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CIVE520 PHYSICAL HYDROLOGY

Homework No. 1

Due on: Friday, September 16, 2011

1. At a climate station, the following measurements are made: air pressure = 1011 *hPa*[1], air temperature = 25 *ºC*, and dew point temperature = 20 *ºC*. Calculate the corresponding vapor pressure, relative humidity, specific humidity, and air density.

2. A sample of moist air has a temperature of 280 *ºK* at a pressure of 900 *hPa*, with a mixing ratio of 0.005 (i.e., 5 *g/kg*). Compute the following quantities for this sample: a) virtual temperature; b) absolute humidity; c) specific humidity; d) relative humidity; e) dew point temperature; f) potential temperature; and g) equivalent potential temperature.

3. Derive expressions for the vertical distributions of pressure, $p(z)$, and density, $\rho(z)$, of an atmosphere whose temperature decreases linearly with elevation at a rate given by Γ_{amb}. Graph your results.

4. Moist air at 1000 *hPa* and 25 *ºC* has a wet-bulb temperature of 20 *ºC*. Find the dew point temperature. If this moist air were expanded until all the moisture condensed and fell out and then compressed to 1000 *hPa*, what would be the resulting temperature? Assume this process is adiabatic while the parcel is unsaturated, and moist-adiabatic while the parcel is saturated.

5. The equivalent potential temperature of an unsaturated parcel of surface air is 340 *ºK*, and its potential temperature is 300 *ºK*. If the ambient air temperature at the lifting condensation level is 295 *ºK*, compute the buoyancy force acting on the parcel at that level. Assume the surface is at a pressure of 1000 *hPa*. State all your assumptions.

The net buoyancy force per unit mass acting on a parcel of air undergoing a finite adiabatic displacement was obtained in class as,

$$F_B = \frac{F}{\rho_p \Delta V} = g\frac{\rho_a - \rho_p}{\rho_p} = g\frac{T_p - T_a}{T_a}$$

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[1] 1 $hPa = 10^2\ Pa$