A NEW CLIMATOLOGY OF 25-YEAR, 50-YEAR, AND 100 YEAR MICROBURST WINDS

James C. Walter *
Salt River Project, Tempe, Arizona

1. INTRODUCTION

Societal impacts of microbursts not only pose a significant threat to personal property and life, but also wreak havoc across a wide range of industries such as the aviation community, public and private utilities, and agriculture. With such a great impact on society there exists a need for a reliable climatology of microburst winds. However, the spatial and temporal scale of microbursts, damaging divergent outflow winds produced by a downburst of air, excludes the majority of events from being measured by the current network of weather stations (Fujita 1985). In an attempt to address this issue, a new potential microburst wind data set was developed using 0000 UTC rawinsonde data for a 30-year summer period that incorporates the months of July and August for the years of 1974-2003. Data for this study was gathered from the FSL/NCDC CD ROM archive (http://raob.fsl.noaa.gov/Raob_Software.html).

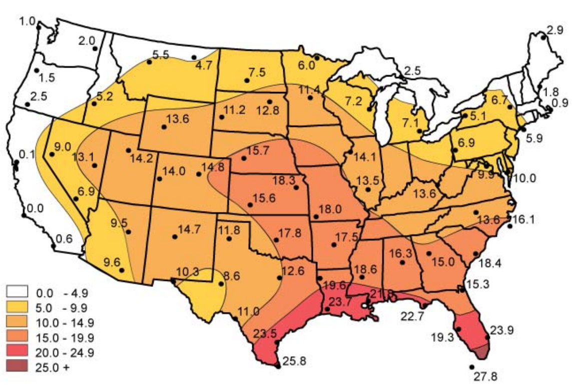

FIG. 1. Average potential microburst days per month for July and August.

* *Corresponding author address*: James C. Walter, Salt River Project, PAB120, 1521 N. Project Dr., Tempe, AZ 85281; email: james.walter@srpnet.com

This new potential microburst data set was developed by calculating days in which microbursts were likely through atmospheric indices (figure 1). First, the surface based convective available potential energy (Weisman and Klemp 1982) was computed to determine an environment favoring convective development. Then, the dry microburst index (Ellrod and Nelson III 1998), and the microburst day potential index (Wheeler and Roeder 1996) were calculated to determine the likelihood of microburst activity. With the potential microburst days calculated, the wind index, or WINDEX (McCann 1994), was used to determine the potential microburst wind speeds for a given microburst day.

2. POTENTIAL MICROBURST WINDS

With the potential microburst wind speed data set calculated, the type I extreme value distribution (Simiu and Scanlan 1986) was used to compute the 25-, 50-, and 100-year potential microburst winds. In addition to this, the standard deviation of sampling error was calculated to gage the goodness of fit. Unfortunately, not all of the upper-air sites were modeled satisfactory by the type I extreme value distribution and these sites were excluded from the spatial analysis. But their values were included and indicated by smaller, italicized fonts in the potential microburst wind recurrence maps.

2.1 25-year Potential Winds

Results from the recurrence intervals indicate that, for a 25-year return period, most of the contiguous United States experiences a potential microburst wind gust of 80 mph or more (figure 2). The weakest 25-year potential microburst wind speeds tend to occur over the coastal regions with a potential microburst wind speed below 80 mph for the East Coast and Gulf Coast areas. In contrast, results indicate that the Plains and Southwest have the highest 25-year potential microburst wind speeds with values exceeding 90 mph. In fact, Tucson, AZ and Desert Rock, NV, have 25-year potential microburst wind speed values greater than 95 mph. In addition, the standard deviation of the sampling error is less than five percent over the contiguous United States indicating the strength of the results.

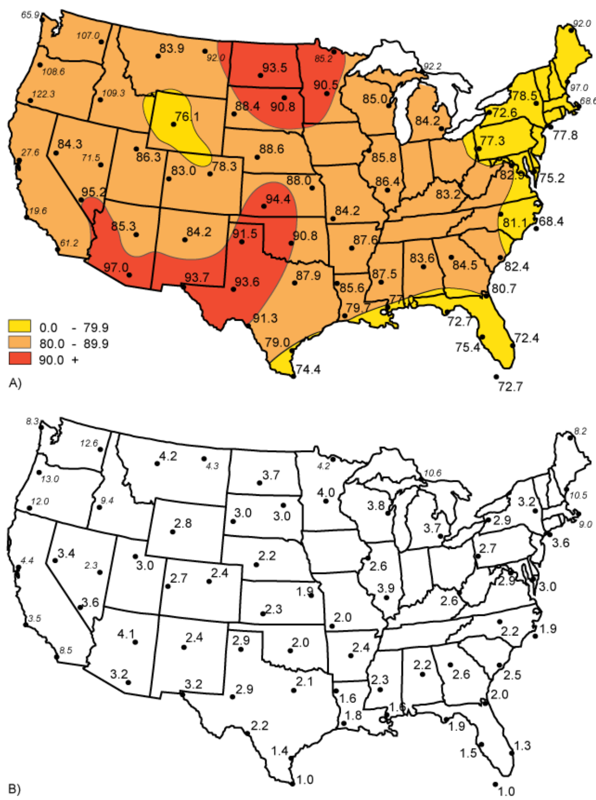

FIG. 2. The calculated A) 25-year recurrence interval for potential microburst peak gust wind speeds (mph), and B) 25-year standard deviation of the sampling error (mph).

2.2 50-year Potential Winds

The 50-year potential microburst wind results show the expansion of the 80-89 mph region with the greatest growth occurring with potential microburst wind speeds greater than 90 mph (figure 3). In addition, the introduction of potential microbursts winds in excess of 95 mph occurs over the Plains with 100 mph potential microburst winds being introduced over the southwestern United States. Much like the 25-year analysis, the coastal regions and portions of the Rockies show the weakest potential microburst winds with wind speed values between 70 and 85 mph.

2.3 100-year Potential Winds

Inspection of the 100-year potential microburst wind speed results show continued expansion of the 90 mph region (figure 4). In fact, this region now covers the majority of the contiguous United States with the Rockies experiencing potential microburst wind speeds between 80 and 90 mph and a few upper-air sites over the Gulf Coast and East coast regions still struggling to exceed 80 mph. Furthermore, the region with potential microburst wind speed in excess of 100 mph expanded to cover a greater portion of the Southwest along with the areas over the Plains. Additionally, the desert Southwest continues to be the area with the most intense potential microburst wind speeds with both Tucson, AZ, and Desert Rock, NV, indicating the possibility of microburst winds in excess of 105 mph.

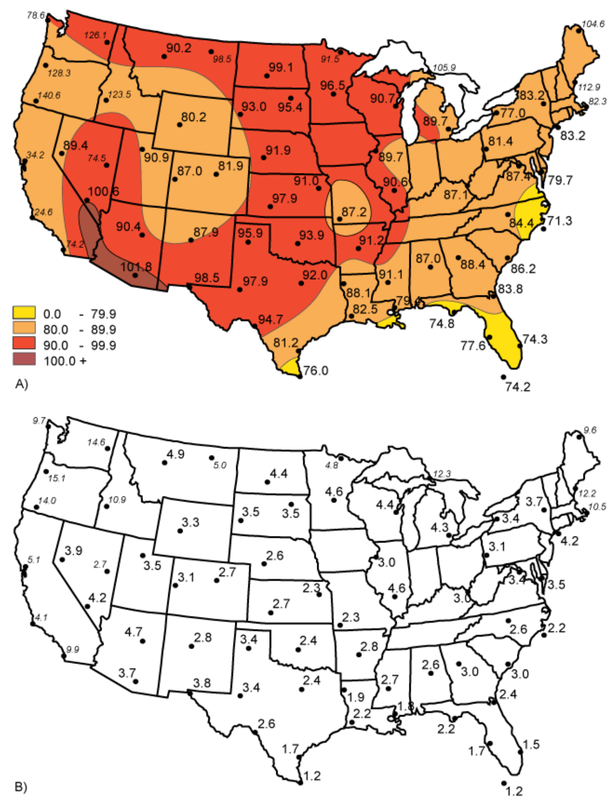

FIG. 3. The calculated A) 50-year recurrence interval for potential microburst peak gust wind speeds (mph), and B) 50-year standard deviation of the sampling error (mph).

3. PREVIOUS CLIMATOLOGIES

Comparing results from this study potential microburst wind data set to previous non-tornadic wind climatologies indicate regions where microburst winds are potentially greater or less than current convective wind climatologies indicate. For example, a study using the same statistical methodology with actual observed wind speeds showed similar spatial patterns across the contiguous United States (Peterka and Shahid 1998). In fact, localized minimums and maximums were even similar. For example, the localized potential microburst minimums (maximums) that occur over Missouri and the Rockies (Plains) also occur in Peterka and Shahid's analysis (figure 5). However, the Southwest stands out as a region where potential microburst wind speeds are as much as fifteen mph greater than Peterka and Shahid's results. This would suggest that for the Southwest microburst winds are by far the greatest severe wind threat of any type of convective straight-line wind.

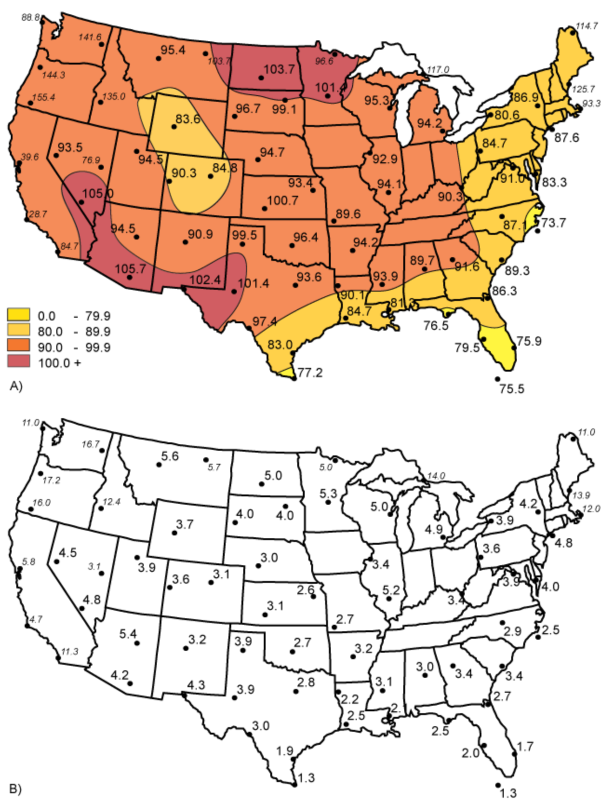

FIG. 4. The calculated A) 100-year recurrence interval for potential microburst peak gust wind speeds (mph), and B) 100-year standard deviation of the sampling error (mph).

Furthermore, results from Kelly et al. (1985) show the greatest frequency of thunderstorm wind speeds exceeding 75 mph occurs over the Plains and into the Great Lakes region. Similar results are indicated by this study; however, this study suggests that in addition to the Plains, portions of the Southwest have a high frequency of thunderstorm winds greater than 75 mph being generated by microbursts indicating the importance of extreme microburst wind speeds over the Southwest. In addition, the Midwest region have a lower frequency of potential microburst winds greater than 75 mph suggesting that other convective straight-line winds, such as derechos are a greater threat than microburst winds over this region.

4. CONCLUSION

Prior thunderstorm wind climatologies have lacked the input of one of the most destructive and hazardous convectively induced straight-line winds, the microburst. This research has addressed this gap in thunderstorm climatologies through a new climatology of potential microbursts winds using rawinsonde data as a proxy for actual

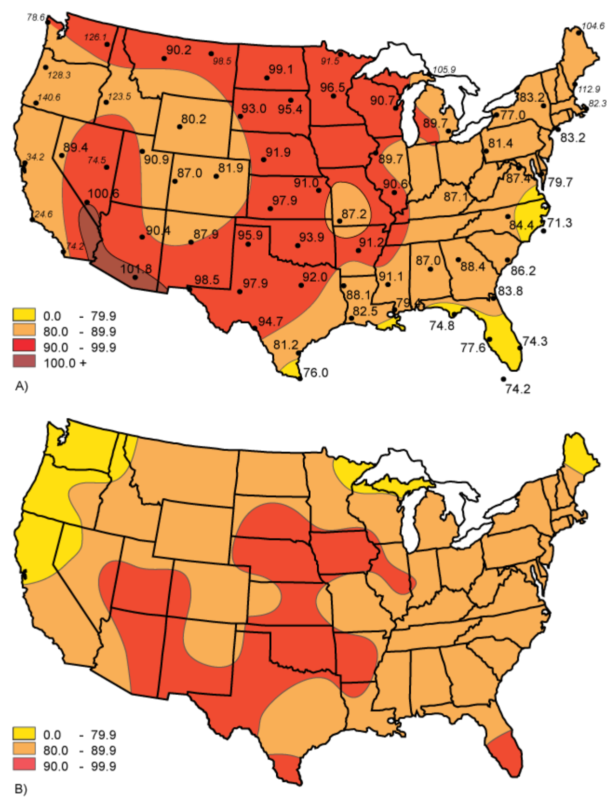

FIG. 5. Comparison of A) 50-year potential microburst wind speeds to B) 50-year peak wind speeds from actual wind data (Peterka and Shahid 1998).

events. Results show that the Southwest and the Plains have the potential to experience the most extreme microburst winds with the coastal areas of the United States experiencing the least extreme microburst winds. Comparisons of these results to previous thunderstorm climatologies indicate that microburst winds pose the greatest threat of any straight-line winds to the Southwest while the Midwest experiences a greater threat of extreme winds from other straight-line winds such as derechos and gust fronts.

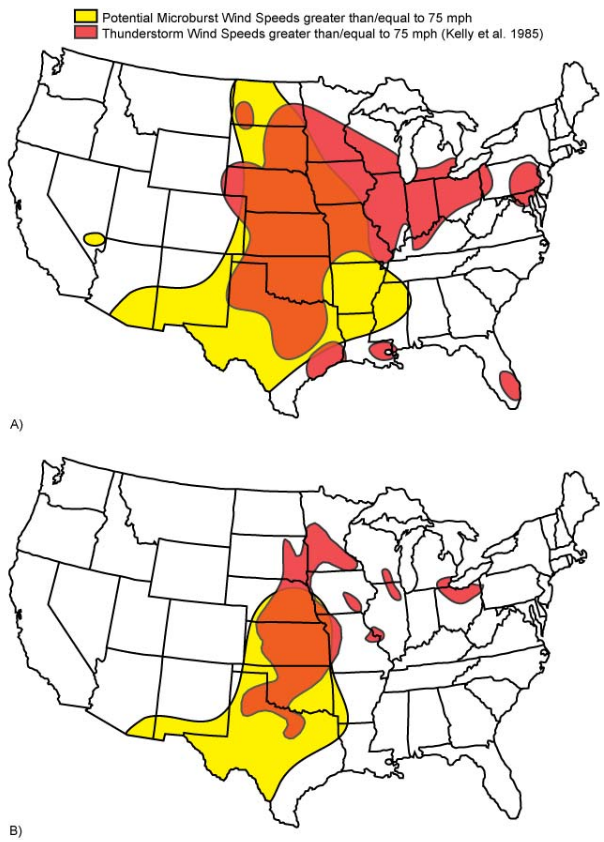

FIG. 5. Comparison of the frequency of non-tornadic thunderstorm winds greater than 75 mph (red) (Kelly et al. 1985) and potential microburst wind speeds greater than 75 mph (yellow). A) 2-year wind speeds, B) 1-year wind speeds.

5. REFERENCES

Ellrod, G. P., and J. P. Nelson III, 1998: Experimental microburst image products derived from GOES sounder data. Preprints, *16^{th} Conf. on Weather Analysis and Forecasting*, Phoenix, AZ, Amer. Meteor. Soc., 43-45.

Fujita, T. T., 1985: *The downburst*. SMRP Research Paper No. 210, The University of Chicago, 122 pp. [NTIS PB-148880.]

Kelly, D. L., J. T. Schaefer, and C. A. Doswell III, 1985: Climatology of nontornadic thunderstorm events in the United States. *Mon. Wea. Rev.*, 113, 1997-2014.

McCann, D. W., 1994: Windex – A new index for forecasting microburst potential. *Wea. Forecasting*, 9, 532-541.

Peterka, J. A., and S. Shahid, 1998: Design gust wind speeds in the United States. J. Struct. Eng., 2, 207-214.

Simiu, E., and R. H. Scanlan, 1986: *Wind effects on structures: an introduction to wind engineering*, 2^{nd} Ed., Wiley Interscience, 604 pp.

Weisman, M. L., and J. B. Klemp, 1982: The dependence of numerically simulated convective storms on vertical wind shear and buoyancy. *Mon. Wea. Rev.*, 110, 504-520.

Wheeler, M. M., and W. P. Roeder, 1996: Forecasting wet microburst on the central Florida Atlantic Coast in support of the United States space program. Preprints, *18^{th} Conf. on severe Local Storms*, San Francisco, CA, Amer. Meteor. Soc., 654-658.