Chapter 6, # 1-2

Chapter 6

6.1 Moist static energy is $MSE = c_pT + gz + Lq$ and must increase with height

c_pT and Lq both decrease with height and so the transport is in the direction of flow in the lower troposphere

gz increases with height and is transported in the direction of flow in the upper branch of the Hadley cell – poleward

The Hadley cell transports water and heat toward the equator and total energy away from the equator. This yields wet climates near the equator and dry climates in the subtropics.

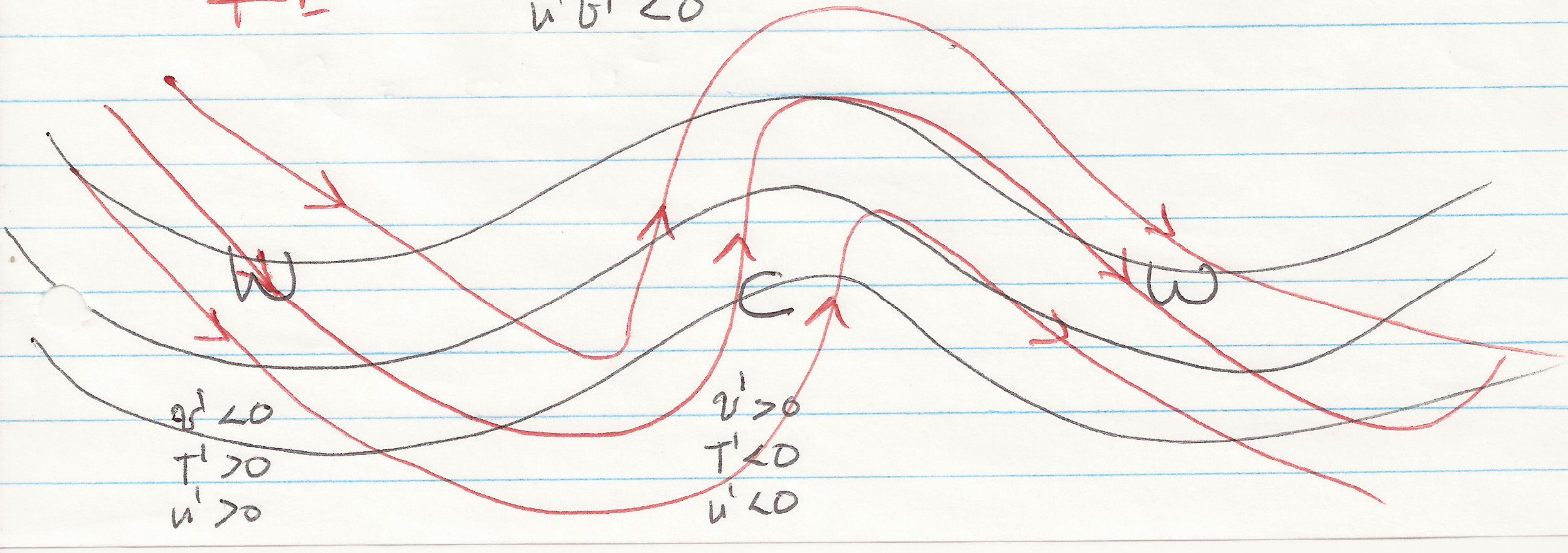
6.2

N

E

$\overline{v'T'} < 0$

$\overline{u'v'} < 0$



Chapter 6 #3-4

<u>6.3</u> $vM = v(\Omega a\cos\varphi + u)a\cos\varphi$

$= a\cos\varphi(vu + v\Omega a\cos\varphi)$

$= a\cos\varphi(\overline{v}\,\overline{u} + \overline{v'u'} + \overline{v}\Omega a\cos\varphi)$

$= a\cos\varphi([\overline{v}][\overline{u}] + [\overline{v}^*\overline{u}^*] + [\overline{u'v'}] + [\overline{v}]\Omega a\cos\varphi)$

$= [\overline{v}](\Omega a\cos\varphi + [\overline{u}])a\cos\varphi$

$+ ([\overline{u'v'}] + [\overline{v}^*\overline{u}^*])a\cos\varphi$

QED

<u>6.4</u> $AM = a\cos\varphi(u + \Omega a\cos\varphi) = \text{const}$

$a\cos(-20°)(0 + \Omega a\cos(-20°)) = a\cos 0°(u_e + \Omega a\cos 0°)$

$\Omega a^2\cos^2(-20°) = a(u_e + \Omega a)$

$\Omega a(\cos^2(-20°) - 1) = u_e$

$u_e = \Omega a(\cos^2(-20) - 1)$

$= 464.5\,ms^{-1}(-0.11697)$

$u_e = \underline{-54.3\ ms^{-1}}$

6.5 To maintain balance, as much angular momentum must be transferred from the atmosphere to the earth in the mid-latitude westerlies as is transferred from the earth to the atmosphere in the tropics

Stress × area × moment arm = constant

since the area is equal and the moment arm is greatest in the tropics, the stress must be greatest in midlatitudes

According to (4.18) $\tau_0 = \rho C_D U^2$

So the wind speed U must be greater in middle latitudes.

Chapter 6, #7

6.7 If you go to Fig. 2.11 a on page 36 you get $R_{net} \sim -20\,Wm^{-2}$ over desert (also accept $-40\,Wm^{-2}$)

To increase solar absorption by -20 to $+20$ we need

$$-S\Delta\alpha = 40 \Rightarrow \Delta\alpha = \frac{40\,Wm^{-2}}{S} = \frac{40}{400} = \underline{0.1}$$

or 0.2 if they used $R_{net} = -40\,Wm^{-2}$

You need to worry that the OLR will increase since

$$\Delta R_{net} = -S\Delta\alpha - \Delta OLR$$

Estimate $\Delta OLR \approx 4\sigma T_e^3 \Delta T_e$

$OLR \sim 275\,Wm^{-2}$ from Fig 2.10 a on page 35

then $T_e = \sqrt[4]{\frac{275}{\sigma}} = 265K$

$$\Delta OLR \approx 4.2\,Wm^{-2}K^{-1} \cdot \Delta T_e$$

$\Rightarrow \Delta T_e \approx 5°K$ Big, so $\Delta\alpha \approx -0.1$

Will probably make $\Delta R > 20$ So that $R_{net} > 0$

$\Rightarrow$ Thermal Low needed.