1. The air mass at sea level has an air temperature of 32°C. If this air mass is lifted along the mountain slope adiabatically, and the clouds start to form at the elevation of the NTU Experimental Forest in Xitou (1200 m asl), answer the following questions. Use the dry adiabatic lapse rate of $\Gamma_d = 0.01$ K m^{-1} and the wet adiabatic lapse rate of $\Gamma_w = 0.005$ K m^{-1}. (10 pt)
   (a) What is the dew point temperature of this air mass? (3 pt)
   (b) What is the temperature of this air mass at the top of a 2000 m mountain? (3 pt)
   (c) If the air loses all the condensed water by precipitation and descends on the leeward to the 0 m elevation, what is the air temperature? (4 pt)

2. Explain the following terms. (10 pt)
   (a) Sensible heat flux (2 pt)
   (b) Latent heat flux (2 pt)
   (c) Soil heat flux (2 pt)
   (d) Net radiation (2 pt)
   (e) Albedo (2 pt)

3. Given a water vapor density ($\rho_v = 20$ g m^{-3}), the molecular mass of water ($M_w = 18$ g mol^{-1}), the molecular mass of dry air ($M_d = 29$ g mol^{-1}), the universal gas constant ($R = 8.31$ Pa m^3 mol^{-1} K^{-1}), atmospheric pressure $P = 100$ kPa, and air temperature is $T = 300$ K, answer the following questions. (20 pt)
   (a) What is the water vapor pressure e (kPa)? (5 pt)
   (b) What is the density of dry air ρ_d (g m^{-3})? (5 pt)
   (c) What is the specific humidity q (g kg^{-1})? (5 pt)
   (d) What is the mixing ratio χ (g kg^{-1})? (5 pt)

4. The snow albedo feedback is an important determinant of climate response to higher atmospheric CO_2 concentration. Explain this feedback. What is the effect of boreal forests on this feedback? (10 pt)

5. In the early growing season, sudden frosts can kill new plant growth. This can be a critical factor in successful forest regeneration. This is mainly due to the radiative cooling in the nighttime. Which is more likely to have a successful seedling establishment, a small clearing, or a large clearcut? What is the reason for it? (10pt)

6. Which effect is relevant to the drought in tropical rainforests in South-east Asia: El Niño or La Niña? What is the reason for it? (10 pt)

7. Recently the extent of Arctic sea ice at the end of summer is frequently reported to record its lowest, which suggests the sea ice extent is gradually decreasing with a warming climate. What effect may this have on the Earth's climate? (10 pt)

8. In the boreal forest region, the vegetation type is sometimes different between north-facing and south-facing slopes. For example, in Interior Alaska, the north-facing slope is covered by black spruce forest over permafrost. In contrast, the south-facing slope is covered by deciduous broadleaf species on the permafrost-free soil. Explain the reason for it from the view of solar radiation and topography. (10 pt)

9. The maximum of daily mean solar radiation occurs in the Arctic and Antarctic regions seasonally, not in the equator. Explain this phenomenon and the reason why. (10 pt)

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