SIO213 Turbulence and Mixing

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COURSE DESCRIPTION: Introduction to turbulence, importance of coherent structures, semi-empirical theories, effects of stratification and rotation on turbulent structure, entrainment and mixing; ocean and atmospheric mixing mechanism, their identification, description and modeling.

SOME TOPICS COVERED

- Introduction to turbulence
  - Experimental descriptions of turbulence, the importance of coherent structures
  - Turbulence and its relation to unstable flows
  - Critical Reynolds number, Reynolds (1884) pipe flow experiments
  - Mixing layer experiments
  - Vortex pairing
  - Eddy coherences and lifetimes; related inferences from correlation measurements

- Summary of basic concepts and their relation to experiments on coherent structures
  - Reynolds equations and the closure problem
  - Dimensional arguments, "laws"' semi-empirical theories:
    - Law of the wall, Velocity defect law,
    - Kolmogorov -5/3, Taylor microscale
  - Pedigrees for various flows: Spectra and correlations

- Stratification effects
  - Kelvin-Helmholtz stability, turbulent and flux Richardson numbers
  - Mixing layer experiments with stratification
  - Stirred grid experiments
  - Entrainment and the turbulent Richardson number

- Boundary layers, rotational effects
  - Boundary layer turbulence observations
  - Turbulent Ekman layer, dimensional arguments
  - Inferred flow structure in the Ekman layer, Planetary boundary layer measurements

- Oceanic mixing mechanisms – across isopycnals
  - Inferences from global advective diffusive balances
  - Estimates from microstructure observations
  - Breaking internal waves
  - Bottom and surface mixed layers
  - Spatially inhomogeneous mixing models

- Isopycnal property distributions and diffusion
  - Isopycnal analysis, Advective diffusive models
  - Inferences from current meters, floats and hydrographic surveys

- Sample special subjects (at discretion of instructor and students)
  - Shear dispersion
  - Variable diffusivity effects

Reynolds, O. 1883. An experimental investigation of the circumstances which determine whether the motion of water shall be direct or sinuous, and of the law of resistance in parallel channels. *Phil. Trans. Roy. Soc.* **174**, 935-982.

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Breidenthal, R. 1981 Structure in turbulent mixing layers and wakes using a chemical reaction. *J. Fluid Mech.* **109,** 1-2

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