Final Report

COMET Partner's Project

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Partners Project: *A Improving Our Understanding of Heavy Rainfall Events in the Texas Hill Country*

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1. SUMMARY OF PROJECT OBJECTIVES

Progress has been good. Amy Schnetzler, a master's student at the University of Missouri-Columbia (UMC) has nearly finished her thesis on this work, and recently presented her results at the AMS 22nd Conference on Hydrology.

Tasks A, B, and C are effectively complete. Output from the North American Regional Reanalysis (NARR) was acquired for cases of heavy rainfall in the Texas Hill Country for the 25-year period, 1982-2006 (Task A). Task B, "Explore alternate definitions of 'heavy rain event…'," has been completed in that the heavy rainfall data were analyzed as a gamma distribution to find the heavy rainfall events in the top 2% (termed 'unusual'), 1% ('rare'), and 0.5% ('extreme'). This distribution was derived for the entire region as well as station by station. In addition, we have classified each of these events, and completed the sounding compotisiting work (Task C).

2. PROJECT ACCOMPLISHMENTS AND FINDINGS

Twenty-five years of daily (24-hour) rainfall data were examined for the Texas Hill Country using observations from 86 cooperative climate stations in the region; the period examined for this study was 1982-2006. Days with measurable precipitation were treated as a gamma distribution in order to determine the top 2%, 1%, and 0.5% to define events as unusual, rare, and extreme, respectively. This approach was applied to each station as well as to the aggregate data for all 86 stations, resulting in an analysis of 130,986 observations of 24-hour precipitation. From this sample, rainfall amounts were also calculated for each station that represent 25-, 50-, 100-, and 200-year return frequencies. For the aggregate gamma distribution, the parameters values of α=0.4678 and β=1.0082 were obtained.

While individual stations varied greatly, the aggregate data yielded a 24-hour rainfall threshold of 67 mm (2.64 in) for an observation to be in the upper 2%, 82.6 mm (3.25 in) to be in the upper 1%, and 98.30 mm (3.87 in) to be in the upper 0.5% of the distribution (which corresponds well to the 4.00" threshold in cases studied by Grice and Maddox [1982]). Three-hourly soundings were reconstructed using North American Regional Reanalysis grids via NSHARP for all each cases of heavy rainfall. For all cases, the sounding with the highest CAPE in the 24-hours prior to the time of the daily rainfall total was chosen for compositing the classic Mesohigh, Frontal, and Synoptic classifications.

Unfortunately, great distinctions were not discovered between the soundings having unusual, rare, or extreme rainfall totals within the three classic classifications. Even when comparing the extreme soundings from the Mesohigh, Frontal, and Synoptic classifications, similar patterns emerged. Each composite environment was moist (all three >4.0 cm of precipitable water), unstable (all three with MUCAPE > 700 J kg^{-1}) and had only weak shear values (winds below 400 mb typically less than 35 knots). These conditions suggest an atmosphere with higher precipitation efficiency, with more upright convective towers and slower cell motion. Indeed, storm motions based upon the 0-6 km wind never exceeded 16 knots. Moreover, each composite featured a jet of 50-55 knots which maximized at the ~200-mb level.

However, some differences were noted. While the extreme rain event soundings for the Mesohigh, Frontal, and Synoptic classifications each had a near-surface inversion, the most pronounced was with the Frontal type, less so with the Synoptic type, and least with the Mesohigh collection. The Frontal and Synoptic composites also had a smaller NCAPE (~0.1 J kg^{-1} mb^{-1}) than the Mesohigh events. Another distinction of the Frontal and Synoptic composites from the Mesohigh composite type was the enhanced veering in the wind profile in the former types. Both

the Frontal and Synpotic types had substantial easterly flow through the lowest ~50 mb, while the near surface flow with the Mesohigh type composte events was southerly with only a weak easterly component. As a quantitative check on this conclusion, the 0-1-km storm relative helicity for the Frontal (Synoptic) type was 104 (101) $m^2 s^{-2}$, while the same metric was only 2 $m^2 s^{-2}$ for the Mesohigh events.

3. BENEFITS AND LESSONS LEARNED: OPERATIONAL PARTNER PERSPECTIVE

The NWS Austin/San Antonio Forecast Office is pleased with the results and plans to use the climatology developed to train forecasters about non-tropical, heavy rain systems in South Central Texas. In addition, the study of proximity soundings indicates some necessary, but not sufficient conditions for heavy rainfall, leading to focus on meso- and synoptic-scale forcing mechanisms in future research.

4. BENEFITS AND LESSONS LEARNED: UNIVERSITY PARTNER PERSPECTIVE

This collaborative effort has been excellent for the Department of Soil, Environmental, and Atmospheric Sciences at the University of Missouri-Columbia. We have strengthened our existing ties with the NWS Austin/San Antonio Forecast Office, which continues to be a crucial partner in our scientific pursuits. Results of this research will be incorporated into Dr. Market's course offering on Mesoscale Meteorology and Dynamics as well as in Synoptic Meteorology II.

5. PUBLICATIONS AND PRESENTATIONS

Schnetzler, A. E., P. S. Market, J. W. Zeitler, 2008: Analysis of Twenty-Five Years of Heavy Rainfall Events in the Texas Hill Country. *22nd Conference on Hydrology*, New Orleans, LA, Amer. Meteor. Soc., P1.3.

Schnetzler, A. E., P. S. Market, and J. W. Zeitler, 2008: Composite soundings of heavy rainfall events in the Texas Hill Country. Missouri Academy of Science Annual Meeting, Missouri Southern State Univ., Joplin, MO.

Schnetzler, A. E., P. S. Market, and J. W. Zeitler, 2008: Composite soundings of heavy rainfall events in the Texas Hill Country. 12th Annual Severe Storms and Doppler Radar Conference, Des Moines, IA.

Schnetzler, A.E., 2008: *Analysis of Twenty-Five Years of Heavy Rainfall Events in the Texas Hill Country*. M.S. Thesis, University of Missouri, 134 pp.

6. SUMMARY OF UNIVERSITY/OPERATIONAL PARTNER INTERACTIONS AND ROLES

Mr. Zeitler, Dr. Market, and Ms. Schnetzler all met to discuss the project in Reno, NV, on 16 October 2007. All were attending the National Weather Association Annual Meeting. Additional discussion via email and teleconference led to focus on proximity soundings from the

NARR, to see if values of common convective parameters were associated with various synoptic event types and event intensity (as measured by return period).

Mr. Zeitler also assisted Ms. Schnetzler by assessing her answers to the standard questions asked for the National Weather Service (NWS) Meteorologist Intern position, to ensure Ms. Schnetzler completely and accurately indicated her knowledge, skills, and experience. Some of the questions related to skills and experience developed through this Partners project.