DY 46: Modelling and Data Analysis

Time: Thursday 15:00–16:00 Location: HÜL 186

DY 46.1 Thu 15:00 HÜL 186

Information transfer in gravity waves as identified with mutual information and network measures — David Kittlaus, Christoph Räth, and •Heike Modest — Forschungsgruppe Komplexe Plasmen, Deutsches Zentrum für Luft- und Raumfahrt (DLR), Argelsrieder Feld 1a, 82234 Wessling, Germany

Nonlinear network based analysis of multidimensional meteorological time series have led to new insights in climatology [1]. On the other hand, atmospheric gravity waves, that play a key role in large scale convection, have never been object to this technique. Here we use a method relying on both linear covariance and nonlinear mutual information as well as varying lags between the time series to construct a family of networks from simulated, multidimensional gravity wave data. Specifically, we analyze the vertical component of the wind speed in 137 vertical layers of the atmosphere ranging from the ground level up to an altitude of approximately 40 km. We prove the presence of nonlinear correlations by statistical tests with covariance preserving surrogate time series. Analyzing the degree centrality of a set of networks allows us to extract information propagation velocities varying with height, which can be interpreted by varying densities and temperatures at different levels of the atmosphere leading to varying propagation speed of gravity waves. Our findings give new insights into the processes of momentum and energy transfer into higher layers of the atmosphere.

[1] Donges F., et al. "The backbone of the climate network."EPL(2009)

DY 46.2 Thu 15:15 HÜL 186

A deeper look at time averages in the study of heart rate variability — •Mozhdeh Massah and Holger Kantz — Max Planck Institute for the Physics of Complex Systems, Dresden, Germany

The fluctuations of human heartbeat of healthy patients, in the sense of convergence of finite sample time averages to a well-defined mean value, are analytically and theoretically studied. The approach for this investigation lies in the theory called large deviations theory, which in it's classical version claims that the large deviations of the identically independently distributed data get suppressed exponentially. It is here shown that long range correlations lead to sub-exponential decay of these deviations. In the case of heart rate variability , data resembles a non-stationary Gaussian process; and hence no convergence at all is found, leading to the conspicuous result of ergodicity breaking.

DY 46.3 Thu 15:30 HÜL 186

MDL based multidimensional step detection in piecewise constant signals — •Marius Bauer[1,2], Gerald Hinze[1], Klaus Müllen[1,3], and Thomas Basché[1,2] — [1]Insitut für Physikalische Chemie, Universität Mainz, Duesbergweg 10-14, 55128 Mainz, Germany — [2]Graduate School Materials Science in Mainz, Staudingerweg 9, 55128 Mainz, Germany — [3]Max-Planck-Insitut für Polymerforschung, Ackermannweg 10, 55128 Mainz, Germany

Recent experimental advances allow tracking single molecule features not easily addressable by ensemble techniques. As a general drawback, low signal intensities compared to ensemble experiments often accompany such experiments, requiring more demanding data evaluation.

Here we present an approach to analyze time dependent single molecule fluorescence data employing a parameter free algorithm based on the minimum description length (MDL) concept. Following single molecule fluorescence, features such as rotational or energy transfer dynamics can be traced. Common models for these processes predict stepwise fluorescence intensity changes, where the identification of steps in the noisy data remains the challenging part of the data analysis.

We introduce a new method for the identification of steps and signal levels in noisy data for both recurring and nonrecurring signal levels. The method has been tested by Monte Carlo simulation to establish its reliability. As an example we have investigated the rotational dynamics of several organic dye molecules by polarization dependent single molecule measurements, yielding time scales and geometry of the reorientation process.

DY 46.4 Thu 15:45 HÜL 186

Estimability of model parameters and state variables from observed time series — •Ulrich Parlitz[1,2], Jan Schumann-Bischoff[1], and Stefan Luther[1,2,3] — [1]Max Planck Institute for Dynamics and Self-Organization, Am Fassberg 17, 37077 Göttingen, Germany — [2]Institute for Nonlinear Dynamics, Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany — [3]Department of Pharmacology, University Medical Center, Robert-Koch-Str. 40, 37075 Göttingen, Germany

For many physical processes a mathematical model exists but not all state variables and parameters can be measured directly. Instead, their values have to be estimated from observed time series and the question arises whether unique results can be expected for the estimates and how reliable the obtained results are. To answer these questions we propose to analyze the null space of the linearized delay coordinates map [1]. This approach to estimability analysis is illustrated and generalized to multivariate time series.

[1] J. Schumann-Bischoff, S. Luther, U. Parlitz, Phys. Rev. E 94, 032221 (2016).