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Are the scaling properties of instrumental and long-term proxy temperature records consistent with a simple energy balance model?

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In an editorial comment, M. E. Mann, Climatic Change (2011), 107:267-276, makes the assertion: ”...the behaviour of the Hurst exponent H in instrumental and long-term proxy temperature reconstructions appears consistent with the results of a simple climate model (EBM) forced by estimated natural and anthropogenic radiative forcing changes, and subject to white noise stochastic weather forcing. Nothing more exotic than the physics of such a simple model is necessary to explain the apparent scaling behaviour in observed surface temperatures.” This conclusion is drawn from application of a number of standard estimation techniques for H to realizations of the purely stochastically forced, and stochastic + radiatively forced, EBM. These estimates are compared to results from the same techniques applied to observation data. Such comparisons show overlap of the distributions of H-estimates for the model realizations and the observation records, which leads the author to conclude that the scaling properties of the observation data are consistent with this simple model. In this contribution we point out the flaws that arise from uncritical application of estimation techniques for the scaling exponent H to time series that do not exhibit scaling. For instance, the stochastically forced model signal is an AR(1) process, which scales like a Wiener process (H=3/2) on scales shorter than the autocorrelation time, and as a white noise (H=1/2) on longer time scales. There is no unique Hurst exponent for this process, but the author estimates it for each realization of the process, producing a distribution with 95% confidence interval (0.60,0.76). Careful examination of power spectra or fluctuation functions for model data and observation data, in particular of the residual resulting from subtracting the (deterministic) radiatively forced response from the observations, demonstrates very clearly that the scaling properties of the model data are different from those of the observation data. We also demonstrate that the model can produce the observed scaling by a generalisation, which involves a long-range memory response that can be interpreted as a delayed heat exchange between the ocean mixed layer and the deep ocean. This physics goes beyond the simple one-box energy model, but it is not particularly “exotic.”