SEVERE THUNDERSTORM ENVIRONMENTS UNDER ANTHROPOGENIC CLIMATE CHANGE

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I. INTRODUCTION

In this study we investigate the possible response of locally severe thunderstorms–namely, those that produce tornadoes and significant wind damage–to the global radiative forcing associated with elevated greenhouse gas concentrations. Although individual thunderstorms are unresolved in typical climate models, we can still utilize climate model data, since the organization of cumulus clouds into intense storms is governed largely by the larger-scale temperature, moisture, and wind. Specifically, the derived quantities of convective available potential energy (CAPE), and vertical wind shear over the 0-6 km AGL layer (S06) can, under certain assumptions, serve as proxies to actual storms; intense thunderstorms are supported theoretically when both quantities are relatively large locally.

II. RESEARCH METHODOLOGY

We evaluate CAPE and S06 using the high-resolution simulations of United States regional climate generated by Diffenbaugh et al. (2005). Modern (1962-1989) and future (2072-2099) integration periods are considered. The time-varying atmospheric CO_2 values for the future integration follow the Special Report on Emissions Scenarios A2 scenario.

III. RESULTS AND CONCLUSIONS

We find that under the A2 emissions scenario, CAPE increases and S06 decreases throughout most of the United States. Upon combining both quantities in an empirical parameter (SEV) that discriminates between environments of severe thunderstorms and all other thunderstorm environments (Brooks et al. 2003), we find that SEV also increases. The projection based on this realization, therefore, is of an increase in the frequency of days on which atmospheric conditions are conducive to the formation of locally extreme thunderstorms. The magnitude of this increase varies geographically and also seasonally. For example, the largest increases in SEV during the summer (June-July-August) season are within roughly 5 degrees latitude of the Gulf of Mexico and Atlantic coastal regions.

Application of this methodology to a European domain is anticipated.

IV. REFERENCES

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

Diffenbaugh N. S., Pal J. S., Trapp R. J., and Giorgi F., 2005: Fine-scale processes regulate the response of extreme events to global climate change. *PNAS*, 102, 15774-15778.