題號： 91

國立臺灣大學 107 學年度碩士班招生考試試題

科目：氣候學

節次： 4

1. From the thermodynamic 1st law, $dW + dQ = dU$ (where $dW = -pd\alpha$, $dU = c_v dT$)

(a) Derive the conservation equation of dry static energy (DSE) $d\mathbf{s}/dt = dQ$ (where $\mathbf{s} = c_pT+gz$) , and describes the components of diabatic heating (dQ) in the atmosphere that can change **s**. (5)

(b) Derive the conservation equation of moist static energy (MSE) $d\mathbf{h}/dt$, where $\mathbf{h}=\mathbf{s}+Lq_v$ (5)

(c) Integrate the above two equations vertically from the surface to the top of atmosphere and express your answer graphically. (5)

(d) How would you apply the vertically integrated DSE and MSE equations at the TOA to understand the zonally averaged energy transport ? (15)

2. Use the bulk aerodynamic formula and the figure below to calculate the evaporation rate and Bowen ratio from the ocean,

assuming $C_{DE}=10^{-3}$, $U=5\ ms^{-1}$, and that the reference level temperature is always 2°C less than the sea surface temperature. Calculate the evaporation rate for

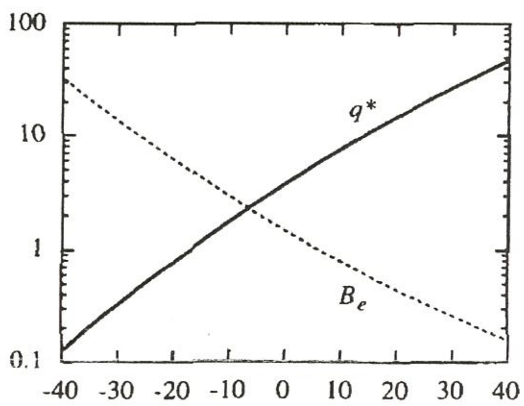
(a) T_s=0°C, q_s*=3.75g kg^{-1}, RH=50%; (b) T_s=0°C, q_s*=3.75g kg^{-1}, RH=100%;

(c) T_s=30°C, q_s*=27 g kg^{-1}, RH=50%; (d) T_s=30°C, q_s*=27 g kg^{-1}, RH=100%. (10)

Assume a fixed density of 1.2 kg m^{-3}, $B_e = (L/c_p \cdot \partial q^*/\partial T)^{-1}$ in the figure

(e) How would you evaluate the importance of relative humidity versus the importance of surface temperature for determining the evaporation rate ? (10)

(f) Use the results to explain why high-latitude land areas often have high surface moisture content. (10)



3. The upper panel of the figure below shows annual mean climatology of SST (black contours at 1°C intervals, contours of SST greater than 27°C thickened) and precipitation (white contours at 2 mm day^{-1}; shaded > 4 mm day^{-1}). The lower panel shows annual mean climatology of surface wind stress vectors (Nm^{-2}) and the 20°C isothermal depth (D20, contours at 20 m intervals, shaded < 100 m). Based on the figure, answer the following questions:

(a) Describe the primary causes of the Pacific cold tongue，ITCZ, and SPCZ. (10)

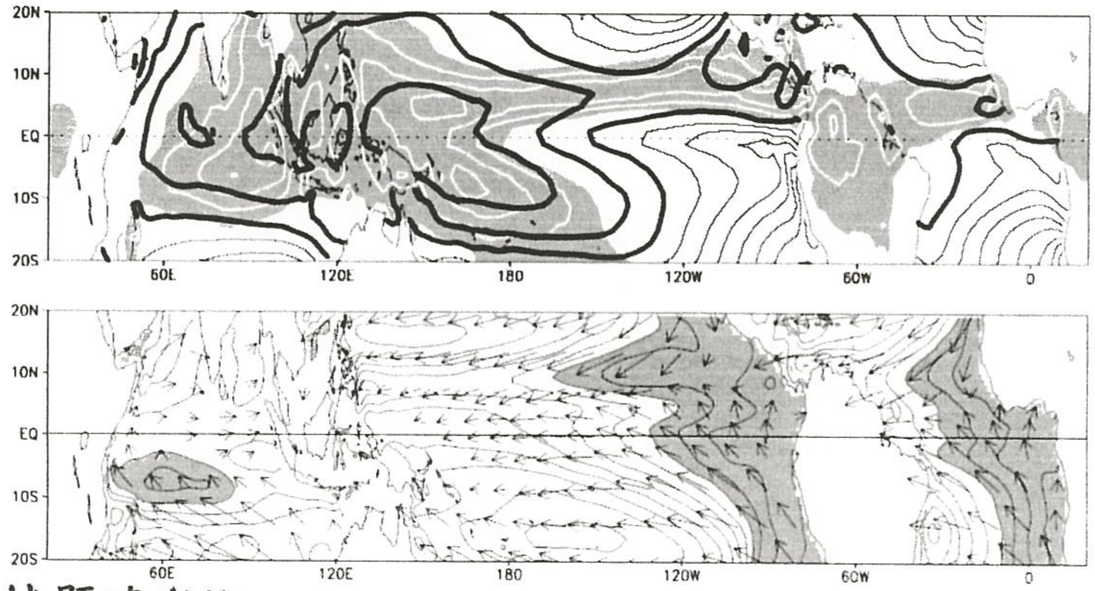
The figure shows that although the distribution of sunshine is symmetrical about the equator, the earth's climate is not. Climatic asymmetries are prominent in the eastern tropical Pacific and Atlantic Oceans where the regions of maximum SST, convective cloud cover, and rainfall are north of the equator. The asymmetry has been attributed to the following factors.

Please describe the processes corresponding to each of the factors to further explain the Climatic asymmetries

(b) interactions between the ocean and atmosphere that are capable of converting symmetry into asymmetry; (10)

(c) the geometries of the continents that determine in which longitudes the interactions are effective and in which hemisphere the warmest waters and the intertropical convergence zone are located; (10)

(d) Low-level stratus clouds over cold waters (10)



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