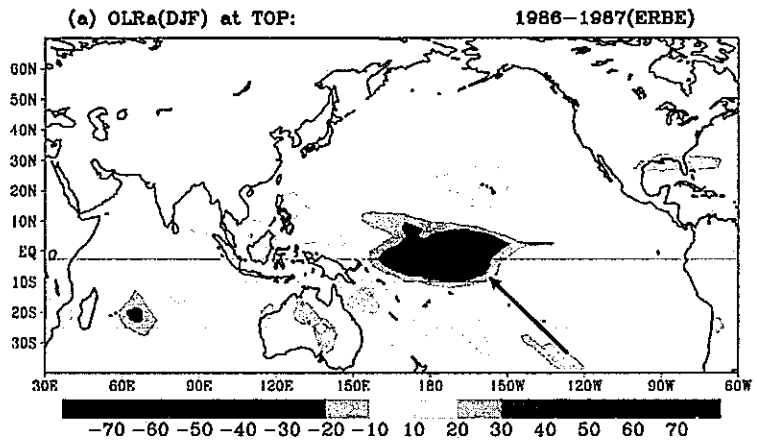
1. As the air parcel being lifted, many important physical processes are involved. **The following question is about all the fundamental concept of an air parcel in the course of atmospheric thermodynamics. [20pt]**
   (a) What is an air parcel? [1pt] What are the assumptions used to describe an air parcel? [2pt]
   (b) Draw an air parcel near surface, provide three examples of diabetic heating for the air parcel. [3pt]
   (c) Derive the mathematical expression of the potential temperature starting from the first law of thermodynamics. Please provide explanation for each step. [5pt]
   (d) Draw the vertical profile of an air parcel (from surface to 5 km) in terms of temperature, potential temperature assuming no condensation occurs (you need to provide specific numbers for the air parcel). [4pt]
   (e) Draw a vertical profile of temperature for an air parcel that is conditional unstable (you need to provide the reference environment and the adiabats to support your profile). [5pt]
   * Given parameters: $\varepsilon = R_d/R_v$, $R_d = 287 Jkg^{-1}K^{-1}$, $R_v = 461.5 Jkg^{-1}K^{-1}$

$$c_p = 1005 Jkg^{-1}K^{-1},\ c_V = 718 Jkg^{-1}K^{-1}\ c_{water} = 4187 Jkg^{-1}K^{-1}, c_{ice} = 2050 Jkg^{-1}K^{-1}$$
$$l_f = 3.33\times10^5 Jkg^{-1},\ l_v = 2.50\times10^6 Jkg^{-1}\ l_s = 2.83\times10^6 Jkg^{-1}$$
$$\rho_w = 1000 kgm^{-3}\ \text{(water)}\ \ \rho_i = 917 kgm^{-3}\ \text{(ice)},\ \ \rho_v = 1.2 kgm^{-3}\ \text{(vapor)}$$
$$\ln\frac{e_s}{6.11} = \frac{l_v}{R_v}\left(\frac{1}{273}-\frac{1}{T}\right) = 19.85 - \frac{5418.7}{T}$$
$$e_s = A\cdot e^{-B/T}, A = 2.53\times10^8\ kPa, B = 5.42\times10^3\ K$$
$$e_{si} = A\cdot e^{-B/T}, A = 3.41\times10^9\ kPa, B = 6.13\times10^3\ K$$

2. El Nino and longwave (LW) radiation **[20pt]**:
   2a. Does the arrow-pointed area have a positive or negative LW anomaly? (5%)
   2b. Does the arrow-pointed area have a warming or cooling tendency? (5%)
   2c. Briefly explain the above answers. (10%)



3. What are the 4 Black Body Radiation Laws and key concept? **[20pt]**

4. (a) Explain why the drop-size increase rate slows down during condensational growth but accelerates during collisional growth as the drop gets lager. **[10pt]**
   (b) Try to relate the above phenomena to the fact that a higher aerosol concentration will lead to a slower rain formation in warm clouds. **[10pt]**

5. Explain the Wegener-Bergeron-Findeisen (or simply Bergeron-Findeisen) process and why it is especially important to the precipitation formation over the mid-latitude continental areas. **[10pt]**

6. What factors determine whether the hail's accretion of cloud water proceeds as a "dry growth" or "wet growth" process? **[10pt]**

試題隨卷繳回