

'Second Workshop on Information Theory and the Earth Sciences'

At the Environmental Hydraulic Institute of Cantabria (IHCantabria), Santander, Spain

Thu May 17th –Sat 19th 2018

FIRST CIRCULAR (Dec 18, 2017)

Workshop Organizers: *Cristina Prieto* (Environmental Hydraulics Institute of Cantabria “IHCantabria”, Santander, Spain), *Uwe Ehret* (KIT Karlsruhe Institute Of Technology), *Hoshin Gupta* (University of Arizona), *Grey Nearing* (NASA Goddard), *Ilias Pechlivanidis* (Swedish Meteorological and Hydrological Institute, SMHI), *Steven Weijs* (University of British Columbia), *Florian Wellman* (Aachen University), *Ben Ruddell* (Arizona State University), *Praveen Kumar* (Illinois University), *Rohini Kumar* (Helmholtz Center for Environmental Research), *Gab Abramowitz* (University. of New South Wales), *Saman Razavi* (University of Saskatchewan), *Jesus Carrera* (Spanish National Research Council, CSIC)

Hosted by: Environmental Hydraulics Institute of Cantabria (IHCantabria), Santander, Spain (<http://www.ihcantabria.com/en/>)

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About the Workshop

There is a growing understanding in both basic physics and the applied physical sciences that information is a fundamental aspect of the nature and workings of reality, and is also fundamental to our understanding of reality. This realization has resulted in a resurgence of interest in the topic of *Information Theory* (hereafter “*IT*”) and its implementation in the *Earth and Environmental Sciences*.

Information Theoretic analyses are essentially general in nature and can be applied to all parts of the scientific endeavor: complex systems, models of those systems, observational data, and the synthesis of these things. Rooted firmly in mathematics and statistical theory, *IT* provides a compelling basis for expanding upon tools and methods that typically make simplifying assumptions of linearity and Gaussianity to address problems of inference. Because of this, *IT* has the potential to help us understand emergent behavior of complex systems in ways that more traditional analyses cannot (e.g., synergistic information, extreme non-linearity, networks etc.). Additionally, *IT* allows us to study any and all parts of a system (real or modeled) under a common dynamical framework, so that, in principle, no a priori assumptions must be made to understand relationships between a large number of diverse dynamical processes.

Goals: The goals of this workshop are to promote the innovative use of *Information Theoretic* concepts in the service of discovery, modeling and decision-making in the *Earth and Environmental Sciences* and, through high level presentations and open discussion, to inspire revolutionary advances in the theories of modeling, learning, inference, and diagnostic evaluation. The workshop focus is on scientific sharing, discussion, debate and fun. The purpose is to foster collaboration among a growing community of Earth scientists who use or are interested in this broad and diverse mathematical theory.

Topics presented in may include, but are not limited to the following:

- How to properly include in models the things we already know (e.g., all physical laws, and not just conservation of mass and energy, etc.).
- How to evaluate the usefulness and robustness of data and models for a given task in a generalized way (i.e., how to establish their task-relevant information content)
- How to evaluate the appropriateness of models given the data and the purpose (i.e., how to establish their generality, parsimony, flexibility, etc.)?
- How to evaluate the interplay of data-, model structure- and predictive “uncertainty” (i.e., the flow of information from data through models to decision-makers)?
- How to learn from the encounter of models and data (i.e., how to detect, diagnose and correct model structural errors)?

The workshop is a continuation of the 2016 Workshop called ‘*Information Theory and the Earth Sciences*’ held at the Schneefernerhaus, Germany (see attached excerpt from the AGU HS Newsletter July 2017), however participation in that previous workshop is not necessary, given that the objective of this follow-on workshop is to foster and develop continued growth and participation in the field.

Format: The workshop will include a number of targeted keynotes, oral and poster presentations by the participants, but will mostly consist of moderated discussion groups focused around specific pre-prepared questions/issues. We encourage every participant to submit an abstract related to the topic of information theory (deadline to be announced, roughly end January).

For newcomers to the field (and also for “experienced” practitioners), we offer a pre-workshop 1-day tutorial on the basic concepts of *Information Theory* (Wed 16th May), and additional tutorials during the days of the workshop. If you are interested in the tutorials, please indicate this clearly in your reply (see registration instructions and deadline below).

Participation/Attendance: To assure a workshop atmosphere, attendance is limited to 40 persons (including organizers), and we request advance registration. Space will be filled on a ‘*first-come-first-served*’ basis, so please indicate your interest in participating, by email, as soon as possible (see registration instructions and deadline below).

Costs/Registration: We charge a small registration fee (€100/-) to help defray organizational costs. Attendees will be responsible for covering their own travel, food and lodging expenses. Coffee and lunch is included in the workshop fee.

Location: The workshop will be hold at the facilities of *IHCantabria* (<http://www.ihcantabria.com/en/>) in Santander, Spain; the lectures and presentations will be at the main Auditorium.

Registration & Deadline: The deadline for registration is **Jan 9th 2018**. To hold a space, please send an email with the subject line heading “Registration for Second Workshop on Information Theory & The Earth Sciences” to Cristina Prieto (cristina.prieto@unican.es). Please also indicate whether you are interested in the 1-day pre-workshop tutorial. Registration fees (€100) must be paid in advance so as to guarantee your space; we will contact you later to indicate how to pay the registration fees.

Tentative schedule (subject to change)

Wed May 16th: Tutorial day

Lecturer: Uwe Ehret

Day 1 (Thu May 17th)

Start 09:00

Morning:

Welcome

Keynote talk by Hoshin Gupta,

Title: Introduction to information theory, main concepts, methods and relation with other fields.

Plenum discussion

Session 1 (topic to be announced)

Talks

Poster presentations

Lunch

Afternoon:

Session 2 (topic to be announced)

Talks

Poster presentations

Plenum discussion, summary of day 1

Tutorials by Allison Goodwell and Praveen Kumar

Dinner & Socializing

Day 2 (Fri May 18th)

Start 09:00

Morning:

Welcome

Keynote talk by Praveen Kumar

Title: How concepts from IT are currently used in Earth Sciences

Plenum discussion

Session 3 (topic will be determined)

Talks

Poster presentations

Lunch

Afternoon:

Small group discussions

Tutorials by Praveen Kumar and/or Allison Goodwell

Dinner & Socializing

Day 3 (Sat May 19th)

Start 09:00

Morning:

Reports from small groups

Plenum discussion

Workshop summary

Noon: Workshop ends

For more information, please contact Cristina Prieto (cristina.prieto@unican.es)

We look forward to meet you at the IHCantabria!

Cristina Prieto, on behalf of the Organizing Committee