10 Wind

10.1 General Description

Montana is a windy location and during the winter there are periods when gusts reach more than 60 mph. The prevailing wind direction varies. Along the eastern border, it is from the southeast, with a west to southwest direction for much of the rest of the state east of the divide. In the west, the prevailing direction is determined by local terrain. Across much of the state, winds are so strong and constant from these directions that the trees fan to the opposite direction of the prevailing wind. Many wind farms have been established across eastern Montana.

10.2 Effectiveness of High Winds at Altitude (Wind Load)

The significance of high winds can be seen if one considers the following equation:

$P = 0.00256 * V^2 * Cd$ where, 0.00256 is the mass density of air at 0°C and normal air pressure.

P is the wind pressure in pounds per square foot (lbs ft^{-2}).

V is the wind speed in miles per hour (mph).

Cd is the shape coefficient number. Most standing structures including cars have a Cd of ~2.0.

For example, Plywood, has a Cd =1.2 and a 4x8 foot sheet would experience 9.8 pounds of wind pressure (with winds blowing directly on it at sea-level) at 10 mph, 61 pounds at 25 mph, 245 pounds at 50 mph, 980 pounds at 100 mph, and 3,920 pounds at 200 mph! Even at Montana's higher elevations where air is not as dense as at sea-level, pressure on any structure increases quickly with increasing winds.

At roughly 10,000 feet for the same example, the results are as following: at 10 mph 7 pounds, at 25 mph 43 pounds, at 50 mph 172 pounds, at 100 mph 688 pounds, and at 200 mph 2752 pounds.

AD is roughly equal to **[0.348444 * P - h * (0.00252 * t - 0.020582)] / (273.15 + t)**, where

AD = Air Density in kg/m^3

P = Air pressure in (mb)

h = Relative Humidity (%)

t = Air Temperature (° C)

For t = 20° C, P = 1013.25 mb, and h = 50%, AD = 1.2 kg m^{-3}

However, wind pressure also varies on structures that are not solid, such as snow fences.

In Montana, the wind often blows. Average and peak wind speeds in and along the Rocky Mountain Front, and to the lee of island ranges are higher than in surrounding locations. This has been borne out through many years of wind data collection, and anecdotal reports.

10.3 Wind power and pressure differences due to elevation.

As one rises from sea level, the air generally becomes less dense. This is mainly due to lower air pressure and higher elevations. On average, the air density is summarized at different elevations in Table 1. As can be seen in the figure, the pressure (given in Pascals and pounds per square foot) exerted on a flat surface by a 70 mph wind is quite different from sea level to the elevation of Great Falls. Thus, the wind pressure of a 70 mph wind at Great Falls is 15 percent less than an equal wind at sea level. This same wind velocity exerts a pressure force that is 10 percent less at Logan Pass than at Great Falls. This same effect can also be seen with a 10 mph wind, as noted in Table 2.

Table 10.1. Power and pressure of a 70 mph wind at standard atmosphere:

	Elevation	Density	Power	Wind Pressure
Sea Level	0	1.2935	39664 W m^{-2}	634 Pa (13.2 lb ft^{-2})
Great Falls	1115m/3658ft	1.10	33731 W m^{-2}	539 Pa (11.3 lb ft^{-2})
Deep Creek	1628m/5340ft	1.05	32197 W m^{-2}	514 Pa (10.7 lb ft^{-2})
Logan Pass	2065m/6775ft	.995	30511 W m^{-2}	487 Pa (10.2 lb ft^{-2})

Table 10.2. Wind Power and Pressure of a 10 mph wind:

	Elevation	Power	Wind Pressure
Sea Level	0	115.5 W m^{-2}	12.9 Pa (0.27 lb ft^{-2})
Great Falls	1115m/3658ft	98.2 W m^{-2}	11.0 Pa (0.23 lb ft^{-2})
Deep Creek	1628m/5340ft	93.8 W m^{-2}	10.5 Pa (0.22 lb ft^{-2})
Logan Pass	2065m/6775ft	88.9 W m^{-2}	9.95 Pa (0.21 lb ft^{-2})

Looking at the average annual winds at several locations throughout central Montana, elevation and location play a role in the average speed. Density and air pressure decrease as altitude increases. Average wind speeds are highest in areas nearest mountains. Table 3, using a U.S. Standard Atmosphere, summaries average wind speeds, power potential from these speeds, and the mean wind pressure at select locations in central Montana.

Table 10.3. Wind Power and Pressure of annual average winds:

	Elevation	Std Prs	Density	Mean wind	Power	Wind Pressure
East Glacier	1463m/4800ft	849 mb	1.07	14.2 mph/6.35 ms^{-1}	274 W m^{-2}	21.6 Pa (0.45 lb ft^{-2}
Cut Bank	1175m/3855ft	880 mb	1.095	13.0 mph/5.8 ms^{-1}	214 W m^{-2}	18.4 Pa (0.38 lb ft^{-2}
Deep Creek	1628m/5340ft	830 mb	1.05	18.0 mph/8 ms^{-1}	538 W m^{-2}	33.6 Pa (0.70 lb ft^{-2}
Havre	792m/2598ft	924 mb	1.15	10.3 mph/4.6 ms^{-1}	112 W m^{-2}	11.1 Pa (0.23 lb ft^{-2}
Great Falls	1115m/3658ft	888 mb	1.10	12.4 mph/5.5 ms^{-1}	183 W m^{-2}	16.6 Pa (0.35 lb ft^{-2}
Lewistown	1270m/4167ft	876 mb	1.08	9.6 mph/4.3 ms^{-1}	86 W m^{-2}	10.0 Pa (0.21 lb ft^{-2}
Judith Gap	1415m/4643ft	852 mb	1.073	12.0 mph/5.4 ms^{-1}	169 W m^{-2}	15.6 Pa (0.33 lb ft^{-2}

Along with altitude, temperature also plays a role in the pressure exerted by a given wind speed. Tables 4 and 5 compare the wind pressure exerted by various wind speeds, to that of Great Falls. These tables also list the equivalent wind speed necessary at each location to exert the same wind pressure that would be measured at Great Falls. Note the differences between the cooler versus the warmer temperatures for the resultant wind pressure. Also, note the variances in wind speeds at the different locations.

Table 10.4. Equivalent wind speeds, velocity pressure, given a Great Falls wind speed and 40°F:

Wind Speed	Wind Pressure	CTB	East Glacier	Deep Creek	Logan Pass	Havre	Sea Level
50 mph	279 Pa (5.8 lb ft^{-2})	50 mph	51	52	53	49	47
60 mph	400 Pa (8.3 lb ft^{-2})	60 mph	61	62	64	58	56
80 mph	710 Pa (14.8 lb ft^{-2})	80 mph	82	83	85	78	75
100 mph	1110 Pa (23.2 lb ft^{-2})	101 mph	103	105	108	98	94

Table 10.5. Equivalent wind speeds, velocity pressure, given a Great Falls wind speed and 70°F:

Wind Speed	Wind Pressure	CTB	East Glacier	Deep Creek	Logan Pass	Havre	Sea Level
50 mph	262 Pa (5.5 lb ft^{-2})	50 mph	51	52	53	49	47
60 mph	375 Pa (7.8 lb ft^{-2})	60 mph	61	62	64	58	56
80 mph	670 Pa (14.0 lb ft^{-2})	80 mph	81	82	84	79	75
100 mph	1045 Pa (21.8 lb ft^{-2})	100 mph	102	103	106	99	95

So, during a winter Chinook, a 60 mph wind at Great Falls would have the same velocity pressure of a 62 mph wind over Marias Pass. The same effect would be felt in the summertime, however the actual velocity pressure of a 60 mph wind would be less in the summer.

Put another way, at Great Falls and Marias Pass, a 60 mph wind in the cool months has the same velocity pressure (8.3 lb ft^{-2} Great Falls and 7.8 lb ft^{-2} Marias Pass) of a 62 mph wind in the warm months. Conversely, a 60 mph wind at 70°F has the same velocity pressure of a 58 mph wind in the winter (14.8 lb ft^{-2} Great Falls and 13 lb ft^{-2} Marias Pass). In the cool months, an 80 mph at Great Falls is equivalent to an 82 mph in at 70°F (14.0 lb ft^{-2}), while the same 80 mph wind in the warm months has the same velocity

pressure of a 78 mph wind in the winter. Similar conditions prevail at Marias Pass, with a three mph change over the seasons. Figure 1 illustrates different velocity pressures given the wind speed and temperature. One can see how the wind pressure decreases with increasing temperature.

Figure 2 shows how the pressure force of an 80 mph wind compares with other locations with different elevation and temperature.

Figure 1. Wind Velocity Pressure force of Wind Speeds at varying Temperatures at Great Falls.

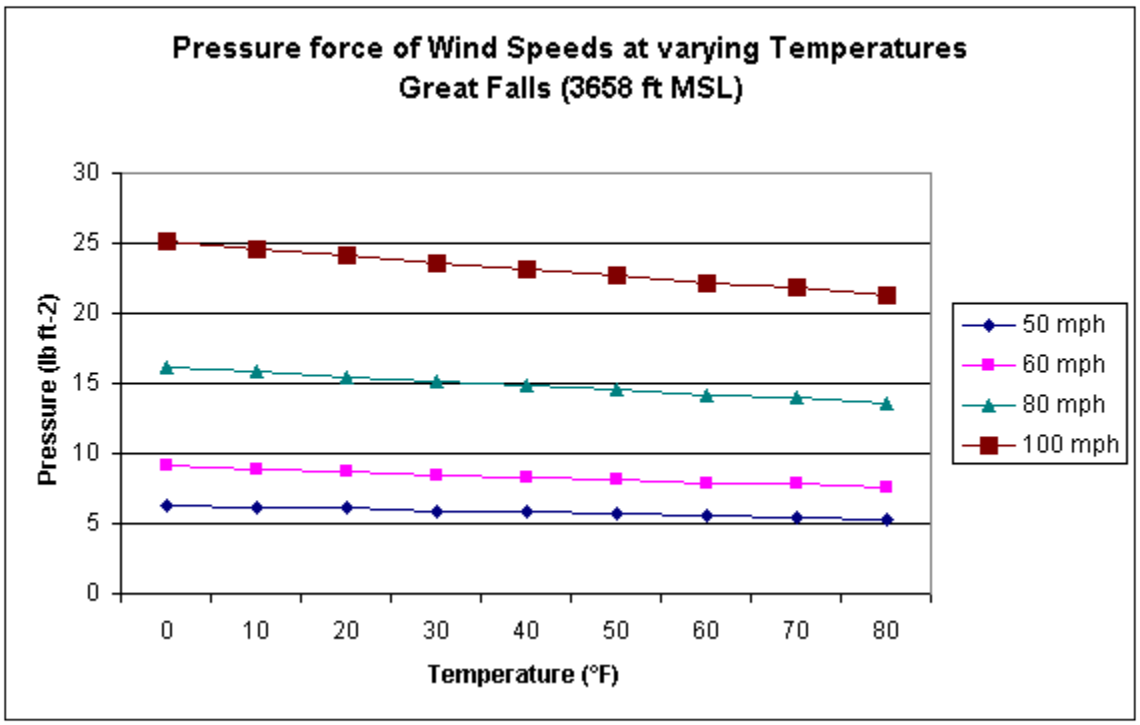
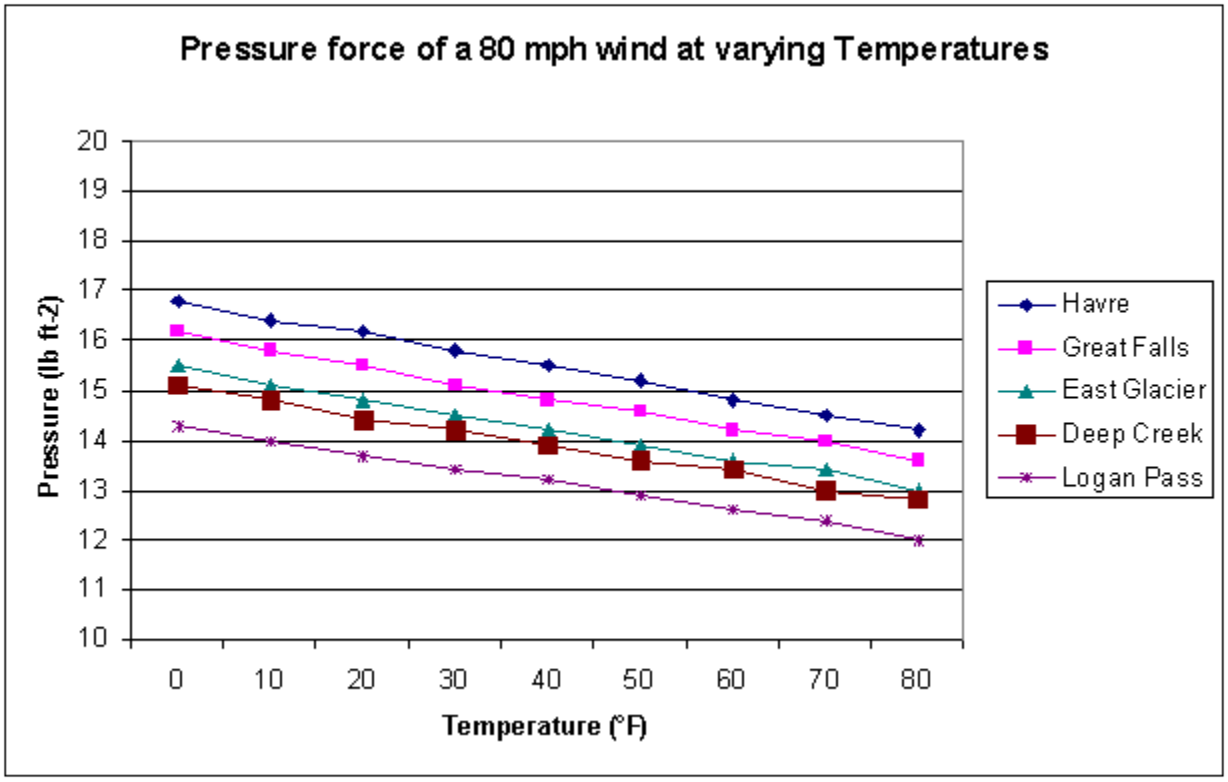


Figure 2. Pressure force of an 80 mph wind at different locations with varying temperature.



Formulas used in this document:

Ft to m = *3.2808
Mph to ms^{-1} = *.44704
Pa to lb ft^{-2} = *.02088
In Hg to mb Hg = *.0295

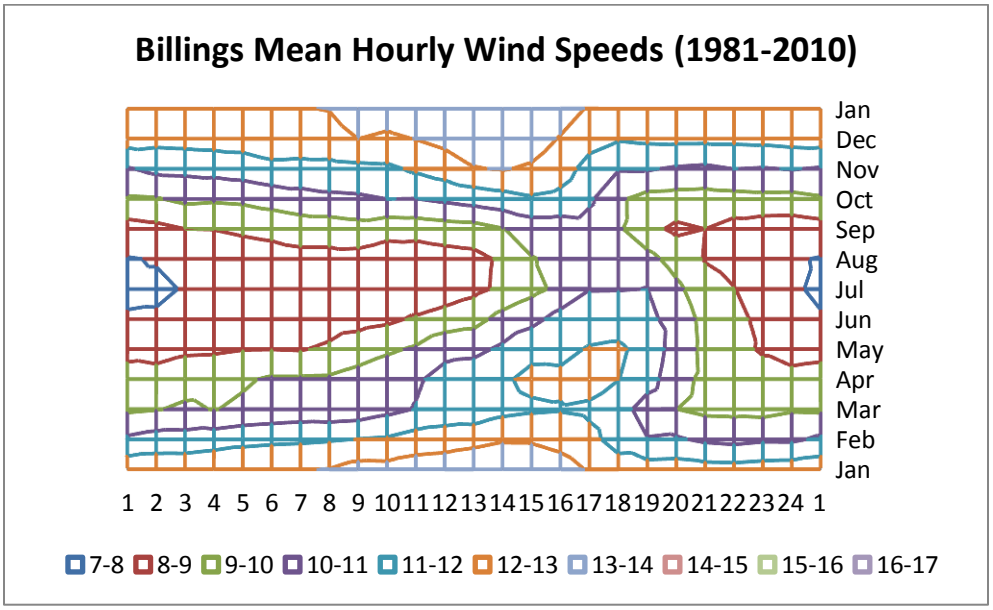
Power formula:
$P \sim \rho U^3$
Where: P = Power (W m^{-2})
ρ = air density (kg m^{-2})
U = wind velocity (m s^{-1})

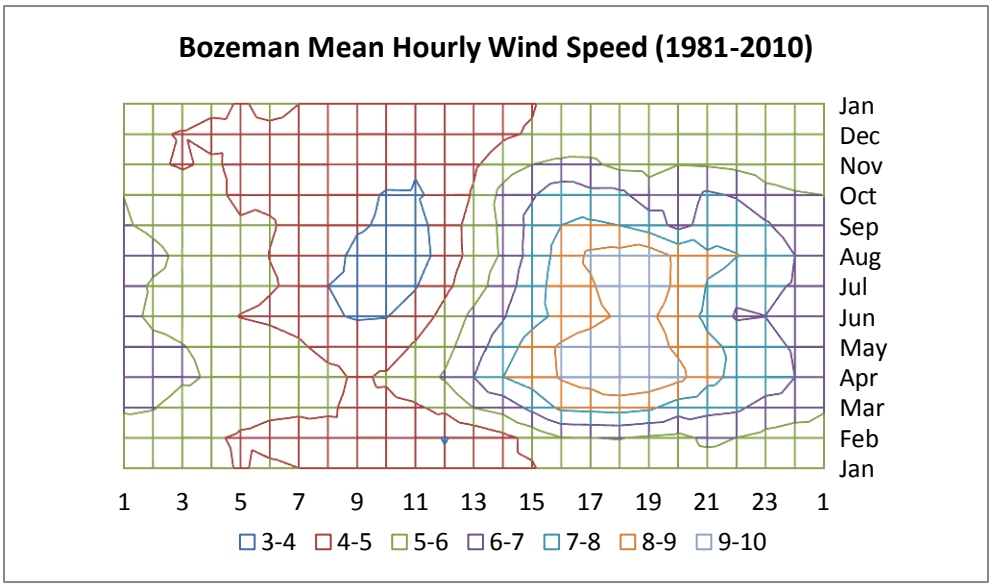
Dynamic Pressure:
$P = .5 \rho V^2$
Where: ρ = air density (kg m^{-2})
V = wind velocity (m s^{-1})

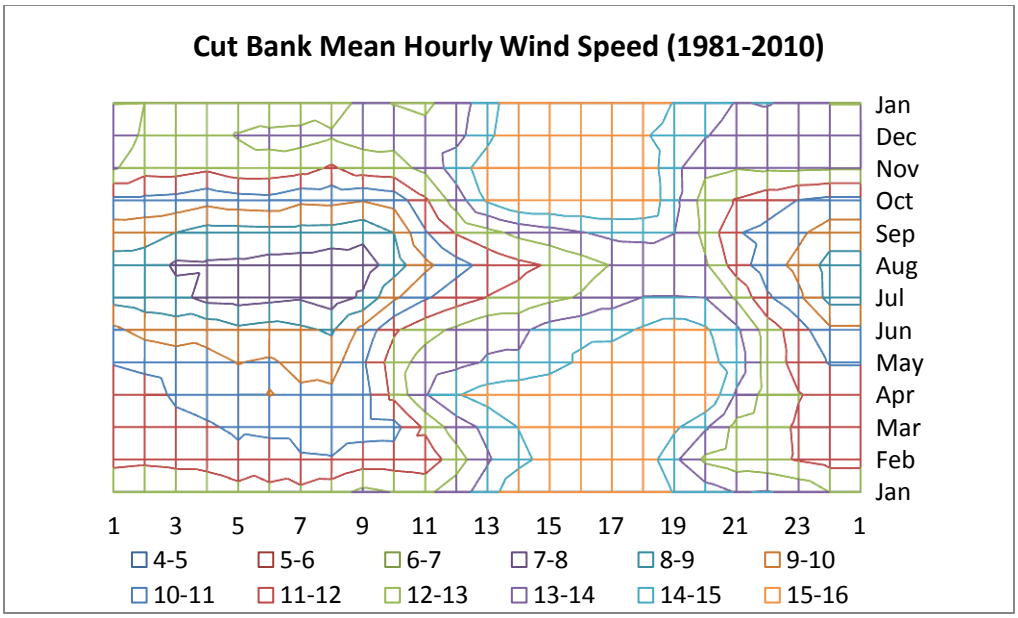
10.4 Mean Hourly winds

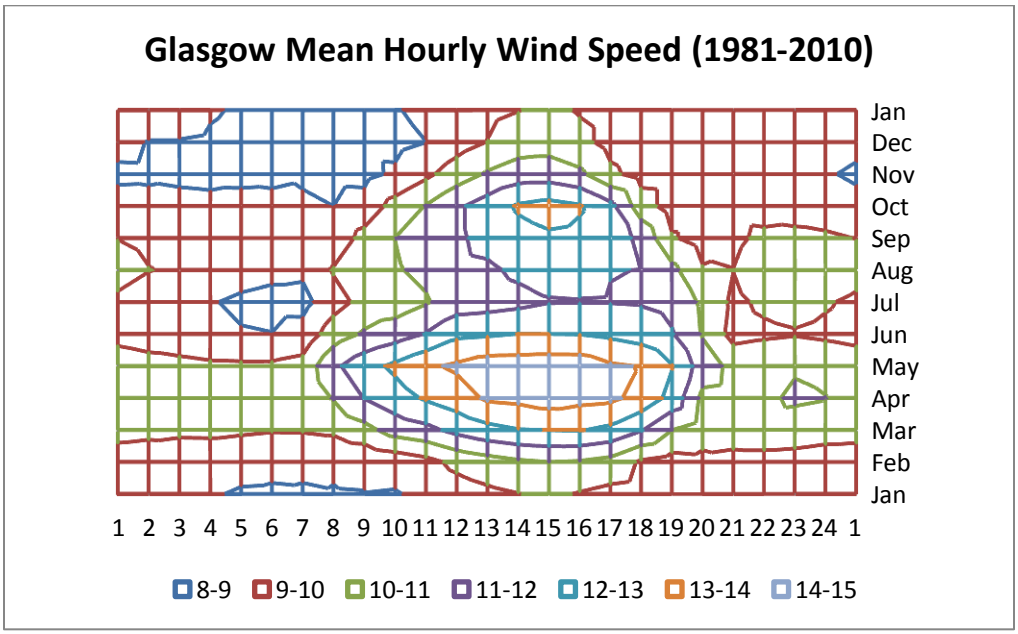
Hourly winds measured at airports are two or three minute averages of three second samples. These are the sustained winds. In many cases, gusts are instantaneous values.

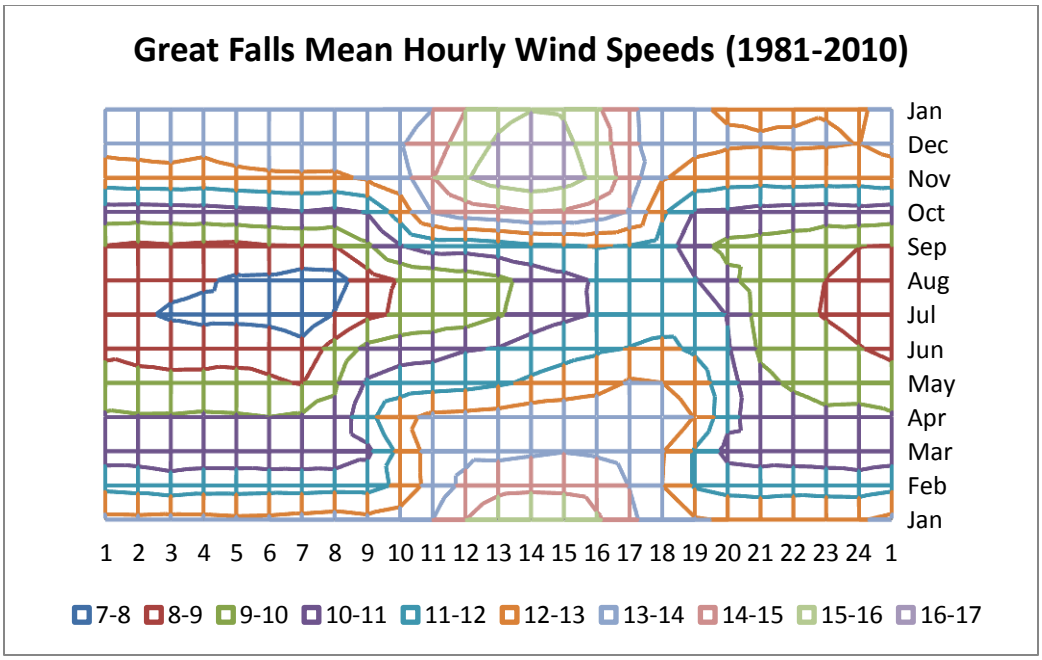
The following figures show mean hourly wind speed at several locations across the state. In general, the weakest winds occur in the mornings and strongest in early to mid-afternoon. The season for the strongest winds varies across the state. The speeds are in miles per hour.

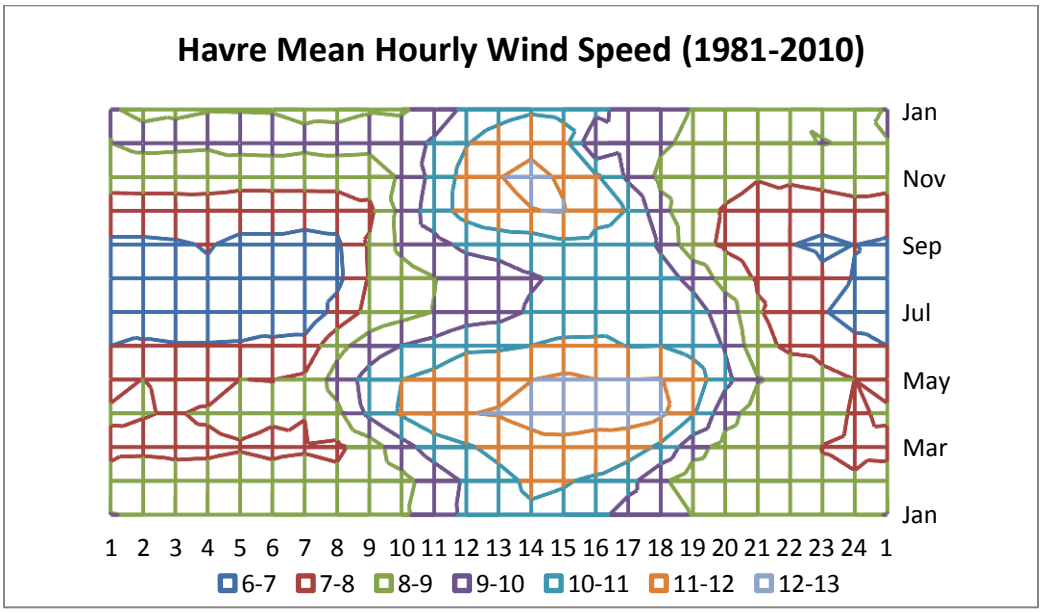


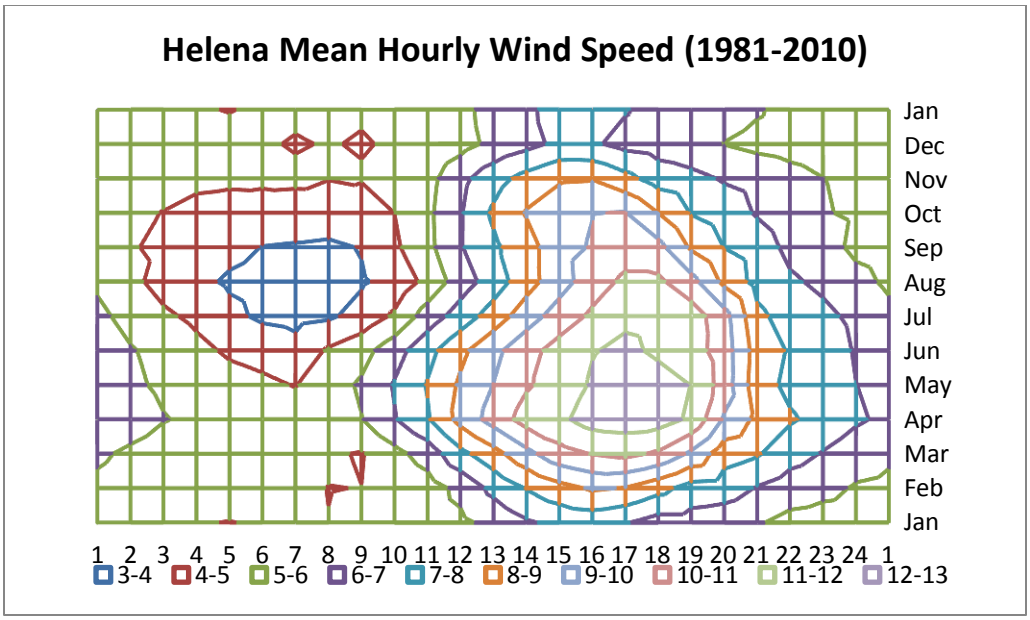


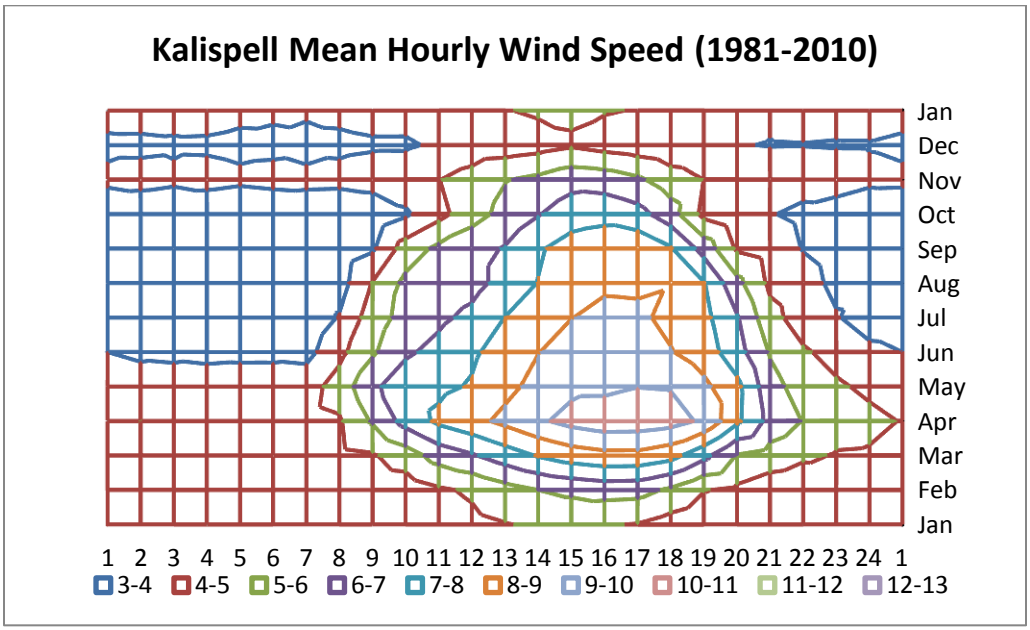

Cut Bank Mean Hourly Wind Speed (1981-2010)
Jan
Dec
Nov
Oct
Sep
Aug
Jul
Jun
May
Apr
Mar
Feb
Jan
1 3 5 7 9 11 13 15 17 19 21 23 1
4-5 5-6 6-7 7-8 8-9 9-10
10-11 11-12 12-13 13-14 14-15 15-16

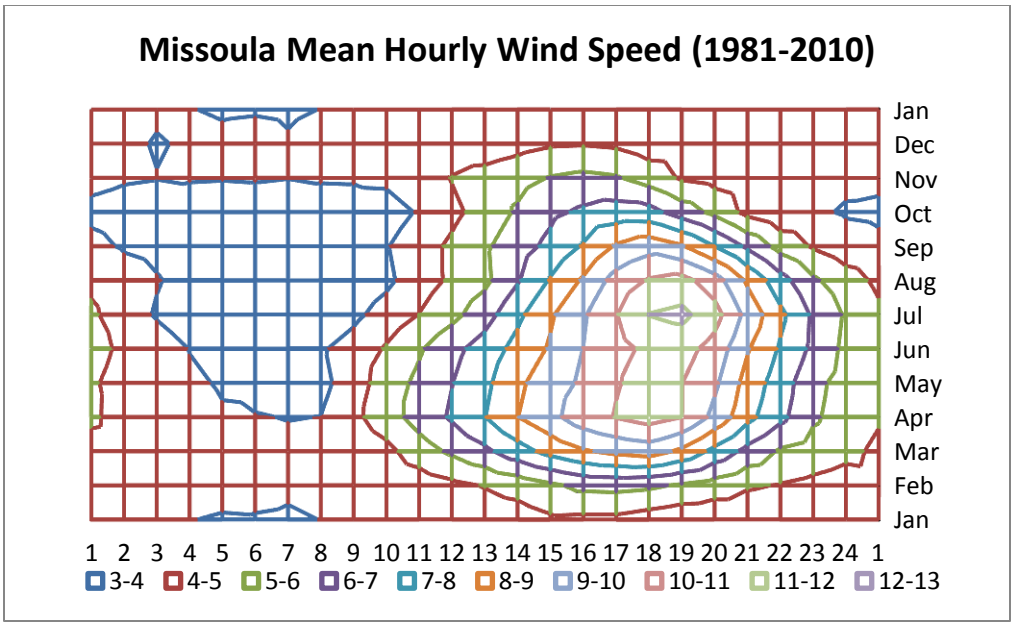

Glasgow Mean Hourly Wind Speed (1981-2010)
Jan
Dec
Nov
Oct
Sep
Aug
Jul
Jun
May
Apr
Mar
Feb
Jan
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 1
8-9 9-10 10-11 11-12 12-13 13-14 14-15


Great Falls Mean Hourly Wind Speeds (1981-2010)
Jan
Dec
Nov
Oct
Sep
Aug
Jul
Jun
May
Apr
Mar
Feb
Jan
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 1
7-8 8-9 9-10 10-11 11-12 12-13 13-14 14-15 15-16 16-17


Havre Mean Hourly Wind Speed (1981-2010)
Jan
Nov
Sep
Jul
May
Mar
Jan
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 1
6-7 7-8 8-9 9-10 10-11 11-12 12-13

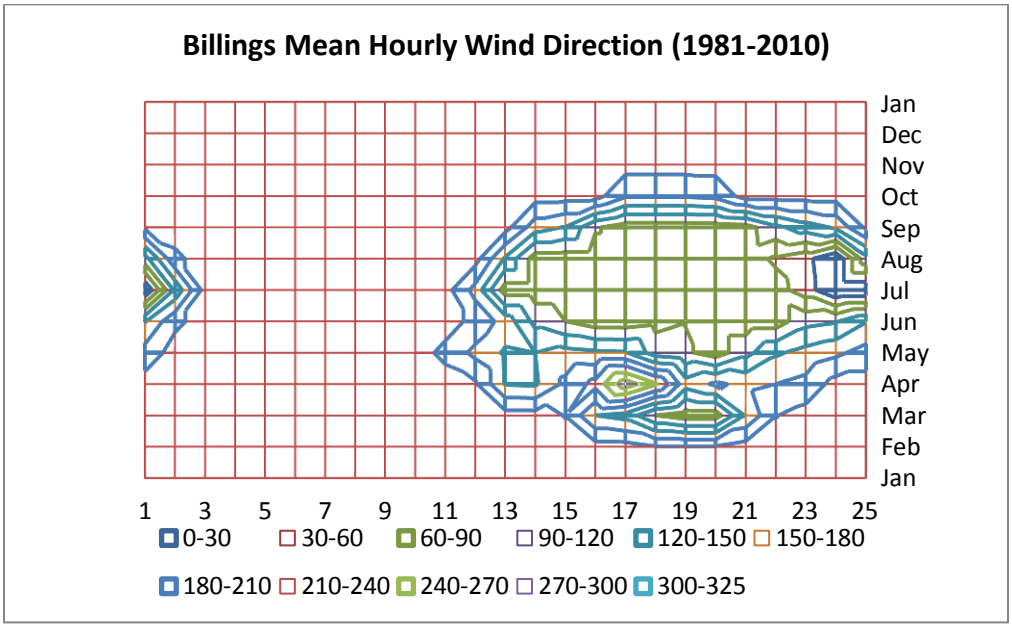

Helena Mean Hourly Wind Speed (1981-2010)
Jan
Dec
Nov
Oct
Sep
Aug
Jul
Jun
May
Apr
Mar
Feb
Jan
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 1
3-4 4-5 5-6 6-7 7-8 8-9 9-10 10-11 11-12 12-13

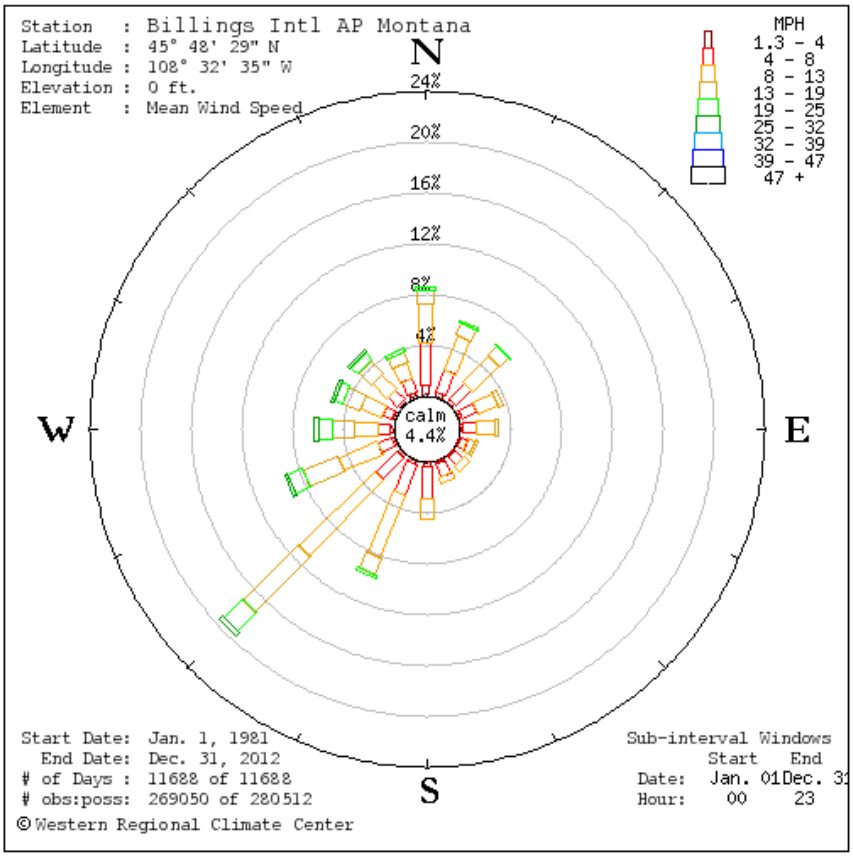

Kalispell Mean Hourly Wind Speed (1981-2010)
Jan
Dec
Nov
Oct
Sep
Aug
Jul
Jun
May
Apr
Mar
Feb
Jan
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 1
3-4 4-5 5-6 6-7 7-8 8-9 9-10 10-11 11-12 12-13


Missoula Mean Hourly Wind Speed (1981-2010)
Jan
Dec
Nov
Oct
Sep
Aug
Jul
Jun
May
Apr
Mar
Feb
Jan
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 1
3-4
4-5
5-6
6-7
7-8
8-9
9-10
10-11
11-12
12-13

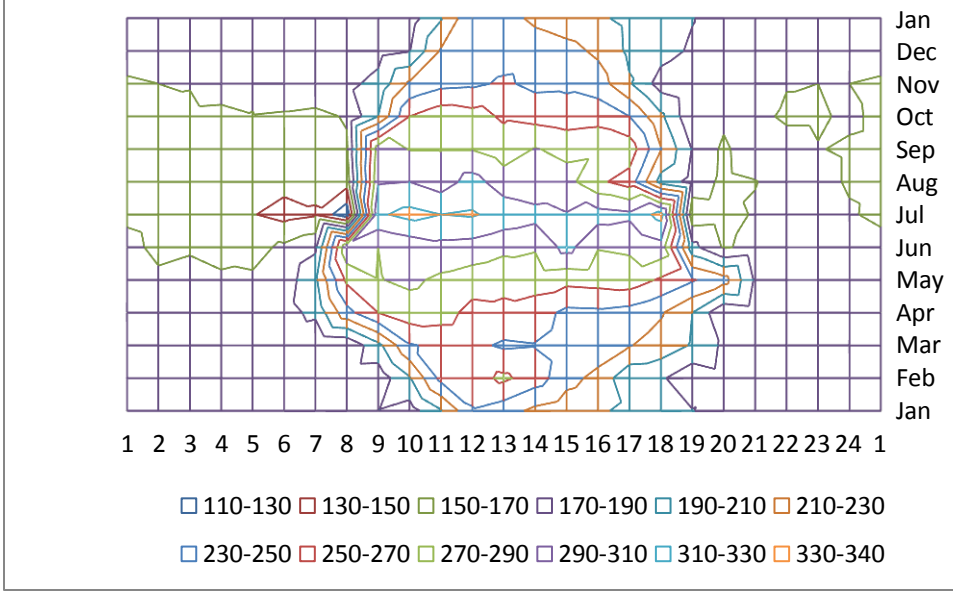
10.5 Mean Hourly Wind Direction and Wind Roses

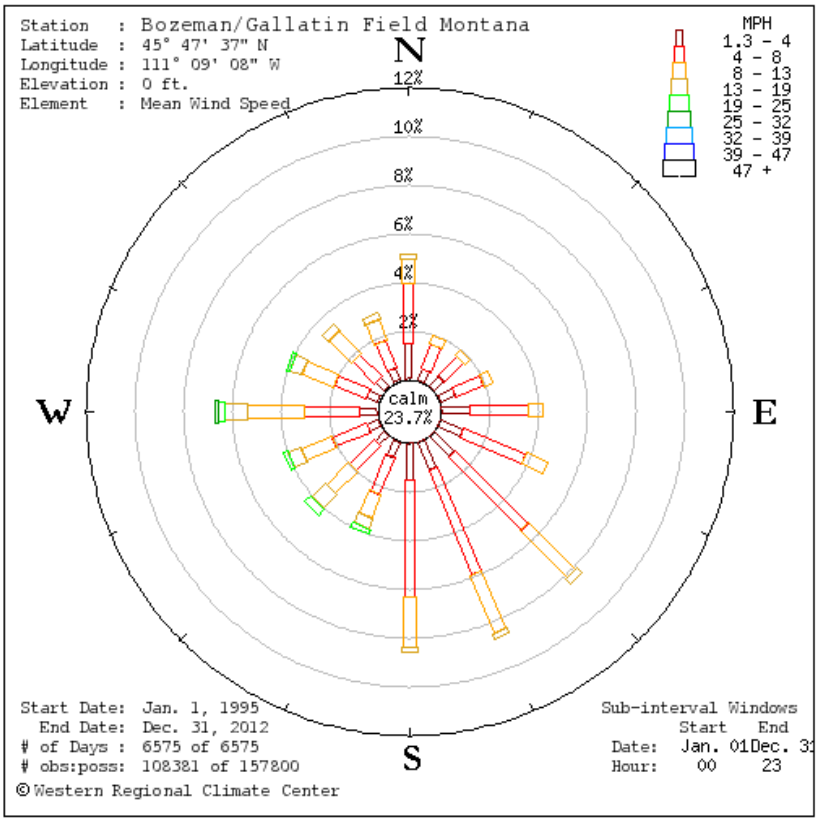
For the following figures, a depiction of wind directions by hour and month are shown.

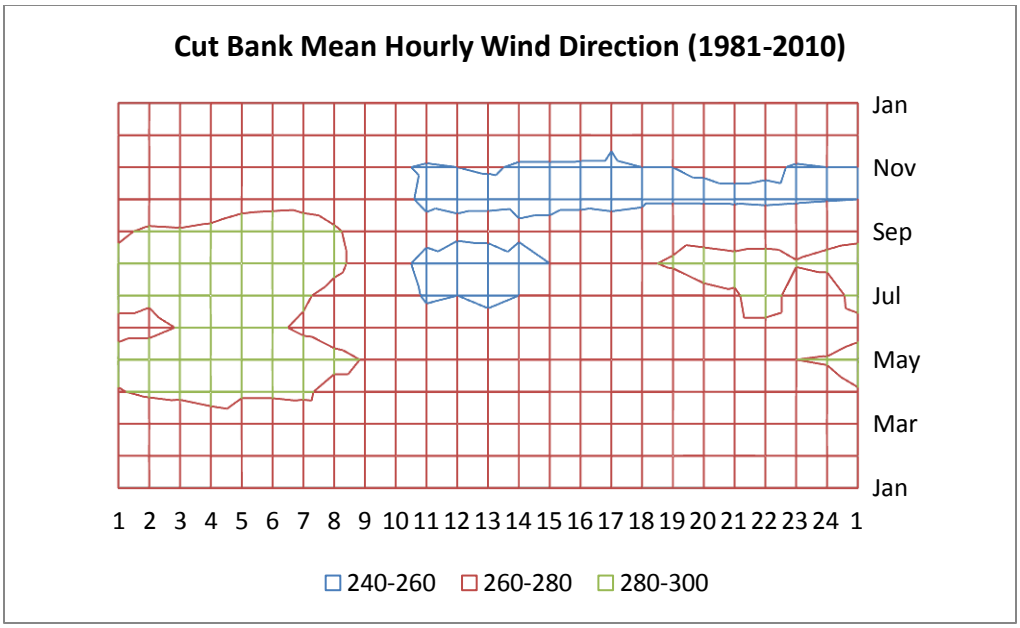


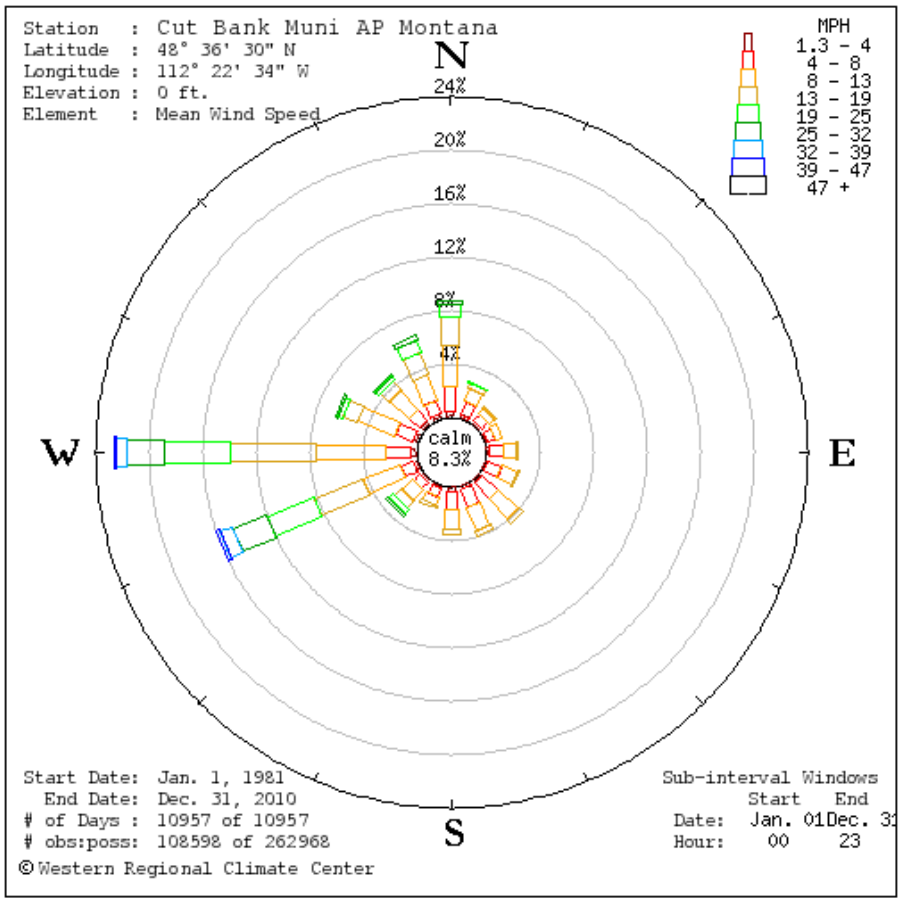


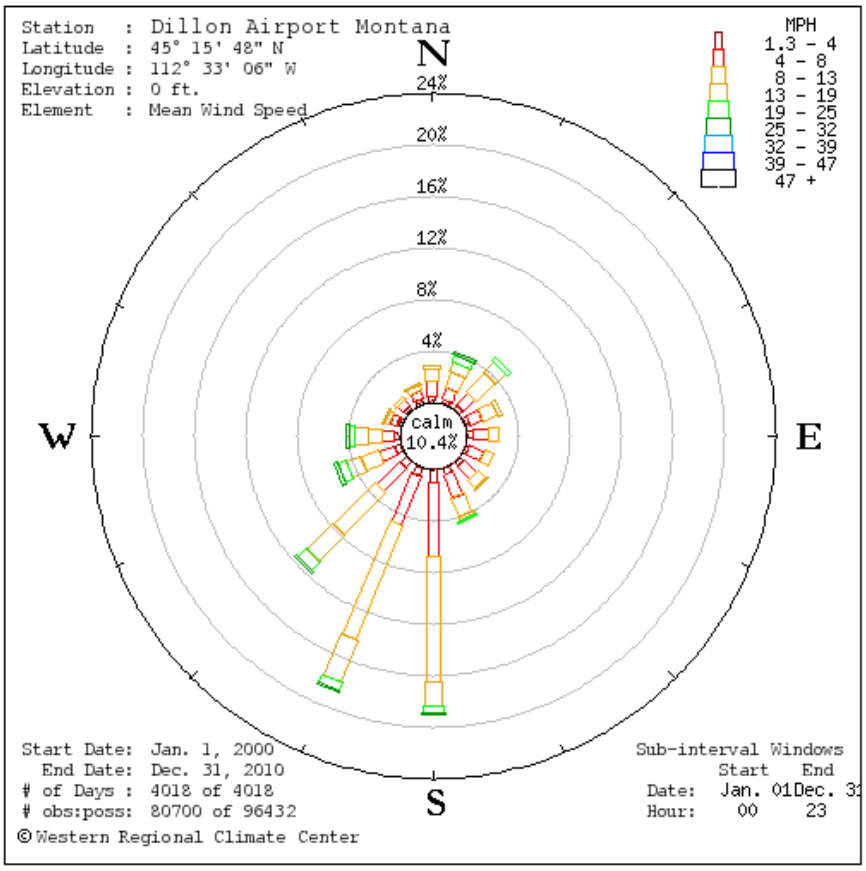
Bozeman Mean Hourly Wind Direction (1981-2010)

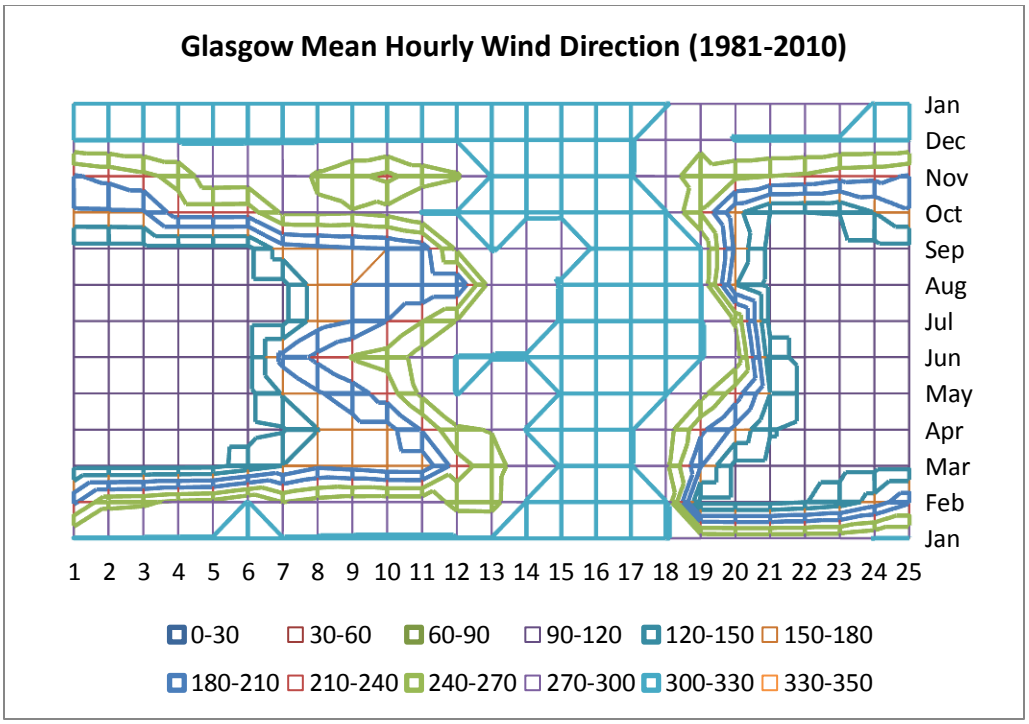


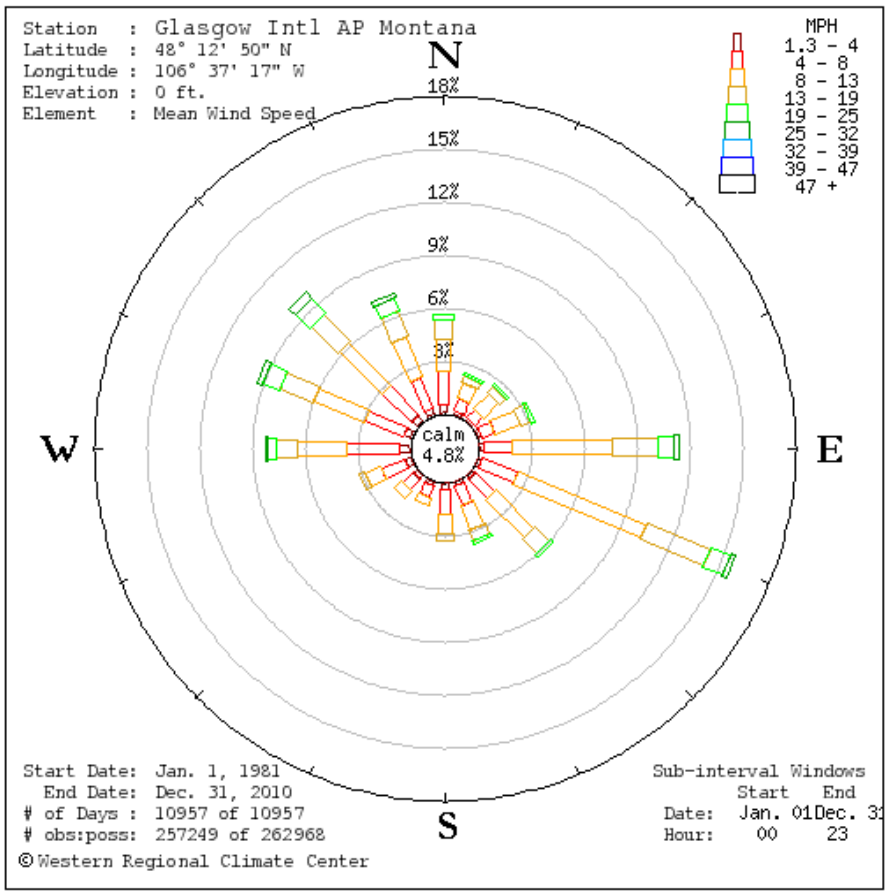


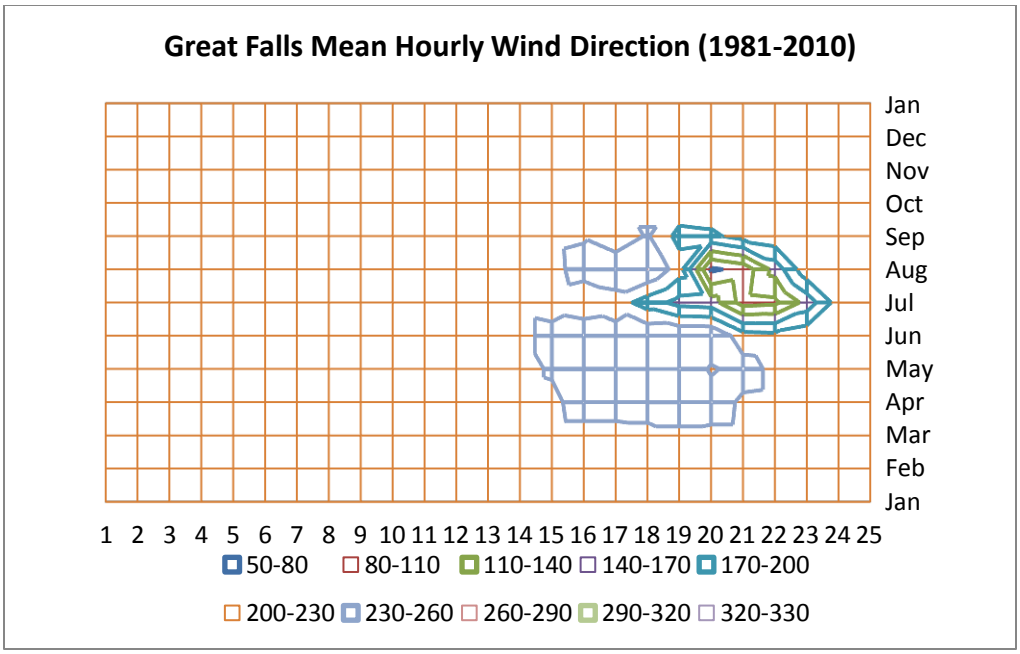

Cut Bank Mean Hourly Wind Direction (1981-2010)
Jan
Nov
Sep
Jul
May
Mar
Jan
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 1
240-260
260-280
280-300

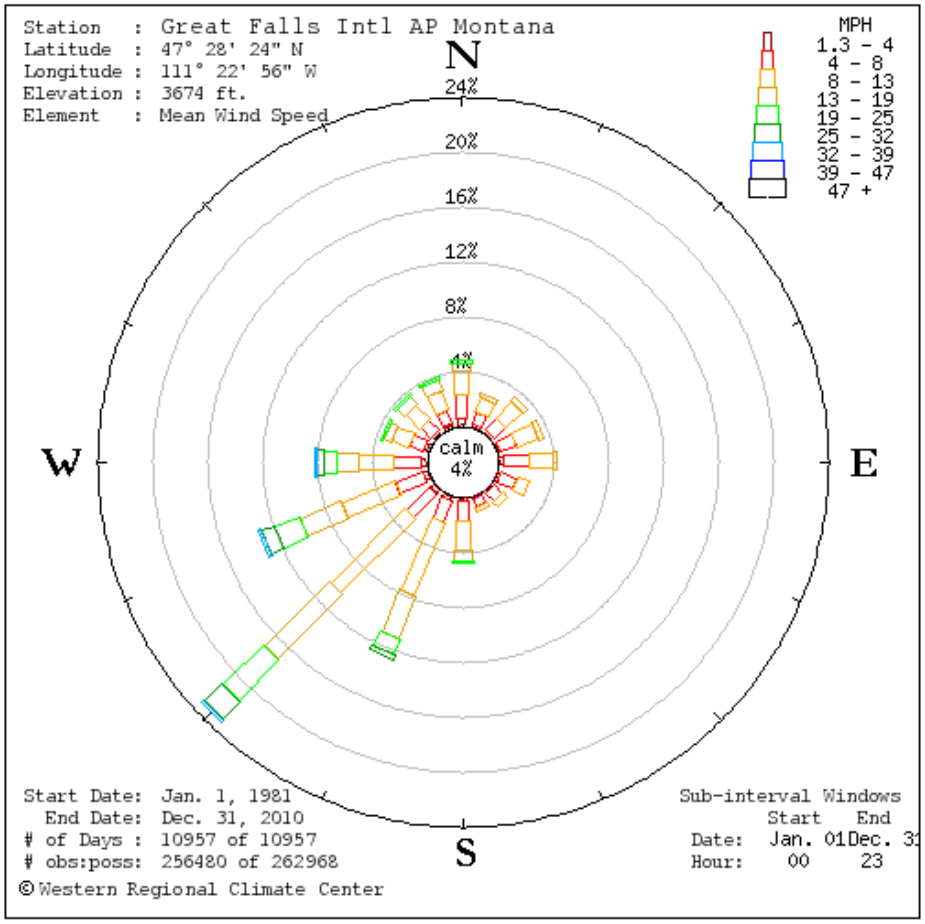

Station : Cut Bank Muni AP Montana
Latitude : 48° 36' 30" N
Longitude : 112° 22' 34" W
Elevation : 0 ft.
Element : Mean Wind Speed
MPH
1.3 - 4
4 - 8
8 - 13
13 - 19
19 - 25
25 - 32
32 - 39
39 - 47
47 +
N
24%
20%
16%
12%
8%
4%
W
E
S
calm
8.3%
Start Date: Jan. 1, 1981
End Date: Dec. 31, 2010
# of Days : 10957 of 10957
obs:poss: 108598 of 262968
Sub-interval Windows
Start End
Date: Jan. 01 Dec. 31
Hour: 00 23
©Western Regional Climate Center

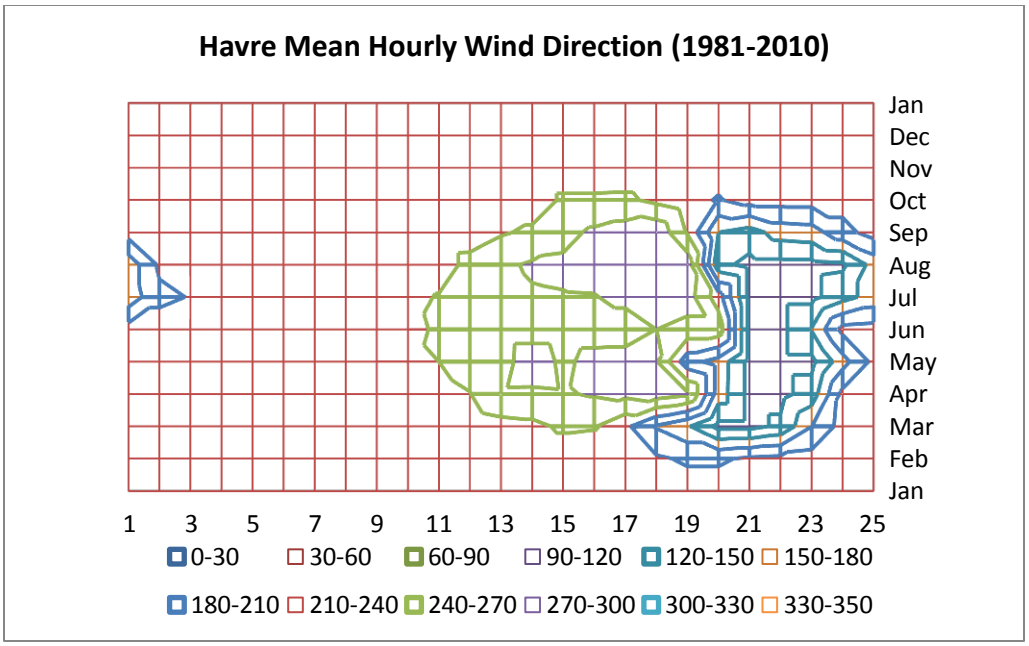

Station : Dillon Airport Montana
Latitude : 45° 15' 48" N
Longitude : 112° 33' 06" W
Elevation : 0 ft.
Element : Mean Wind Speed
MPH
1.3 - 4
4 - 8
8 - 13
13 - 19
19 - 25
25 - 32
32 - 39
39 - 47
47 +
N
E
S
W
24%
20%
16%
12%
8%
4%
calm
10.4%
Start Date: Jan. 1, 2000
End Date: Dec. 31, 2010
# of Days : 4018 of 4018
obs:poss: 80700 of 96432
Sub-interval Windows
Start End
Date: Jan. 01 Dec. 31
Hour: 00 23
©Western Regional Climate Center

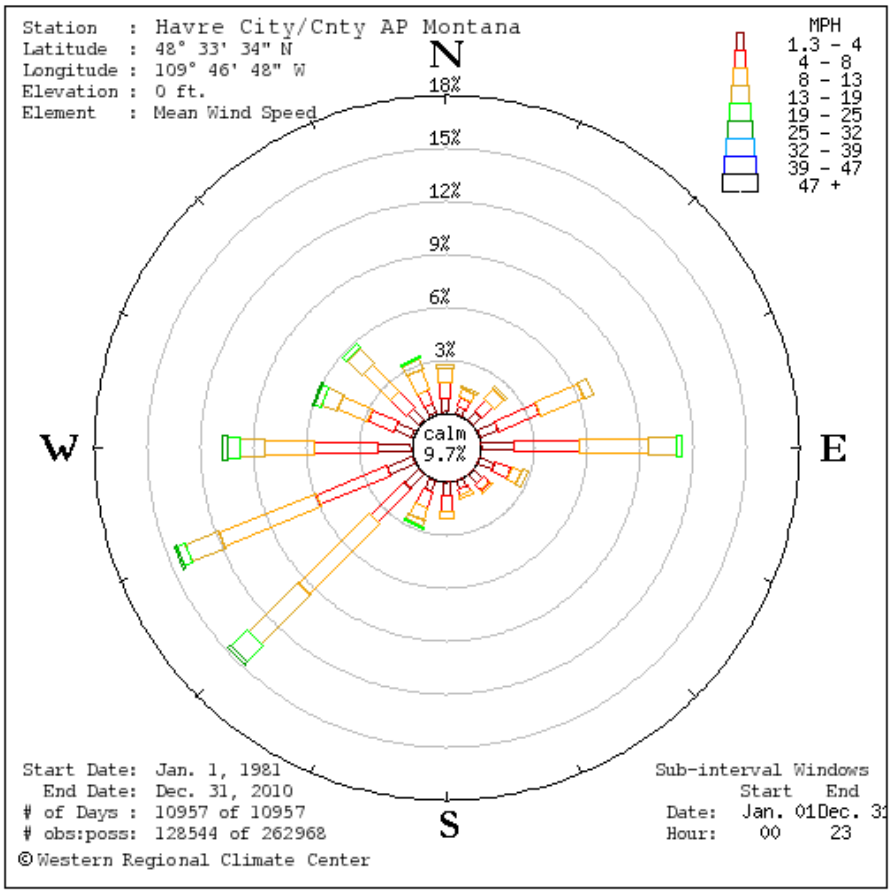

Glasgow Mean Hourly Wind Direction (1981-2010)
Jan
Dec
Nov
Oct
Sep
Aug
Jul
Jun
May
Apr
Mar
Feb
Jan
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
0-30
30-60
60-90
90-120
120-150
150-180
180-210
210-240
240-270
270-300
300-330
330-350

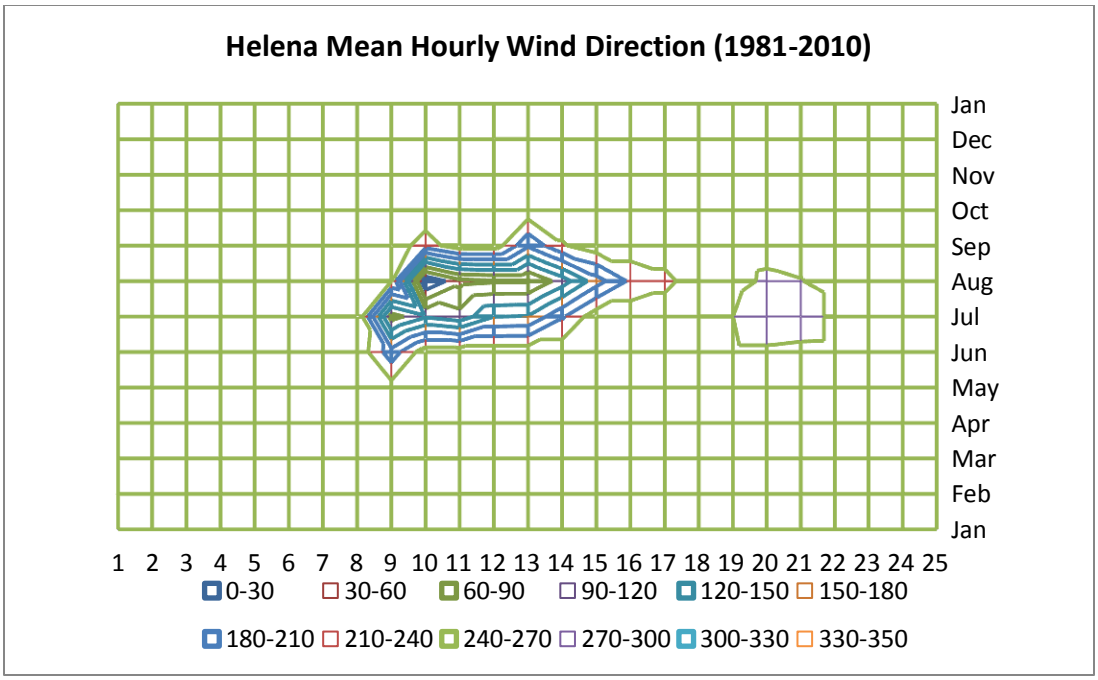

Station : Glasgow Intl AP Montana
Latitude : 48° 12' 50" N
Longitude : 106° 37' 17" W
Elevation : 0 ft.
Element : Mean Wind Speed
MPH
1.3 - 4
4 - 8
8 - 13
13 - 19
19 - 25
25 - 32
32 - 39
39 - 47
47 +
N
E
S
W
18%
15%
12%
9%
6%
3%
calm
4.8%
Start Date: Jan. 1, 1981
End Date: Dec. 31, 2010
# of Days : 10957 of 10957
obs:poss: 257249 of 262968
Sub-interval Windows
Start End
Date: Jan. 01 Dec. 31
Hour: 00 23
©Western Regional Climate Center

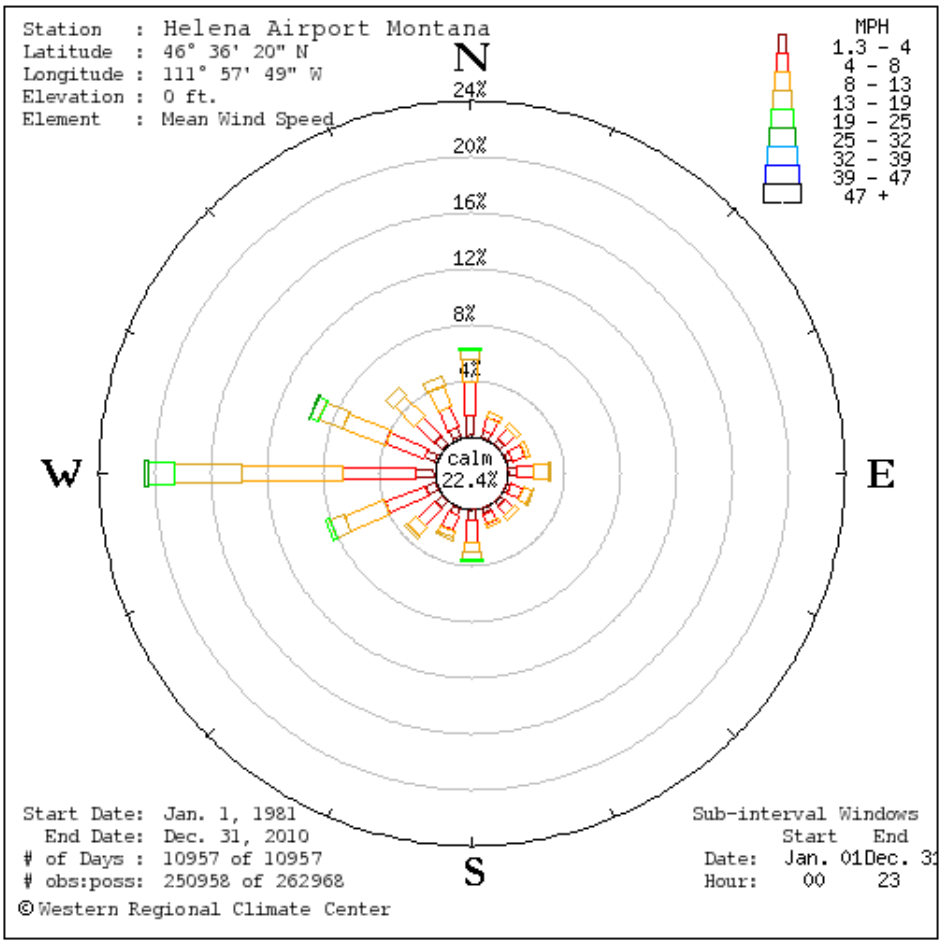

Great Falls Mean Hourly Wind Direction (1981-2010)
Jan
Dec
Nov
Oct
Sep
Aug
Jul
Jun
May
Apr
Mar
Feb
Jan
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
50-80
80-110
110-140
140-170
170-200
200-230
230-260
260-290
290-320
320-330

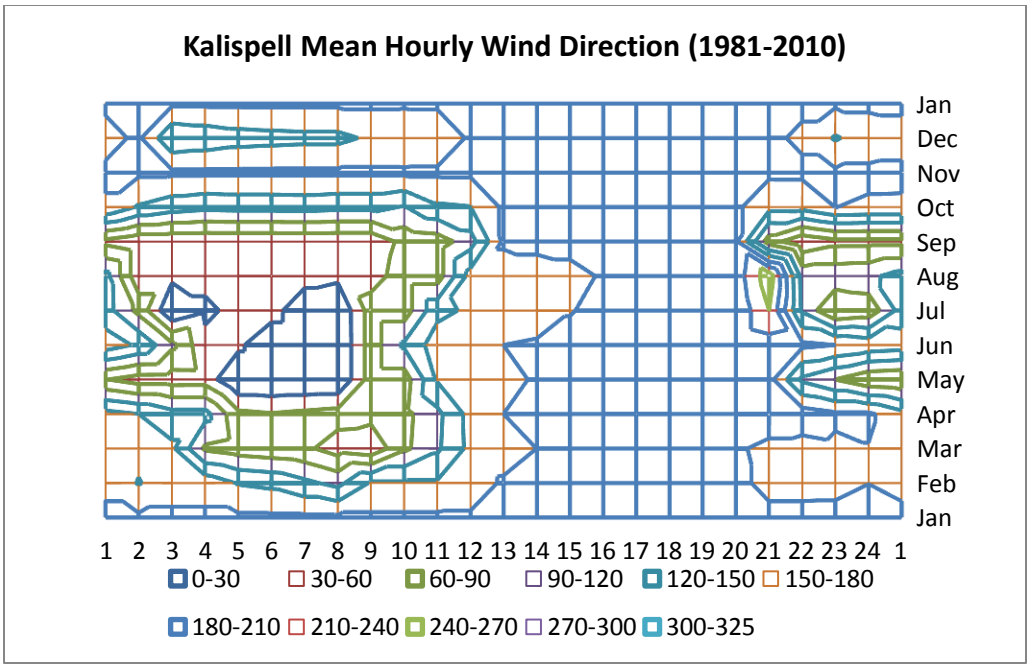

Station : Great Falls Intl AP Montana
Latitude : 47° 28' 24" N
Longitude : 111° 22' 56" W
Elevation : 3674 ft.
Element : Mean Wind Speed
MPH
1.3 - 4
4 - 8
8 - 13
13 - 19
19 - 25
25 - 32
32 - 39
39 - 47
47 +
N
24%
20%
16%
12%
8%
4%
W
E
S
calm
4%
Start Date: Jan. 1, 1981
End Date: Dec. 31, 2010
# of Days : 10957 of 10957
obs:poss: 256480 of 262968
Sub-interval Windows
Start End
Date: Jan. 01 Dec. 3
Hour: 00 23
©Western Regional Climate Center

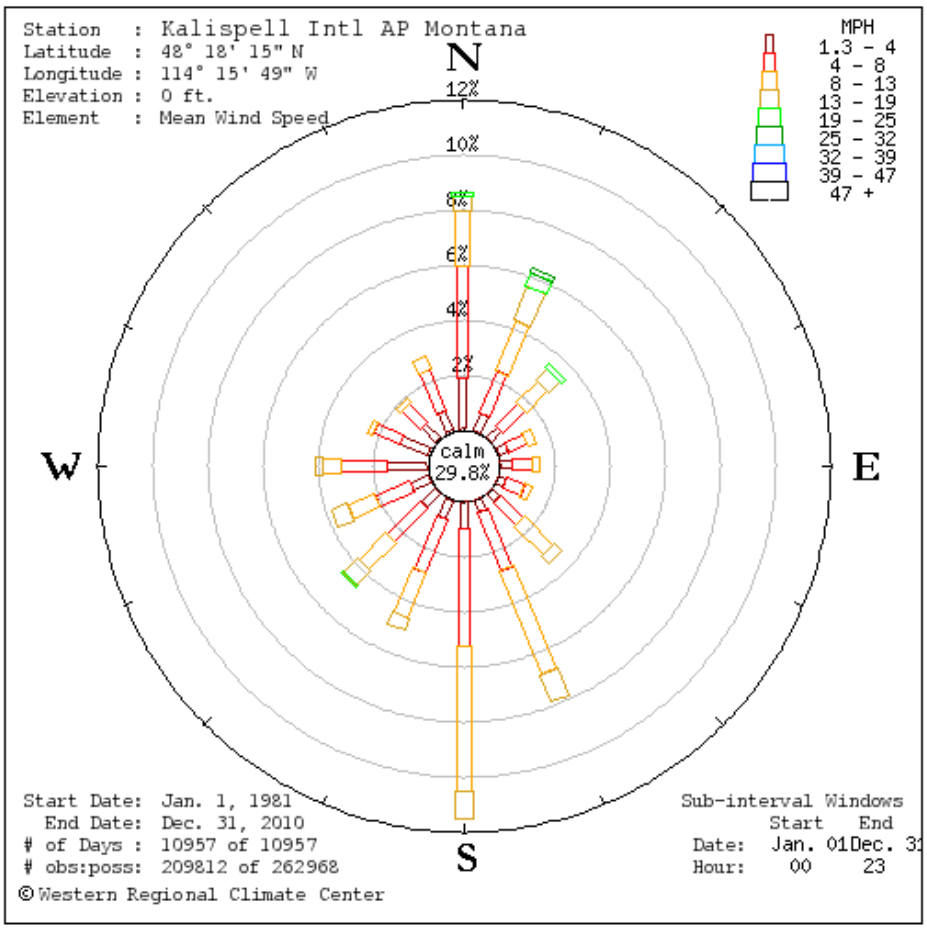

Havre Mean Hourly Wind Direction (1981-2010)
Jan
Dec
Nov
Oct
Sep
Aug
Jul
Jun
May
Apr
Mar
Feb
Jan
1 3 5 7 9 11 13 15 17 19 21 23 25
0-30 30-60 60-90 90-120 120-150 150-180
180-210 210-240 240-270 270-300 300-330 330-350

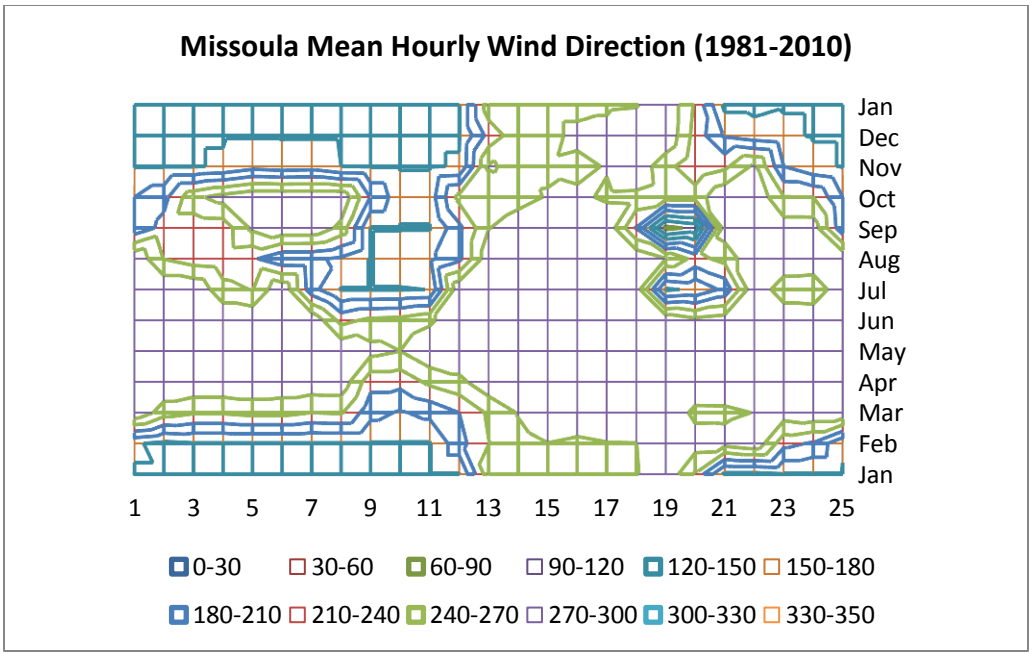

Station : Havre City/Cnty AP Montana
Latitude : 48° 33' 34" N
Longitude : 109° 46' 48" W
Elevation : 0 ft.
Element : Mean Wind Speed
MPH
1.3 - 4
4 - 8
8 - 13
13 - 19
19 - 25
25 - 32
32 - 39
39 - 47
47 +
N
E
S
W
18%
15%
12%
9%
6%
3%
calm
9.7%
Start Date: Jan. 1, 1981
End Date: Dec. 31, 2010
# of Days : 10957 of 10957
obs:poss: 128544 of 262968
Sub-interval Windows
Start End
Date: Jan. 01 Dec. 31
Hour: 00 23
©Western Regional Climate Center

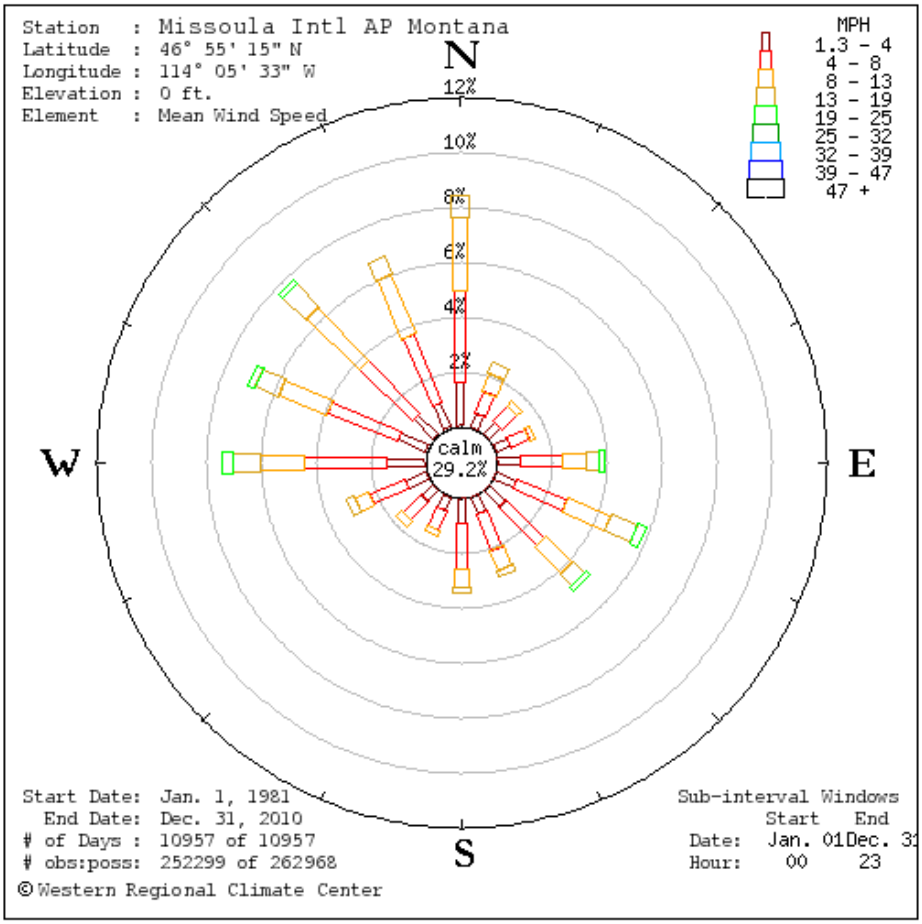

Helena Mean Hourly Wind Direction (1981-2010)
Jan
Dec
Nov
Oct
Sep
Aug
Jul
Jun
May
Apr
Mar
Feb
Jan
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
0-30
30-60
60-90
90-120
120-150
150-180
180-210
210-240
240-270
270-300
300-330
330-350

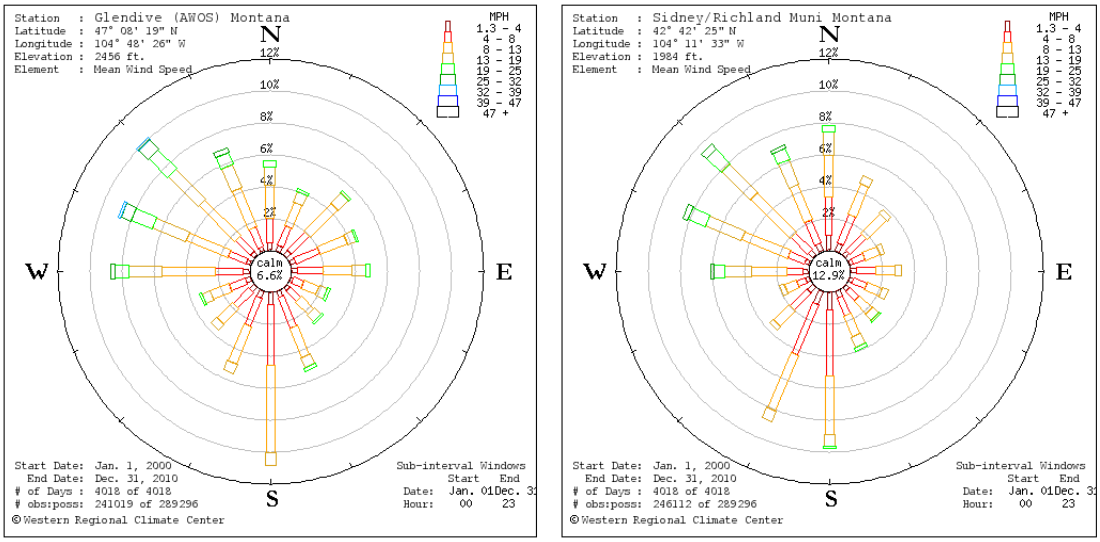

Station : Helena Airport Montana
Latitude : 46° 36' 20" N
Longitude : 111° 57' 49" W
Elevation : 0 ft.
Element : Mean Wind Speed
MPH
1.3 - 4
4 - 8
8 - 13
13 - 19
19 - 25
25 - 32
32 - 39
39 - 47
47 +
N
24%
20%
16%
12%
8%
4%
W
E
S
calm
22.4%
Start Date: Jan. 1, 1981
End Date: Dec. 31, 2010
# of Days : 10957 of 10957
obs:poss: 250958 of 262968
Sub-interval Windows
Start End
Date: Jan. 01 Dec. 31
Hour: 00 23
©Western Regional Climate Center


Kalispell Mean Hourly Wind Direction (1981-2010)
Jan
Dec
Nov
Oct
Sep
Aug
Jul
Jun
May
Apr
Mar
Feb
Jan
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 1
0-30
30-60
60-90
90-120
120-150
150-180
180-210
210-240
240-270
270-300
300-325


Station : Kalispell Intl AP Montana
Latitude : 48° 18' 15" N
Longitude : 114° 15' 49" W
Elevation : 0 ft.
Element : Mean Wind Speed
MPH
1.3 - 4
4 - 8
8 - 13
13 - 19
19 - 25
25 - 32
32 - 39
39 - 47
47 +
N
E
S
W
12%
10%
8%
6%
4%
2%
calm
29.8%
Start Date: Jan. 1, 1981
End Date: Dec. 31, 2010
# of Days : 10957 of 10957
obs:poss: 209812 of 262968
©Western Regional Climate Center
Sub-interval Windows
Start End
Date: Jan. 01 Dec. 31
Hour: 00 23


Missoula Mean Hourly Wind Direction (1981-2010)
Jan
Dec
Nov
Oct
Sep
Aug
Jul
Jun
May
Apr
Mar
Feb
Jan
1 3 5 7 9 11 13 15 17 19 21 23 25
0-30 30-60 60-90 90-120 120-150 150-180
180-210 210-240 240-270 270-300 300-330 330-350


Station : Missoula Intl AP Montana
Latitude : 46° 55' 15" N
Longitude : 114° 05' 33" W
Elevation : 0 ft.
Element : Mean Wind Speed
MPH
1.3 - 4
4 - 8
8 - 13
13 - 19
19 - 25
25 - 32
32 - 39
39 - 47
47 +
N
E
S
W
12%
10%
8%
6%
4%
2%
calm
29.2%
Start Date: Jan. 1, 1981
End Date: Dec. 31, 2010
# of Days : 10957 of 10957
obs:poss: 252299 of 262968
Sub-interval Windows
Start End
Date: Jan. 01 Dec. 31
Hour: 00 23
©Western Regional Climate Center



10.6 Chinooks and other strong winds

Residents of Montana know that the wind can, and will blow. This is especially true east of the divide. It is difficult to determine from historic storm data whether a high wind during the summer was the result of a severe thunderstorm, microburst, or a larger scale weather system. Since 1994, there have been four deaths and 34 injuries due to high winds. A summer maxima in high wind events is related to severe thunderstorms, while a winter maxima is due to strong synoptic-scale winds that are often associated with Chinook conditions. Strong Chinook winds of over 140 mph have caused considerable damage along the Rocky Mountain front, but no deaths and only a few injuries. Figure 10.6.1 shows the peak wind gusts by county. Most of the high gusts across the eastern third of Montana (away from the Rocky Mountain Front) occurred during summer thunderstorms. Many of the gusts west of the divide also occurred during strong cold fronts or with summer thunderstorms. Strong winter-time Chinook winds occur with regularity each winter. Figure 10.6.2 shows the monthly average number of threshold wind speeds along the Rocky Mountain Front. December and January have the greatest number of high wind events (greater than 58 mph gusts).

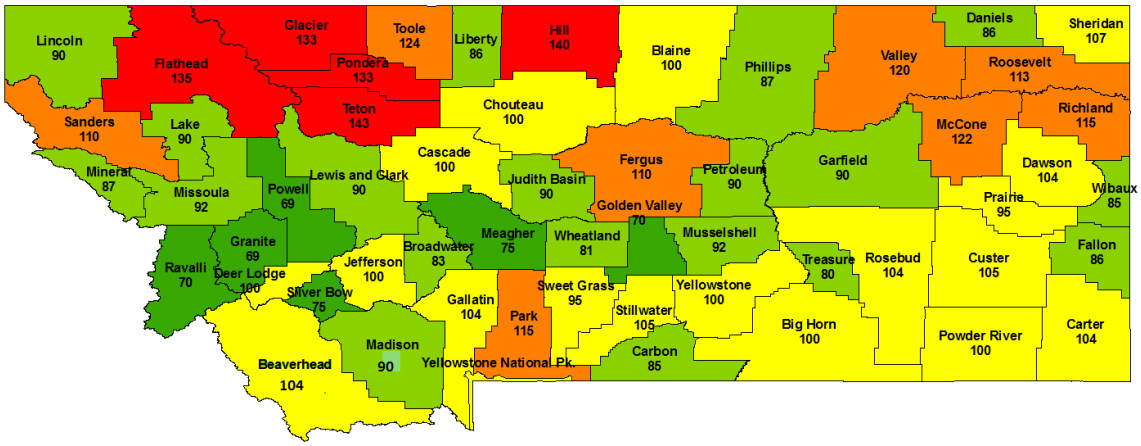


Figure 10.6.1. Peak Wind gusts across Montana, by county.

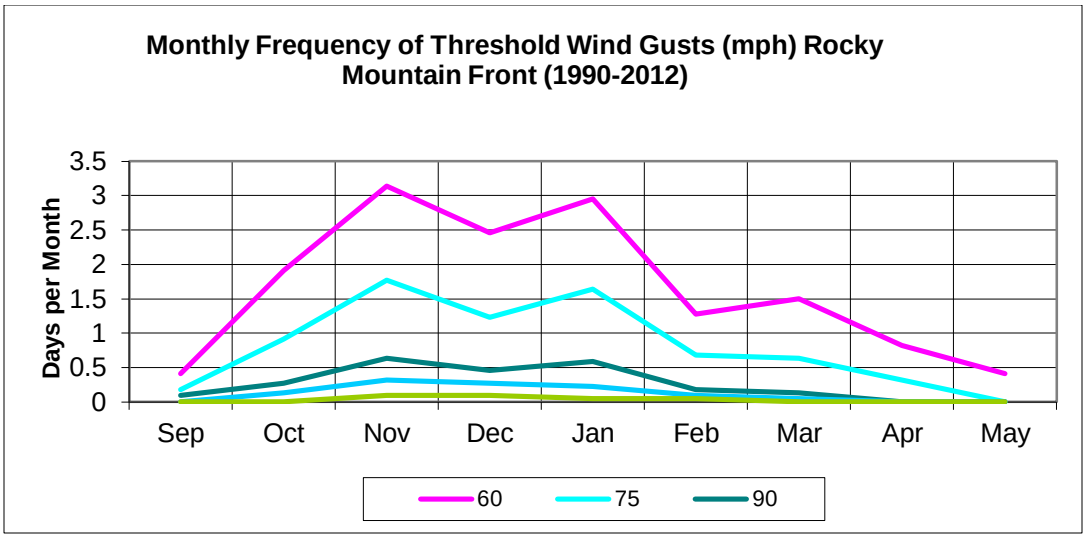


Figure 10.6.2. Monthly number of days of threshold wind speeds along the Rocky Mountain Front.

How often do Chinooks occur? It depends upon how a Chinook wind is defined. Looking at the daily wind speed averages of greater than 20 mph, this could be considered a Chinook, or strong downslope wind. Figure 10.6.3 shows the frequency of these winds at Cut Bank and Great Falls. There is not a clear trend as to whether the frequency of these wind speeds is increasing or decreasing. However, at Cut Bank, the average number of days with wind speeds of 20 mph or greater is 53 days per year. At Great Falls, the recent average has been about 26 days per year, with the longer-term average about 40 days. Figure 12 depicts the number of days with peak winds greater than 30 mph. Here the trend is for a greater number of windy days along the northern Rocky Mountain Front.

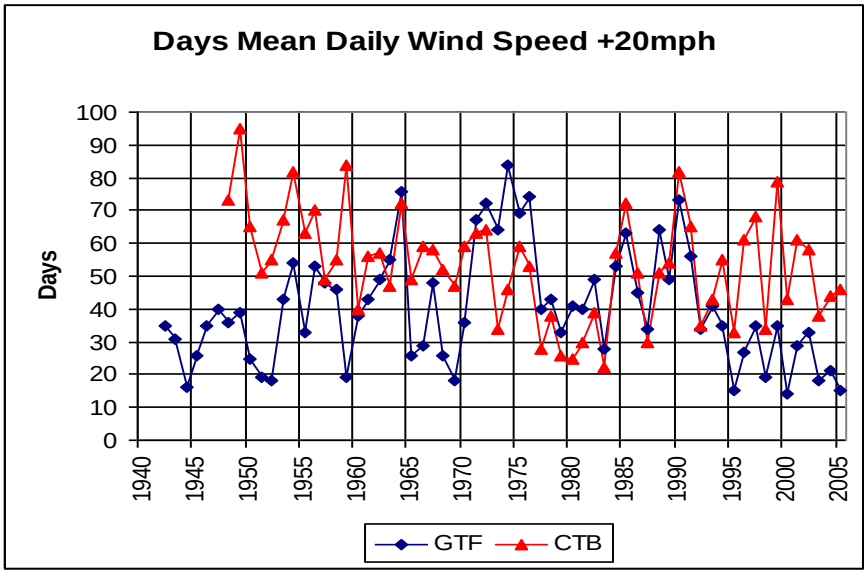


Figure 10.6.3. Annual number of days with mean wind speeds of 20 mph or greater at Great Falls and Cut Bank.

1/16/2015

Wind extremes range as high as 143 mph at Miller Colony during a Chinook condition in February 2002.

Tables 10.6, 10.7 and 10.8 show some wind average and gust information for the state.

Table 10.6 Montana wind records (mph)

Record Highest	143	21 Feb 2002	Miller Colony
Highest Average Annual	17.7		Logan Pass
Lowest Average Annual	2.3		Condon

Table 10.7 Montana monthly record wind gusts (mph)

Jan	133	29/1979	Heart Butte
Feb	143	21/2002	Miller Colony
Mar	117 103	12/2007 11/2007	Logan Pass Choteau N
Apr	139 90	09/2014 22/1960	Logan Pass Lake Blaine
May	110 84	03/2010 24/1966	Logan Pass Miles City
Jun	138	30/1979	Havre N
Jul	140	30/1957	NE Hill County
Aug	104	01/2013	Polaris (Bvhd)
Sep	109	29/1999	East Glacier near
Oct	109 106	31/2009 17/2003 17/2005	Pendroy 17 WNW Babb Logan Pass
Nov	126 124	13/2006 15/2006	Logan Pass Choteau
Dec	130 117	31/2008 24/1992	Logan Pass Dupuyer

Table 10.8 Peak wind gusts at select cities (mph)

Billings	85	7 Jul 2007
Bozeman	75	24 Nov 1958
Butte	62	29 Aug 2006
Cut Bank	95	20 Jan 1989
Dillon	72	22 Jul 2008
Glasgow	83	7 Jul 1974
Glendive	98	2 Aug 1985
Great Falls	92	27 Jan 1970
Havre	90	28 Jan 1961
Helena	84	3 Jul 1975
Kalispell	75	Oct 2009
Lewistown	81	19 Jun 2013
Livingston	115	20 Nov 1962
Miles City	91	4 Jul 2000
Missoula	79	23 Jun 2012
Sidney	91	12 Jul 2011
Wolf Point	72	24 Jun 2012

Some monthly have particularly high wind averages. In November, Deep Creek RAWS has an average speed of 24.8 mph while Logan Pass has an average of 22.5 mph.

Table 10.9 summarizes the average windiest and calmest months of record in the state. Wind records generally began statewide in 1936.

Table 10.9 Windiest and calmest months of record, and average monthly wind speed (mph) in Montana

Windiest and Calmest Months of record, and avg monthly wind in Montana					
Month	**Windiest**	**Year**	**Calmest**	**Year**	**Avg**
January	13.3 mph	1972	6.3 mph	1941	9.2
February	13.0 mph	1976	5.8 mph	2010	13.0
March	12.4 mph	1955	7.4 mph	1947	9.6
April	12.9 mph	1970	8.2 mph	1941	9.8
May	11.6 mph	1964	7.8 mph	1940	9.7
June	11.0 mph	1973	7.5 mph	2009	8.7
July	9.6 mph	1949	7.2 mph	1941	8.1
August	10.2 mph	1964	7.0 mph	1941	8.1
September	13.0 mph	1948	6.4 mph	2008	8.0
October	11.4 mph	1967	6.9 mph	1940	8.7
November	11.6 mph	1990	6.8 mph	1940	9.2
December	12.0 mph	1978	7.4 mph	2010	9.0
Year	10.5 mph	1964	7.5 mph	1938	8.9

10.7 Average Seasonal Wind Speeds

Wind speeds vary across the state, not only by location, but seasonally as well. The lightest average winds are in western valleys. Winds are strongest over the northern Rockies and adjacent eastern plains in the fall through spring period, then tail off during the summer. Figures 10.7-10.11 show the mean wind speeds by season and annually.

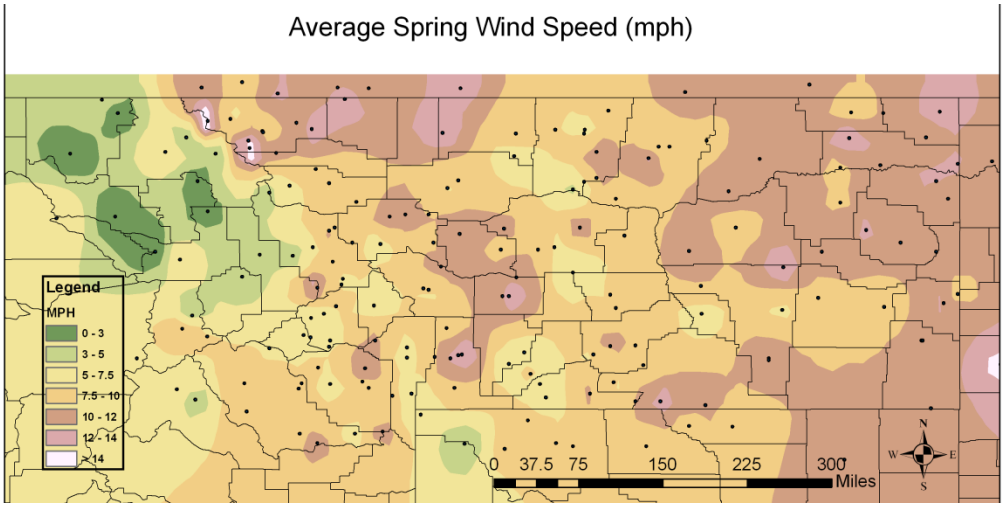


Figure 10.7. Average spring wind speed.

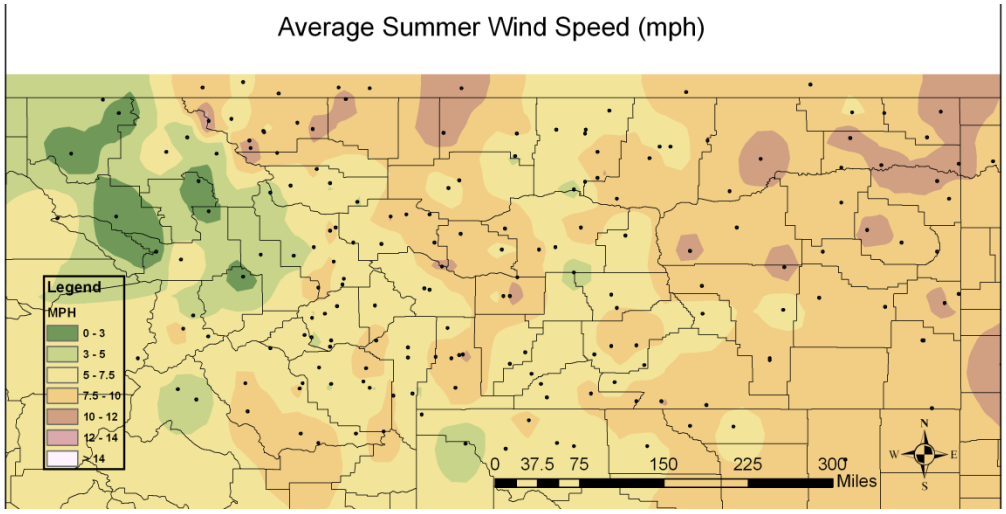


Figure 10.8. Average summer wind speed.

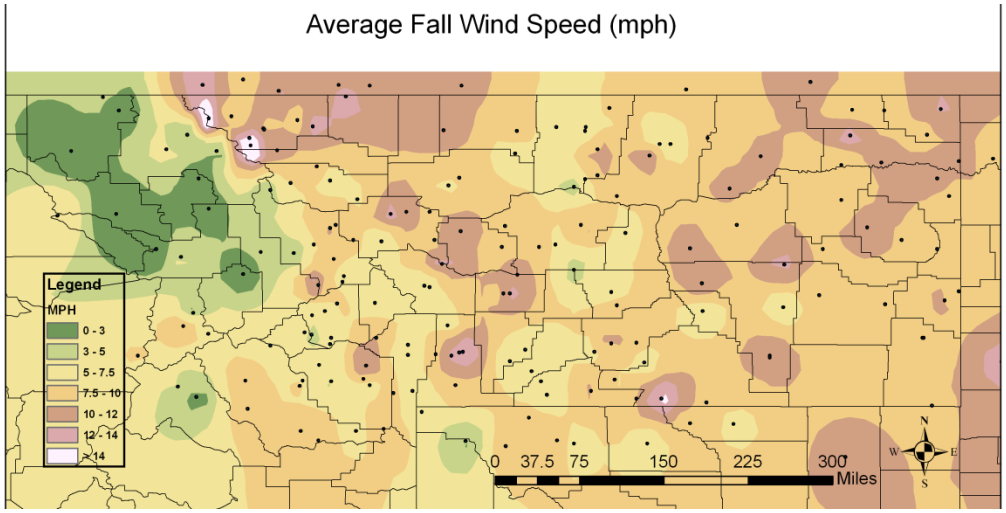


Figure 10.9. Average fall wind speed.

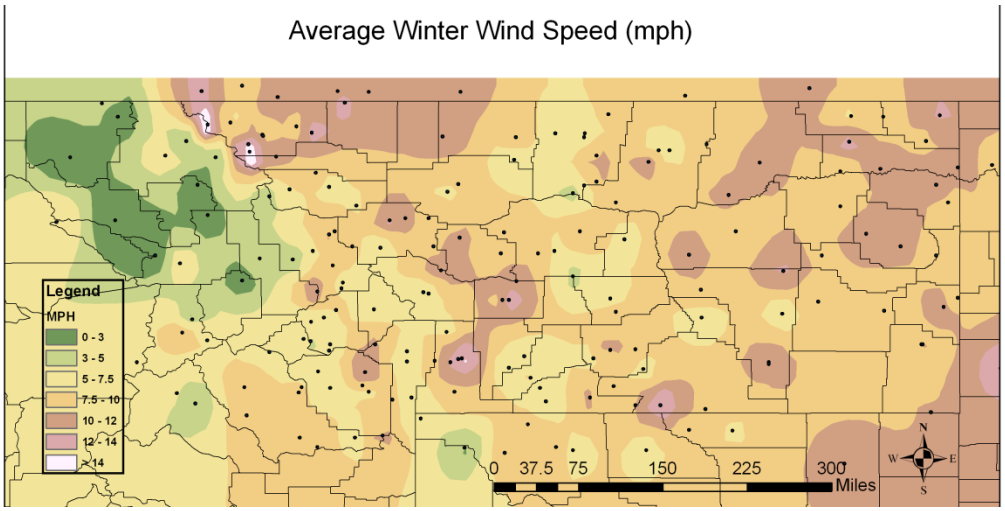


Figure 10.7. Average winter wind speed.

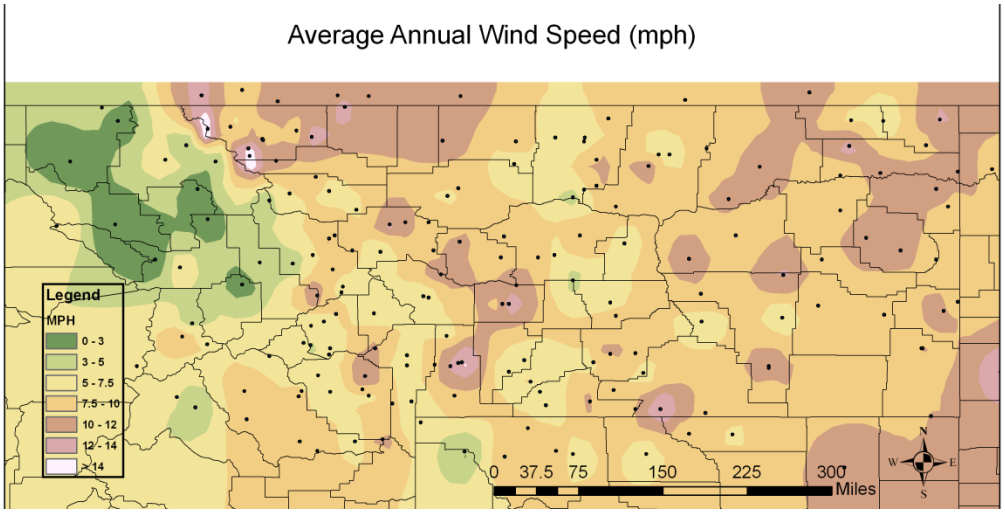


Figure 10.7. Average annual wind speed.