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Climate Variability and Nonequilibrium Steady-States[1]

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The climate system is forced by incoming solar radiation and damped by outgoing long-wave radiation. As a result, the climate system is not in thermodynamic equilibrium but is better conceptualized as residing in a nonequilibrium statistically steady-state. Nonequilibrium steady-states have internal fluctuations which appear as natural variability of the climate system. Additionally, the phase space has nonzero probability current loops which are manifested as preferred patterns of natural climate variability. Nonequilibrium steady-states are often modeled by stochastic Langevin dynamics, and many aspects of the physics of these models are well understood. Simple stochastic models have been applied to a variety of climate phenomena including El-Niño, the North Atlantic Gulf Stream, surface temperature patterns, ocean heat content, and atmospheric Storm Tracks. In their simplest form, these models describe a stable steady-state with linear nonconservative damping perturbed by additive Gaussian white noise and thus fall into the class of models capturing nonequilibrium steady-states where previous results from Langevin models apply while the climate context motivates additional new questions.

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