

A SUMMARY OF WIND STATISTICS FOR GREEN BANK

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As input for the design of the Green Bank Telescope it is important to have an estimate of the highest wind speed likely to be experienced during the nominal lifetime of the telescope. In an LFST report von Hoerner (1966) presented detailed observations extending over a period of two years. From these he concluded that there is less than a 1 percent chance that a wind of speed 100 mph will occur in an interval of 30 years. He also noted that the wind speed measured at the 300-ft site is less than that at the 85-1 (Tatel) telescope, by as much as 5 mph for winds between 15 and 25 mph, and by up to 9 mph for winds in excess of 40 mph.

Since von Hoerner's report, a much more extensive data base on wind speeds has been compiled. The interferometer operators record the maximum value of the wind speed observed during each eight hour shift. Recently Len Howell has been constructing a computerized version of these data. For each day the greatest value from the three shifts is entered into a computer file, along with other information such as cloud cover, precipitation, and temperature. Len and the interferometer operators are working back into the records as time permits, and currently have available all data from the present back to 1974 logged into the computer. Len supplied us with a LOTUS-style disk copy of these data.

There are three notes of caution to be made. First, the data come variously from either the wind tower near the interferometer control building or from a tower at the Tatel telescope. They are therefore useful in describing the wind that is typical of Green Bank, but can not be used at all to explore differences in wind statistics from place to place on the site. Second, there was a period of a few months when the Green Bank anemometer appeared to show systematically higher values than expected from the weather station in Elkins. The instrument was changed and the readings returned to normal. However, the date of the problem is difficult to reconstruct, and so no attempt has been made to remove any data. Finally, there is some quantization in the wind speeds as recorded. For example, a speed of 15 mph appears 10 times more frequently than do speeds of 14 or 16 mph. We have therefore binned the data to smooth out this effect.

The data are summarized in Table 1. The first part of the table gives the frequency of occurrence of wind speeds in intervals that are 5 mph in width. From this follows directly the function $f(V)$ defined to be the probability that the maximum wind speed on a given day will fall into a 5 mph bin of a given value. The second part of the table shows the number of days on which the wind speed exceeded a given value. From this follows directly the function $F(V)$, defined as the probability of having a maximum wind greater than a given value. We have attempted to estimate the uncertainty in $F(V)$ by using the square root of the number of occurrences; these uncertainties are also shown in Table 1.

As we tabulated the data it seemed clear that the high winds occurred preferentially in the first part of the observing period. We therefore split the data base into two parts, and have tabulated the results in Tables 2 and 3.

To estimate the survival wind, we plot the data from Table 1 in Figure 1. The data are well-fitted by an exponential function of the form expected using the Weibull model distribution for wind speed (Justus 1985). The model can be expressed as (Justus equation 33.13)

$$p(V > V_0) = \exp[-V_0/A]^k \quad (1)$$

where p is the probability that the wind speed V exceeds a given value V_0 , A is a scaling term, and k is called the "shape factor". The range of k is typically between 1.2 and 3.5. The best fit to our data is $k = 1.61$.

Also shown in Figure 1 are the early and late halves of the data. They follow generally the same trend in wind speed, but differ from each other by an amount that is greater than the suggested uncertainties. Perhaps the figure merely emphasizes the well-known result that the weather is highly variable on time scales of years.

In order to estimate the survival wind, we have plotted the function $F(V)$ on an expanded scale in Figure 2. We have added a point representing the highest wind speed recorded in Green Bank in 30 years (74 mph; von Hoerner 1989). We then extrapolate the curve of equation 1 to a probability of 1 percent of one day in thirty years (a probability of 9.1×10^{-7}), and find the survival wind speed to be $V_s = 94$ mph.

References

- Justus, C. G. 1985, in Handbook of Applied Meteorology, ed. David D. Houghton (New York:John Wiley & Sons), p.915.
 von Hoerner, S. 1966 LFST Memo Number 16.
 von Hoerner, S. 1989 NLSRT Memo Number 64.

TABLE 1. ALL WIND DATA (1974-1987)

Range In V	No. Obs.	f(V)	V	No. Obs.	F(V)	Uncertainty
3 - 7	231	0.045	0	5110	1.000	
8 - 12	2103	0.412	5	5101	0.9982	
13 - 17	1207	0.236	10	4616	0.9033	
18 - 22	812	0.159	15	2628	0.5143	
23 - 27	280	0.055	20	1390	0.2720	
28 - 32	206	0.040	25	701	0.1372	.00518
33 - 37	101	0.020	30	442	0.0865	.00411
38 - 42	86	0.0168	35	252	0.0493	.00311
43 - 47	32	0.0063	40	150	0.0294	.00240
48 - 52	33	0.0065	45	73	0.0143	.00167
53 - 57	10	0.0020	50	41	0.00802	.00125
58 - 62	1	0.0002	55	12	0.00235	.00068
≥ 63	4	0.0008	60	5	0.00098	.00044
TOTAL	5106		65	3	0.00059	.00034

TABLE 2. WIND DATA (1974 - 1980)

Range In V	No. Obs.	f(V)	V	No. Obs.	F(V)	Uncertainty
3 - 7	133	0.0521	0	2554	1.000	
8 - 12	883	0.3460	5	2548	0.9977	
13 - 17	523	0.2049	10	2337	0.9150	
18 - 22	478	0.1873	15	1473	0.5767	
23 - 27	174	0.0682	20	937	0.3669	
28 - 32	129	0.0505	25	509	0.1993	0.00883
33 - 37	81	0.0317	30	344	0.1347	0.00726
38 - 42	81	0.0317	35	225	0.0881	0.00587
43 - 47	27	0.0106	40	137	0.0536	0.00458
48 - 52	28	0.0110	45	65	0.0255	0.00316
53 - 57	10	0.00392	50	36	0.0141	0.00235
58 - 62	1	0.00039	55	12	0.00470	0.00136
≥ 63	4	0.00157	60	5	0.00196	0.00088
TOTAL	2552		65	3	0.00117	0.00068

TABLE 3. WIND DATA (1981 - 1987)

Range In V	No. Obs.	f(V)	V	No. Obs.	F(V)	Uncertainty
3 - 7	98	0.0384	0	2556	1.000	
8 - 12	1220	0.4777	5	2553	0.9988	
13 - 17	684	0.2678	10	2279	0.8916	
18 - 22	334	0.1308	15	1155	0.4519	
23 - 27	106	0.0415	20	453	0.1772	0.00833
28 - 32	77	0.0301	25	192	0.0751	0.00542
33 - 37	20	0.00783	30	98	0.0383	0.00387
38 - 42	5	0.00196	35	27	0.0106	0.00203
43 - 47	5	0.00196	40	13	0.00509	0.00141
48 - 52	5	0.00196	45	8	0.00313	0.00111
53 - 57	0	0	50	5	0.00196	0.00087
58 - 62	0	0	55	0	0	
≥ 63	0	0	60	0	0	
TOTAL	2554		65	0	0	

GREEN BANK WIND STATISTICS

SEMI-LOGARITHMIC 5 CYCLES X 70 DIVISIONS
 FRACTION OF TIME WIND SPEED EXCEEDS A GIVEN VALUE

DATA FROM 5110 DAYS
 1974-1987

$\text{Exp}(-V/18.9)^{1.61}$

+ 1981-1987

o 1974-1980

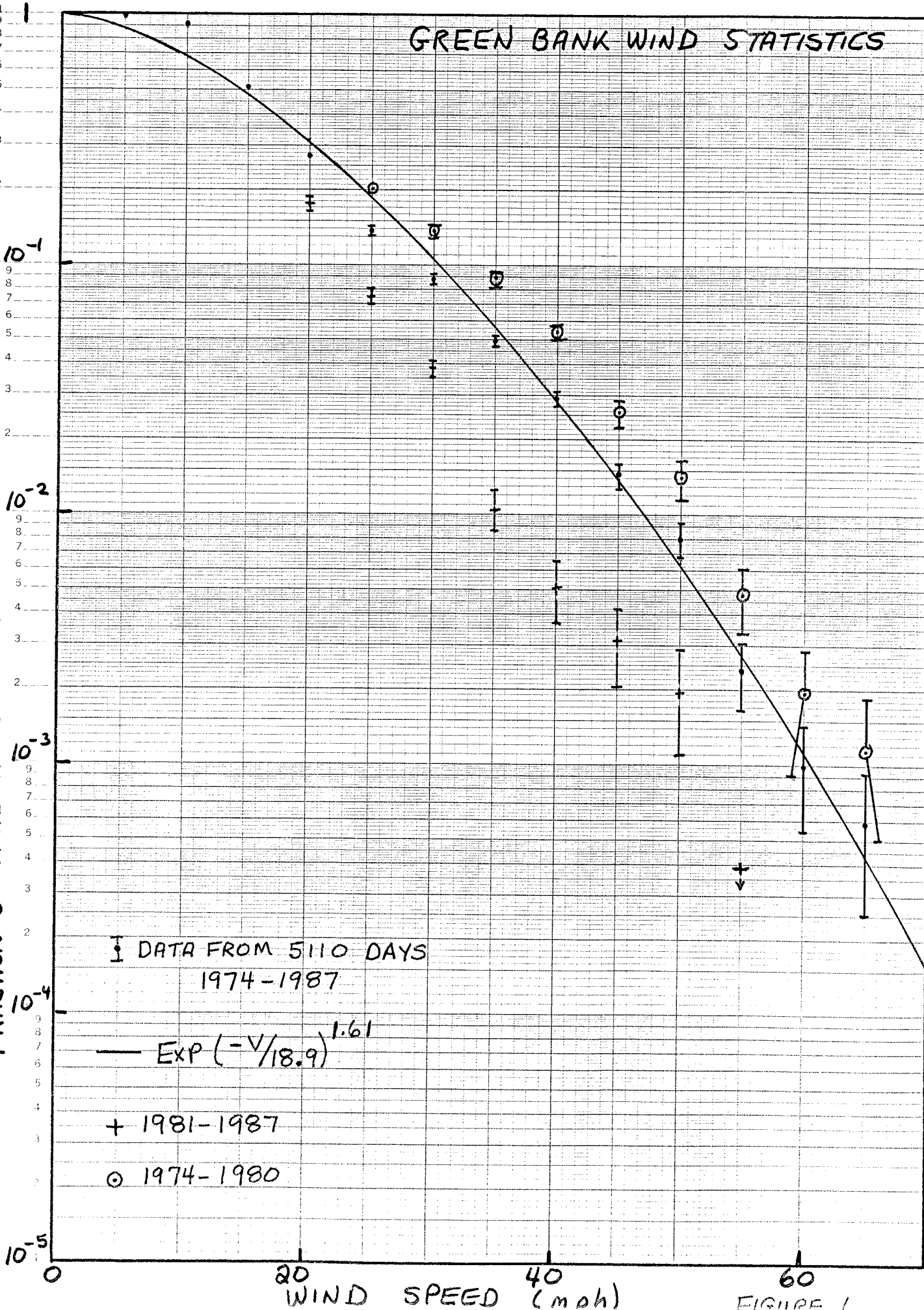


FIGURE 1

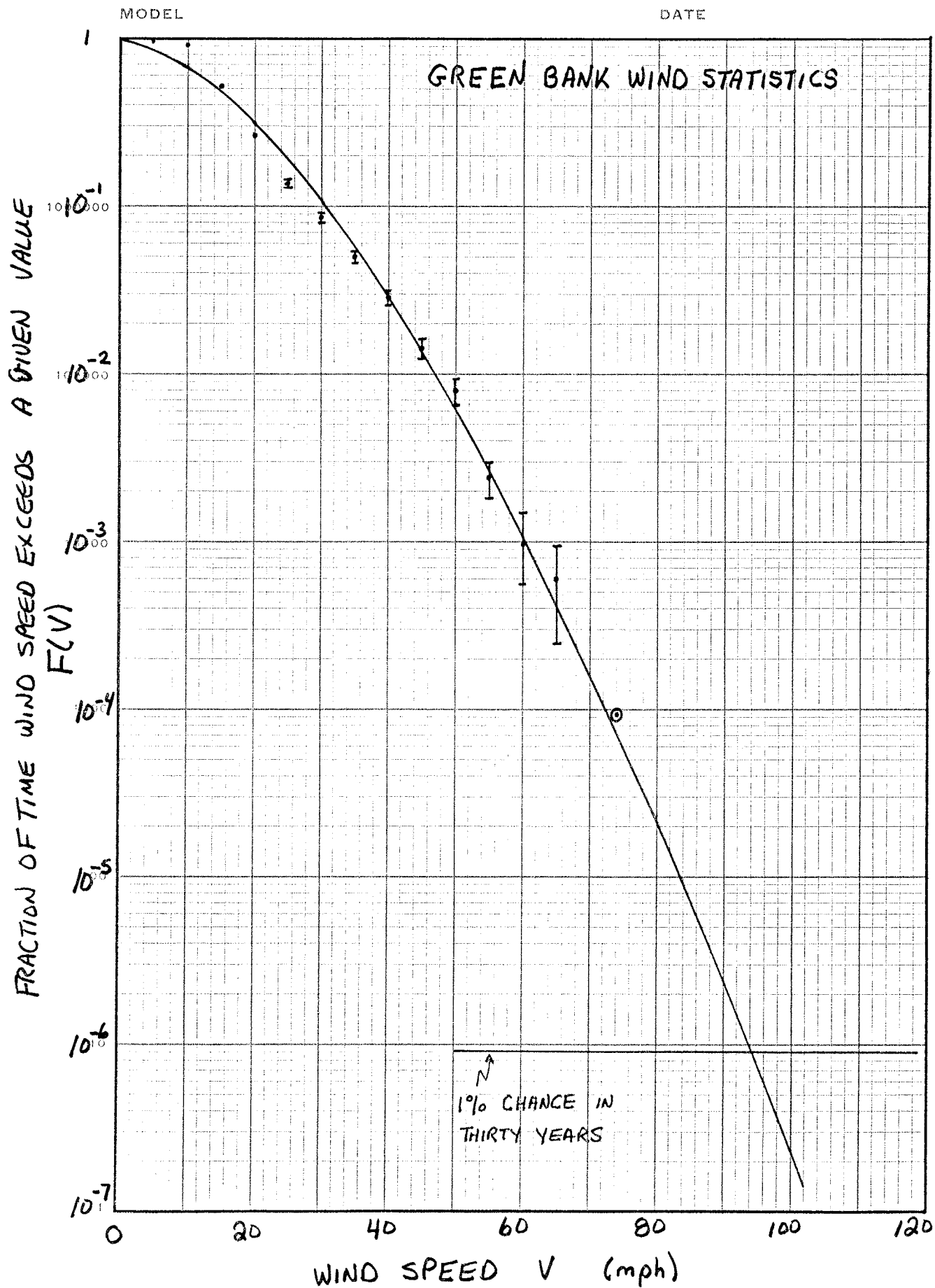


FIGURE 2