

Sunshine Report: Solar Energy in Western New York

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Introduction

The WNY Peace Center has proposed the construction of two large solar arrays: one at the Niagara Falls Air Force Base and the other at the Lewiston Pump Storage Reservoir (Figure 1). The objective of the proposal is to provide clean energy to 184,000 homes, and to provide employment opportunities for the region in light of a potential base closure.



Figure 1: Eight counties of Western New York. White dot shows approximate location of the Niagara Falls Air Force Base and Lewiston Pump Storage Reservoir.

The intent of this study is to assess the character of solar energy resources in Western New York (WNY), as measured by a number of indicators, including direct solar insolation, percent possible sunshine, and cloud cover. In addition, the potential impact of terrain (solar view) and 'lake effect' processes on the location of solar arrays are explored.

National Comparison: Insolation

It is a useful exercise to compare solar insolation in WNY with the rest of the country. A number of maps are available showing various tilts and orientations of solar arrays, each giving different values of $\text{kWh/m}^2/\text{day}$ or sunshine hours. In this study, for purposes of comparison, we chose to examine insolation on a horizontal flat plate. Confusion over values can often be associated with how the data is presented. Insolation values are usually reported as averages, but can also be reported as minimum and maximum values. Secondly, insolation values are often reported under varying tilts and orientations which lead to some confusion over reported values. In this report only two insolation scenarios are reported: average radiation incident onto a horizontal surface; and an orientation and tracking scenario which provides a maximum capture of average solar insolation. Within these two scenarios modeling data provides typical errors (uncertainties) of about $\pm 9\%$.

One look at a map of daily solar insolation incident onto a horizontal flat plate (Figure 2) clearly reveals that WNY is not geographically positioned to best receive solar energy. Indeed, the Great Lakes basin and the Northwest U.S. are regions that receive the least insolation in the country. WNY's average daily values for insolation fall in the ballpark of 3 to $4 \text{ kWh/m}^2/\text{day}$ (3 to 4 sun-hours), as compared to values in the 5 to $6 \text{ kWh/m}^2/\text{day}$ range for much of the country's Southwest (region receiving the highest insolation values). Summer values for WNY average 6 to $7 \text{ kWh/m}^2/\text{day}$ as compared to 8 to $10 \text{ kWh/m}^2/\text{day}$ for the Southwest (Figure 3), whereas winter averages in WNY are 0 to $2 \text{ kWh/m}^2/\text{day}$ as compared to 3 to $4 \text{ kWh/m}^2/\text{day}$ for the extreme Southwest (Figure 4). A winter value is often used to express a worst case scenario, and it is in the winter months that WNY lags most behind the Southwest region.

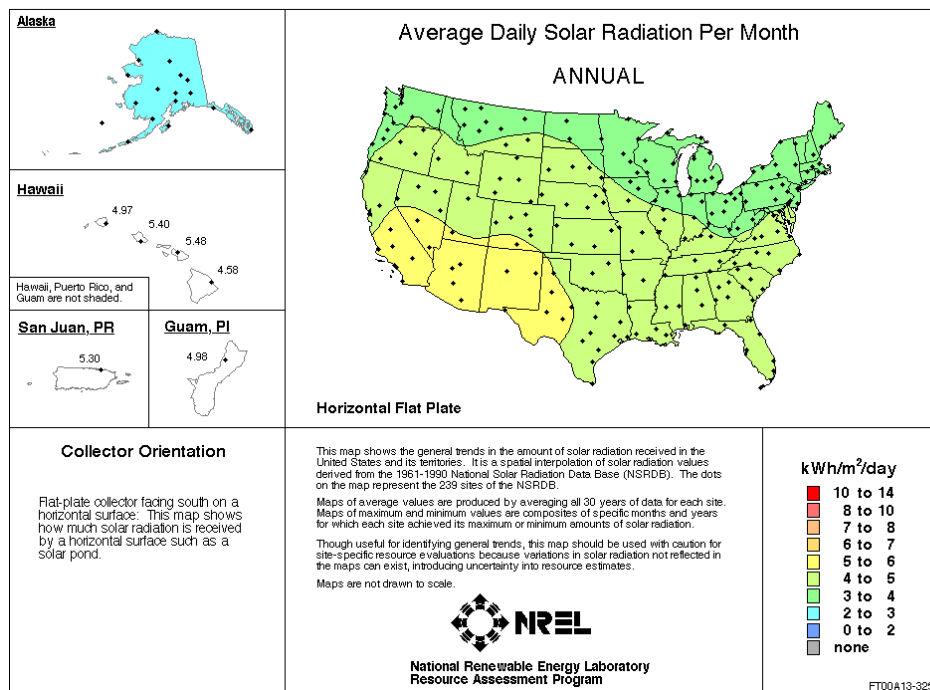


Figure 2. Annual solar radiation as measured by a flat plate collector on a horizontal surface.¹

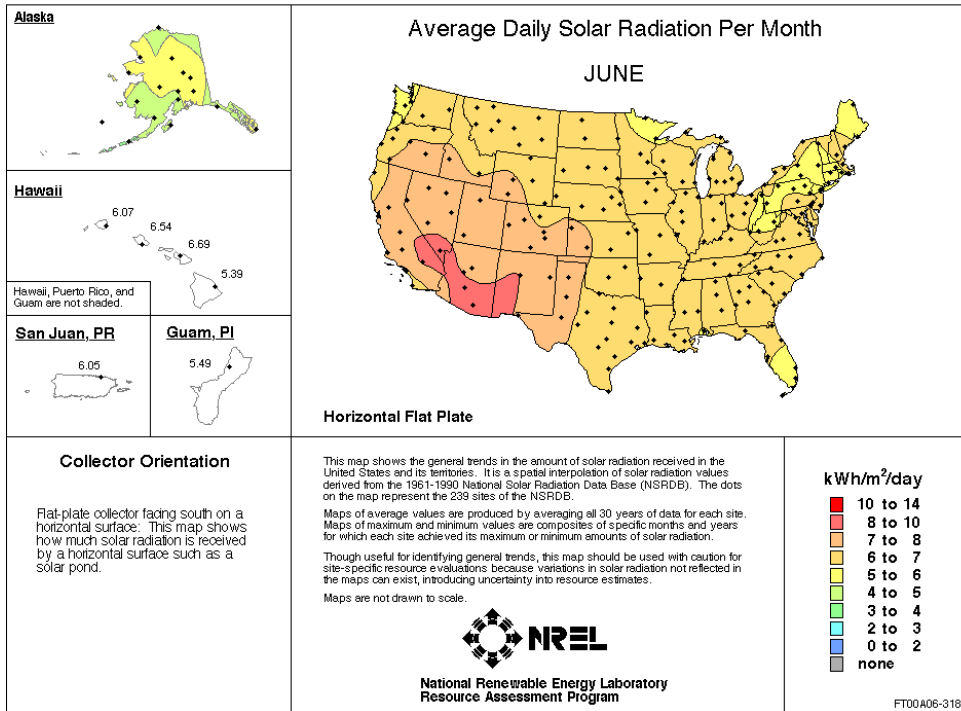


Figure 3. Average June solar radiation as measured by a flat plate collector on a horizontal surface.¹

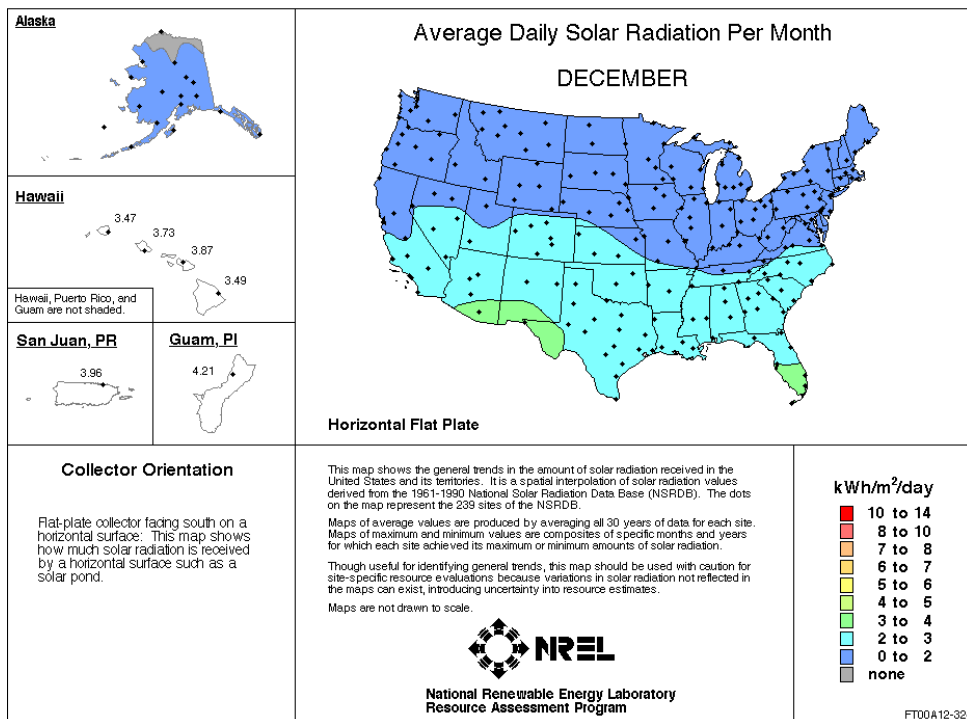


Figure 4. Average December solar radiation as measured by a flat plate collector on a horizontal surface.¹

WNY: Insolation

Modeled Horizontal Surface

The best measure of ‘sunshine’ is to measure solar insolation. The average annual solar insolation in WNY was plotted on latitude & longitude grids based on modeled data (Figure 5a). For insolation incident on a horizontal surface the values range from 3.55 to 3.74 $\text{kwh/m}^2/\text{day}$, with the highest values found in the northern section of the study area. While the difference between grids is not great, the lower values in the south may be attributed to ‘lake effect’ cloud cover south of Buffalo. Thus, the proposed locations of the solar arrays in Niagara County take advantage of the highest solar insolation values in WNY. The range of monthly values (Figure 5b) provides both the best and worst monthly scenarios. The lowest value of 1.18 $\text{kwh/m}^2/\text{day}$ occurs in December, while the highest value of 6.04 $\text{kwh/m}^2/\text{day}$ occurs in June.

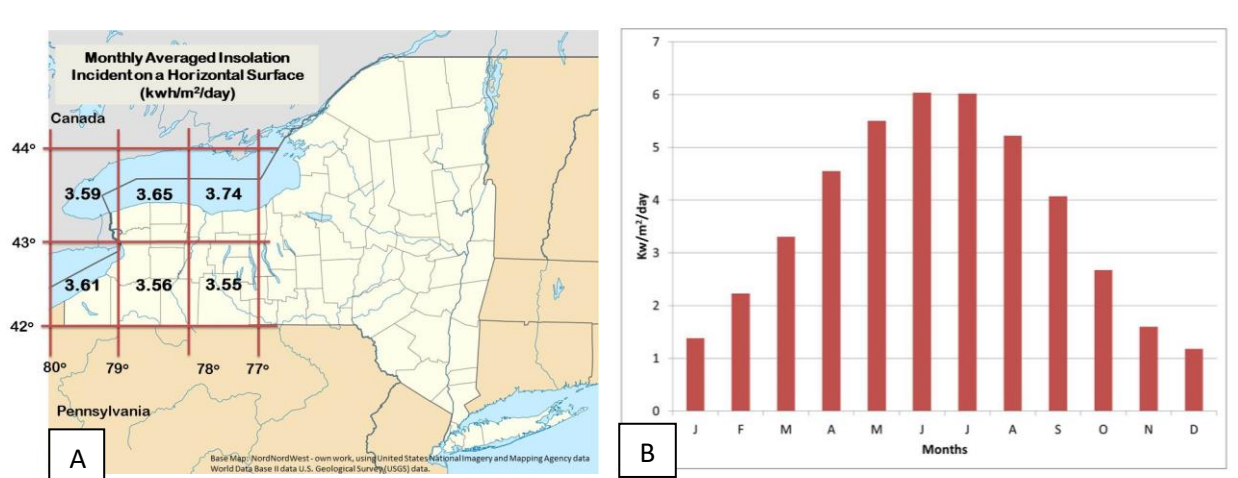


Figure 5: Average Annual Insolation (a)². The monthly insolation is shown for the Niagara Falls area (b)².

Measured Horizontal Surface (Buffalo State Site)

Solar radiation is routinely measured at the Buffalo State campus weather station (Davis Instruments, Vantage Pro). The solar radiation sensor measures ‘Global Solar Radiation’ which is the intensity of the sun’s radiation (both direct and reflected from the sky) onto a horizontal surface. The mean annual value of 3.45 $\text{kwh/m}^2/\text{day}$ (Figure 6) is comparable to the national map (3 to 4 $\text{kwh/m}^2/\text{day}$ in Figure 2), as are the June and December values, 5.77 $\text{kwh/m}^2/\text{day}$ (6 to 7 $\text{kwh/m}^2/\text{day}$ in Figure 3) and 0.93 $\text{kwh/m}^2/\text{day}$ (0 to 2 $\text{kwh/m}^2/\text{day}$ in Figure 4), respectively. As expected, the Buffalo State values are slightly less than those reported for Niagara Falls (Figure 5a), but do follow the monthly pattern, as shown in Figure 5b. Yearly plots, between 2005 and 2012, are shown in Appendix I.

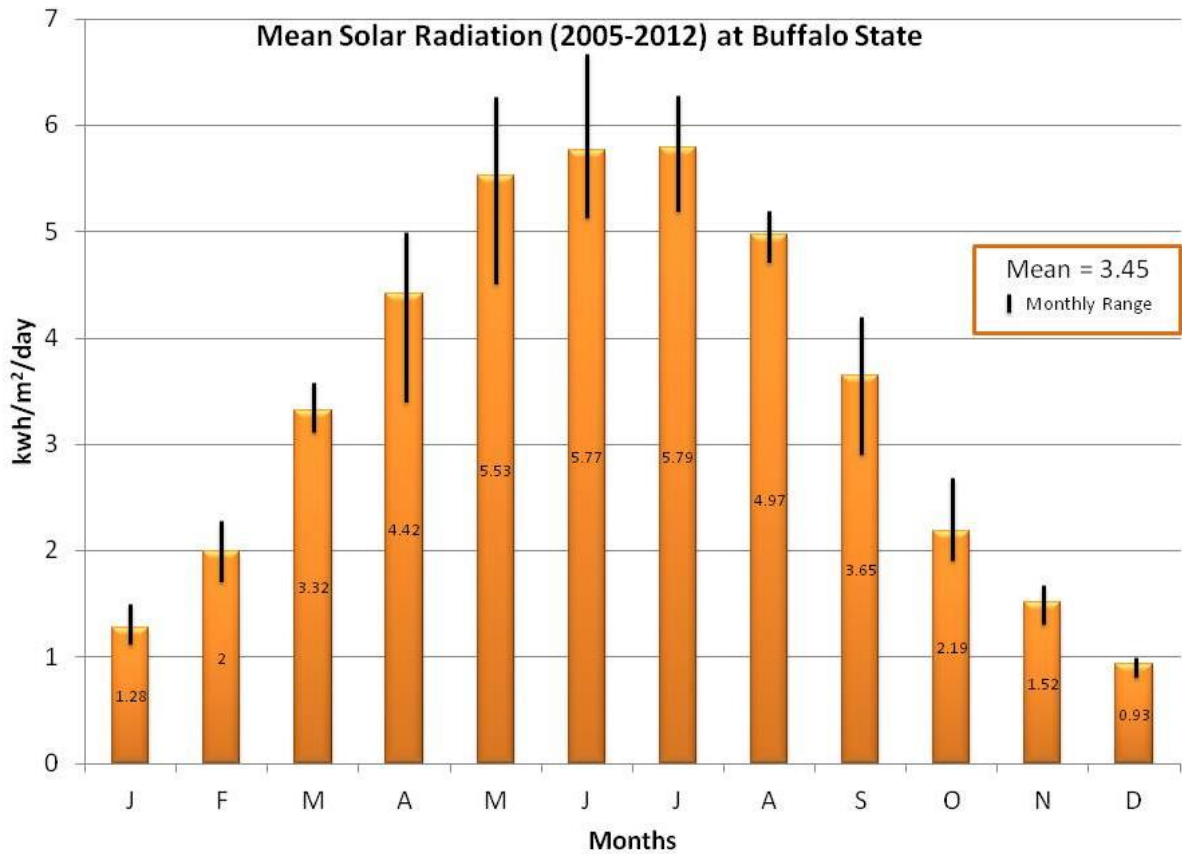


Figure 6. Average solar radiation at Buffalo State between 2005 and 2012.

Best Orientation of Solar Arrays

The insolation values reported above for WNY represent average radiation incident onto a horizontal surface. Angling of a solar panel can maximize the amount of solar insolation captured by solar arrays. For example, at Buffalo, NY an average value of 3.7 kWh/m²/day (incident onto a horizontal surface) can be maximized to 5.3 kWh/m²/day given a proper orientation and tracking of the solar arrays – June values can be increased from 6.1 to 8.1 kWh/m²/day, and December insolation 1.3 to 2.2 kWh/m²/day.³ (see box area in Table 1).

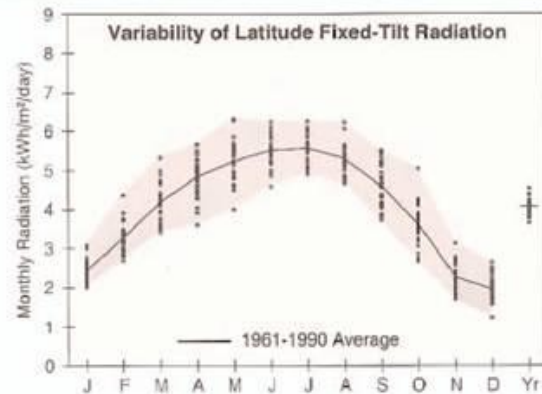
Table 1. Solar Radiation for WNY optimized for various tilts and orientations.³

Buffalo, NY

WBAN NO. 14733

LATITUDE: 42.93° N
 LONGITUDE: 78.73° W
 ELEVATION: 215 meters
 MEAN PRESSURE: 991 millibars

STATION TYPE: Secondary



Solar Radiation for Flat-Plate Collectors Facing South at a Fixed Tilt (kWh/m²/day), Uncertainty ±9%

Tilt (°)		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
0	Average	1.6	2.4	3.4	4.5	5.5	6.1	6.0	5.2	3.9	2.6	1.6	1.3	3.7
	Min/Max	1.4/1.8	2.0/2.8	3.0/4.0	3.6/5.2	4.3/6.5	5.1/6.9	5.4/6.7	4.6/5.9	3.4/4.5	2.2/3.3	1.3/1.9	1.1/1.5	3.4/4.0
Latitude -15	Average	2.2	3.1	4.1	5.0	5.6	6.0	6.0	5.5	4.6	3.4	2.1	1.8	4.1
	Min/Max	1.9/2.7	2.5/4.0	3.4/5.1	3.7/5.8	4.3/6.7	5.0/6.8	5.3/6.7	4.8/6.4	3.8/5.4	2.6/4.7	1.6/2.8	1.2/2.3	3.7/4.5
Latitude	Average	2.4	3.3	4.2	4.8	5.2	5.5	5.5	5.3	4.6	3.6	2.3	1.9	4.1
	Min/Max	2.0/3.1	2.7/4.4	3.4/5.3	3.6/5.7	4.0/6.3	4.6/6.2	4.9/6.2	4.7/6.2	3.7/5.5	2.7/5.0	1.7/3.1	1.2/2.6	3.6/4.5
Latitude +15	Average	2.5	3.4	4.1	4.5	4.6	4.8	4.8	4.8	4.3	3.6	2.3	2.0	3.8
	Min/Max	2.1/3.3	2.7/4.6	3.3/5.2	3.3/5.3	3.5/5.6	4.0/5.4	4.3/5.4	4.2/5.7	3.5/5.3	2.6/5.1	1.7/3.2	1.2/2.8	3.4/4.3
90	Average	2.4	3.0	3.3	3.0	2.7	2.6	2.8	3.0	3.2	3.0	2.0	1.9	2.7
	Min/Max	1.9/3.2	2.3/4.2	2.5/4.1	2.3/3.6	2.2/3.2	2.3/2.9	2.5/3.0	2.7/3.6	2.5/3.8	2.1/4.2	1.4/2.9	1.0/2.7	2.4/3.1

Solar Radiation for 1-Axis Tracking Flat-Plate Collectors with a North-South Axis (kWh/m²/day), Uncertainty ±9%

Axis Tilt (°)		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
0	Average	2.0	3.1	4.4	5.9	7.1	7.9	7.9	6.8	5.2	3.5	1.9	1.6	4.8
	Min/Max	1.7/2.5	2.5/4.1	3.6/5.7	4.3/7.2	5.1/8.9	6.1/9.4	6.8/8.9	5.9/8.1	4.2/6.4	2.6/5.0	1.5/2.6	1.1/2.0	4.3/5.4
Latitude -15	Average	2.5	3.6	5.0	6.3	7.2	7.9	7.9	7.2	5.8	4.1	2.4	1.9	5.2
	Min/Max	2.1/3.2	2.9/5.0	4.0/6.6	4.4/7.7	5.1/9.1	6.1/9.4	6.8/9.0	6.1/8.5	4.5/7.1	2.9/6.0	1.7/3.3	1.2/2.7	4.6/5.8
Latitude	Average	2.7	3.8	5.1	6.2	7.0	7.6	7.7	7.0	5.8	4.3	2.5	2.1	5.1
	Min/Max	2.2/3.5	3.0/5.3	4.0/6.7	4.3/7.7	4.9/8.9	5.9/9.1	6.5/8.7	6.0/8.4	4.4/7.2	3.0/6.2	1.8/3.5	1.2/2.9	4.5/5.8
Latitude +15	Average	2.8	3.8	5.0	6.0	6.6	7.1	7.2	6.7	5.6	4.3	2.5	2.2	5.0
	Min/Max	2.3/3.7	3.1/5.4	3.9/6.6	4.2/7.4	4.6/8.4	5.4/8.5	6.1/8.2	5.7/8.0	4.3/7.0	2.9/6.3	1.8/3.7	1.2/3.1	4.4/5.7

Solar Radiation for 2-Axis Tracking Flat-Plate Collectors (kWh/m²/day), Uncertainty ±9%

Tracker		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
2-Axis	Average	2.8	3.8	5.1	6.3	7.3	8.1	8.1	7.2	5.8	4.3	2.6	2.2	5.3
	Min/Max	2.3/3.7	3.1/5.4	4.0/6.7	4.5/7.8	5.2/9.2	6.3/9.6	6.9/9.2	6.2/8.6	4.5/7.2	3.0/6.3	1.8/3.7	1.2/3.1	4.7/6.0

Direct Beam Solar Radiation for Concentrating Collectors (kWh/m²/day), Uncertainty ±8%

Tracker		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
1-Axis, E-W Horiz Axis	Average	1.1	1.5	2.1	2.7	3.3	3.7	3.7	3.2	2.6	2.1	1.1	0.9	2.3
	Min/Max	0.6/1.7	1.0/2.8	1.4/3.6	1.4/3.7	1.7/4.7	2.4/4.9	2.8/4.7	2.4/4.3	1.6/3.6	1.0/3.6	0.6/2.1	0.1/1.5	1.8/2.9
1-Axis, N-S Horiz Axis	Average	0.7	1.3	2.3	3.5	4.3	4.9	4.9	4.2	3.1	2.0	0.8	0.6	2.7
	Min/Max	0.3/1.1	0.9/2.5	1.6/4.0	1.8/4.8	2.2/6.2	3.1/6.5	3.7/6.1	3.1/5.4	2.0/4.4	1.0/3.5	0.4/1.5	0.1/0.9	2.2/3.4
1-Axis, N-S Tilt=Latitude	Average	1.2	1.8	2.8	3.7	4.2	4.6	4.7	4.3	3.5	2.6	1.3	0.9	3.0
	Min/Max	0.6/1.8	1.2/3.4	1.9/4.8	1.9/5.1	2.2/6.1	2.9/6.1	3.6/5.9	3.2/5.7	2.2/5.0	1.3/4.6	0.6/2.3	0.2/1.6	2.3/3.7
2-Axis	Average	1.3	1.8	2.8	3.8	4.5	5.0	5.0	4.4	3.5	2.6	1.3	1.0	3.1
	Min/Max	0.6/2.0	1.3/3.5	1.9/4.8	1.9/5.2	2.3/6.4	3.2/6.7	3.8/6.3	3.3/5.8	2.2/5.0	1.3/4.6	0.7/2.4	0.2/1.7	2.4/3.9

Average Climatic Conditions

Element	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Temperature (°C)	-4.7	-4.2	1.0	7.3	13.7	18.8	21.7	20.6	16.6	10.6	4.7	-1.6	8.7
Daily Minimum Temp	-8.3	-8.1	-3.4	2.3	8.3	13.6	16.6	15.6	11.7	5.9	1.1	-5.1	4.2
Daily Maximum Temp	-1.0	-0.2	5.4	12.3	18.9	24.1	26.8	25.5	21.6	15.2	8.4	1.8	13.2

WNY: Percent Sunshine

Sunshine is often expressed as the 'percent possible sunshine'. On average (65 year record) Buffalo, NY receives 48% of possible sunshine. Values in Upstate New York generally hover around this mark, with Rochester receiving 51%, Syracuse 46%, Binghamton 49%, and Albany receiving 53% of possible sunshine. These totals are well below the national average. While the total percentage of sunshine does not vary much between Upstate cities, the monthly percentage does. For example, Buffalo and Rochester (WNY) receive much of their sunshine during the summer months, and can boast to have some of the sunniest summers in Upstate New York (Figure 7). Other Upstate cities mimic this pattern somewhat (i.e. Syracuse, and Binghamton), but as one moves further east the distribution of the sunshine flattens out, where a greater percentage of the sunshine is received during the spring and fall seasons in cities such as Albany and New York (dashed lines). It is worth noting that the WNY cities show a dramatic drop in sunshine percentage between October and November. For example the percent sunshine in Buffalo drops from 50% in October to 29% in November.

The data used to compare the percent sunshine between cities was obtained from a large database (each site in Upstate New York with over 50 years of record) of direct solar measurements. However, the database is not current, as Buffalo is the only National Weather Service site currently monitoring solar radiation (as percent sunshine) in New York State.

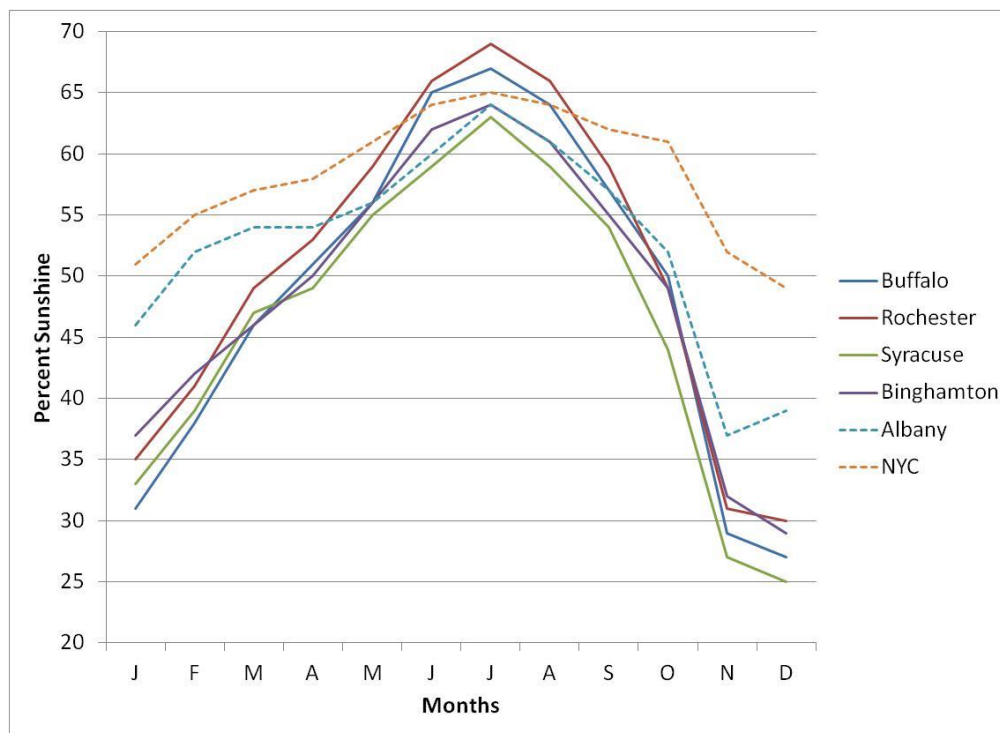


Figure 7: Percent Possible Sunshine⁴

WNY: Sunshine Derby

While researching solar energy in WNY, the 'Sunshine Derby', as published in the Buffalo News, was scrutinized. The Sunshine Derby maintained a running total of the number of Buffalo's sunny days (50% or greater sunshine) for month- and year-to-date. This number was compared to four other cities (Rochester, Syracuse, Orlando, and Phoenix). With the exception of Phoenix, Buffalo usually came out ahead in this count, and this number was often used by local media and tourist promoters to extol Buffalo's "sunny" disposition within upstate New York. Our research revealed that the sunshine derby was measuring sunny days differently between cities, in ways that were not comparable. The findings of our research can be found in Appendix II of this report, along with a copy of the Buffalo News article taken from the press release.

WNY: Cloud Cover

Both Buffalo and Rochester share a dubious distinction: the most rainy days of any large city – 167 days. Cloud cover is the least useful way to measure sunshine, but it is a measure that unlike solar radiation is routinely measured by NWS stations. On average Buffalo experiences 54 clear days, 103 partly cloudy days, and 208 overcast days. Rochester experiences 61 clear days, 104 partly cloudy days, and 200 overcast days.⁵ A look at the Annual Sky Cover (Figure 8) -- what percentage of the sky is covered with clouds on average, if you add up the hourly observations – shows WNY cloudy 71 to 75 percent of the time (sunrise to sunset). Figure 9 shows Buffalo's cloud cover broken down by month. The summer months exhibit the least percentage of cloud cover. Note the rapid increase in cloud cover between October and November, which was previously described as a rapid drop in percent sunshine between these two months.

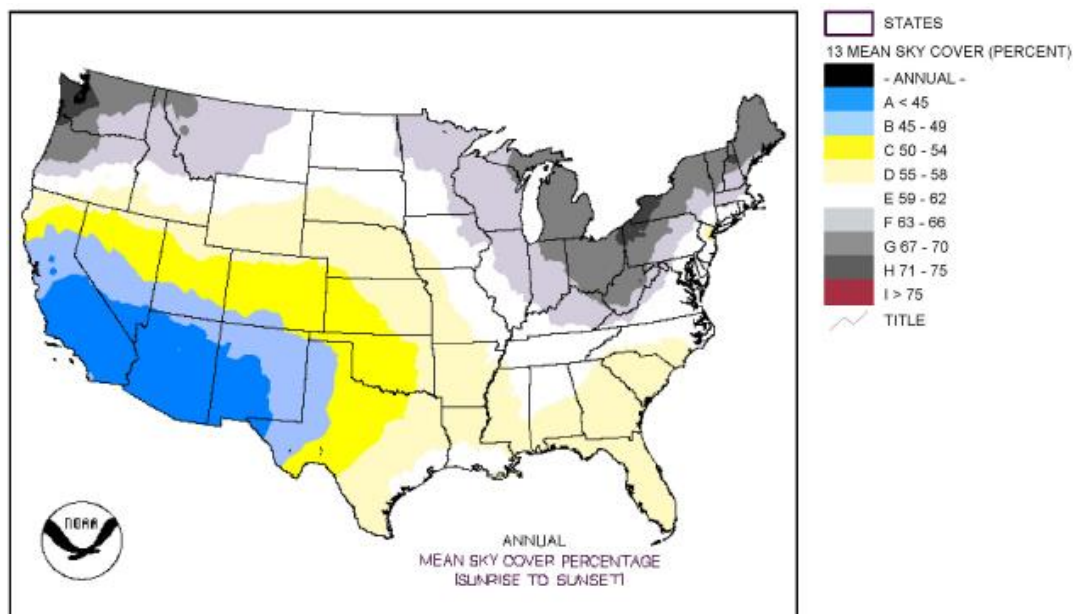


Figure 8: Percentage of the sky is covered with clouds on average, if you add up the hourly observations (sunrise to sunset).⁶

Cloudy Days

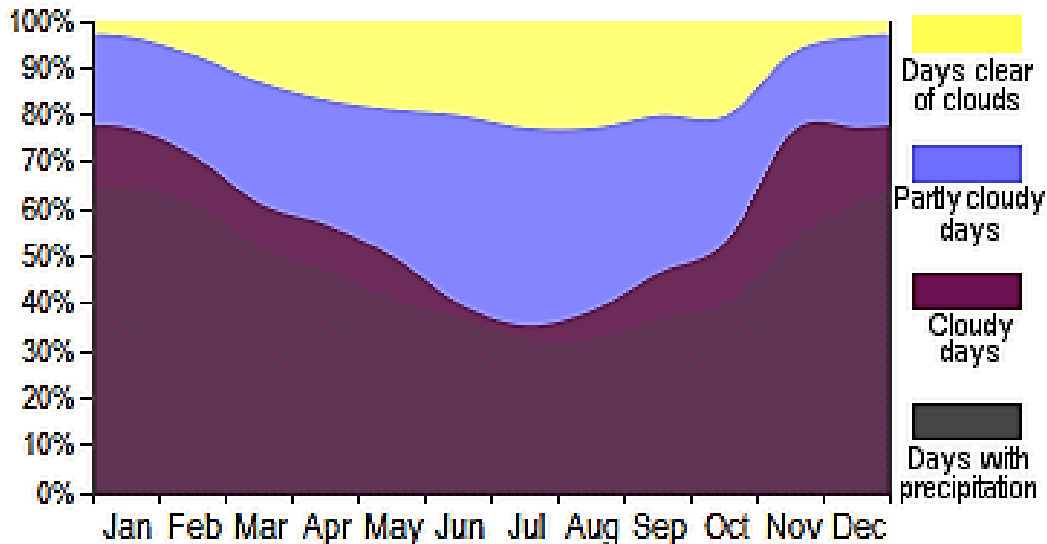


Figure 9: Buffalo's cloud cover.⁷

Cloud Cover and Visibility: Niagara Falls Air Force Base

Summary cloud cover data was obtained from the Niagara Falls Air Force Base⁸. The first set of summary data is average monthly cloud cover, expressed in tenths (see Appendix III). The data is averaged over a 30 year period prior to 1987, although the exact years used are not clear in the summary. The summary shows average monthly cloud cover ranging from 6/10's to 9/10's (higher values in winter), averaging 7/10's annually. These values are similar to cloud cover as reported in Figure 8 (71 to 75% cloud cover).

The second page of Appendix III shows the percentage of time that the lowest clouds are present in the sky (CIG – height of lowest cloud layer) or visibility (VSBY). This appears to be an aviation product that needs to be interpreted carefully. The monthly values refer to the times, expressed as a percentage, that either cloud cover is below a certain level (in feet) or visibility is less than a certain value (in miles) - for example (CIG < 3,000 feet or VSBY < 3 miles). The data is averaged over a 10 year period prior to 1987, but the exact years used are not clearly noted. The numbers describe the 'presence' of clouds not cloud 'coverage'. The cloud could be present as solid, broken, scattered or few, and the percentage of clouds above the ceiling are not noted. While useful for aviation, this data has little value for solar radiation.

Limited visibility (often fog, mist, or haze) may reduce incoming insolation at the surface. Visibility data during 13 forecast hours is presented as a separate table in Appendix IV. We believe the data represents a summary from 1951 to 2010 but we are not certain. Using the 13Z (7:00 a.m.) and 19Z (2:00 p.m.) forecast hours, Figure 10 shows the percentage of times that visibility for each of seven visibility classes occur at the Niagara Falls Air Force Base. Visibility is unlimited 66% of the time, while serious restrictions to visibility (fog < 0.5 miles) or mist (<1.5 miles) account for 7% of the time.

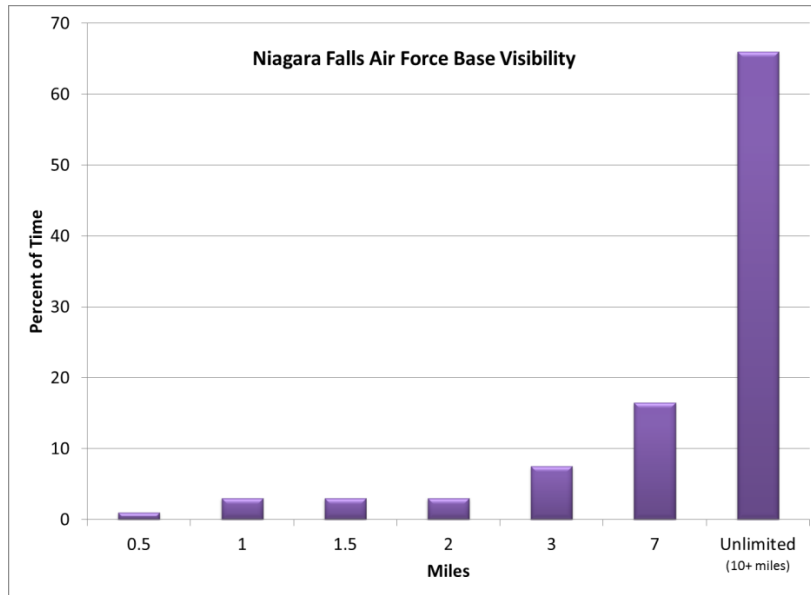


Figure 10: Visibility limitations at the Niagara Falls Air Force Base⁸

Solar View

The topography of Western New York is generally flat in the north, with the exception of the Niagara Escarpment which forms a thin ribbon of relief across an otherwise flat terrain. To the south is the Allegheny Plateau which is exposed as raised relief (ridges and valleys) reaching elevations to about 2,000 ft. The proposed location of both solar panel arrays are in areas of flat terrain. An initial assessment of the solar view, from each of the proposed solar array locations, shows no terrain-related obstructions (Figure 11). Each line in the graph represents the sun's meridian at different times of the year. On each meridian the local standard time is shown. Hypothetical locations of solar arrays at three locations in areas of relief show that terrain obstructions (loss of early morning or late afternoon sun) must be considered (Figure 12).

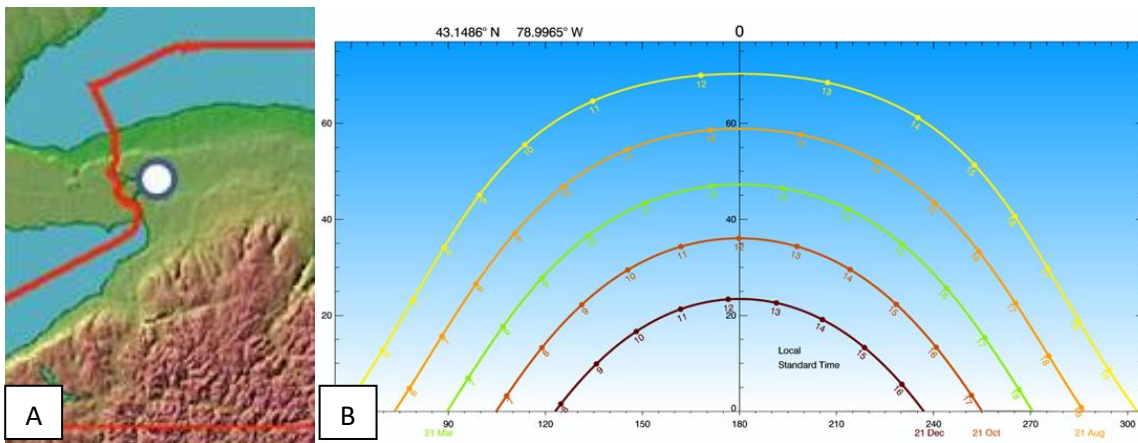
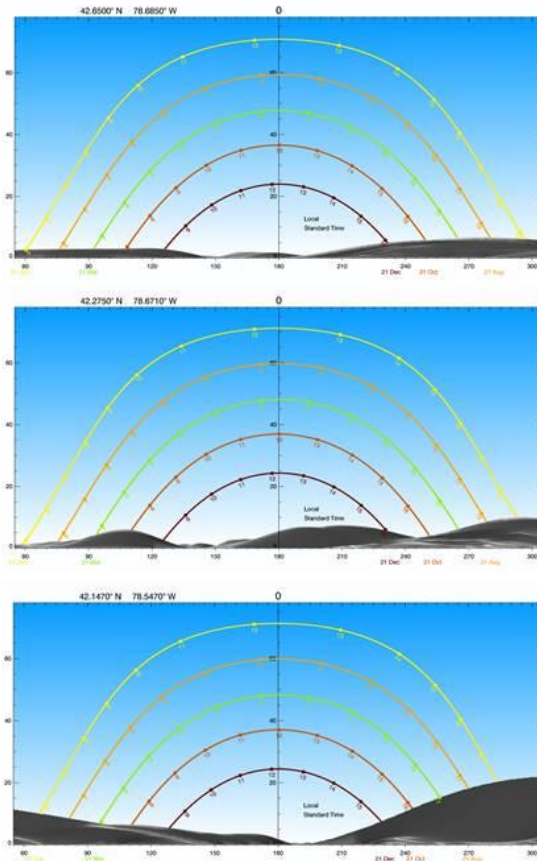


Figure 11: Location of proposed solar array in relation to relief (a); and graph showing solar meridians at solstice and equinoxes for both solar array locations (b).⁹



Colden, NY

Ellicottville, NY

Alleghany, NY

Figure 12: Hypothetical locations for solar arrays showing potential problems with terrain obstructions.⁹

Regional Variability of Snowfall

The average seasonal snowfall in the Buffalo Area is 83.6" (1981-2010 Normal average is 94.7"), and about 60" in Niagara Falls (Figure 13a). These totals are taken from the National Weather Service at the Buffalo International Airport, and from a volunteer snow spotting network. A 30-year average snowfall of 67" is reported at the Niagara Falls Air Force Base (see Appendix III) and is inline with values reported in Figure 13a. The Lewiston site is located further north and is closer to the 60" isoline (perhaps a little less). As seen in Figure 13a, there is a substantial north-south gradient of snowfall across WNY. Seasonal snowfall totals average under 60" in northern- and central-Niagara County, increasing to about 80" in Buffalo, and to over 150" in southern Erie County and northern Chautauqua County.

The snowfall in WNY is attributable to both synoptic (large scale general snows) and localized 'lake effect' snows. Over half of the regions snowfall can be attributed to the 'lake effect' process. Cold winds blowing across a warm lake pick up energy and moisture, resulting in increased snowfall downwind. The regions prevailing winds are from the west and southwest, thus the lake effect snow bands are more

common off of Lake Erie where they dump snow south of Buffalo. Snow has been reported in 8 months out of the year, although the typical snow season usually runs from late-November to mid-March.

In addition to snow, the 'lake effect' process generates more clouds and rain in late summer and fall, which like the snow, is more concentrated in areas to the south of Buffalo, rather than to the north (Figure 14). An opposite effect, known as the 'Oasis Effect', due to the stabilizing nature of cold water, tends to keep the areas skies clearer during the late spring and early summer.

The proposed location of both solar panel arrays are in areas where average seasonal snow totals are about 60", the low end of the regional snowfall totals (Figure 13a), and in the northern part of the study area that experience less cloud cover and rain days than areas to the city's south. The period of most intense snowfall is from December to March (Figure 13b).

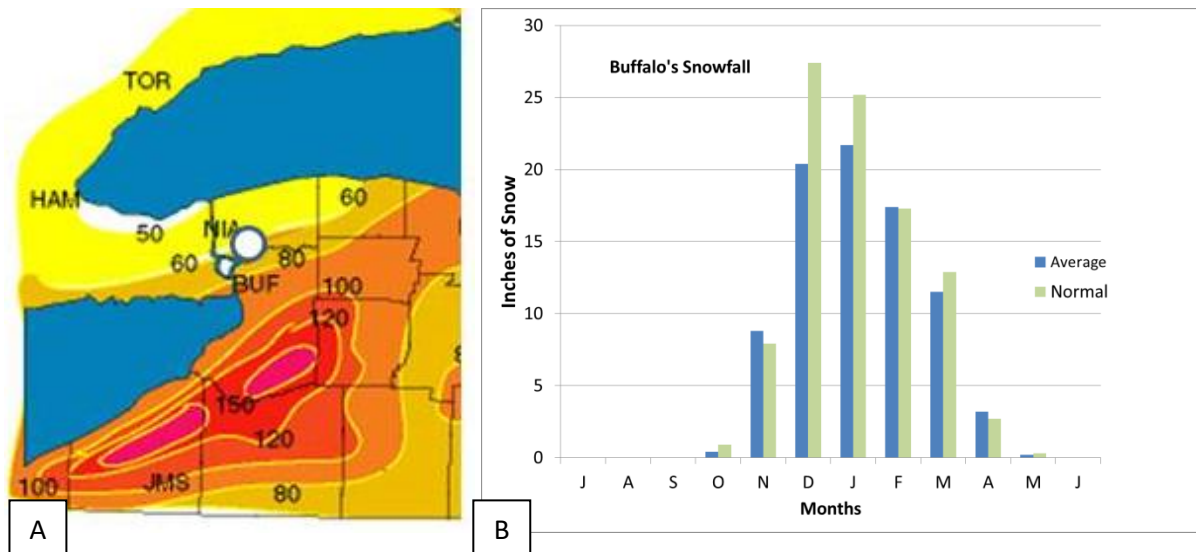


Figure 13. Location of proposed solar arrays in relation to WNY average seasonal snowfall totals (a); and snowfall frequency as recorded at Buffalo (b)¹⁰. Average values are based on 60 years of record, Normals are 1981-2010.¹¹



Figure 14. A view of lake effect clouds looking south of Buffalo.¹²

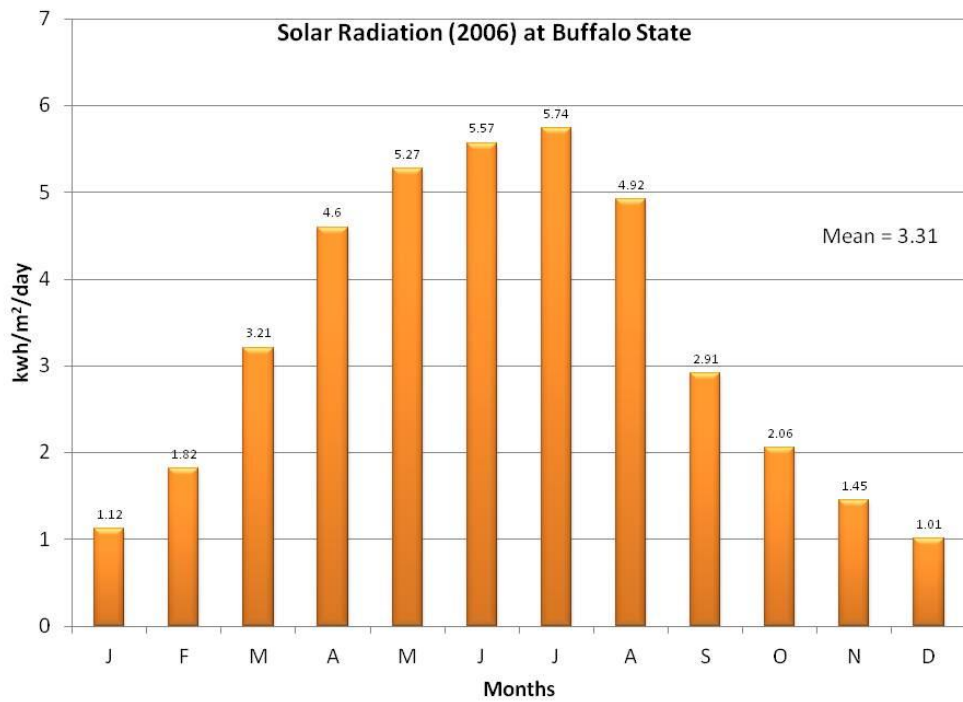
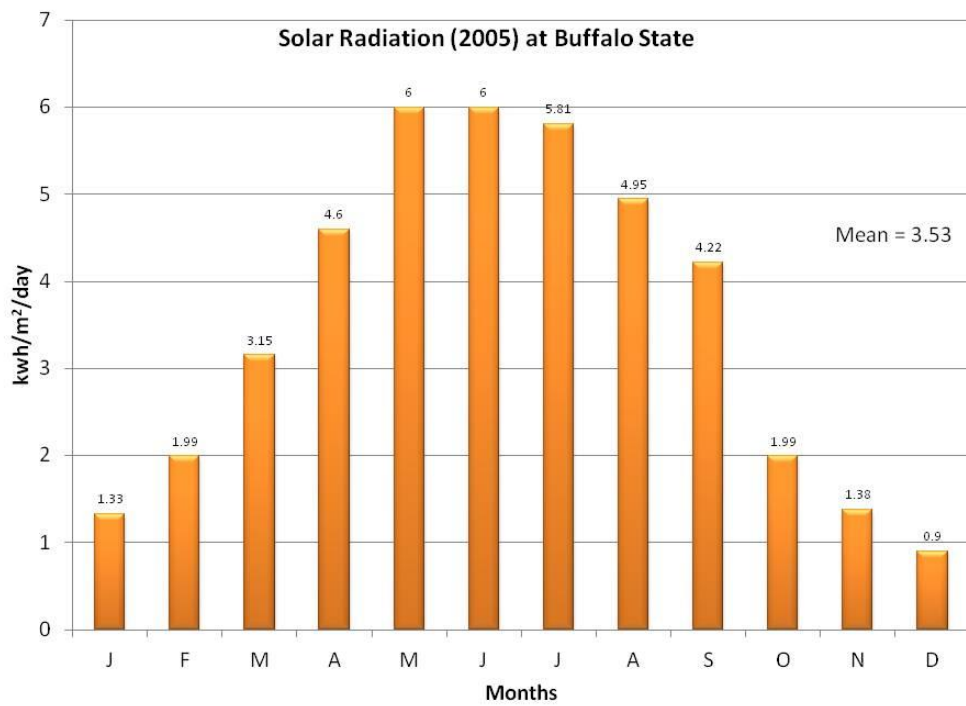
Conclusion

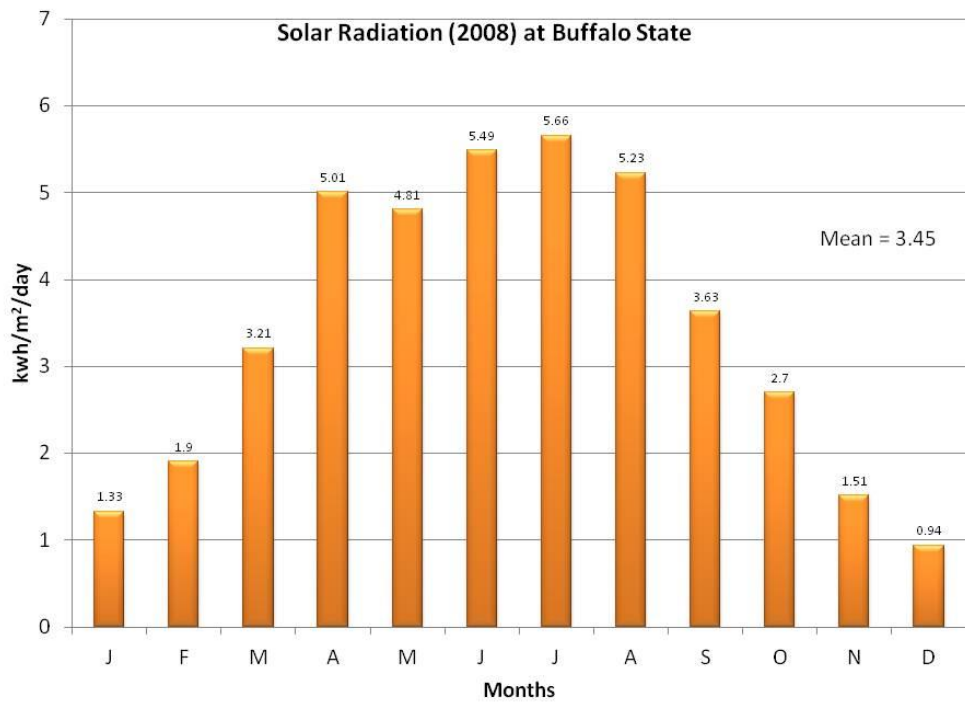
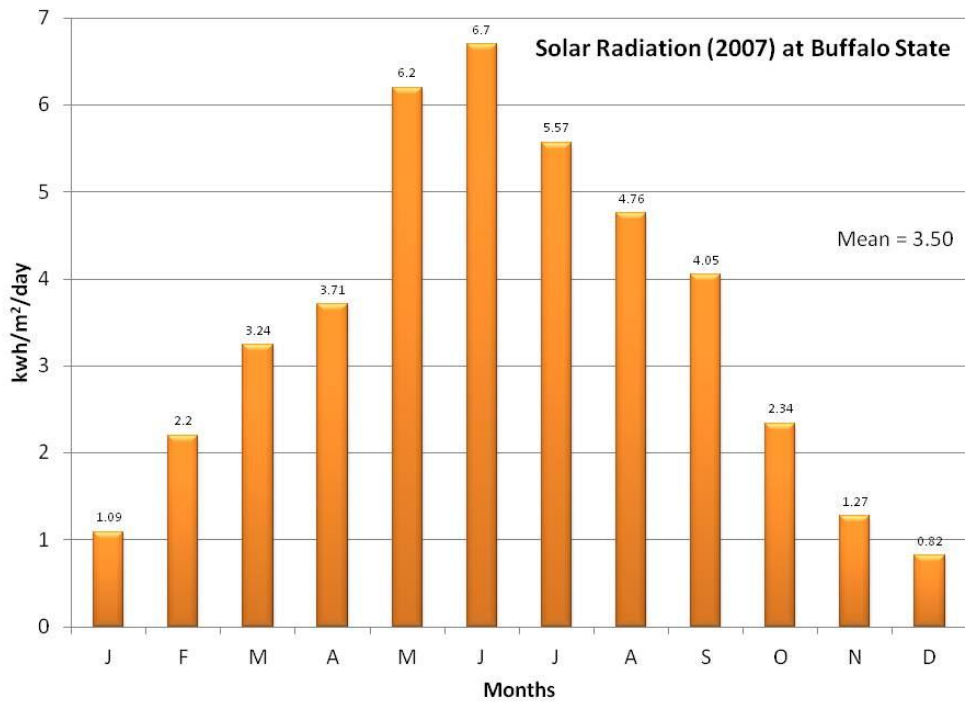
The data in this report represents a number of perspectives related to sunshine - including percent possible sunshine, solar energy (kwh/m²/day), and various forms of cloud cover. Data was obtained for a number of sites in WNY. Overall, the various forms and sources of data are in agreement. The proposed locations for the solar arrays (Niagara Falls Air Force Base and the Lewiston Pump Storage Reservoir) are best suited for WNY to maximize solar energy and the solar view, and to minimize the impact of 'lake effect' clouds, and snowfall amounts. Average insolation (incident on a horizontal surface) ranges from 3.5 to 3.7 kwh/m²/day at the proposed site of the solar arrays, but with careful consideration of orientation and tilt in design the solar radiation could be maximized to an average of 5.3 kwh/m²/day - an average low of 2.2 kwh/m²/day in December and an average high of 8.1 kwh/m²/day in June. Western New York city's receive comparable sunshine, expressed as 'percent possible sunshine', with other cities in Upstate New York (percentages vary by a few percent), but there is a stronger seasonal pattern with more summer sunshine (expressed as percent of possible sunshine, and solar energy) and less winter sunshine (expressed as percent possible sunshine, and solar energy) than other New York cities. WNY experiences considerable cloud cover (71 to 75 percent) over a year, however the cloud cover is most prominent during the winter months, and even days with cloudy sky coverage allows for the penetration of some insolation. The months from March through to and including September are best suited for the collection of insolation. The seasonality of solar energy might be considered when designing the tilt and orientation of solar arrays, whether to optimize for winter or summer conditions and/or to operate the solar arrays yearly or restrict their use to specific seasons.

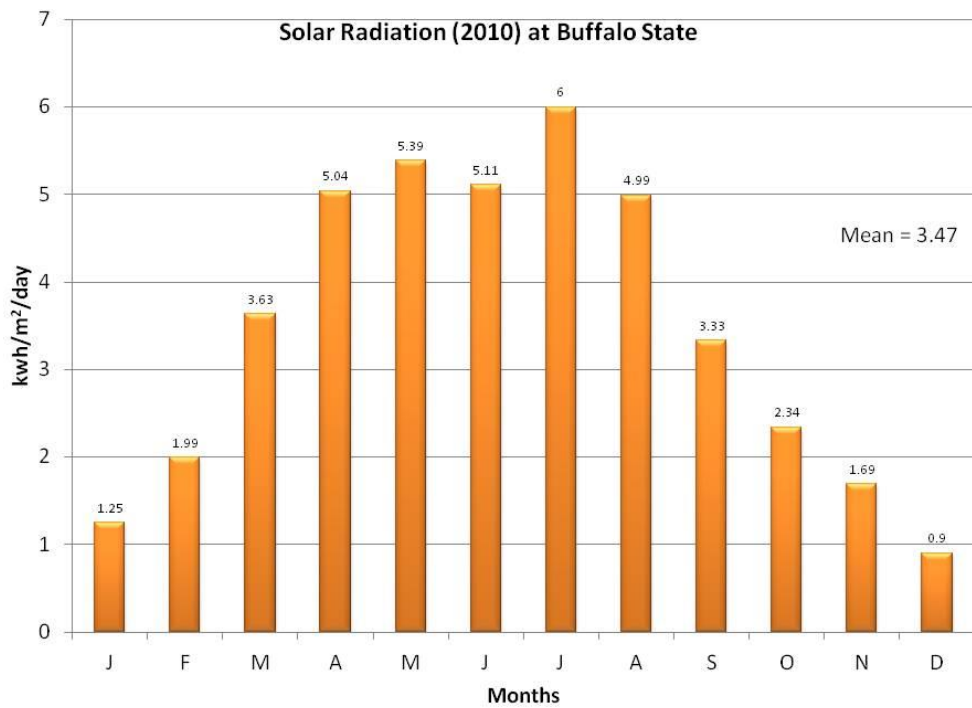
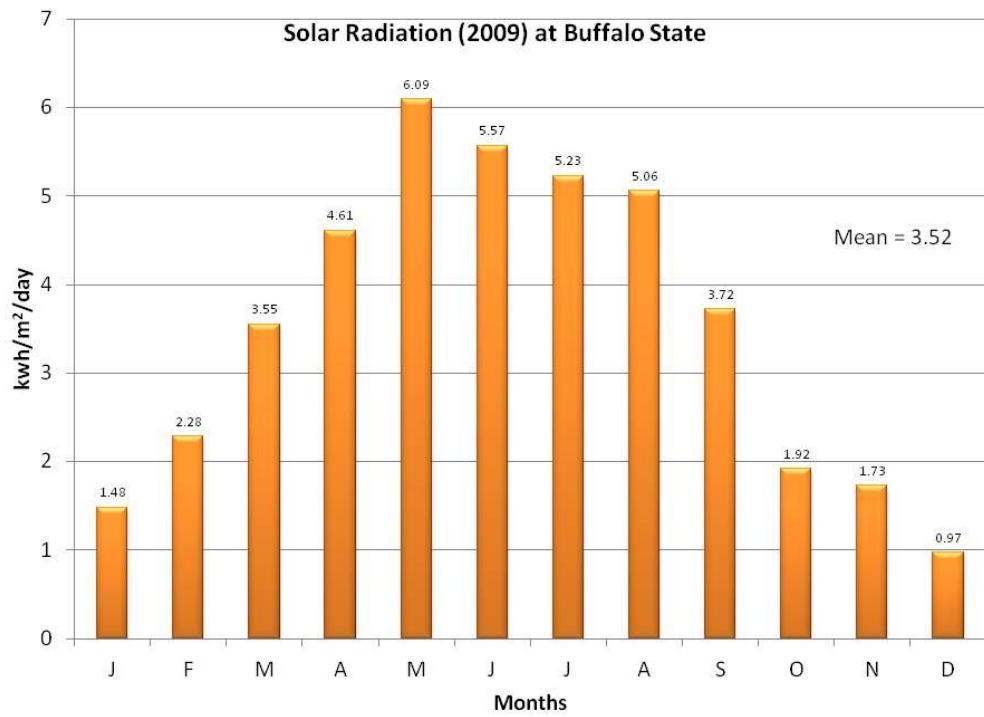
References

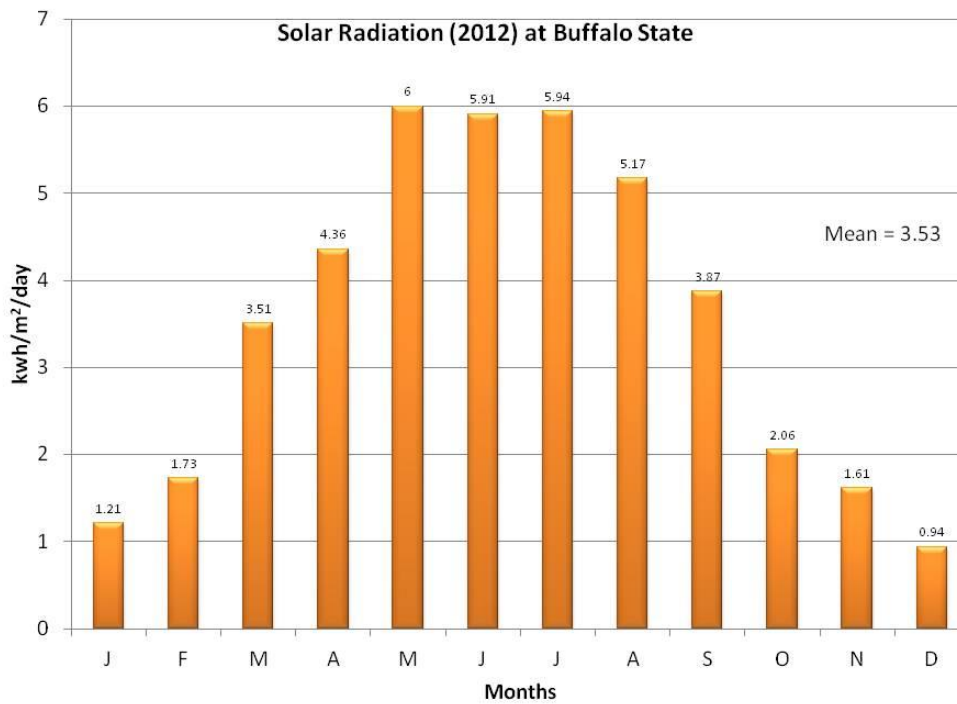
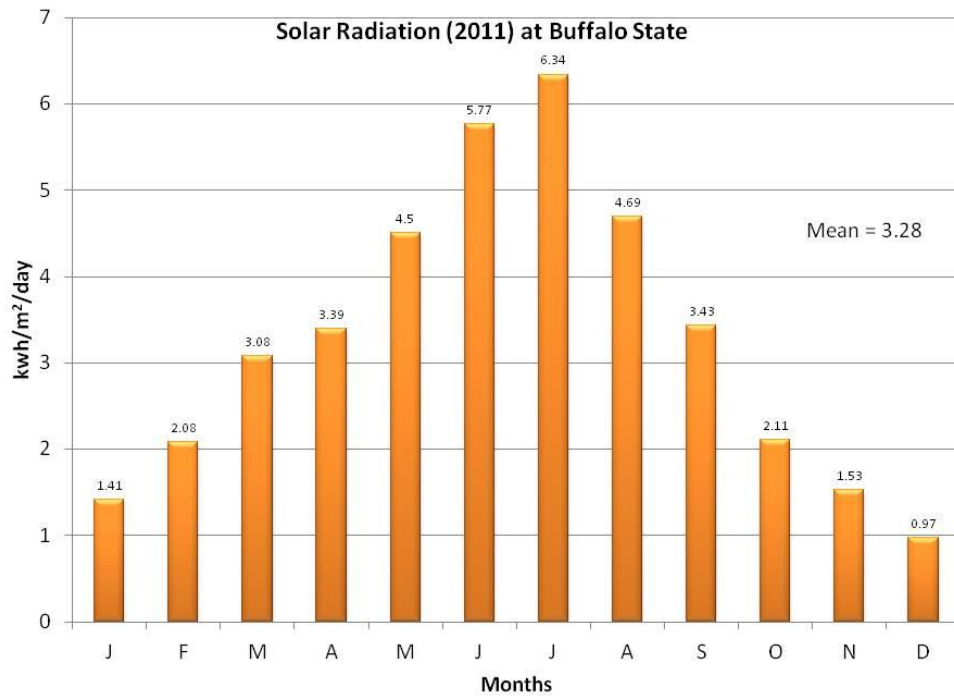
1. http://rredc.nrel.gov/solar/old_data/nsrdb/1961-1990/redbook/atlas/
2. <http://eosweb.larc.nasa.gov/cgi-bin/sse/grid.cgi>
3. <http://rredc.nrel.gov/solar/pubs/redbook/PDFs/NY.PDF>
4. <http://www.nrcc.cornell.edu/ccd/pctpos.html>
5. <http://www.nrcc.cornell.edu/ccd/clpcdy.html>
6. <http://www.accuweather.com/en/weather-blogs/weathermatrix/always-cloudy-and-windy-in-pennsylvania/22223>
7. <http://www.city-data.com/city/Buffalo-New-York.html>
8. Obtained from Jamie Felvus (Niagara Falls Air Force Base).
9. <http://solarview.niwa.co.nz/>
10. <http://www.erh.noaa.gov/er/buf/lakeeffect/snowseason.html>
11. http://www.erh.noaa.gov/buf/climate/buf_snownorm.htm
12. <http://www.wbuf.noaa.gov/hp.htm>

Appendix I









Appendix II

PRESS RELEASE

A Cloud Hovers over the Sunshine Derby

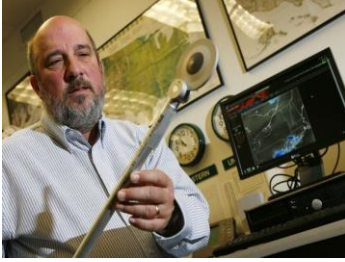
The 'Weather Derby', as calculated and maintained by AccuWeather, Inc from raw data taken from the National Weather Service web site, and reported on the 'Weather' page in the Buffalo News, maintains a running total of the number of Buffalo's sunny days (50% or greater sunshine) for month- and year-to-date. This number is compared to four other cities (Rochester, Syracuse, Orlando, and Phoenix). With the exception of Phoenix, Buffalo usually comes out ahead in this count, and this number is often used by local media and tourist promoters to extol Buffalo's "sunny" disposition within upstate New York.

Dr. Stephen Vermette is a climatologist within the Department of Geography and Planning at Buffalo State, where he helps to coordinate the Meteorology and Climatology Program within the department. He has published numerous articles about Buffalo's climate. Working with students from his Applied Climatology course, along with assistance from Jack Kanack of Weather Medic Inc., he has revealed a "cloud" hovering over this Derby that is best seen by comparing the difference in counts between Buffalo and Rochester. As of October 31, 2012 Buffalo's year-to-date count was 165 sunny days, compared to only 64 days for Rochester. There is no weather explanation to account for this scale of difference between the two cities. Years of historic data, using 'Percent Possible Sunshine' data, actually gives Rochester a slight sunshine edge over Buffalo, with 51% versus 48% respectively. Similarly, Rochester experiences an average of seven more 'clear' days than Buffalo, based on decades of cloud cover data (Northeast Regional Climate Center).

The reason for the Sunshine Derby discrepancy has more to do with comparing 'apples' with 'oranges', than with differences between the two cities. Buffalo's count is based on a measurement of solar energy, as described in the Derby, but Rochester's count is based on cloud cover; more specifically, we believe that AccuWeather Inc. calculates the number of days with less than 5/10th cloud cover. Sometime in the 1990's the National Weather Service discontinued the measurement of solar radiation at many stations (including Rochester), but maintained it at Buffalo. Most National Weather Service stations record cloud cover in tenths. A count of days with greater than 50% sunshine based on sunshine measurements is easier to obtain than sky coverage of less than 5/10th cloud, providing a reason for the difference in days counted between the two cities.

A proper comparison would be to count the number of days with cloud cover (less than 5/10th) between Buffalo and Rochester. Using this measure, as of October 31, 2012 Buffalo had accumulated 58 days, as compared to Rochester's 64 days. Again, as with the historic data, the city of Rochester is seen to be as a sunnier (or less cloudy) city than that of Buffalo for the first 10 months of 2012. In fact, when compared to the other cities, as included in the Derby, Buffalo is the cloudiest of the five. A case may be made, using 'percent possible sunshine' from historic data that Buffalo receives slightly more sun in the summer months, with the exception of Rochester, than many Northeast cities (Albany, NYC, Boston, and Philadelphia), but this comes at a cost to its other months that receive less sunshine than those cities.

Solar energy provides a more accurate measurement of a “sunny day” than does cloud cover but, unless the National Weather Service restores these measurements in Rochester and other cities, we recommend that either the Sunshine Derby be discontinued as a statistic or uses cloud cover as the common measurement starting in 2013.



Professor rains on Buffalo's high ranking in Sunshine Derby

Finds local measurement different from Orlando's

BY: [Mark Sommer](#)

The sun has set on The Buffalo News' Sunshine Derby and with it some fallacies about Buffalo's sunny days.

Buffalo does not typically have more sunshine than Rochester, nor was the Queen City sunnier some years than Orlando, as the rankings in the Sunshine Derby have shown – and been widely reported – in the past.

As a Buffalo State College professor recently discovered and the National Weather Service was aware of, Buffalo's numbers were unintentionally skewed because of the way sunshine was calculated for its month-to-date and year-to-date comparisons as opposed to the four other cities in the derby.

"It's often said we are sunnier than Orlando. That sounds really nice, but we're not," said Stephen Vermette, who coordinates Buffalo State's meteorology and climatology program.

It also turns out Buffalo is one of the few cities in the country – and apparently the only one in New York State – where the National Weather Service continues to measure sunshine by looking for shadows.

The other cities – Rochester, Syracuse, Orlando and Phoenix – measure sunshine through a cloud-cover system, which provides a less accurate measurement of a sunny day, according to Vermette and National Weather Service meteorologist Jon Hitchcock.

"It's an apples-to-oranges comparison. The numbers are totally invalid," Hitchcock said.

That realization led The News on Thursday to stop running the Sunshine Derby, which was presented exclusively in a weather package provided by AccuWeather, a private weather company based in State College, Pa.

Vermette reached his conclusion with students in his applied climatology class and with Jack Kanack of Weather Medic, a weather consultant. Historic dates they researched found Buffalo had trailed Rochester by 3 percent in sunshine percentage. That changed – often dramatically – after the other cities switched during the 1990s to measuring cloud cover.

As of Wednesday, Buffalo was said to have experienced 174 days of 50 percent or more sunshine this year, compared with 71 for Rochester, according to the Sunshine Derby.

"There is no weather explanation to account for this scale of difference between the two cities," Vermette said. "If they were measuring Buffalo and Rochester the same way, we would

But Buffalo would fare the worst when compared with the other cities in the derby if cloud cover was the basis for measuring sunshine, Vermette said.

“If all five cities used the cloud-cover system, Buffalo’s total would have shrunk to 58 sunny days, making it the cloudiest city of the five,” he said.

Still, the Buffalo State professor said the way Buffalo’s sunny days are calculated provides a more accurate measurement than does the cloud-cover system. The other cities underreport their sunny days, he said.

Unless the National Weather Service restored solar-energy measurements in Rochester and the other cities that switched to cloud-cover measurements in the 1990s, Vermette said there was no point in continuing the comparisons.

He said he was surprised that the inaccurate comparison went on as long as it did.

“I’m surprised folks from Rochester didn’t say anything long ago about why their sunshine was undercounted,” Vermette said.

It turns out that The News did field complaints from readers, which were shared with AccuWeather, according to Jim Piro, the weather company’s climatology supervisor.

“We had known it was a problem but didn’t realize how big of a problem it was,” Piro said. He said the company responded by attempting to adjust for the discrepancy in measurement systems.

Ed Healy, a spokesman for Visit Buffalo Niagara, said he didn’t think Buffalo would suffer because of what turned out to be invalid comparisons.

“I’m aware of [the Sunshine Derby], but it’s not like we have spent a lot of time promoting that particular notion. We spend much more time promoting Buffalo as a city with great architecture and history that has appeal as a four-season destination,” Healy said.

“We haven’t invested a lot of time and energy in trying to promote Buffalo as the Miami of the North.”

Appendix III

A W S CLIMATIC BRIEF October 1987	Station Name: NIAGARA FALLS IAP NY		Elevation: 590 ft											
	Latitude/Longitude: N43 06 W078 57		Station MSC: 725287											
	Hourly Obs POR: Jul 77 to Jun 87		Call Sign: KIAG											
	Summary of Day POR: Jun 51 to Jun 60 Oct 61 to Jul 64 Nov 68 to Jun 87		Supersedes: Apr 1982											
MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	YOR
XTRM MAX TEMP °F	59	64	79	84	92	94	95	95	96	84	79	71	84	30
MEAN MAX TEMP °F	30	32	41	55	66	76	81	79	71	60	47	35	56	30
MEAN MON TEMP °F	24	26	33	46	57	66	71	70	62	52	41	30	48	30
MEAN MIN TEMP °F	17	19	26	36	46	56	62	60	53	43	34	24	40	30
XTRM MIN TEMP °F	-16	-17	-8	12	29	33	46	40	30	23	-2	-8	-17	30
D/W TEMP > 85°F	0	0	0	0	1	3	9	5	2	0	0	0	20	30
D/W TEMP > 80°F	0	0	0	1	3	10	18	15	5	#	0	0	52	30
D/W TEMP < 32°F	29	25	24	10	1	0	0	0	#	3	13	25	130	30
D/W TEMP < 10°F	7	6	1	0	0	0	0	0	0	0	#	3	17	30
VPR PRESS ("Hg)	.10	.10	.14	.20	.30	.42	.52	.52	.42	.27	.20	.13	.24	10
MEAN DEWPOINT °F	17	18	25	35	45	54	60	60	54	42	34	24	39	10
99.95% PA Ft	1500	1300	1350	1300	1100	1050	950	900	1000	1200	1250	1350	1200	10
MEAN RH 07 LST %	80	80	79	76	75	76	78	82	83	82	79	80	79	10
MEAN RH 13 LST %	74	71	64	59	56	56	55	60	62	62	69	73	63	10
24HR MAX PRECIP "	1.4	3.1	2.3	1.6	1.9	2.5	2.6	3.2	4.4	2.4	1.7	1.3	4.4	30
MAX MON PRECIP "	4.6	4.8	5.0	4.78	6.5	4.9	6.16	9.0	7.9	7.2	7.5	6.6	9.0	30
MEAN MON PRECIP "	2.5	2.3	2.8	2.9	2.9	2.8	2.6	3.6	3.1	2.8	3.2	3.2	34.7	30
MIN MON PRECIP "	.94	.6	.8	1.04	.7	.2	#	.8	1.1	.3	1.1	1.1	#	30
D/W PRECIP > .01"	18	15	14	13	11	10	9	10	10	11	15	18	154	30
D/W PRECIP > .5"	1	1	2	2	2	2	2	2	2	2	1	1	20	30
24HR MAX SNFL "	11	16	18	6	#	0e	0	0	#	3e	10	10	16	30
MAX MON SNFL "	41	39	24	12	#	0	0	0	#	3	26	53	53	30
MEAN MON SNFL "	18	14	9	3	#	0	0	0	#	#	6	17	67	30
D/W SNFL > .1"	15	12	8	2	#	0	0	0	#	#	4	12	53	30
D/W SNFL > 1.5"	4	3	2	1	0	0	0	0	0	#	1	4	15	30
MEAN WND DRCTN	W	WSW	SW	SW	SW	SW	SW	SW	SW	W	W	W	SW	10
MEAN WND SPD Kts	11	10	10	9	8	8	8	7	8	8	10	10	9	10
MAX WND SPD** Kts	58	58	60	51	56	54	53	42	38	47	43	49	60	4
MEAN CLD CVR 10th	9	8	8	7	7	6	6	7	7	7	8	9	7	10
D/W TSTORMS	#	#	1	3	3	6	6	6	4	1	1	#	31	30
D/W FOG VSBY < 7mi	14	14	15	13	14	14	15	18	16	14	15	15	177	30

Legend: D/W = Mean number of days with... YOR = Years of record
 @ = Based on less than full months # = Amount less than unit(s) given in heading
 ** = Instantaneous peak winds \$ = Percentage of calm winds > mean direction

REMARKS: Hurricanes/tropical storms observed (1900-1985):

	JUN	JUL	AUG	SEP	ANNUAL
Within 60NM	0/0	0/0	0/0	0/0	0/0
Within 120NM	0/0	0/0	0/0	0/0	0/0
Within 240NM	0/1	0/0	0/4	0/1	0/6

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A W S
CLIMATIC BRIEF
October 1987

Station Name: NIAGARA FALLS IAP NY
Latitude/Longitude: N43 06 W078 57
Hourly Obs POR: Jul 77 to Jun 87
Summary of Day POR: Jun 51 to Jun 60
Oct 61 to Jul 64
Nov 68 to Jun 87

Elevation: 590 ft
Station MSC: 725287
Call Sign: KIAG
Supersedes: Apr 1982

	LST	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	YOR
CIG/VSBY	00-02	53	43	32	20	16	13	9	15	18	20	35	47	27	
	03-05	57	44	33	25	19	18	16	19	20	22	35	46	30	
	06-08	59	49	37	28	22	23	20	26	28	27	37	50	34	
	09-11	58	47	38	28	20	19	18	22	25	27	37	53	33	
	12-14	53	47	36	28	17	15	13	19	22	25	39	53	31	
	15-17	51	42	30	23	15	10	8	11	15	17	36	50	26	
	18-20	49	38	29	19	12	9	6	10	15	17	35	48	24	
	21-23	50	39	29	20	11	11	7	11	16	18	35	48	25	
	00-24	54	44	33	24	17	15	12	17	20	22	36	49	29	10
	CIG/VSBY	00-02	27	22	17	11	10	7	6	11	11	11	15	20	14
03-05		28	22	17	13	14	12	12	15	12	13	16	21	16	
06-08		32	26	22	17	14	17	16	21	19	17	17	24	20	
09-11		38	30	22	13	11	10	9	10	14	13	20	25	18	
12-14		29	25	16	10	7	6	5	8	9	10	18	27	14	
15-17		29	21	14	9	5	5	4	5	7	8	17	26	13	
18-20		25	20	14	9	6	6	4	6	9	8	14	23	12	
21-23		24	21	16	9	7	6	4	7	11	9	15	22	13	
00-24		29	23	17	11	9	9	8	10	12	11	17	24	15	10
CIG/VSBY		00-02	18	14	14	7	8	4	3	5	7	9	11	14	10
	03-05	20	14	13	9	9	8	7	7	9	9	12	14	11	
	06-08	18	16	15	12	11	9	9	10	12	11	12	16	13	
	09-11	21	20	13	8	6	5	4	3	8	9	12	18	11	
	12-14	16	16	11	7	3	3	2	3	5	7	11	18	9	
	15-17	18	14	9	5	4	3	2	2	4	5	10	18	8	
	18-20	15	13	10	6	4	3	2	2	5	6	10	17	8	
	21-23	16	12	11	6	6	4	2	3	6	6	10	16	8	
	00-24	18	15	12	8	6	5	4	4	7	8	11	16	10	10
	CIG/VSBY	00-02	2	4	2	#	1	#	#	1	2	3	1	3	2
03-05		2	4	3	1	3	1	1	2	2	3	1	3	2	
06-08		2	3	2	2	2	1	1	2	2	4	2	2	2	
09-11		1	1	2	1	0	0	0	0	#	2	1	2	1	
12-14		1	3	1	#	#	0	0	0	0	#	1	3	1	
15-17		2	3	1	0	0	0	0	0	#	#	1	3	1	
18-20		2	2	1	#	#	0	0	0	#	1	1	2	1	
21-23		1	3	2	1	#	#	#	0	1	2	1	3	1	
00-24		2	3	2	1	1	#	#	1	1	2	1	3	1	10

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Appendix IV

Wind Stratified Conditional Climatology [User Manual](#)

STATION SELECTION

Select Search Type: ICAO Block Station Station Name Country

Select the station from the drop down list

KIAG -- 725287 -- NIAGARA FALLS INTL, NY -- UNITED STATES

STATION INFORMATION

WMO	NAME
725287	NIAGARA FALLS INTL, NY
ICAO	COUNTRY
KIAG	UNITED STATES
LATITUDE	LONGITUDE
N 43.100	W 78.933

CONDITIONS

CURRENT	REVISED
MONTH January	
HOUR 19 Z	Select
WIND SECTOR 176 - 275	All
CEILING < 3000	Unlimited
VISIBILITY < Unlimited	Unlimited

Sequence Number: 1

Units: feet / miles feet / meters meters / meters

Sequence Number represents a unique set of wind sectors and ceiling/visibility parameters

SEQUENCE INFORMATION

PERIOD OF RECORD	HOUR BIN
1951/06/01 - 2010/05/31	2

CURRENT OBSERVATION (Raw Trends)

METAR KIAG 031853Z 24015KT 10SM FEW021 OVC029 M02/M06 A2996 RMK AO2 SNE10 SLP165 P0000 T10221061 \$=

CEILING

13 FCST HRS	1	2	3	4	5	6	7	8	9	12	15	18	24
TIME	20Z	21Z	22Z	23Z	00Z	01Z	02Z	03Z	04Z	07Z	10Z	13Z	19Z
200 ft			0	0	1	0	0	0	1	1	2	0	0
500 ft	0	0	1	1	1	1	1	2	2	3	2	3	2
700 ft	2	2	3	3	2	1	1	2	2	2	2	2	3
1000 ft	2	4	4	3	3	5	4	4	4	2	3	5	5
1500 ft	9	10	8	8	9	8	8	7	6	8	9	8	6
3000 ft	68	57	49	43	38	35	34	35	33	32	31	31	32
10000 ft	11	14	18	23	25	25	26	26	27	28	23	26	20
Unlimited	9	13	18	19	21	25	25	24	25	25	28	25	32
OCCURRENCES	515	515	516	513	514	515	514	512	512	503	498	507	511

Total Initial Condition Observations: 1768

VISIBILITY

13 FCST HRS	1	2	3	4	5	6	7	8	9	12	15	18	24
TIME	20Z	21Z	22Z	23Z	00Z	01Z	02Z	03Z	04Z	07Z	10Z	13Z	19Z
0.5 mi	0	0	0	0	0	0	0	0	0	0	1	1	1
1 mi	0	1	1	1	0	1	1	1	0	2	2	2	4
1.5 mi	1	1	1	1	1	1	1	1	1	2	2	3	3
2 mi	1	1	1	1	1	1	1	1	2	2	2	3	3
3 mi	2	3	3	3	3	3	3	3	4	5	5	8	7
7 mi	7	11	12	11	9	11	12	12	13	14	16	17	16
Unlimited	90	84	82	83	85	83	82	82	79	76	73	67	66
OCCURRENCES	1084	1083	1082	1078	1076	1080	1075	1074	1073	1041	1038	1070	1078

Total Initial Condition Observations: 1768

OPR: 14WS/WXED
 DSN: 673-9010
 Comm: 828-271-4220
 Last Updated: 26 July 2010
 Version: 1.2