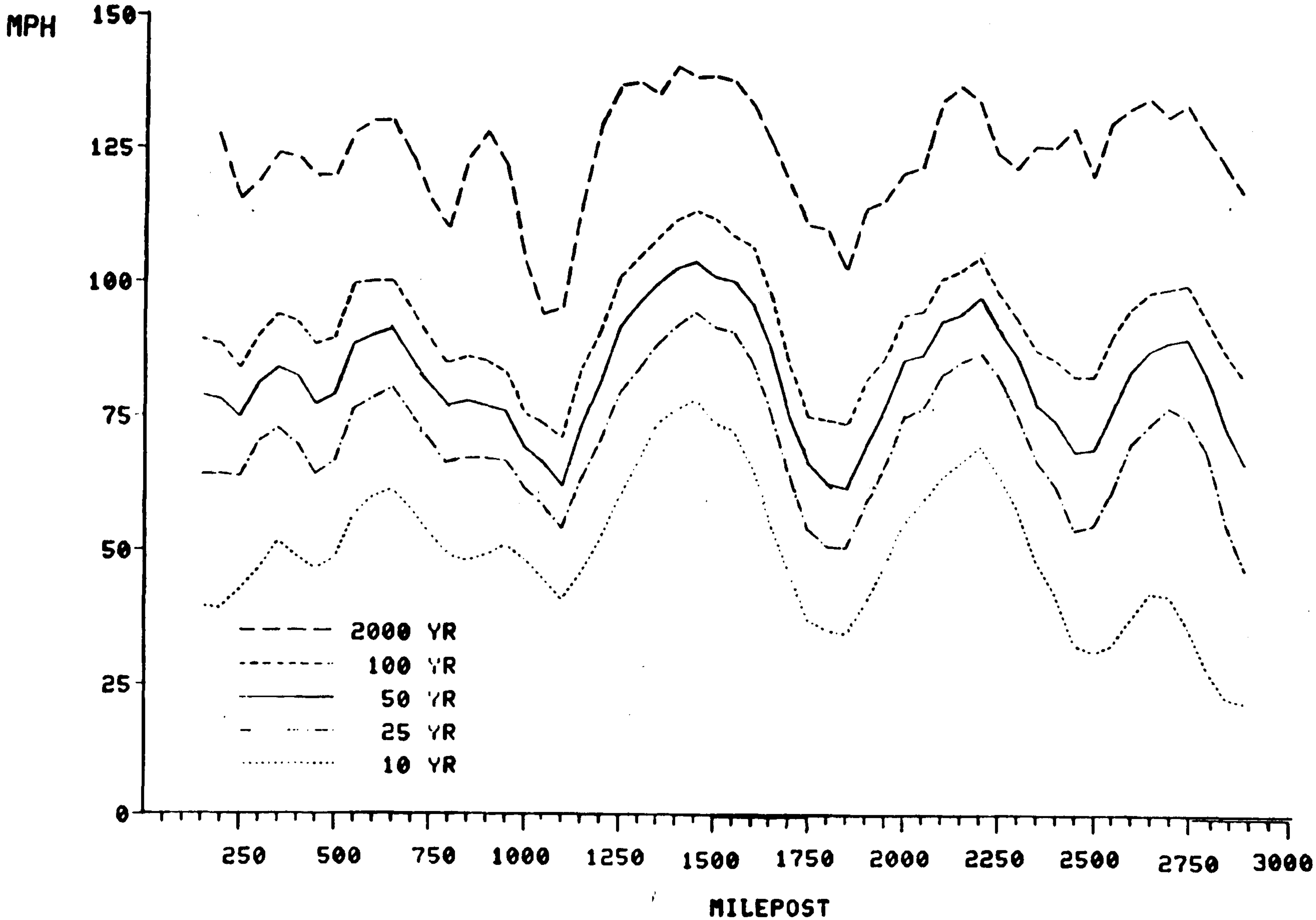

Figure 3. Estimated fastest-mile hurricane wind speeds blowing from any direction at 10 m above ground in open terrain at 200 km inland, for various mean recurrence intervals (1 mph = 0.47 m/s). (Batts, et. al., 1980)