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An evaluation of the statistics of rainfall extremes in satellite-based and reanalysis products using Universal Multifractals

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Confidence in the estimation of variations in the frequency of extreme events, and specifically extreme precipitation, in response to climate variability and change is key to the development of adaptation strategies. One challenge to establishing a statistical baseline of rainfall extremes is the disparity among the types of data sets (observations versus model simulations) and their specific spatial and temporal resolutions. In this context, a multifractal framework was applied to three distinct types of rainfall data to assess the statistical differences among time-series corresponding to individual raingauge measurements alone (NCDC, National Climatic Data Center), model-based reanalysis (North America Regional Reanalysis, NARR grid points), and satellite-based precipitation products (Global Precipitation Climatology Project, GPCP pixels) for the western United States (west of 105ºW). This study shows that, as expected, multifractal parameters estimated from the NCDC raingauge data map the geography of known hydrometeorological phenomena in the major climatic regions, including the strong orographic gradients from west to east. Whereas the NARR parameters reproduce the spatial patterns of NCDC parameters, the frequency of large rainfall events, the magnitude of maximum rainfall, and the mean intermittency are underestimated. That is, the statistics of the NARR climatology suggest milder extremes than those derived from raingauge measurements. The spatial distributions of GPCP parameters match closely the NCDC parameters over arid and semi-arid regions (i.e., the Southwest), but there are large discrepancies in all parameters in the mid-latitudes. This study provides a an alternative independent backdrop to benchmark the use of reanalysis products and satellite data sets to assess the impact of climate change on extreme rainfall.