P8.4 PRECIPITATION EFFICIENCY ASPECTS OF FLASH FLOOD PRODUCING MCSs

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1. INTRODUCTION

Although it seems intuitive that flash floods result from rain-producing systems with high precipitation efficiency (PE), this assumption has never been established quantitatively. Recent work on precipitation efficiency forecasting (Market et al. 2002) has afforded a small sample of actual precipitation efficiency estimates for summertime mesoscale convective systems (MCSs) over the Midwest. This study will demonstrate that those MCSs which engender flash flooding are more efficient at processing water vapor into precipitation. In addition, we will also examine the propagation characteristics of flash flood (~higher PE) versus non-flash flood (~lower PE) MCSs.

2. METHOD

The procedure for calculating the PE for each MCS is detailed in Market et al. (2002). To determine the nature of PE for flash flood (FF) versus non-flash flood (NFF) MCSs, basic statistics as well as the non-parametric Wilcoxon rank sum test were applied to the data. The latter test is ideally suited to establishing the independence of population medians.

A total of 24 MCSs for which robust data were obtained occurred over Missouri during the summer months of 2000 and 2001. Because some MCSs exist on timescales longer than 6 hours, and the PE calculations are time averages over 6 hour periods, the total number of PE calculations becomes 33. Statistics on these PE values are shown in Table I.

3. ANALYSIS

3.1 Significance of flash flood PE

Of the 33 periods for which a PE was calculated, 9 were associated with a flash flooding event somewhere in Missouri. Of these 9 FF events, 7 of them were in the top one-half (16) of the 33 calculated PE values. In addition, 3 of the top 4 PE values were associated with flash flood producing MCSs.

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Table I. Statistical characteristsics of PE for flash flood (FF) versus non-flash flood (NFF) MCSs over Missouri during the summers of 2000 and 2001.

	FF cases	**NFF cases**
N	9	24
Mean	32.9%	23.1%
St. Dev	8.5%	10.2%
Range	22%-48%	4%-40%

The 9 FF events exhibited a mean precipitation efficiency of 32.9% (σ=8.5%), while the PE of the remaining 24 NFF events had an average value of 23.1% (σ=10.2%). Ranges on each of these categories run from 22 to 48% for the FF cases and 4 to 40% for NFF cases (Table I). Clearly, overlap exists between these categories.

In order to determine whether a real difference in PE exists between the FF and NFF cases, the Wilcoxon rank sum test was employed. The null hypothesis states that the sample distributions are identical, while the alternative states that median of one sample distribution will be larger or smaller than that of another sample. In this case we tested the FF sample against the NFF sample to determine if the median of the FF sample distribution was indeed larger than the median of the NFF sample distribution (a one-tail Wilcoxon test).

The Wilcoxon rank sum test provided a p-value of 0.0131, easily smaller than the α value of 0.05, thus providing sufficient evidence that we may reject the null hypothesis and conclude that the precipitation efficiency of flash flood cases is typically larger than that of non-flash flood cases. Still, there is overlap between the FF and NFF samples (Fig. 1), and what the Wilcoxon test permits us to say with 95% confidence is that the FF PE values exceed those of NFF PE cases by between 1% and 18%. Although this range is rather broad, the two sample Wilcoxon rank sum test does support the intuitive visual assessment of Fig. 1 that FF cases are more efficient.

3.2 PE and MCS propagation

When searching for the causes of excessive rainfall, those mesoscale convective systems that are quasi-station-

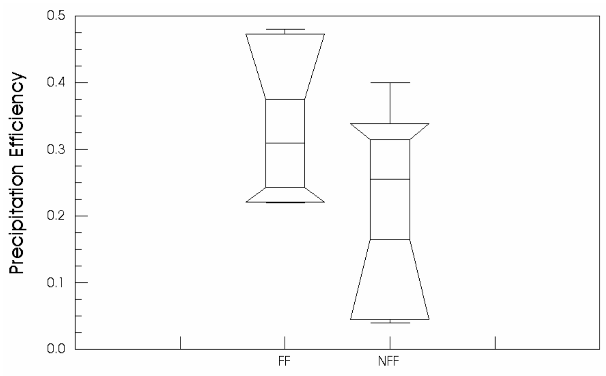

Figure 1. Box plot of PE values for non-flash flood (NFF) versus flash flood (FF) cases. Lines on each box represent (from bottom to top) the minimum value, the 10th, 25th, 50th (median), 75th, and 90th percentiles, and the maximum value. The ordinate represents PE as a fraction (0.0-1.0) instead of a percent value.

ary or possess a regenerative behavior (e.g., Chappell 1986) are immediately suspects. Interestingly, only about half (4 of 9) of the FF PE cases studied were quasi-stationary or regenerative (Table II). Conversely, 10 of the *total* 32 periods (1 NFF MCS case excluded, as adequate radar data was unavailable for determining propagation) exhibited quasi-stationary or regenerative propagation, so there were 6 such MCS cases that were *not* associated with flash flooding. Moreover, the MCSs with the top 7 PE values (both FF and NFF cases) were *all* forward propagating systems. Therefore, neither high PE values nor flash flooding are strictly the purview of stationary or regenerative MCSs.

4. SUMMARY

The PE for thirty-three 6 *h* periods were calculated for MCSs over Missouri during the summers of 2000 and 2001. Of the 33 periods, 9 were associated with a flash flood event somewhere in the state. Statistical testing demonstrates that those precipitation systems associated with flash flooding often feature significantly higher precipitation efficiencies.

Table II. Precipitation efficiency and propagation characteristics of flash flood producing MCSs over Missouri during the summers of 2000 and 2001.

Date	PE	Propagation Type
04 June 2001	48%	Forward
09 Sep. 2001	41%	Forward
12 July 2000	39%	Forward (line merger)
29 Aug. 2001	33%	Quasi-stationary
20 July 2000	32%	Forward
08 Aug. 2000	30%	Regenerative
25 July 2001	28%	Forward
26 July 2001	23%	Regenerative
28 July 2000	22%	Regenerative

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