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Winter Precipitation Efficiency of Mountain Ranges in the Colorado Rockies under Climate Change

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Orographic precipitation depends on both the environmental conditions and the barrier shape. As a measure of precipitation efficiency of a mountain range we use the drying ratio (DR), defined as the ratio of precipitation to incoming water flux. In this study, we explore the winter precipitation efficiency of mountain ranges in the Colorado Rockies under the current and future warmer and moisture conditions. The sensitivity of the DR to the barrier shape, temperature, stability, and horizontal velocity of the incoming air mass is examined for a number of individual mountain ranges in the Colorado Rockies. This analysis is based on the results of the Colorado Headwaters Simulations, carried out with the Weather Research and Forecasting (WRF) model run at the 2 km grid spacing over the inter-mountain west region of the US for four different winter seasons. For studying future climate scenarios, a pseudo-global warming (PGW) technique was applied.

For given environmental conditions, we find the DR to be primarily dependent on the upwind slope for wider mountain ranges, and on the width of the barrier for narrower ranges. Temperature is found to exert an influence on the DR for all Colorado mountain ranges, with DR decreasing with increasing temperature, under both the current and future climate conditions. Finally, while the DR of the Colorado mountain ranges is found to be sensitive to temperature, the predicted decrease of DR is less than 0.5% per degree K of warming for all examined mountain ranges.