

Homework 3

The first problem is an exercise of Reynolds averaging. In the second problem, we compute the eddy energy and surface stress. In the third problem, we make use of the momentum equation in the boundary layer.

1. RFV virus (10 points)

A consortium of personal computer manufactures has contracted with a local genetic engineering firm to create a new virus call RFV. When humans breath this virus, it causes Ramchip Fever, resulting in an insatiable urge to buy a computer.

The concentration, c , of RFV in the air is governed by the following conservation equation: $dC/dt = a C^2 T$

where “a” is a constant and T is absolute temperature. Derive the forecast equation for \overline{C} in turbulent air. Put it into flux form.

2. Turbulence (10 points)

A surface site shows the following observations

U(m/s)	5	6	8	3	4	7	5	3	4	6
V(m/s)	1	-1	0	1	0	1	-1	-1	1	-1
W(m/s)	0	-1	1	0	-2	1	2	1	-1	-1

(a) Calculate the mean and turbulent kinetic energies (per unit mass).

(b) Calculate u_* .

3. Wind acceleration (10 points)

Suppose that: $\overline{u'w'} = -(u_* + cz)^2$, $\overline{v'w'} = 0$, $\overline{U_g} = 5\text{m/s}$, $\overline{V_g} = 5\text{ m/s}$ at all heights, $f_c = 10^{-4}\text{ s}^{-1}$, $u_* = 0.3\text{ m/s}$, and $c = 0.001\text{ s}^{-1}$ in the boundary layer. Find the acceleration of the air in the x and y directions at a height of 100 m in the BL, assuming that initially $\overline{U} = 4\text{ m/s}$ and $\overline{V} = 2\text{ m/s}$ at that height.