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Observation and Modelling of 1/f-Noise in Weather and Climate

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A scaling power spectrum with an exponent in the vicinity of unity is denoted as 1/f or flicker noise. 1/f noise is a special case of long term memory and defines the limit for stationary processes. These spectra are known in physics for nearly a century and have been detected in meteorology and oceanography during the last decades. As examples, 1/f spectra are observed in long term sea surface temperature (SST) observations and simulations in the Antarctic and the North Atlantic oceans, in high resolution TOGA COARE measurements (temperature, humidity, and wind speed), and in the daily discharge of the Yangtze. Due to the vicinity to nonstationarity the presence of 1/f hampers the application of statistical analyses. Although frequent in nature this type of spectrum is still lacking an interpretation in terms of a convincing and universal physical model. The most common mathematical models are infinite order autoregressive processes and a suitable superposition of Lorentzian spectra. A physical model for the SST spectra is given by a two compartment vertical heat diffusion model with a large difference in the diffusivities. For extreme events in time series with 1/f spectra the return time distribution is well approximated by a Weibull-distribution, and the correlation between the return times follows a power law with weaker long term memory. The long term memory of 1/f time series opens new opportunities for prediction.