

Mechanical Engineering Seminar Series

October 6, 2026, 11:00AM

Dean's Conference Room, E 203E

Title: The Role of Canopy Turbulence in Wildland Fire Behavior

Dr. Tirtha Banerjee

University of California, Irvine

Abstract: The traditional motivation behind studying the dynamics of turbulent wind flow in vegetation canopies has been to understand the nature of mass, momentum, and energy exchange between the land surface and the atmosphere. The nature of this interaction determines the microclimate in a forest environment where plants exchange carbon and water, and its understanding is relevant for a plethora of applications ranging from ecology, hydrology, agriculture, and the modeling of weather and climate. However, the fundamental nature of turbulence in a vegetation canopy is significantly different from the atmospheric surface layer lying above, which means that scaling laws and exchange coefficients from traditional wall-bounded flows are not applicable. In a forest canopy, momentum absorption happens not only at the ground surface but throughout the depth of the canopy, resulting in a unique 'roughness sub layer.' Instead of a log-layer, the mean velocity profile is inflected, second-order moments are variable with height, and skewnesses are large. Large-scale coherent structures impart a significant impact on turbulence dynamics. A mixing layer model is found to be a better model for describing canopy flows. High-frequency measurements and computational fluid dynamics modeling, especially Large Eddy Simulations (LES) have been instrumental in revealing the nature of canopy turbulence in the last few decades. Now, this knowledge is being used to push the frontiers of our limited understanding of how wildland fires behave. The main controls on wildland fire behavior – fuel (canopy and grasslands), weather, and topography are strongly influenced by the fine-scale physics of canopy turbulence. We will demonstrate that further developments in the understanding of canopy turbulence can benefit wildfire modeling tools and develop actionable management strategies

Bio: Tirtha Banerjee is currently an Associate Professor at the University of California, Irvine, where he has been a faculty member since 2019. Prior to this, he conducted postdoctoral research at the Karlsruhe Institute of Technology in Germany and Los Alamos National Laboratory as a Chick Keller and subsequently a Director's Postdoctoral Fellow. Dr. Banerjee earned his B.S. in Civil Engineering from Jadavpur University (India) and his Ph.D. in Environmental Science from Duke University, along with a graduate certificate in Nonlinear and Complex Systems Science. His primary expertise lies in turbulent fluid mechanics, with a focus on atmospheric boundary layers and environmental flows, ecosystem-atmosphere interactions, wildfire behavior, and natural hazards. He is the recipient of the 2022 NSF CAREER Award, the 2024 American Meteorological Society Outstanding Early Career Award from the Committee on Boundary Layers and Turbulence, a 2024 visiting fellowship from the Institute of Advanced Studies, University of Surrey, UK, and the the 2025 American Geophysical Union (AGU) Global Environmental Change Early Career Award. He currently serves as an Editor of Agricultural and Forest Meteorology (Elsevier), and an Editorial board member of Scientific Reports (Nature) and ARC Geophysical Research. He serves on the Science Advisory Panel of the Fire and Forest Resilience Task Force for the State of California and is Vice-President of the ICCLAS Coupled Land-Atmosphere Systems Commission under the International Association of Hydrological Sciences (IAHS). He is currently serving on a National Academy of Science, Engineering, and Medicine (NASEM) Consensus study expert committee on Wildland Fires and was also selected to participate at the NAE Frontiers of Engineering Symposium in 2026.