MAE *Seminar* SERIES

THURSDAY,
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TOWARD PREDICTIVE MODELING OF WINDS AROUND COMPLEX TERRAIN UNDER STABLY STRATIFIED CONDITIONS

ABSTRACT

Prediction and short-term forecasting of winds around complex terrain find several applications in wind energy, agriculture, air quality, and defense operations. Advances in supercomputing technologies enable spatial and temporal resolutions in numerical simulations that are much finer than resolutions used in practice. With fine resolutions, large-eddy simulations of winds around complex terrain become feasible. Specifically, wall-modeled Cartesian immersed boundary technique and turbulent inflow boundary conditions can be coupled to predict winds around complex terrain under neutrally stratified atmospheric conditions with reasonable accuracy. However, neutrally stratified conditions are the exception rather than the norm in the atmosphere. Stable stratification prevails during nighttime and in cold climates. Unlike its well-mixed, unstable counterpart, turbulence in stable stratification is poorly understood due to several mystifying processes such as turbulent bursts, relaminarization and wave-turbulence interactions. This gap in our comprehension of stratified turbulence hinders progress in developing accurate parameterization of subgrid-scale eddies, which is essential for a predictive simulation capability.

In the first part of my talk, I will present a computational capability to predict winds around arbitrarily complex terrain using a large-eddy simulation paradigm accelerated with graphics processing units. In the second part of my talk, I will present a fluid-physical investigation to better comprehend the physics of katabatic winds. The investigation is centered around a relatively less known exact solution from Ludwig Prandtl. A linear stability analysis, supported with direct numerical simulations, demonstrates that the Prandtl model for katabatic slope flows is prone to transverse and longitudinal modes of instability. A unique dimensionless parameter is introduced that plays a strong role in the dynamics of these instabilities.

BIO SKETCH

Inanc Senocak is an associate professor of mechanical engineering at the University of Pittsburgh. He obtained his PhD degree in aerospace engineering from the University of Florida and his B.Sc. degree in mechanical engineering from the Middle East Technical University in Ankara, Turkey. He conducted postdoctoral studies at the Stanford University and the Los Alamos National Laboratory prior to starting his faculty career at the Boise State University in 2007. Senocak is a fellow of the American Society of Mechanical Engineers (ASME), an associate fellow of the American Institute of Aeronautics and Astronautics (AIAA). He has received a CAREER Award from the National Science Foundation.

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