香港科技大學
THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

土木及環境工程學系
DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

SEMINAR

LAND SURFACE MODELING AT A CROSSROADS: PROGRESS, COMPLEXITY, AND THE ROAD TO RELIABILITY AND ROBUSTNESS

Speaker

Prof. Xu Liang

University of Pittsburgh

Abstract

Thirty years have passed since we published a modern (generation 2B) land surface model (LSM), VIC (Liang et al., 1994). During this time, rapid advances in ecology, biology, hydrology, and atmospheric sciences have expanded our understanding of many critical physiological, physical, and hydrological processes. It is an exciting time for researchers – not only to study the exchanges of energy, water, and momentum across the land-atmosphere interface, but also to investigate how ecosystems respond to the atmospheric conditions through the cycling of water, energy and carbon within the soil-plant-atmosphere continuum.

In this talk, I will briefly review how a modern LSM was developed, what enhancements have been introduced over time, and what today's LSMs encompass. Current efforts to incorporate new scientific understanding have improved the completeness of LSM representations of water, energy, carbon, and nitrogen interactions. However, these advances have also increased the complexity, often introducing unconstrained parameters that degrade model performance in practice. To address this, I will present a two-fold approach to mitigating the equifinality problem.

As our modeling goals become more ambitious, new challenges are emerging, including cross-disciplinary model integration and scaling models across platforms for broader applications. Addressing these challenges requires a holistic, collaborative approach.

To support this shift, we must embrace a new paradigm. We have been developing Cyberwater, a cyberinfrastructure platform that unites data and models to facilitate exploration, evaluation, model coupling, and collaboration. CyberWater (https://cyber-water.luddy.indianapolis.iu.edu/) significantly lowers technical barriers and enables researchers, small teams, and students to conduct complex, hypothesis-driven studies that bridge disciplines through integrated data and models.

Biography

Dr. Xu Liang is a Professor in the Department of Civil and Environmental Engineering at the University of Pittsburgh. Her research includes land surface modeling, hydroinformatics using advanced statistical methods, cyber system development, and the application of sensors and wireless sensor networks in environmental systems. She integrates physical understanding with computational approaches to advance modeling of complex environmental systems. Her work combines process-based modeling, quantitative analysis, and multiscale observations, including field-measurements, radar, and satellite data, to study the coupled physical, hydrological, and eco-biological processes across the soil–plant–atmosphere continuum. She actively collaborates with computer scientists, atmospheric scientists, plant biologists, and geo-engineering researchers.

Dr. Liang has been instrumental in the initial and subsequent development of the VIC land surface model and the VIC+ model. She currently leads the NSF funded multi-institutional, interdisciplinary cyberinfrastructure development project – CyberWater. .She received the Chancellor's Distinguished Research Award (senior category, 2016) from the University of Pittsburgh, the Carnegie Science Environmental Award (2014), and the Hellman Foundation Junior Faculty Research Award (2000) from the University of California, Berkeley. She is an elected Fellow of the American Meteorological Society (since 2016) and held the William Kepler Whiteford Professorship (2014 – 2019). Her research is primarily supported by NSF, NASA, NOAA, DOE, DOT, and Schmidt Sciences. Before joining the University of Pittsburgh, she was a faculty member at the University of California, Berkeley. Dr. Liang earned her Ph.D. in hydrology from the University of Washington (Seattle) and completed postdoctoral work at Princeton University.

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