This study will examine observations of, causes for, and implications of convective-scale and mesoscale processes due to orographic precipitation systems in the tropics and mid-latitude warm seasons. Results from a twelve-year (1998-2009) analysis of the 3-D radar reflectivity structure provided by the Tropical Rainfall Measuring Mission Precipitation Radar (TRMM-PR) will be presented in mountain barrier-relative coordinate systems to investigate the spatial patterns, vertical structure, and inferred dynamics of precipitation systems near selected mesoscale mountain ranges. The TRMM-PR reveals, as never before observed in many areas of the tropics, widely varying spatial scales of mesoscale precipitation accumulation variability, as well as unique precipitation vertical structures, that tend to favor preferred elevation zones in wide regions of many mountain ranges. This talk will address the causes in variations in instantaneous to climatological rainfall spatial patterns through combined observational and modeling approaches.

Alongside a new high-quality reanalysis dataset from the NASA Modern Era Retrospective-Analysis for Research and Applications or MERRA, the controlling mechanisms long thought to indicate the regime of orographic precipitation in conditionally unstable flow will be examined alongside depictions of the horizontal and vertical structure of observed 3-D precipitation as observed by the TRMM-PR. High-resolution idealized simulations the National Center for Atmospheric Research advanced research core of the Weather Research and Forecasting (WRF) model will be presented to evaluate inferred controlling mechanisms on observed orographic precipitation structures, including: mountain airflow dynamics (including moist Froude number and critical layer), latent heating, moisture profiles, radiative forcing, and land-atmosphere interactions and mountain shape. Finally, the impact of convective and mesoscale processes due to orographic precipitation systems on global and regional scale weather and climate simulations will be discussed.