# PROXIMITY SOUNDINGS FOR EUROPE AND THE UNITED STATES FROM REANALYSIS DATA

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## I. INTRODUCTION

Proximity sounding analysis has a long tradition in severe thunderstorm studies in identifying environments that are favourable for severe storms and tornadoes (e.g., Brooks et al. 1994; Rasmussen and Blanchard 1998 and references therein.) Much of our understanding of storm environments has come from numerous studies in the United States that have looked at the environmental conditions in the vicinity of storms. Brooks et al. (2003) applied results of a proximity sounding study using soundings derived from the NCAR/NCEP reanalysis to estimate the distribution of significant severe thunderstorms (5 cm or larger hail, hurricane force wind gusts, or F2 or stronger tornado) and significant tornadoes. The proximity relations were derived from events that occurred in the US. The reanalysis has soundings every 6 hours from 1958-1999 at a spacing of about 1.9° latitude and longitude.

One of the questions that comes up in such an effort is how representative the US environments are of the severe weather environments around the world. Although it seems unlikely that the physics of the atmosphere changes depending on the geographic location, it is quite possible that storms could develop in environments that are poorly sampled in the US. As a result, testing the applicability of the US results by developing proximity datasets from other parts of the world have been a goal. The recent creation of the European Severe Weather Database (ESWD) (http://www.essl.org/ESWD) has provided an opportunity for that. The results have importance both for forecasting and for understanding the climatic distribution of severe storms and possible changes in future climates.

## II. METHODOLOGY

Events were selected using 0000 UTC soundings from 1997-1999 for the US and for any time and any year for Europe. A total of 1090 severe soundings were collected for the US and 184 for Europe. One of the critical problems in any proximity study is the question of appropriate null cases. Comparing severe thunderstorm soundings to those taken in the middle of winter in high latitudes is unlikely to provide insight into the forecasting problem. In order to limit consideration to a reasonable range of soundings, the soundings from the other 41 years of the reanalysis database taken at the same location and same time of the same day of the year were collected. The distributions of those soundings in CAPE (using a parcel mixed over the lowest 100 hPa) and "deep shear" (magnitude of the difference between the surface and 6 km winds) space are shown in Fig. 1. Although the shear distribution is reasonably similar for the US and Europe, the US distribution is shifted into much higher CAPE ranges.

Probabilities of severe thunderstorm occurrence can be calculated on the grid shown in Fig. 1 by simply counting the frequency that severe storms were associated with the conditions over the total number of soundings there. In order to facilitate the calculation, all soundings within a distance of 0.3 (in log-log space, 3 grid points on the figures) of the gridpoint location are assumed to be associated with that point. The calculation is not carried out if fewer than 30 soundings are associated with a point.

In addition to the CAPE/Shear space calculations, CAPE*Shear for each sounding is calculated. The LCL height, again for a mixed layer parcel, is used as a second dimension and the probabilities of severe thunderstorms are calculated in a similar fashion with the vertical grid spacing being 25 m in LCL space.

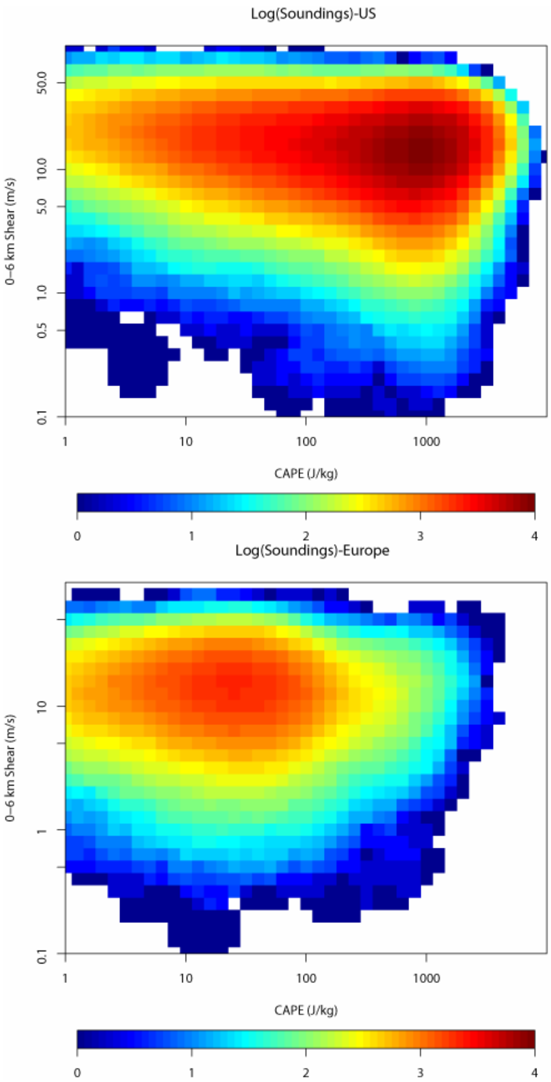


FIG. 1: Distribution of soundings in CAPE/Deep Shear space for proximity datasets for US (top) and Europe (bottom). Axes and scale are both in log space. Gridding for distribution is also log-log.

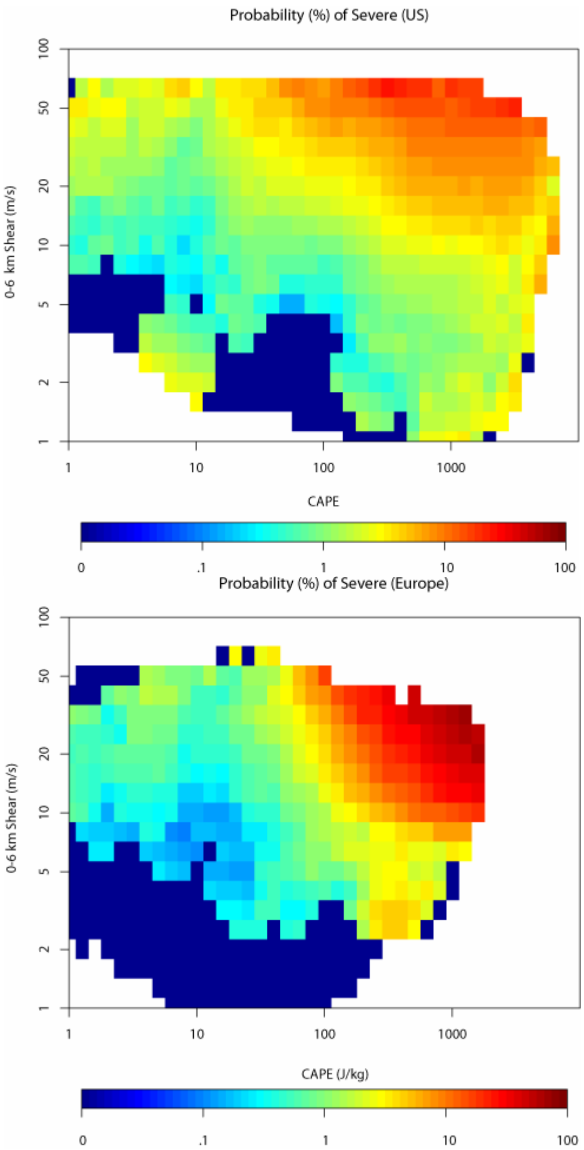


FIG. 2: Probability (%) of sounding being associated with significant severe thunderstorms, given combination of CAPE/Shear, for US (top) and Europe (bottom). Axes and scale are both in log space.

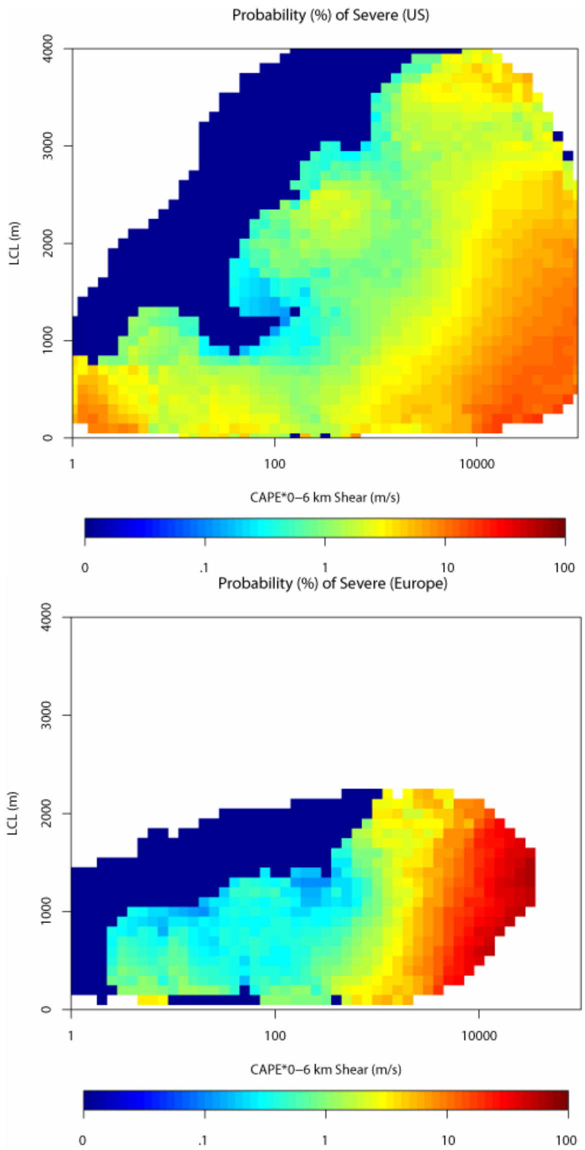


FIG. 3: Same as Fig. 2, except horizontal axis CAPE*Shear, vertical is LCL height. Horizontal axis and scale are both in log space.

## III. RESULTS AND CONCLUSIONS

Probabilities of a sounding being associated with severe weather go up dramatically with increasing CAPE and Shear (Fig. 2). The peak values of European probabilities are higher than in the US, but the combination of conditions is very rarely visited. It appears that combining CAPE*Shear and comparing it to the LCL (Fig. 3) produces the strong gradient in probability of severe in about the same location for both datasets, implying that it may have promise in producing a globally-applicable parameter to estimate severe thunderstorm environments.

One of the important results (not shown) is that the probability of severe thunderstorms appears to be strongly dependent on the probability of initiation. European environments are similar to those seen in the cool season of the southeastern US, where convective initiation is much more likely for the same combination of CAPE and Shear, probably because of stronger synoptic forcing and, in the case of Europe, topographic forcing.

## IV. ACKNOWLEDGMENTS

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## V. REFERENCES

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