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Is Hydroclimate Fractal? Another Look

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Fractal dynamics, defined for our purposes as log-space linear scaling of the power spectrum, are important to water resource scientists for two broad reasons. The first is fundamental: such behaviour is commonly believed to be very widespread in nature, and is therefore a central and important feature of physical systems – including watershed hydrological systems. The second is practical: associated properties, such as runs and clustering, violate the usual assumptions of many standard statistical and time series analysis techniques in applied hydrology and climatology, such as flood frequency analysis and long-term trend analysis. Recent work, however, has indicated that some instrumental climatic and hydroclimatic records, which seem initially suggestive of 1/f$\gamma\beta$ scaling, may in fact be insufficiently long to reliably distinguish between fractal dynamics and simpler, low-order linear memory processes which are also known to be common in such systems. With the aim of more carefully assessing the general presence of fractal dynamics in light of historical environmental dataset limitations, we apply here a simple new rule-of-thumb for record length sufficiency, in conjunction with standard Fourier transform-based spectral analysis techniques, to a smorgasbord of long-term time series drawn from watershed hydrology, climatology, and glaciology at various study sites worldwide.