JOHNS HOPKINS
Center for Environmental
& Applied Fluid Mechanics

Friday, November 1, 2019
3:00 PM, 132 Gilman Hall

"A Computational "Rheometer" for Turbulent Flows"

Presented by Prof. Ali Mani
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Hosted by Dennice Gayme (MechE)

This study presents a numerical procedure, which we call the macroscopic forcing method (MFM), which reveals the differential operators acting upon the mean fields of quantities transported by underlying fluctuating flows. Specifically, MFM can reveal differential operators associated with turbulent transport of scalars and momentum. We present this methodology by considering canonical problems with increasing complexity. For spatially homogeneous and statistically stationary systems, we observe that eddy diffusivity can be approximated by an operator of the form $D/\sqrt{1-l^2\nabla^2}$, where l is a length scale on the order of large-eddy size and D is a coefficient. A validation test shows that this operator leads to significant improvement in RANS prediction of axisymmetric turbulent jets. We show a cost-effective generalization of MFM for analysis of non-homogeneous and wall-bounded flows, where eddy diffusivity is found to be a convolution acting on the macroscopic gradient of transported quantities. We introduce MFM as an effective tool for quantitative understanding of non-Boussinesq effects in turbulence, particularly, the effects associated with anisotropy and non-locality of macroscopic mixing.