The impact of inter-annual variability of annual cycle on long-term memory in long historical temperature records

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Changes in the estimation of long-term correlation induced by inter-annual variability of annual cycle have been investigated by means of detrended fluctuation analysis (DFA). In a consequence of the intrinsic nonlinearity of the climate system, the annual cycle suffers from both amplitude and phase fluctuations. How does this changing annual cycle affect the fluctuation of temperature anomalies? A recently developed adaptive data analysis tool, the Nonlinear Mode Decomposition (NMD), is used to extract and remove time-varying annual cycle. We compared the differences of the long-term correlation calculated by removing different annual cycle, time-varying and stationary. The study was based on long historical temperature records around the North Atlantic Ocean. The traditional climatology annual cycle which lack characteristic of inter-annual fluctuation would lead to: (1) the estimation of Hurst exponent (2) how to choose scaling range and (3) the goodness of fit. Especially removing steady climatology annual cycle would introduce an artificial crossover around one-year period in the DFA curve. The conclusion is verified by generating deterministic time series through Monte Carlo simulations.