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Nonequilibrium Statistical Mechanics and Climate Variability

The variability of climate features has significant human impacts but is difficult to model and predict. Recent theoretical developments in nonequilibrium statistical mechanics cover a class of simple stochastic models that are often used for climate phenomena. The theory for entropy production is developed for simple stochastic climate models and applied to observed tropical sea surface temperatures (SST). The results show that tropical SST variability is approximately consistent with fluctuations about a nonequilibrium steady-state. The presence of fluctuations with negative entropy production indicates that tropical SST dynamics can, on a seasonal timescale, be considered as small and fast in a thermodynamic sense. This work demonstrates that nonequilibrium statistical mechanics can address climate-scale phenomena and suggests that other climate phenomena could be similarly addressed by nonequilibrium statistical mechanics.