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Precipitation extremes in present-day and future climates: scaling properties and long-term memory

H. Zhang, K. Fraedrich, and R. Blender
University of Hamburg, Meteorological Institute, Hamburg, Germany (huan.zhang@zmaw.de)

The maxima of observed rainfall events follow a remarkable power-law in their duration. The maxima are extracted globally and the scaling is valid in six orders of magnitude from minutes to years (Jennings, 1950). This scaling law is assessed using grid-point data from two global climate models (ECHAM5/MPI-OM, ECHAM6/MPI-OM, HadGEM2-ES) in different resolutions (T63 and T31). The analysis includes paleo, present-day and global warming simulations (millennium run, 20C, A1B, and RCP8.5). The models reproduce the observed scaling, however with large deviations for low model resolutions in the millennium run. The scaling range is reduced to three orders of magnitude accessible in the simulations. The intensity of the precipitation extremes is one order of magnitude lower in the grid point data. The model results are compared to observations and stochastic models. The maximum-duration relationship corresponds to Hurst's (1951) rescaled range (R/S) analysis introduced to describe long-term memory variability in hydrology. The extreme value analysis can be extended by a multifractal analysis which considers the scaling of moments in terms of generalized Hurst exponents.

References:

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