4. List the four physical processes that determine buoyancy at the convective scale.

Sol) ( )* ≡ perturbation variable.

(a) Perturbation temperatures

$T^* > 0$ will lead to positive buoyancy.

(b) Perturbation pressures

$P^* < 0$ positive buoyancy.

(c) Moisture

Moist air is less dense. It will be positively buoyant.

(d) Hydrometeors

The greater the # of hydrometeors ⇒ the less buoyancy

5. a. Explain the process(es) by which horizontal vorticity can be transformed into vertical vorticity.

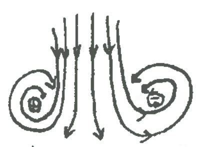
b. A parcel of air is negatively buoyant, e.g. a downdraft. Draw a sketch of streamlines showing the horizontal vorticity that is produced. Make sure that your streamlines have arrows that indicate the sense of the vorticity.

Sol)

(a) Horiz. vort. ⇒ vert. vort.

This may occur due to tilting/twisting of the horizontal vorticity. In addition, horiz. vort may result from baroclinic sources due to horiz. gradients of buoyancy. Then, this horiz. vort. may be transformed into vert. vort. by tilting/twisting

(b)



Horiz. vort. is produced about a horiz. axis running into and out of the page.

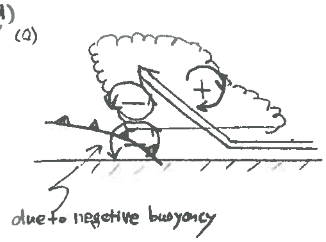
6. Draw two cross sections that show how a cold pool (gust front) can be influenced by vertical wind shear. Specifically,

a. One sketch shows the gust front with no environmental shear. Use horizontal vorticity concepts to explain whether new cell development is likely

b. The second sketch shows the gust front with low level wind shear. Use horizontal vorticity concepts to explain whether new cell development is likely.

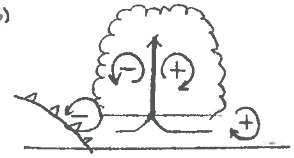
Sol)

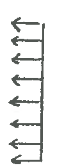
(a)



no shear: cold pool associated with gust front more (−) horiz. vort. Updraft tilts to the left. new cell development not likely. weaker vertical motions. (air less likely to reach LFC)

(b)





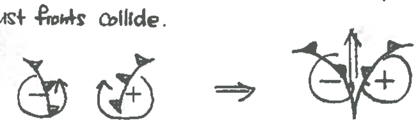
Horiz. vorticities balance. The pos. horiz. vort. due to the shear cancels out neg. horiz. vort. due to the cold pool. We expect upright convection and maximum vert. motions. New cell development is likely.

7. Draw a cross section through a multicell storm complex. It should be oriented along the direction of storm complex motion. Show the various cells as well as streamlines indicating the flow. Indicate where air is coming into or out of your cross section. Describe the important points of your cross section in several sentences. (Remember that the sketch alone is not sufficient).

Sol) Skip.

8. Use the concept of horizontal vorticity to explain why storms frequently develop when two gust fronts collide – even through the environmental shear is very small

Sol) Even though environmental shear is very small, colliding gust fronts frequently result in new storm development. This occurs as one of the gust fronts acts as the environmental shear. Vertical motions (upward) are maximized as the gust fronts collide.



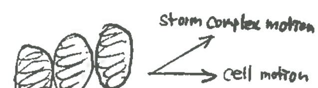
9. a. Explain the difference between discrete and continuous propagation. Which is dominant in multicell storms? ... in supercell storms?

b. Show a cell motion vector and a .... propagation vector that often are associated with flash flooding. Explain what is going on

Sol)

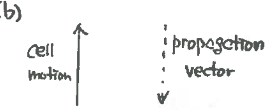
(a) Discrete propagation: new cells form as old cells die

The whole complex moves one direction, while individual cells, which are forming and dying, move in another direction. This is usually found in multicell storm complexes.



Continuous propagation: a single cell will constantly be changing form as one side of the cell is favored over another. This is usually associated with supercells.

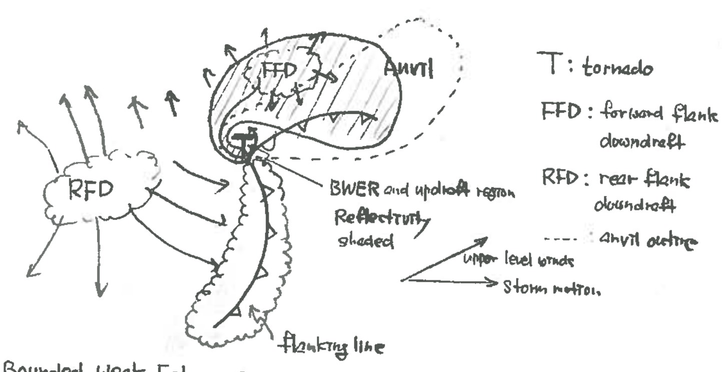
(b)



These two vectors are of equal and opposite strength and therefore cells may stay over the same location for long periods of time ⇒ training

10. Sketch a plan view of a classic tornadic supercell. Indicate the various gust fronts and downdrafts areas, the bounded weak echo region and updraft, the anvil, the flanking line, and the location of the tornado. Label each item carefully

Sol)



Bounded Weak Echo region