Environmental Fluid Dynamics

ME EN 7710 | Homework #1 | Due: January 24th

1.) Arya - Chapter 2, Exercise 5

Explain the following terms or concepts used in connection with the surface energy budget:

(a) "ideal" surface

(b) evaporative cooling

(c) oasis effect

(d) flux divergence

2.) Arya - Chapter 3, Exercise 2

(a) Estimate the combined sensible and latent heat fluxes from the surface to the atmosphere, given the following observations:
- Incoming shortwave radiation = $800\ \mathrm{W\ m^{-2}}$
- Heat flux to the submedium = $150\ \mathrm{W\ m^{-2}}$
- Albedo of the surface = 0.35

(b) What would be the result if the surface albedo were to drop to 0.07 after irrigation?

3.) Arya - Chapter 3, Exercise 3

The following measurements or estimates were made of the radiative fluxes over a short grass surface during a clear sunny day:

- Incoming shortwave radiation: $675\ \mathrm{W\ m^{-2}}$
- Incoming longwave radiation: $390\ \mathrm{W\ m^{-2}}$
- Ground surface temperature: 35°C
- Albedo of the surface: 0.20
- Emissivity of the surface: 0.92

(a) From the radiation balance equation, calculate the net radiation at the surface.

(b) What would be the net radiation after the surface is thoroughly watered so that its albedo drops to 0.10 and its effective surface temperature reduces to 25°C?

(c) Qualitatively discuss the effect of watering on the other energy fluxes to or from the surface.

4.) Arya - Chapter 3, Exercise 7

Discuss the merits of the proposition that net radiation R_N can be deduced from measurements from solar radiation $R_{S\downarrow}$ during the daylight hours, using the empirical relationship

$$R_N = AR_{s\downarrow} + B$$

where A and B are constants. On what factors are A and B expected to depend?

5.) Boltzmann and Planck

Derive Stefan-Boltzmann's Law from Planck's Law.

6.) Wein and Planck

Derive Wein's Law from Planck's Law.