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Climate variability scaling on decadal to millennial time scales in observations and simulations

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Scaling of climate variability is ubiquitous and occurs from annual to millennial time scales. For positive exponents b in the power spectrum, $S(f) \sim f^{-b}$, scaling is associated with long term memory (LTM). LTM is due to slow oceanic processes and mainly found in the sea surface temperature (SST) of the Antarctic Circumpolar Current and in a restricted region of the North Atlantic. For centennial time scales nonstationary LTM is found in the ACC. LTM is found in the temperature but not in the surface pressure and precipitation. The simulation of the observed centennial LTM is feasible with dynamic ocean models. Quantitative agreement with Greenland ice core fluctuations is attained up to time scales of 1000 years. Conceptual models for the observed LTM, and 1/f noise in particular, are given by a linear diffusion models with several compartments. The statistical properties of extreme events are modified in the presence of LTM. The distribution of recurrence times can either be approximated by stretched exponentials or by power-law distributions. The correlation between successive recurrence times shows LTM with lower vales of scaling exponents compared to as the process. The global structure of the near surface temperature LTM hints to a direct relationship with climate sensitivity.