GRACE Science School

Combining Modern Statistical Methods and Thermodynamic Principles for Dynamic System Analysis in Environmental Sciences

Date: February 27 – March 2, 2018

Place: Building 10.81, Room 305

Lecturer: Dr. Rui Perdigão

Credits: 2.0

Content

Analysing complex and dynamic environmental systems often reaches technical and theoretical limits of statistical standard tools. This is the case as most classical statistical approaches fundamentally require assumptions about statistical independence and stationarity, which are especially problematic as soon as we deal with non-linearity and coevolution. Many promising approaches founded in scientific fields ranging from theoretical physics to information theory have been developed, still their application to applied climate and environmental sciences remains challenging.

This 4-day block course will introduce a set of modern tools for rigorous analyses of dynamic systems. Starting off with examples from geophysics and fluid mechanics the course will guide you during an excursion through stochastic physics, information theory, phase-state analyses and applications with big data and scaling. We especially invite you to bring own data and application questions to provide hands-on utilisation of the concepts and tools within your field of research.

Programme

Day 1 – From fluid mechanics to dynamical systems
The first day ensures a common basis for all participants. With fundamentals from classical fluid dynamics, thermodynamics, stability and scaling laws the foundation is laid.
The day will consist of four teaching units with practical analytical and numerical examples across the earth sciences.

Day 2 – Coevolutionary dynamical systems
The second day will extend the classical fluid dynamics with stochastic physics and information theory. With this, complexity will be rigorously treated in a simple and coherent framework providing the physical background to coevolutionary dynamics and organisation.
The day will consist of two teaching units and two real-world application cases.

Day 3 – Mastering conjugated dimensions
The third day will redefine the state-space system analyses with physical principles and thermodynamic limits as true phase-state analyses towards dynamic system understanding without the requirement for single attractors, finite phases and fixed scales. It also includes conjugated pairs and a new breed of non-paired conjugates.
The day will consist of two teaching units, one unit with real-world applications and one unit transferring the approaches to own analyses of the participants.
Evening: Preparation of applications to own data.

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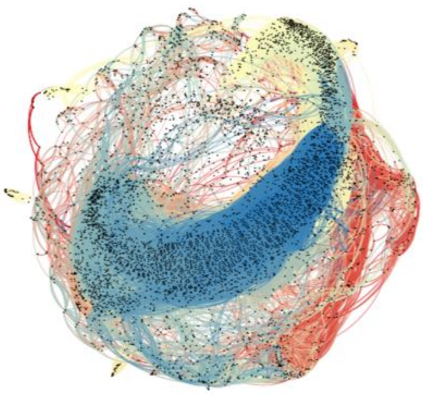

Day 4 – Presentations and frontier topics

The fourth day will start with two units presenting first results of applications to own data. Subsequently frontier topics of scaling and big data applications will be tackled.
Evening: Discussion of possible collaboration and emerging aspects.

Lecturer

Dr. Perdigão is a Mathematical Physicist and Earth System Dynamicist at the Institute of Hydraulic Engineering and Water Resources Management of the Vienna University of Technology. Moreover, he serves as Editor in the EGU journal Earth System Dynamics. In the context of the ERC project, he is responsible for fundamental research on mathematical physical methods and dynamical processes for better understanding and modelling flood regime changes and underlying physical causes.
His main research interests are:

- **Mathematical Physics and Modelling:** Methodological developments on Nonlinear Dynamics and Statistics, Information Theory and Causality.
- **Hydro-Climate Dynamics:** Atmospheric, Oceanic and Hydrological Dynamics, from a new, unified theoretical approach beyond the stochastic-dynamic divide.
- **Predictability and Uncertainty Dynamics:** Fundamental laws of error dynamics and predictability, and application to hydro-climatic systems.
- **Flood Change Detection and Attribution:** Detection of fundamental dynamical properties leading to the understanding of flood regimes, transient states and sustained changes; Attribution of physical causes by retrieval of dynamic, causal relationships and feedbacks between floods and their controls.

Rui Perdigão holds a Doctorate in Physics with the highest honours. He has since then conducted independent research on mathematical physics, predictability and uncertainty dynamics, from conceptual and methodological research to applications to the physics of climate.

Registration

Please register for this competence skill course via the online form.