A Climatological Investigation of the Diurnal Patterns of Precipitation over the Complex Terrain of Western Colorado

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Introduction

Hourly precipitation patterns in the highly complex terrain of western Colorado were analyzed for diurnal biases from 1948 to the present. To gain a regional perspective, the precipitation patterns for numerous locations across western Colorado were studied to determine, spatial, diurnal and seasonal patterns. This study will also discern differences based on actual quantitative precipitation amounts. To examine more significant events, comparisons between events greater than 2.5 mm (0.10 inches) and 6.4 mm (0.25 inches) were utilized.

Site Climatology and Biases

The sites chosen for this study all reside in western Colorado west of the Continental Divide. Only locations with a significant climatological history had hourly precipitation data collected, with all stations possessing at least 55 years worth of precipitation records.

These climatological sites were selected because they had strong datasets that extended back at least to 1948. Where Cooperative Observer hourly precipitation data were first available. Most of the sites are found in valley locations and are associated with western Colorado population centers. The dataset elevations range from a low point of 1478 m at Grand Junction to 2737 m at Crested Butte. Annual precipitation amounts range from 221 m at Grand Junction to 628 mm at Aspen.

The chosen sites offer some interesting comparisons. Three sites, Crested Butte, Gunnison, and Cochecton Creek all reside in one hydrologic basin in the north, center, and south respectively. Some sites have a favored orographic precipitation flow. North-westerly flow produces increased precipitation for Aspen, Cochecton Creek, Duray, and Teluride. South-Southwest flow favors Cedaredge, Crested Butte, and Mesa Verde NP. See Figure 1 and Table 1 for a breakdown of locations, elevations and annual precipitation amounts at each location.

Observation Collection Methods

The hourly precipitation data were collected from the National Climatic Data Center in Asheville, North Carolina for a period of record consisting of 1948 through 2005. These data were then ingested into spreadsheets and analyzed to reveal data signatures.

To help eliminate noise from the data set and to make precipitation recording methods consistent, only events greater than 2.5 mm were analyzed, with a snow-only cutoff at 6.4 mm, which was used to focus on more extreme precipitation events. In addition, the precipitation data was combined into three hour increments, with the study examining the diurnal trends during the eight 3 hour periods between midnight and midnight local standard time.

Preliminary Results

Preliminary findings of the precipitation data show that several sites exhibited consistent diurnal patterns during the warm season, defined as the period of May through September, including Crested Butte, Gunnison, Teluride and Grand Junction. Precipitation maxima for events greater than 2.5 mm tended to peak during the afternoon and evening hours (1200 to 2100 MST), with Grand Junction (a low valley location) typically peaking up to 3 hours later than the higher valleys and mountain locations.

Significant precipitation across western Colorado is normally received from two sources, the winter snows (November through March) and monsoonal thunderstorms (July through September).

The winter season diurnal tendencies exhibited a shift from the monsoon season tendency with an afternoon and evening pattern to a primarily nocturnal tendency. The stations which were noted at Mesa Verde, Telluride, Crested Butte, Grand Junction and Aspen.

The transitional months of autumn (November) and spring (April through June) data was particularly noisy and showed no significant trends.

Winter Season

• Defined as November through March for this study.
• Majority of precipitation events greater than 2.5 mm occur between 0600 and 1200 MST.
• Nocturnal events peaked in the month of January with strong signals noted at several sites between 0600 and 1200 MST.
• By March, pattern starts to shift to more daytime driven events.

Monsoonal Season

• Defined as July through September for this study.
• Majority of precipitation events greater than 2.5 mm occur between 1500 and 1800 MST.
• Two exceptions at Grand Junction and Rite where events shifted to between 1800 and 2100 MST.
• September tended to show more variability in timing of events.

Special Sites

• Northern sites exhibited less seasonal variability than sites located in southwest Colorado.
• Northern sites also exhibited timing shifts of only +/- 3 hours from season to season.

• Southern sites exhibited strong timing shifts, most notable between the winter and monsoonal seasons.

Conclusion

This ongoing study examines diurnal precipitation trends in western Colorado. Preliminary findings show the diurnal precipitation maxima tend to peak during the warm-season late afternoon and evening hours.

During the cool season, the patterns shifted to more nocturnal events with the majority of all the lower valleys seeing more significant precipitation events ending before mid-morning. Mountain locations showed a slightly longer duration, with events last through midnight, tapering off during the afternoon hours.

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Figure/Table 1 Map of western Colorado study locations with site location identifier and elevation.