Boulder Fluid and Thermal Sciences Seminar Series

Tuesday, September 29, 2015
3:30pm-4:30pm (refreshments at 3:15pm)
Bechtel Collaboratory in the Discovery Learning Center (DLC)
University of Colorado, Boulder

On the prediction of turbulent diapycnal mixing in stably stratified geophysical flows

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Two key quantities that are essential for estimating turbulent diapycnal (irreversible) mixing in stably stratified flows are: the dissipation rate of the turbulent kinetic energy and the mixing efficiency, which is a measure of the amount of turbulent kinetic energy that is irreversibly converted into background potential energy. A linear relationship between the Thorpe (vertical overturn) length scale and the Ozmidov scale is widely assumed in oceanography to infer the dissipation rate of turbulent kinetic energy. This approach is particularly attractive since the vertical scales of overturns are easily calculable using a sorting algorithm from inversions in standard density profiles obtained from Conductivity-Temperature-Depth (CTD) measurements in the ocean. Hence the Thorpe scale is essentially a kinematic scale that provides a description of the turbulence at a given sampling location and instant in time. On the other hand, The Ozmidov scale is obtained from dimensional reasoning based on the assumption that there is a balance between inertial and buoyancy forces. In other words, the Ozmidov scale is a representative dynamic length scale of the largest eddy that is unaffected by buoyancy. A review of a number of recent studies that were conducted in our research group will be presented in this talk to highlight the lack of a linear relationship between the Thorpe length scale and the Ozmidov scale. These studies indicate that inferred estimates of the dissipation rate of turbulent kinetic energy may be biased high by up to an order of magnitude or more especially for large overturns in the ocean. An alternative framework using a two-dimensional parameter space based on a buoyancy strength parameter (i.e. an inverse Froude number) and a shear strength parameter will be presented to characterize the scaling correspondence of the overturning scale with pertinent turbulent length scales. A discussion on the mixing efficiency and implications for estimates of diapycnal mixing in the ocean will be presented.

Biography: Dr. Karan Venayagamoorthy is an associate professor of Civil and Environmental Engineering, Borland Professor and Monfort Professor at Colorado State University. He received his BScEng (summa cum laude) and MScEng (cum laude) degrees in Civil Engineering from the University of Natal in Durban, South Africa and his PhD in Civil and Environmental Engineering from Stanford University. He is a recipient of several awards including the 2014 APS-DFD Frenkiel Award, NSF CAREER Award and the Office of Naval Research Young Investigator Award in 2012. His research interests focus on environmental fluid mechanics, geophysical fluid dynamics, hydraulics and hydrology using computational flow modeling in combination with theoretical and experimental methods.