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Fractal-multifractal ensembles of downscaled precipitation and temperature sets as implied by climate models

Mahesh Lal Maskey[1,2,4], David Joseph Serrano Suarez[3], Joshua H. Viers[1], Josue Medellin-Azuara[2], Bellie Sivakumar[5], and Laura Elisa Garza Diaz[6]

[1]VICE Lab, Civil and Environmental Engineering, University of California, Merced, United States of America (mmaskey@ucmerced.edu)
[2]Water Systems Management Lab, Civil and Environmental Engineering, University of California, Merced, United States of America
[3]Department of Civil Engineering, Universidad Pontificia Bolivariana - Seccional Bucaramanga, Colombia
[4]Hydrologic Sciences Graduate Group, Department of Land, Air, and Water Resources, University of California, Davis, , United States of America
[5]Department of Civil Engineering, Indian Institute of Technology Bombay, Powai, India
[6]Water Management Lab, Department of Land, Air, and Water Resources, University of California, Davis, , United States of America

Describing the specific details and textures implicit in real-world hydro-climatic data sets is paramount for the proper description and simulation of variables such as precipitation, streamflow, and temperature time series. To this aim, a couple of decades ago, a deterministic geometric approach, the so-called fractal-multifractal (FM) method,[1,2] was introduced. Such is a holistic approach capable of faithfully encoding (describing)[3], simulating[4], and downscaling[5] hydrologic records in time, as the outcome of a fractal function illuminated by a multifractal measure. This study employs the FM method to generate ensembles of daily precipitation and temperature sets obtained from global circulation models (GCMs). Specifically, this study uses data obtained via ten GCM models, two sets of daily records, as implied from the past, over a year, and three sets projected for the future, as downscaled via localized constructed analogs (LOCA) for a couple of sites in California. The study demonstrates that faithful representations of all sets may be achieved via the FM approach, using encodings relying on 10 and 8 geometric (FM) parameters for rainfall and temperature, respectively. They result in close approximations of the data's histogram, entropy, and autocorrelation functions. By presenting a sensitivity study of FM parameters' for historical and projected data, this work concludes that the FM representations are useful for tracking and foreseeing the records' complexity[6] in the past and the future and other applications in hydrology such as bias correction.

References