Can we predict seasonal changes in high impact weather in the United States?

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Summary and Conclusion

Severe storms threaten lives throughout the United States (US) every year, suggesting that any predictive capability is of great societal benefit. While it is well recognized that predicting individual tornado outbreaks is only possible a few hours in advance, the large-scale background atmospheric conditions that influence the likelihood of tornado outbreaks may be more predictable.

Severe storms occur most readily when Convective Available Potential Energy (CAPE) and vertical wind shear both are large in a local environment. During May-June-July (MJJ), the evolution (not shown) and geographical location of CAPE is similar to the combination of CAPE and shear, and further, shear (climatology and variance) is weak (Fig. 1). Hence, in this study, CAPE is used as background state in which variations create conditions that are more or less favorable for severe weather occurrence (Fig. 1 and Fig. 2).

We analyzed 30 years of MJJ predicted CAPE from May 1st initialized forecasts from NCAR CCSM4. The forecasts were compared with observational estimates from North American Regional Reanalysis (NARR). The results show that an area-averaged SST anomaly in the Gulf of Mexico (GoM index) is a possible predictor for forecasting CAPE anomalies in the US. The warmer the SST in the Gulf of Mexico (GoM), the higher CAPE in the contiguous US during MJJ months (Fig. 3). The mechanism behind the correlation between GoM index and CAPE in the US is due to variations in moisture transport from the GoM to US (Fig. 4). Considering our current ability to predict SST in the GoM (Fig. 5) compared to the difficulty of predicting high-impact weather in the US, the findings are promising for the seasonal prediction of enhanced or decreased tornado activity in the US during MJJ using the GoM SST. This study further emphasizes that the influence of ENSO (contemporaneous as well as antecedent winter ENSO) in the Gulf of Mexico SST (and ultimately tornado activity in the US) is weak during MJJ, and there is no clear relationship between US CAPE and ENSO during MJJ (Fig. 3).

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