MICMoR Summer School 2017

Transport Phenomena and the Limits of Life in the Biosphere

Institute of Meteorology and Climate Research
KIT/IMK-IFU, Garmisch-Partenkirchen, Germany
August 9-18, 2017

The term "biosphere" is the place on the Earth's surface where life dwells. Since its inception in 1875, this concept launched one of the most ambitious interdisciplinary collaborative efforts in science as it forged partnerships between atmospheric sciences, biology, chemistry, climate, earth sciences, ecology, engineering, geology, geography, hydrology, mathematics, and physics.

This course covers fundamentals and principles of air and water movement within the biosphere. It elaborates on key applications spanning subsurface water movement, the soil-plant system, xylem-phloem water movement, overland flow, the hyporheic zone and adjacent stream flow, and air flow in the lower atmosphere. The common theme weaving all the lectures is that fluid flow exerts significant controls on the form and function of the biosphere. The limits of life, as we know it in the biosphere, may well be governed by few dimensionless parameters to be elaborated upon in these lectures.

The lectures are supplemented with modeling and lab projects to be supervised by instructors. These mini-projects are to be carried out by students within groups and later 'fused' into working models of the biosphere. By the end of the course, participants will be able to model mass, momentum, and energy movement within the biosphere. Participants will gain hands-on experience with model construction, model evaluation, and presentation of model results. As preparation for these group projects, basic programming (in Matlab or similar language) will be needed. To assist students who are not experienced in programming, they will be paired with experienced students in group projects. Basic tutorials will be provided at the beginning of the School as well. Four capstone projects involving all the various groups will also be carried out. At the end of the School, findings from these capstone projects will be presented by the group of students.

Lecturers

- Gabriel Katul (Duke University, Durham, NC, USA)
  – lead lecturer & MICMoR Visiting Scientist
- John Finnigan (CSIRO Atmospheric Research, Canberra, Australia)
- Kaare Jensen (Technical University of Denmark)
- Wilfried Konrad (University of Tübingen, Germany)
- Costantino Manes (Politechnico di Torino, Italy)
- Stefano Manzoni (Stockholm University, Sweden)
- Matthias Mauder, Nadine Rühr and Hans Peter Schmid
  (all KIT/IMK-IFU, Garmisch-Partenkirchen, Germany)

Contact:

MICMoR Coordination Office
KIT / IMK-IFU
Kreuzeckbahnstraße 19
82467 Garmisch-Partenkirchen

www.micmor.kit.edu
info@micmor.kit.edu

Eligibility

PhD students, Master students, or postdocs. Participants should have completed an introductory course in fluid dynamics (or equivalent), have working knowledge in elementary differential equations, and have some programming skills.

Application & Costs

Applicants must submit a standard CV, a 1-page motivation letter, and one recommendation letter from their immediate supervisor. Applications should be sent to elija.bleher@kit.edu (Dr. Bärbel Elija Bleher) **by 31 May 2017** at the latest. There is no tuition fee; however, participants must cover travel and accommodation costs.

Course Overview

A detailed course program will be forthcoming. The course begins on 9 August at 9 a.m. and ends on 18 August after lunch. Formal coursework will be augmented by weekend (12 August) / holiday (15 August) excursions and group activities.

Content	Lecturers
Overview Lecture: Exploring life's limits with dimensionless numbers (material based on a manuscript by Steven Vogel)	Gabriel Katul
Part 1: The slow flow • Microscopic view of fluid flow and upscaling fluid properties from molecular to continuum • Soil water movement and root water uptake • Xylem flow, catastrophic bubbles and xylem repair • Stomata and gas exchange in leaves • Photosynthesis, leaf transpiration, turgor, and sucrose production • Osmoregulation and water/carbohydrate flow in the phloem network • New research directions (Kaare Jensen, Wilfried Konrad, Nadine Rühr)	Gabriel Katul, Kaare Jensen, Wilfried Konrad, Nadine Rühr
Part 2: The fast flow • General overview of turbulent flows • Scaling laws and similarity theories • Water flow in streams and hydraulic constraints on shape and function of living organisms • Stratified air flow over the land-surface • Bringing in the biosphere: Turbulent flows within canopies, case studies of bridging ecology and turbulence • New research directions (John Finnigan, Costantino Manes, Matthias Mauder)	John Finnigan, Gabriel Katul, Costantino Manes, Matthias Mauder, Hans Peter Schmid
Part 3: A static view of life's limits: Stoichiometry and Biogeochemistry • Introduction to soil micro-organisms and how they use soil resources at a microscopic scale • Thermodynamic and biochemical techniques that predict relations between microscopic structure of soil pores and microbial activity • Linking micro- and macro-scale predictions of climate change and its effects on ecosystems	Stefano Manzoni
Part 4: Group projects Students will be split into groups and work on collaborative model building activities related to lectures.	All instructors

Pictures: Gabriel Katul

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