MOUNT WASHINGTON CHANGES IN RECORDED MAXIMUM WIND SPEED FREQUENCY AND DIRECTION RELATING TO THE 1980 CHANGE IN PITOT EXPOSURE AND THE MOVE TO THE NEW OBSERVATORY

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MWO CHANGES IN RECORDED MAXIMUM WIND SPEED FREQUENCY AND DIRECTION RELATING TO THE 1980 CHANGE IN PITOT EXPOSURE AND THE MOVE TO THE NEW OBSERVATORY was published in an abbreviated version in *Windswept* (v. 39, no. 3, 1998). It is made available in PDF format in the interests of scientific research and public information requests, and is reproduced from the original 1998 text with an introduction and updated project photos.

Dave Glidden is a Field Specialist in Wind and Mountain Climatology, and has conducted wind studies for the National Park Service in Rocky Mountain National Park in Colorado. More recently, he has pursued field work on the variability of mountain winds and gust factors in Denali National Park in Alaska. A strong advocate of women in the sciences, he has been fortunate to have many women share in the excitement and rewards of field work. (Laura Capella, a former Observatory EduTrip ATL in mountain climatology during the early 1990's, assisted Dave during his 1995 field studies in Denali.) He specialized in Mountain Climatology at the University of Massachusetts/Amherst, where he directed a climatological research project in the White Mountains of New Hampshire, which included extensive field studies from the Presidential to the Franconia Ranges. Also while at UMASS, he investigated severe glacier winds in the early 1970s near the Icy Bay area of southeast Alaska. He has published studies and articles on mountain winds and climatology, and has been actively involved, through the Observatory, in trying to improve the participation of girls and women in the sciences. He has been associated with the Mount Washington Observatory since 1970, and has led winter EduTrips in mountain meteorology and climatology since their beginning some 14 years ago. When not in the field, Dave has been Head Coach of women's soccer at the collegiate level.

INFRARED TEST ARRAY, OLD MT. WASHINGTON OBSERVATORY TOWER.
UMASS CLIMATOLOGICAL RESEARCH PROJECT, 1972-73. After D. E. Glidden

Introduction

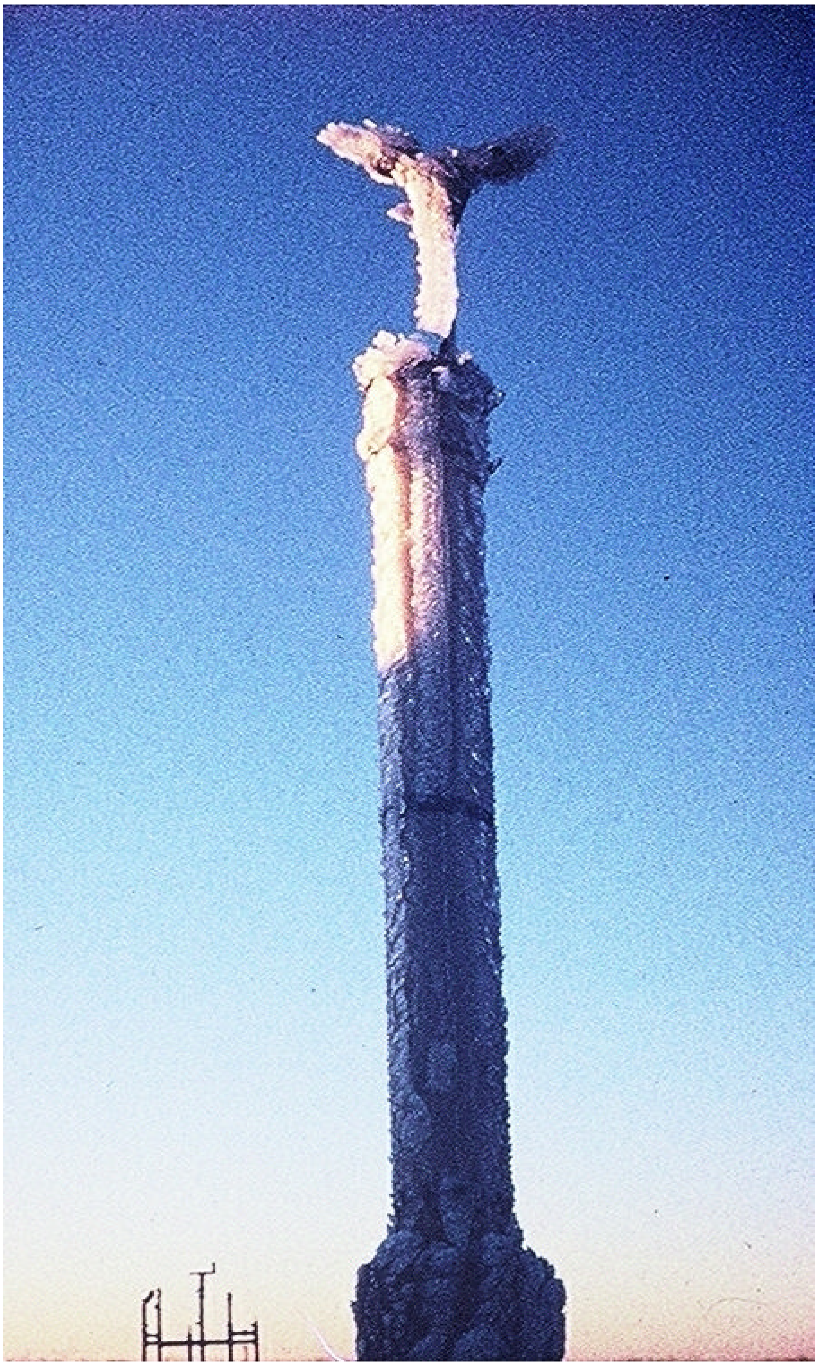
Following the recent challenge from Typhoon Paka to Mount Washington's world record wind, there has been considerable discussion about the lack of extreme maximum wind gusts recorded from east-southeast in current times, and especially since the 1980 move to the new Observatory. The point is often made that no wind speeds exceeding 200 MPH have been recorded since the world record back in April 1934.

The Observatory and others have long recognized that both the recorded frequency and strength of east-southeast maxima appear to have changed since the early days, but that change has not always been publicly documented. Recent studies with sonic anemometry, and the ongoing cooperative project (see *Windswept,* summer 1997) are attempting to model and quantify differences in summit site exposures, but the field effort will not be easy because of the continuing problems of measuring superhurricane gusts in severe icing.

There have been several storms since the world record in which winds were suspected of being much higher than were actually recorded. One such storm occurred in February 1972 and caused considerable damage to summit facilities. Officially peaking at 166 MPH from the east (the worst of the flow was actually from the southeast) under severe icing, some of us present at the time felt that the actual peak was greater than this because of the physical damage, pressure oscillations, and comparison with other storms. Guy Gosselin, present with me on the summit, commented at the time that he thought the structure of the Old Observatory was closely compromised during the height of this event. Conditions were so bad during the night for a while that, after the front steps of the Observatory were blown away, Guy and Al Oxton decided not to try to get outside again!

During the mountain meteorology and climatology EduTrips I lead on the summit each winter, a part of the sessions are usually spent analyzing a variety of historical summit data. On several occasions, we have looked at comparing how recorded maximum wind speeds may have changed with the move from the Old to the New Observatory tower, which was further removed from the east-southeast rim of the summit. The upstream topography of the current tower is different from that of the Old Observatory, which was still not as close to the eastern rim as the Old Stage Office (site of the world record wind).

We know from other field studies, which compare the variation of maximum wind speed with varying topography (Glidden, 1974, 1981, 1982, 1995) that even small changes in topography and anemometer exposure can result in sharp differences. For field studies of this nature, we use the same anemometers, with the same response characteristics and calibration: in other words, we are comparing apples to apples.



MAXIMUM WIND SPEED COMPARISON TESTS, OLD MOUNT WASHINGTON OBSERVATORY TOWER VS. TOP OF YANKEE BUILDING. UNIVERSITY OF MASSACHUSETTS CLIMATOLOGICAL RESEARCH PROJECT, 1972-73

After D. E. Glidden

It has been 18 years since the Observatory moved. We ran a frequency comparison of monthly wind maxima and directions, which included the 18-year period before the move.

Preliminary Observations

- For the 18 years preceding the 1980 move, or at the Old Observatory, there were 40 occurrences of monthly peak gust maxima from 45-135 degrees (northeast-southeast); from 1980 through 1997, there were 11, a 72.5% decrease. (Tables 1 and 2)

- For gusts ≥130 MPH from 45-135 degrees, there were 13 occurrences pre-1980 and only 5 following the move, a 61.5% decrease. (Tables 3 and 4)

- For the 18 years preceding the 1980 move, there were 171 occurrences of monthly peak gusts from 225-320 degrees (southwest-northwest); from 1980 through 1997, there were 191 occurrences, a 10.5% increase. (Table 5)

- For gusts ≥130 MPH from 225-320 degrees, there were 28 occurrences pre-1980 and 56 following the move, a 50% increase Table 6)

Assuming no differences in overall climatological atmospheric persistencies, or differences as a result of changes in instrumentation, reviewing this limited data more or less quantifies what we already suspected: on the surface, the 1980 move may have had significantly more impact on frequencies of recorded maximum flow from the east. Westerly maxima increased somewhat following the move (for example, a peak gust average of 117 MPH versus 105 MPH; 178 MPH versus 160 MPH maximum; for monthly gust maxima ≥130 MPH, a 50% increase.

Prototype infrared anemometer test array, SE side of TV Building.
The site overlooks Tuckerman's Ravine. After D. E. Glidden, 1972-73.

This parallels impressions gained from short-term field studies in the early 1970's, while comparing summit variation of maximum winds from the following sites: southeast side of TV Transmitter; top of Yankee Building; the east slope of the Old Stage Office; a northwest summit exposure, probably close to where the current Observatory is located (Glidden, 1974, p. 156; Vincent, 1975, p. 71).

Future analysis of data acquired from east-southeast exposures may establish transect ratios quantifying the differences, under varying wind direction and gust factor conditions. For example, in a field study at 3600 meters in Rocky Mountain National Park, Fig. 1 shows the ratios of wind maxima for five transects around a central site (TR 10), while west, northwest, and north sites all had lower average maxima.

Concerning the Mount Washington environment, surface roughness and the influence of summit structures may all determine how these numbers vary. Such an analysis, together with the right exposure, instrumentation and de-icing capability, may provide information on what may have been lost or gained from the Observatory's 1980 move, especially in terms of recording future world record winds.

The Observatory's modeling and measurement program, in association with Dr. Andreas Pfitsch of the Rurh-University in Germany, may offer hope in resolving some of these issues and improving our understanding of the wind problem on Mount Washington. Although the theoretical and modeling aspects are important, of greater importance is the measurement of what actually occurs in the field on the summit during severe icing.

None of this will be easy, but it will be scientifically rewarding.

Shielded infrared heating tests, Old Mount Washington Observatory Tower, 1972-73. After D. E. Glidden

THE FOLLOWING MWO FREQUENCY COMPARISON TABLES LIST THE PEAK WIND GUSTS AND DIRECTIONS 18 YEARS BEFORE (AT THE OLD OBSERVATORY) AND 18 YEARS AFTER (AT THE SHERMAN ADAMS TOWER) THE MOVE.

PEAK WIND GUSTS 45-135 DEGREES - 1962-79
MOUNT WASHINGTON OBSERVATORY

PEAK GUST (MPH)	DIR (DEG)	YEAR	MONTH
174	135	1979	09
166	90	1972	02
154	90	1977	02
150	135	1979	01
148	90	1978	12
143	135	1977	01
140	90	1967	05
133	90	1966	01
132	135	1965	02
132	135	1974	12
131	90	1978	02
130	90	1969	12
130	90	1973	04
126	135	1962	04
125	135	1976	10
123	135	1970	02
122	90	1968	11
120	135	1979	03
118	135	1973	10
113	135	1970	12
113	45	1963	11
111	135	1962	12
109	135	1971	08
109	135	1972	11
108	135	1969	04
106	135	1979	11
103	45	1977	10
102	135	1962	02
101	135	1962	09
100	135	1968	09
100	90	1966	12
98	135	1966	11
97	90	1973	05
96	135	1973	06
93	90	1972	06
91	135	1969	11
91	135	1973	03
88	135	1967	09
82	135	1974	06
74	135	1968	05

Count: 40
Minimum PG: 74
Maximum PG: 174
Total: 4,682
Average: 117

TABLE 1

PEAK WIND GUSTS 45-135 DEGREES - 1980-97
MOUNT WASHINGTON OBSERVATORY

PEAK GUST (MPH)	DIR (DEG)	YEAR	MONTH
155	45	1991	04
145	90	1993	03
144	90	1985	02
134	135	1995	11
130	90	1988	10
128	135	1985	09
128	90	1984	02
123	90	1988	04
121	90	1983	04
89	90	1997	08
82	135	1992	06

Count: 11
Minimum PG: 82
Maximum PG: 155
Total: 1,379
Average: 125

TABLE 2

PEAK WIND GUSTS =>130 MPH AND 45-135 DEGREES - 1962-79
MOUNT WASHINGTON OBSERVATORY

PEAK GUST	DIR	YEAR	MONTH
174	135	1979	09
166	90	1972	02
154	90	1977	02
150	135	1979	01
148	90	1978	12
143	135	1977	01
140	90	1967	05
133	90	1966	01
132	135	1965	02
132	135	1974	12
131	90	1978	02
130	90	1969	12
130	90	1973	04

Count: 13
Minimum PG: 130
Maximum PG: 174
Total: 1,863
Average: 143

TABLE 3

After D. E. Glidden, 1998

PEAK WIND GUSTS =>130 MPH AND 45-135 DEGREES - 1980-97
MOUNT WASHINGTON OBSERVATORY

PEAK GUST	DIR	YEAR	MONTH
155	45	1991	04
145	90	1993	03
144	90	1985	02
134	135	1995	11
130	90	1988	10

Count: 5
Minimum PG: 130
Maximum PG: 155
Total: 708
Average: 142

TABLE 4

PEAK WIND GUSTS 225-320 DEGREES - 1962-79
MOUNT WASHINGTON OBSERVATORY

PEAK GUST DIR YEAR MONTH

Count: 171
Minimum PG: 59
Maximum PG: 160
Total: 17,967
Average: 105

PEAK WIND GUSTS 225-320 DEGREES - 1980-97
MOUNT WASHINGTON OBSERVATORY

PEAK GUST DIR YEAR MONTH

Count: 191
Minimum PG: 62
Maximum PG: 178
Total: 22,418
Average: 117

TABLE 5

PEAK WIND GUSTS =>130 MPH AND 225-320 DEGREES - 1962-1979
MOUNT WASHINGTON OBSERVATORY

PEAK GUST DIR YEAR MONTH

Count: 28
Minimum PG: 130
Maximum PG: 160
Total: 3,881
Average: 139

PEAK WIND GUSTS =>130 MPH AND 225-320 DEGREES - 1980-1997
MOUNT WASHINGTON OBSERVATORY

PEAK GUST DIR YEAR MONTH

Count: 56
Minimum PG: 130
Maximum PG: 178
Total: 7,968
Average: 142

TABLE 6

TRANSECT	SW	W	NW	N	NE
Rmean	1.08	0.93	0.95	0.95	1.03

$$R = \frac{vt}{v10}, \quad \text{where } R = \frac{\text{wind maxima at transect}}{\text{wind maxima at main site}}$$

vt = wind maxima at transect
v10 = wind maxima at TR 10 (main site)

FIG. 1
Ratios of wind maxima for 5 transects around the TR 10 research site, Rocky Mountain National Park (After Glidden, 1981, p. 40)

After D. E. Glidden, 1998

1998 TEXT REFERENCES

Glidden, D. E., 1974, "The Great Windstorm of 2 April 1973 on Cannon Mountain, New Hampshire," *Weatherwise*, 27 (4), 156-161.

Glidden, D. E., 1981, Summer Wind Studies Near the Alpine Visitors' Center, Rocky Mountain National Park, NPS Technical Report, Rocky Mountain Nature Association, Estes Park, CO, 53 p.

Glidden, D. E., 1982, Winter Wind Studies in Rocky Mountain National Park, NPS Technical Report, Rocky Mountain Nature Association, Estes Park, CO, 28 p.

Glidden, D. E. 1995, Field Studies of Wind Variability in Denali National Park, Alaska, NPS Technical Report, Denali National Park and Preserve, Denali Park, AK, 32 p.

Vincent, Lee, 1975, Instant Legends from the Rock Pile, New England History Press, Somersworth, NH, p. 71

UPDATED REFERENCES

Glidden, D. E., March, 2016, *Mount Washington Trends in Selected Climatological Variables*, Occasional Paper, 18 p. (1.78 MB)
http://npshistory.com/publications/wind-research/mount-washington/climatological-variables.pdf
https://irma.nps.gov/DataStore/Reference/Profile/2237707

Glidden, D. E., 2007, *Mount Washington Wind Climatology: Recent Data Analysis and Historical Changes in Summit Sensor Location*, Occasional Paper, 7 p.
http://npshistory.com/publications/wind-research/mount-washington/wind-climatology.pdf
https://irma.nps.gov/DataStore/Reference/Profile/2237709

Glidden, D. E. 2012, *University of Massachusetts Climatological Research in the White Mountains, NH 1972-73: Selected Excerpts*, Occasional Paper, 35 p. (6.6 MB)
http://npshistory.com/publications/wind-research/mount-washington/umass-climatological-research.pdf

Glidden, D. E., June 2016, *Superhurricane Winds and Extreme Gust Factors at Longs Peak and Rocky Mountain National Park,* Occasional Paper, 15 p.
http://www.npshistory.com/publications/romo/wind-research/superhurricane-2016.pdf
https://irma.nps.gov/DataStore/Reference/Profile/2237701

Glidden, D. E., April, 2016, *Mount Washington Trends in Average Station Pressure and Annual Wind Speed,* Occasional Paper, 11 p. (5.61 MB)
http://npshistory.com/publications/wind-research/mount-washington/avg-pressure-wind-speed.pdf

Glidden, D. E., 1981, *Summer Wind Studies Near the Alpine Visitors' Center, Rocky Mountain National Park*, Rocky Mountain Nature Association, Estes Park CO, 53 p.
http://npshistory.com/publications/romo/wind-research/summer-wind-studies.pdf
https://irma.nps.gov/DataStore/Reference/Profile/2237704

Glidden, D. E., 1982, *Winter Wind Studies in Rocky Mountain National Park,* Rocky Mountain Nature Association, Estes Park CO, 29 p.
http://npshistory.com/publications/romo/wind-research/winter-wind-studies.pdf