Spring 2026 EEPS1820
Homework 9, due Apr 17, 11:59PM

COVERING: Wyngaard 9, 10, 11, 12; Thorpe Ch 6

1 Wyngaard (2010) Problem 10.3

10.3 Derive an expression like Eq. (10.21) but for the surface temperature flux.

2 Wyngaard (2010) Problem 10.12

10.12 Explain the role of the second-moment budgets in turbulent flow calculation.

3 Wyngaard (2010) Problem 11.2

11.2 Develop a criterion for the negligibility of the effects of horizontal inhomogeneity and time changes on mixed-layer similarity.

4 Wyngaard (2010) Problem 12.2

12.2 A surface is cooler than the air above and is evaporating water so that the vertical flux of water vapor is positive. The virtual temperature flux is zero. What is the stability index z/L? Using M-O similarity, write the expression for the vertical gradient of potential temperature.

5 Thorpe (2007) Problem 6.7

P6.7 (M) Mixing near the seabed. Temperature profiles through the benthic boundary layer is shown in Fig. 6.8. It appears that mixing near the bed has homogenized the relatively uniform temperature gradient in the overlying water.

Supposing that the water overlying the seabed has a uniform density gradient with corresponding buoyancy frequency, N, equal to 3×10^{-3} s^{-1}, estimate the change in potential energy per unit horizontal area required in order to homogenize this uniform

density gradient and to form a bottom layer of thickness $2H = 20$ m. Assuming that 20% of the energy available from the working of the shear stress on the seabed when $\langle U^2|U|\rangle = 1.25 \times 10^{-4}$ m^3 s^{-3} (chosen to correspond to $\langle U^2|U|\rangle^{1/3} = 0.05$ m s^{-1}, a speed typical of the deep-ocean benthic boundary layer) is used in mixing, estimate how long it will take to complete the mixing of the near-bed uniform density gradient to the thickness of 20 m.

References

Thorpe, S. A. (2007). *An introduction to ocean turbulence.* Cambridge University Press, Cambridge.

Wyngaard, J. C. (2010). *Turbulence in the Atmosphere.* Cambridge University Press.