Appendix A.5 Temporal distributions of heavy precipitation

1. Introduction

Temporal distributions of precipitation amounts exceeding precipitation frequency estimates for the 2-year recurrence interval are provided for 6-, 12-, 24-, and 96-hour durations. The temporal distributions are expressed in probability terms as cumulative percentages of precipitation totals at various time steps. To provide detailed information on the varying temporal distributions, separate temporal distributions were also derived for four precipitation cases defined by the duration quartile in which the greatest percentage of the total precipitation occurred.

Stations were grouped into two climate regions, shown in Figure 4.1.1, and separate temporal distributions were derived for each climate region. The Mississippi Valley region (region 1) also includes stations from the Mississippi Valley region (region 4) from NOAA Atlas 14 Volume 8 (see Figure 4.1.1 in Volume 8). Regions were delineated based on extreme precipitation characteristics expressed through 24-hour mean annual maximum (MAM) estimates, mean annual precipitation, elevation and latitude.

2. Methodology and results

The methodology used to produce the temporal distributions is similar to the one developed by Huff (1967) except in the definition of precipitation cases. In accordance with the way a precipitation case ("event") was defined for the precipitation frequency analysis, a precipitation case for the temporal distribution analysis was computed as the total accumulation over a specific duration (6-, 12-, 24-, or 96-hours). As a result, it may contain parts of one or more storms. Because of that, temporal distribution curves presented here may be different from corresponding temporal distribution curves obtained from the analysis of single storms. Also, precipitation cases for this project always start with precipitation but do not necessarily end with precipitation, resulting in potentially more front-loaded cases when compared with distributions derived from the single storm approach. Cases were selected from all events of a given duration that exceeded the 2-year average recurrence interval at each station. Table A.5.1 shows the total number of precipitation cases and number of cases in each quartile for each region and duration.

For each precipitation case, cumulative precipitation amounts were converted into percentages of the total precipitation amount at one hour time increments. All cases for a specific duration were then combined and probabilities of occurrence of precipitation totals were computed at each hour. The temporal distribution curves for nine deciles (10% to 90%) were smoothed using a linear programming method (Bonta and Rao, 1988) and plotted in the same graph. Figure A.5.1 shows, as an example, temporal distribution curves computed from all cases for the four selected durations for the Mississippi Valley region (region 1); time steps were converted into percentages of durations for easier comparison.

The cases were further divided into four categories by the quartile in which the greatest percentage of the total precipitation occurred. Table A.5.1 shows the numbers and proportion of precipitation cases used to derive the temporal distributions in each quartile. Unlike the cases of 12-, 24-, and 96-hour durations in which the number of data points can be equally divided by four, the cases of 6-hour duration contain only six data points and they cannot be evenly distributed into four quartiles. Therefore, in this analysis, for the 6-hour duration, the first quartile contains precipitation cases where the most precipitation occurred in the first hour, the second quartile contains precipitation cases where the most precipitation occurred in the second and third hours, the third quartile contains precipitation cases where the most precipitation occurred in the fourth hour, and the fourth quartile contains precipitation cases where the most precipitation occurred in the fifth and sixth hours. This uneven distribution affects the number of cases contained in each quartile for the 6-hour duration. Figures A.5.2 through A.5.5 show the Mississippi Valley region's temporal distribution curves for the four quartile cases for 6-hour, 12-hour, 24-hour and 96-hour durations, respectively.

Table A.5.1. Total number of precipitation cases and number (and percent) of cases in each quartile for selected durations for each climate region: Mississippi Valley region (1) and Southeast region (2). Region 1 in this volume includes stations from region 4 of Volume 8.

Duration	Region	All cases	First quartile cases	Second quartile cases	Third quartile cases	Fourth quartile cases
6-hour	1	9,142	3,050 (33%)	2,829 (31%)	2,087 (23%)	1,176 (13%)
	2	2,131	748 (35%)	698 (33%)	426 (20%)	259 (12%)
12-hour	1	9,631	3,519 (37%)	2,476 (26%)	2,203 (23%)	1,433 (15%)
	2	2,189	826 (38%)	550 (25%)	463 (21%)	350 (16%)
24-hour	1	9,325	3,316 (36%)	2,278 (24%)	2,171 (23%)	1,560 (17%)
	2	2,218	764 (34%)	476 (21%)	505 (23%)	473 (21%)
96-hour	1	8,908	3,696 (41%)	1,962 (22%)	1,653 (19%)	1,597 (18%)
	2	2,113	747 (35%)	504 (24%)	414 (20%)	448 (21%)

From the Precipitation Frequency Data Server, regional temporal distribution data are available in a tabular form for a selected location under the "Supplementary information" tab or through the temporal distribution web page (http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_temporal.html). For 6-, 12- and 24-hour durations, temporal distribution data are provided in 0.5-hour increments and for 96-hour duration in hourly increments.

3. Interpretation

Figure A.5.1 shows as an example the temporal distribution curves of all precipitation cases in the Mississippi Valley region for the 6-, 12-, 24-, and 96-hour durations. For these plots, time steps were converted into percentages of total durations for easier comparison. Figures A.5.2 through A.5.5 show temporal distribution curves for the first-, second-, third-, and fourth-quartile cases for 6-hour, 12-hour, 24-hour and 96-hour durations, respectively. First-quartile plots show temporal distribution curves for cases where the greatest percentage of the total precipitation fell during the first quarter of the duration (e.g., the first 3 hours of a 12-hour duration). The second, third, and fourth quartile plots are similarly for cases where the most precipitation fell in the second, third, or fourth quarter of the duration.

The temporal distribution curves represent averages of many cases and illustrate the temporal distribution patterns with 10% to 90% occurrence probabilities in 10% increments. For example, the 10% curve in any figure indicates that 10% of the corresponding precipitation cases had distributions that fell above and to the left of the curve. Similarly, 10% of the cases had temporal distribution falling to the right and below the 90% curve. The 50% curve represents the median temporal distribution.

The following is an example of how to interpret the results using the figure in the upper left panel of Figure A.5.4 for 24-hour first-quartile cases in the Mississippi Valley region.

- In 10% of the first-quartile cases, 50% of the total precipitation fell in the first 2 hours and 90% of the total precipitation fell by 5.6 hours.
- A median case of this type will drop half of the precipitation (50% on the y-axis) in approximately 5.1 hours.
- In 90% of the cases, 50% of the total precipitation fell by 10.1 hours and 90% of precipitation fell by 22.1 hours.

Temporal distribution curves are provided in order to show the range of possibilities. Care should be taken in the interpretation and use of temporal distribution curves. For example, the use of different temporal distribution data in hydrologic models may result in very different peak flow estimates. Therefore, they should be selected and used in a way to reflect users' objectives.

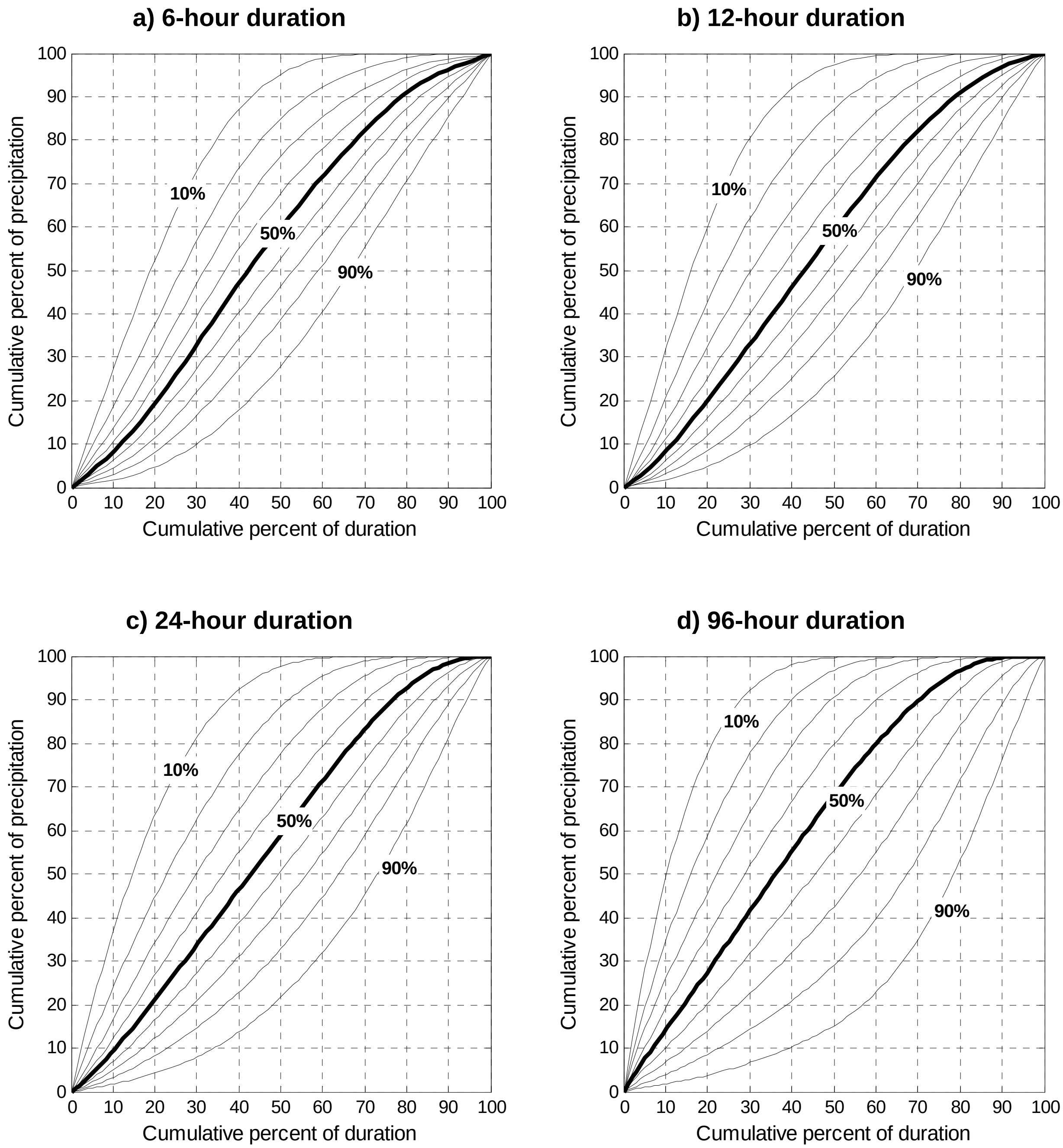

Figure A.5.1. Temporal distribution curves for the Mississippi Valley region (region 1) all cases for: a) 6-hour, b) 12-hour, c) 24-hour, and d) 96-hour durations.

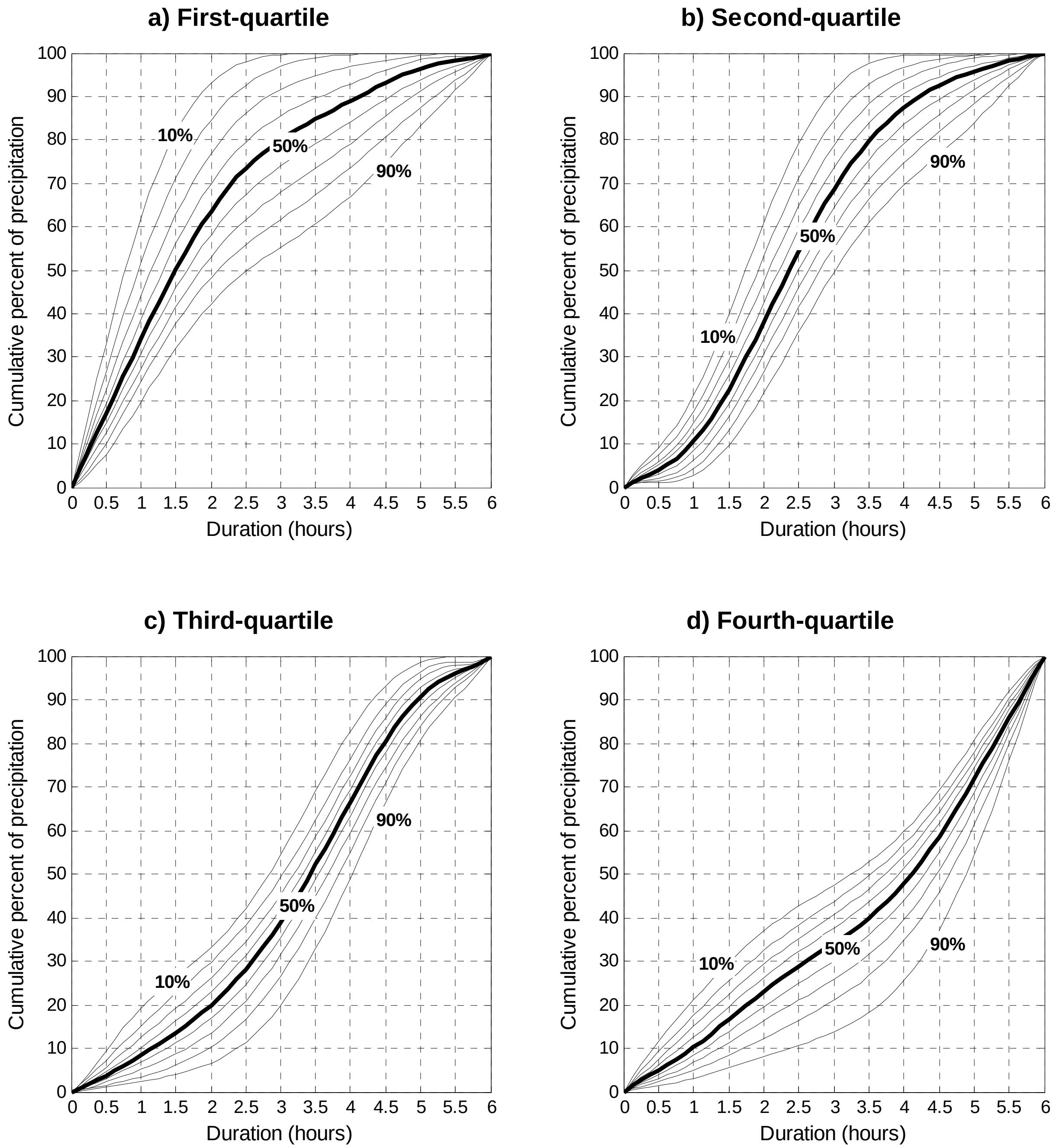

Figure A.5.2. 6-hour temporal distribution curves for the Mississippi Valley region (region 1)**:**
a) first-quartile, b) second-quartile, c) third-quartile, and d) fourth-quartile cases.

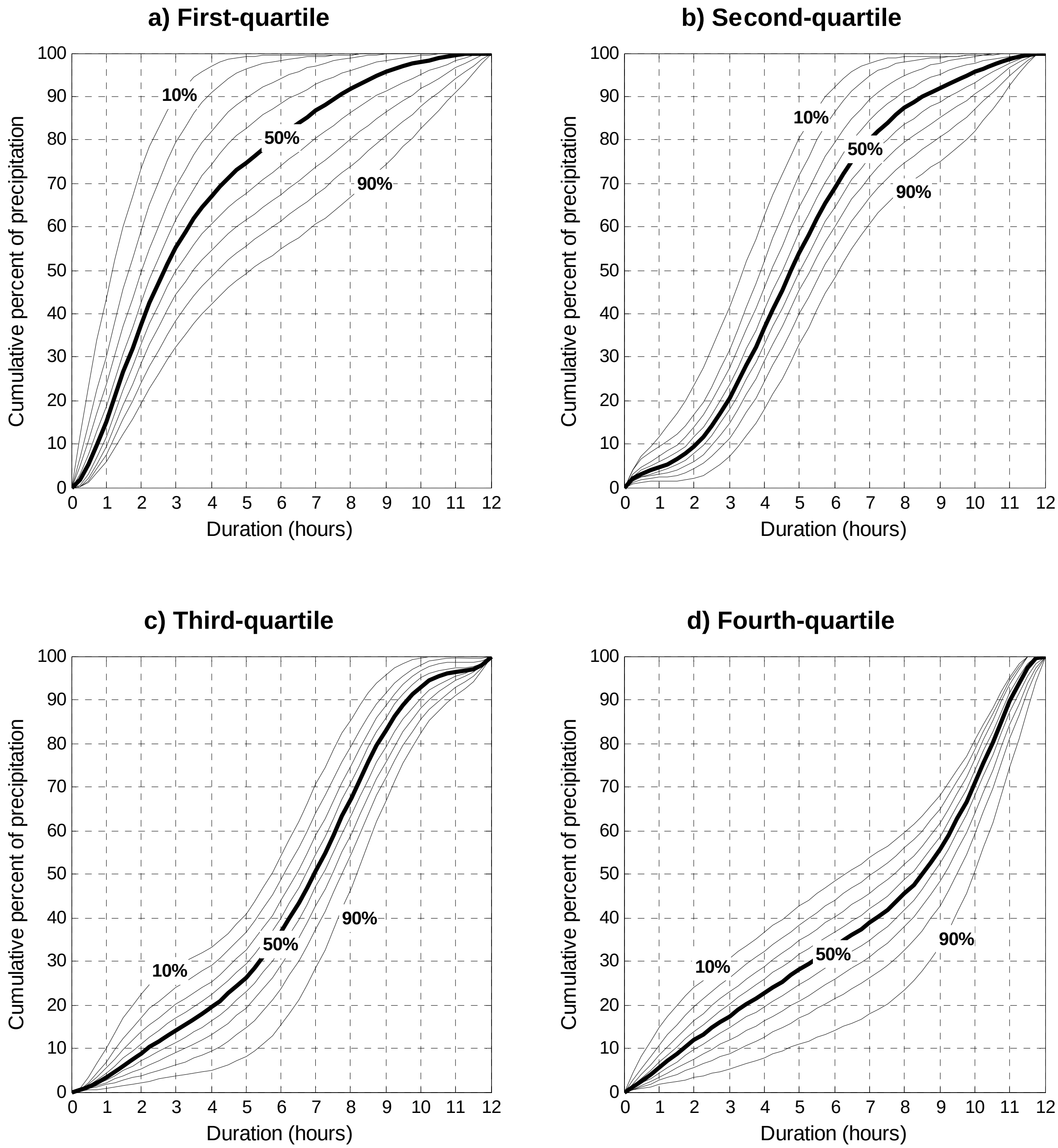

Figure A.5.3. 12-hour temporal distribution curves for the Mississippi Valley region (region 1):
a) first-quartile, b) second-quartile, c) third-quartile, and d) fourth-quartile cases.

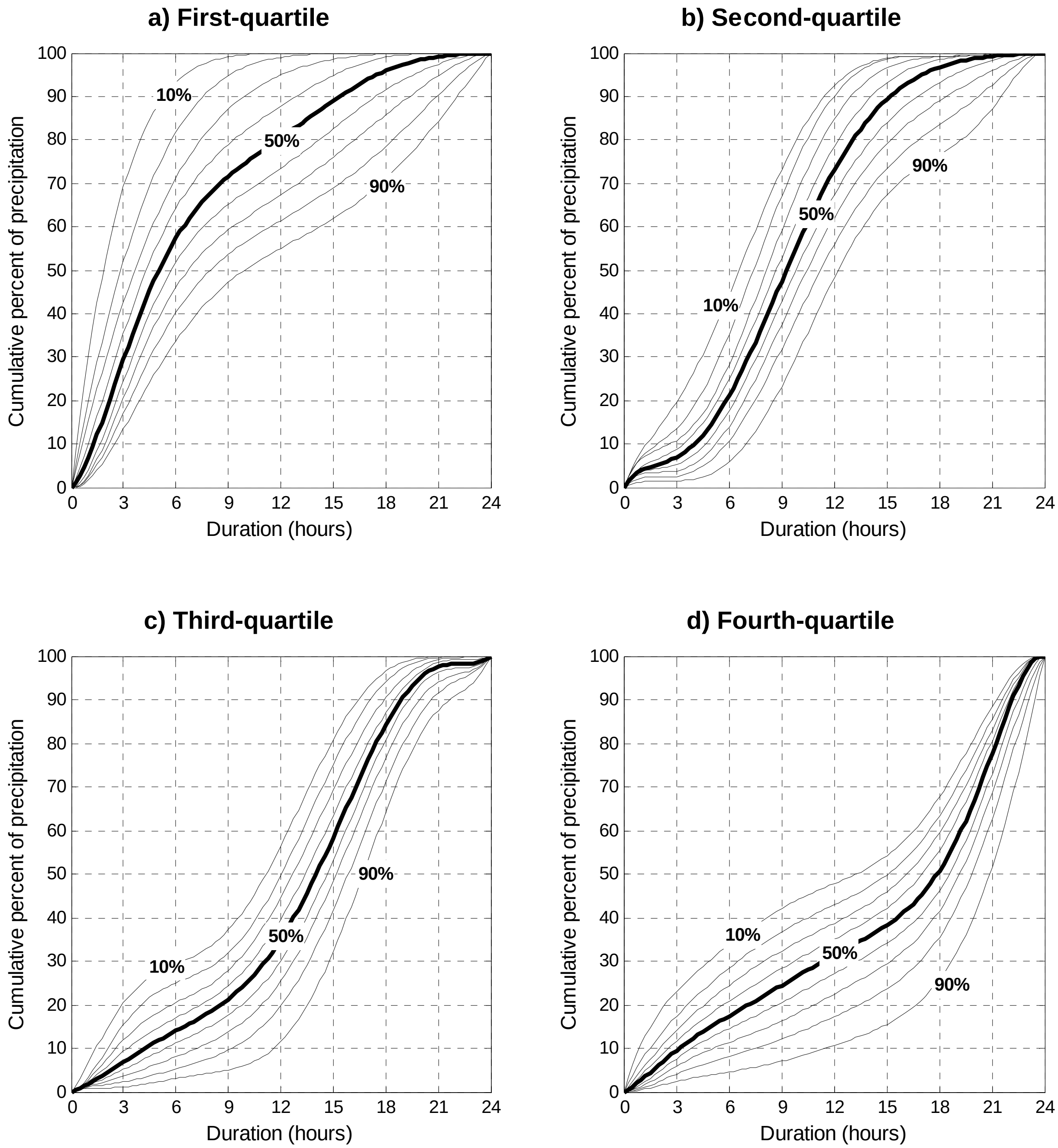

Figure A.5.4. 24-hour temporal distribution curves for the Mississippi Valley region (region 1): a) first-quartile, b) second-quartile, c) third-quartile, and d) fourth-quartile cases.

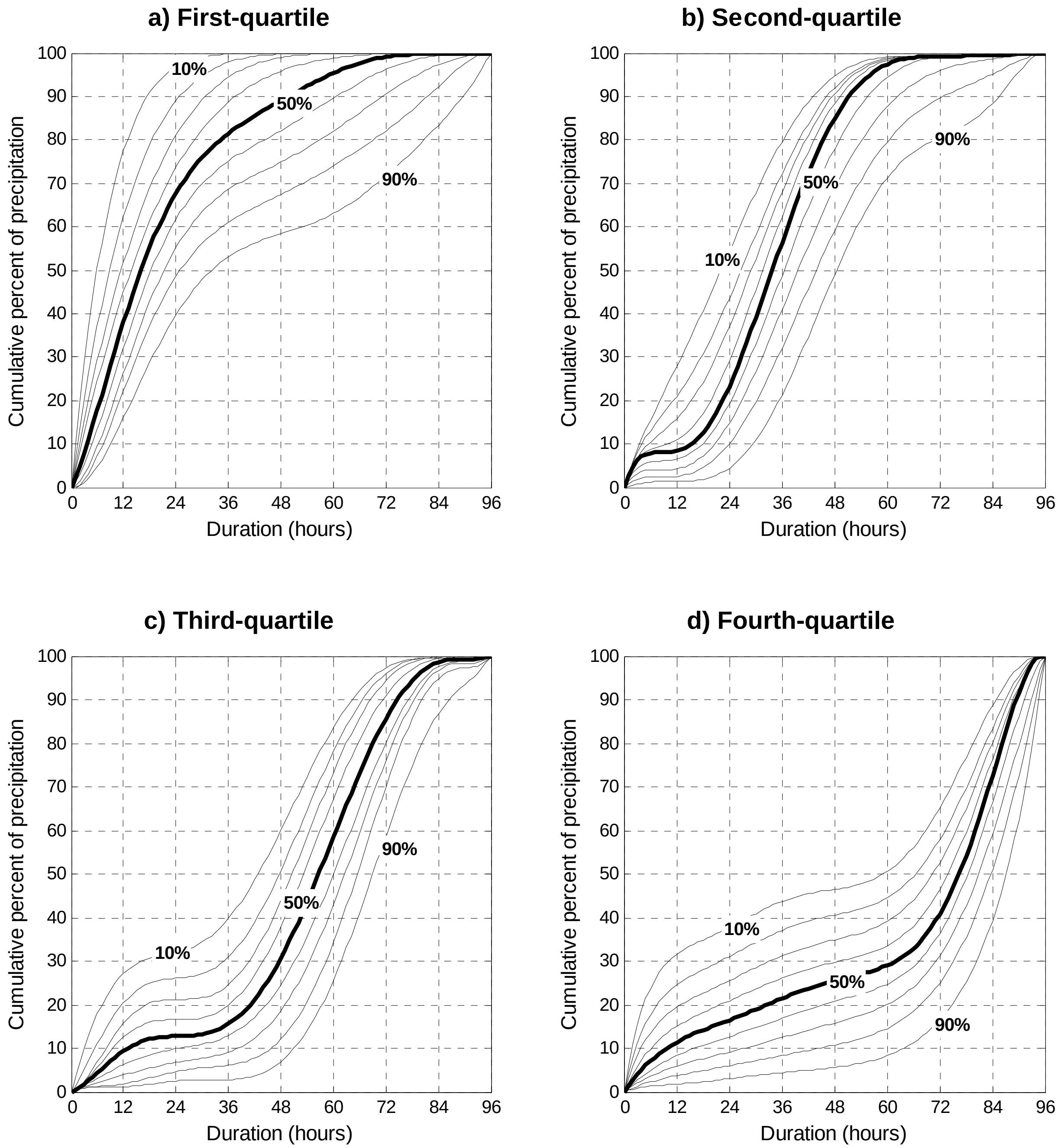

Figure A.5.5. 96-hour temporal distribution curves for the Mississippi Valley region (region 1): a) first-quartile b) second-quartile, c) third-quartile, and d) fourth-quartile cases.