PHYS4520 Physics in Meteorology

Problem Set 11

Given: specific latent heat of vaporization for water $L_v = 2.5 \times 10^6$ J kg^{-1}, gas constant for water vapor $R_v = 461.5$ J kg^{-1} K^{-1}, saturated vapor pressure at 0°C is $e_{s0} = 6.11$ mbar (1 bar $= 10^5$ Pa), dry adiabatic lapse rate $\Gamma_a = 0.01$ K m^{-1}, saturated adiabatic lapse rate $\Gamma_s = 0.005$ K m^{-1}.

1. *Chinook wind.* Moist air blowing from the west is being forced over a 3000-meter high mountain. On the west side surface level, the pressure is $p = 800$ mb, the temperature is $T = 293$ K and the mixing ratio is $w = 15$ g kg^{-1}.

    (a) What is the relative humidity r, the dew point temperature T_d and the height of the lifting condensation level z_{LCL} of the air at the surface level on the west side of the mountain?

    (b) What is the relative humidity r' and temperature T' of the air at the summit of the mountain?

    (c) Assume any condensation product fell as precipitation on the west side of the mountain and no moisture was added or subtracted from the air as it traveled downslope the east side of the mountain. Calculate the relative humidity r'' and the temperature T'' at the surface level on the east side if the pressure p'' there equals p.

2. *Radiation cooling.* Heat near the surface of the Earth is readily exchanged between the ground and the air above. As the ground loses heat in the evening, dew may condensed on the grass and fog may form in the air near the surface. Suppose moist air with temperature 20°C and relative humidity 70% moves over land and starts to cool. At what temperature will fog from?