Universität Münster

GEOPHYSIK Uni MÜNSTER

Institut für Geophysik

Geophysikalisches Kolloquium

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Climate Oscillations and Linear Gaussian Nonequilibrium Steady-States

Climate oscillations such as the El-Niño/Southern Oscillation (ENSO) and the Madden-Julian Oscillation (MJO) provide the potential for skillful long-range forecasts beyond the two week weather chaos limit. Complex weather and climate models struggle to accurately capture climate oscillations, leading to the need for more fundamental understanding of these phenomena.

Climate oscillation studies often use linear inverse modeling (LIM), where modeled and observed data is fit to a low-dimensional linear additive-Gaussian stochastic differential equation of Ornstein-Uhlenbeck (OU) form. Despite their extreme simplicity, these models can be surprisingly skillful. The OU equations describe the trajectories of a linear Gaussian Nonequilibrium Steady-State (LG-NESS). The utility of these models suggests that climate oscillations are, to some degree, manifestations of fluctuations within an LG-NESS.

Stochastic thermodynamics analyzes nonequilibrium processes in terms of their fluctuating trajectories under a variety of dynamics, including OU equations. The LIM algorithm and resulting OU dynamics provide a bridge connecting climate oscillations and stochastic thermodynamics. Here we discuss applications of stochastic thermodynamics to climate oscillations, their entropy production, predictability, and event sizes.

Climate oscillations are clearly more complex than an LG-NESS and many aspects of oscillations, such as the important asymmetry between positive and negative oscillation phases, are invisible to linear Gaussian models. We propose that despite this limitation, LG-NESS's can serve a

foundational role for climate oscillations, analogous to linear Rossby and Kelvin wave theory in geophysical fluid dynamics, and provide a null hypothesis for climate oscillations. Additionally, the use of LIMs across turbulence, geophysics, ecology, and economics suggests that self-organization into low-dimensional approximate LG-NESS's is a common phenomenon.

Das Kolloquium findet um 16:00 Uhr im Seminarraum GEO 315, Corrensstr. 24, 48149 Münster statt. Alle an dem Thema Interessierten sind hierzu herzlich eingeladen.

Die Dozenten des Instituts für Geophysik