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Scale-dependent Error Growths in Multi-hierarchical Systems

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In the common understanding of chaotic systems the exponential error growth rate (Lyapunov exponent) is on average a constant and independent of the error's size. However in two-dimensional turbulence models [Lorenz1969] and in the real weather forecasting system ECEP- GFS [Harlim2005] scale-dependent error growth has been found. In these systems the exponential error growth rate increases with decreasing error size.
In this talk I will introduce a multi-hierarchical toy-model to show that different time and length scales are crucial to generate scale-dependent error growth and that in the theoretical limit of infinitely many hierarchies the system has an intrinsically limited range of predictability, irrespective of the initial error.
Thereby we gain insight into the dynamical mechanisms possibly explaining that real weather forecasts pose an intrinsic limit on forecast time, irrespective of the accuracy of input observables.