Downscaling of Severe Thunderstorms from Reanalysis Data

Harold E. Brooks
NOAA/National Severe Storms Laboratory

The project was funded to create artificial soundings from data derived from the NCAR/NCEP global reanalysis, and then to analyze those soundings for convective potential. To date, 10^9 soundings have been created from around the world 1958-1999 (approximately 92% of the total) and remaining holes in the data set are being filled in. Approximately 1% of the soundings have been studied using various sounding analyses packages to look at their convective potential.

Three primary approaches to the analysis are underway, designed to look at global, regional, and point-by-point scales of the convective problem. All soundings at a quarter of the land points of the globe for a three year period (1997-9) have been examined and the distribution of environments supportive of significant severe thunderstorms (5 cm diameter hail, 120 km/h wind gusts, or F2 or stronger tornado) has been mapped (Fig. 1), updating the work of Brooks et al. (2003). Regions with the greatest potential for severe thunderstorms include the areas east of the Rocky Mountains and the Andes, equatorial Africa, and the region around the Himalayas.

Secondly, all soundings from three regions (the eastern US, Australia, and Europe) for a period of 7 years have been considered. From these, mean patterns of important convective ingredients, such as the timing of the arrival of significant low-level moisture are being produced (Fig. 2). Although the pattern in the case of Fig. 2 is not surprising, the reanalysis data provides greater spatial coverage of boundary-layer moisture content than other datasets. When analysis of the complete record is done, interannual variability of moisture will also be possible. For now, an initial study of the differences in convective parameters for the spring in the US Great Plains in 1973 (a prolific tornado year) and 1987 (a year with relative few tornadoes) has started. 1987 is marked by having significantly lower values of deep-layer shear, even though the distribution of convective available potential energy (CAPE) is the same or greater (Fig. 3).

Finally, all soundings at selected gridpoint locations in the reanalysis have been analyzed for convective parameters. Long-term time series have been derived for those parameters. As an example, the 75th percentile value of CAPE for all days during a year with CAPE for Oklahoma City, USA and Brisbane, Australia have been compared (Fig. 4). Interannual variability of CAPE at Oklahoma City is clearly much larger, carrying a suggestion of low-frequency variability, with the late 1960s being a low-CAPE period and the late 1980s being a high-CAPE period. In contrast, interannual variability at Brisbane is relatively small and long-term trends, if any, are not readily apparent.

Completion of the sounding database is anticipated by the end of September and additional sounding analysis will take several more months. A Ph.D. student at the University of Oklahoma will begin to use the dataset for research in the fall, and collaborations with scientists in Australia, South Africa, Brazil, and Italy are being planned.

Reference:

Brooks, H. E., J. W. Lee, and J. P. Craven, 2003: The spatial distribution of tornado environments from global reanalysis data. *Atmos. Res.*, **67-68**, 73-94.

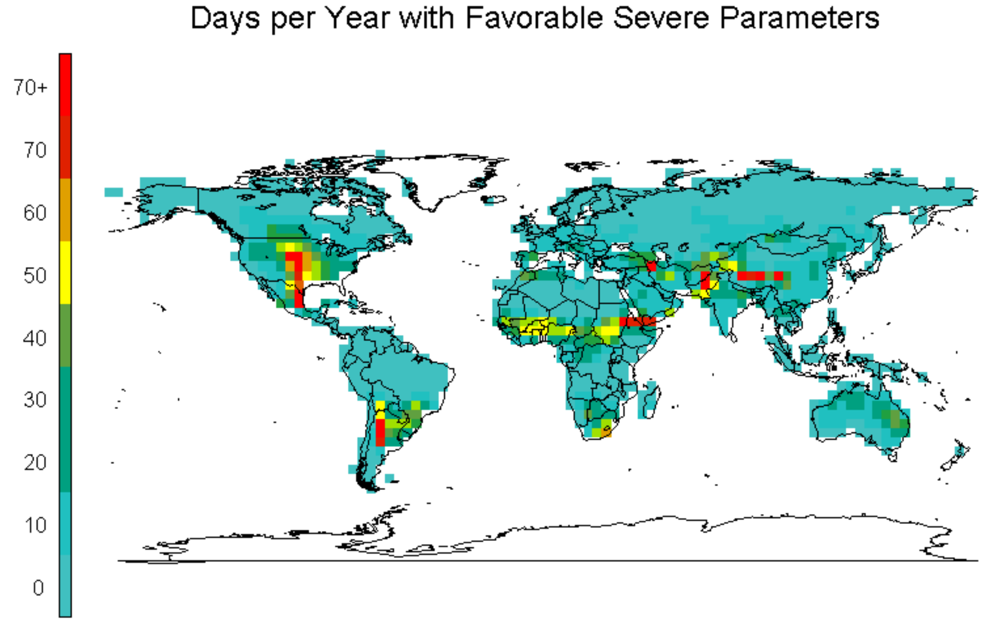

Fig. 1: Mean number of days per year with favorable conditions for significant severe thunderstorms (based on 1997-9).

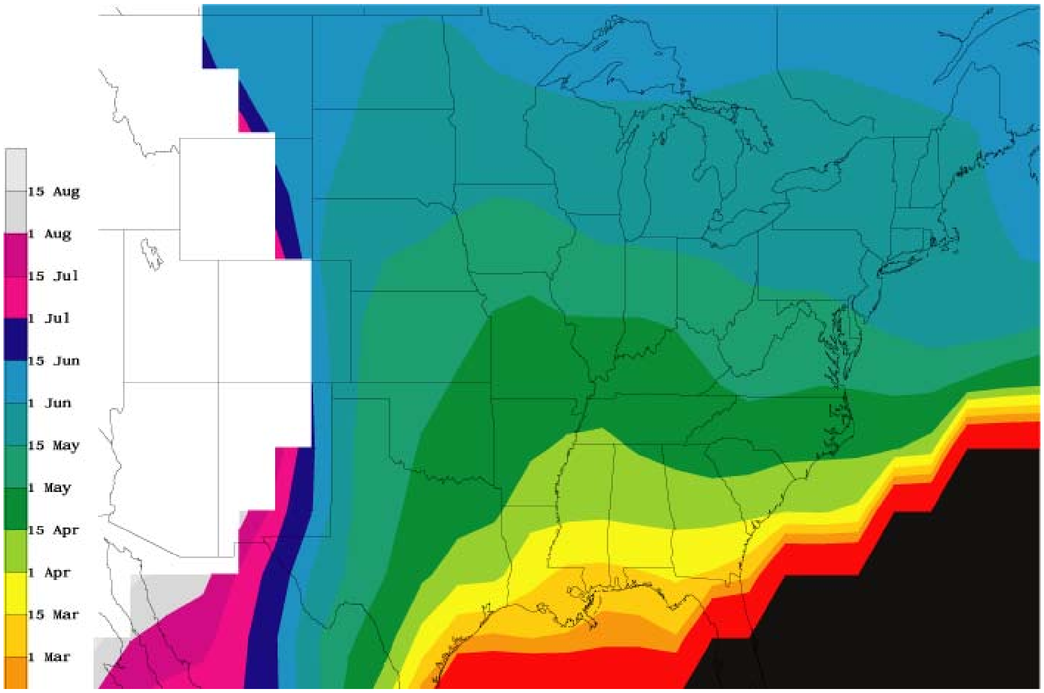

Fig. 2: Mean date of first day of year with mean 8 g/kg mixing ratio of water vapor for well-mixed lowest 100 hPa layer.

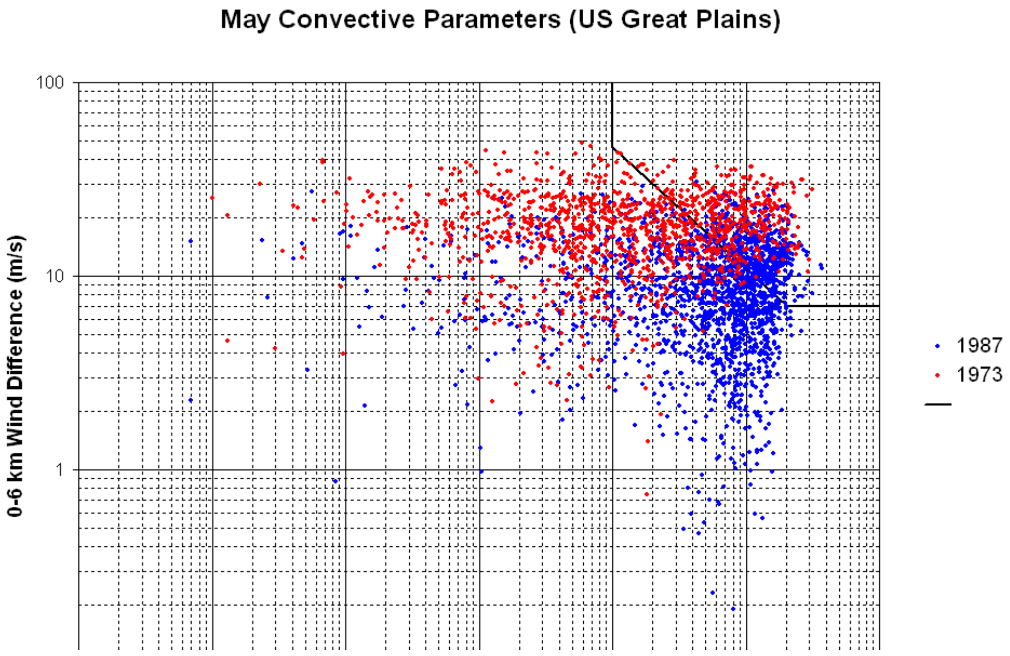

Fig. 3: Scatter plot of deep shear (wind difference between surface and 6 km) and CAPE for reanalysis soundings in US Great Plains in May of 1987 (blue) and 1973 (red).

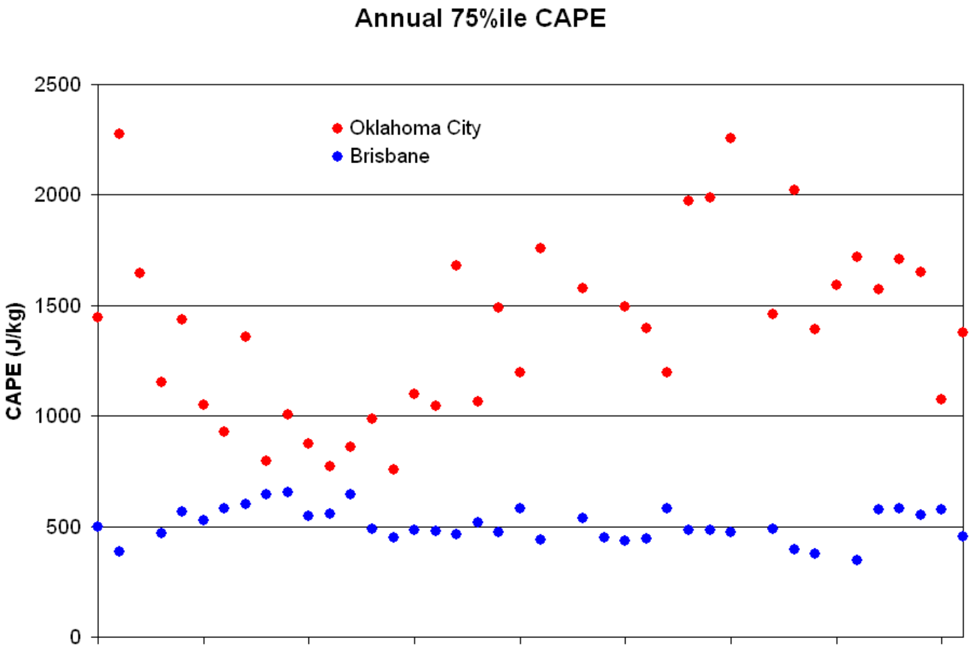

Fig. 4: Annual value of 75%ile of CAPE for days with positive CAPE for Oklahoma City, USA (red) and Brisbane, Australia (blue).