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A Dynamical Systems Explanation of the Hurst Effect and Atmospheric Low-Frequency Variability

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The Hurst effect plays an important role in many areas such as physics, climate and finance. It describes the anomalous growth of range and constrains the behavior and predictability of these systems. The Hurst effect is frequently taken to be synonymous with Long-Range Dependence (LRD) and is typically assumed to be produced by a stationary stochastic process which has infinite memory. However, infinite memory appears to be at odds with the Markovian nature of most physical laws while the stationarity assumption lacks robustness. Here we use Lorenz's chaotic model to show that regime behavior can also cause the Hurst effect. By giving an alternative, parsimonious, explanation using nonstationary Markovian dynamics, our results question the common belief that the Hurst effect implies a stationary infinite memory process. We also demonstrate that our results can explain atmospheric variability without the infinite memory previously thought necessary and are consistent with climate model simulations.