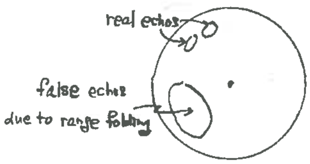
MET5511C – Mid-term : Fuelberg.

1. Describe the concepts of range folding and velocity folding in words. How would each appear on a radar display?

Sol) Velocity folding is a type of aliasing which occurs with higher radial velocities. For example, if the atmospheric radial velocity is 60 kts for a particular place, the radar may not receive that value correctly. (appear slower than actual) The value will be lower than the actual. Velocity folding occurs due to the PRF, or pulse repetition frequency, which is usually about $1000s^{-1}$. We can minimize velocity folding by choosing a higher PRF. This will serve to increase our maximum unambiguous velocity, but at the same time, our maximum unambiguous range will decrease. On a radar display, we may therefore see areas of precipitation which are not really there due to this range folding.



To see if we are being affected by this phenomena, we can tweak the PRF a little in order to see if our suspect area of radar echos is moving or not.

2. List and very briefly describe the factors which adversely affect precipitation estimates from radar.

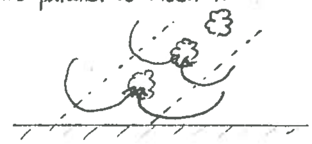
Sol) – not all precipitation droplets (different drop size distributions?) will be similar for different types of storms
– not all precipitation droplets are liquid
– Because the radar beam gains altitude with increasing distance from the radar site, some of the precipitation at the lower levels of the atmosphere will not be sampled properly.
– The volume of the beam will not always be filled completely by precipitation droplets
– Incorrect calibration

3. How are the inland penetration and strength of the sea breeze affected by the large scale flow? Refer to Arritt's paper in your discussion, but you don't have to give all of the specifics that he does. How does hydrostatic stability affect the sea breeze? Why does it occur?

Sol)
- Offshore large scale flow : Sea breeze does not penetrate as quick due to opposing flow; sea breeze is stronger with offshore flow due to a strengthening of $\nabla_s T$ → Stronger ∇p ⇒ stronger convergence at low levels/divergence at upper levels → stronger vertical motion ⇒ more instability ⇒ possible strong convection.
The optimal value for the strongest sea breeze is an offshore flow value of around 3 m/s. However, we can still have inland penetration for speeds as high as 11 m/s.
- Onshore large scale flow : farther penetration, but weaker sea breeze circulation as $\nabla_s T$ not as strong.
- Calm large scale flow : Similar to but not as strong as offshore case.
- Hydrostatic stability
– more unstable conditions ⇒ more vertical mixing ⇒ depth of ∇T is greater (∇T extends through a deep layer) ⇒ this strengthens the entire sea breeze circulation ⇒ stronger sea breeze.
– more stable conditions ⇒ less vertical mixing ⇒ depth of ∇T is less ⇒ weaker sea breeze.

4. Describe horizontal convective rolls in words and sketches. Explain how they appear in visible satellite imagery and why this occurs. How might HCRs influence convective development along a sea breeze front?

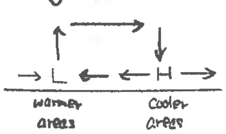
Sol) HCR's are areas of rotating air about a horizontal axis which leads to lines of cumulus parallel to mean flow



They appear on visible imagery as cloud streets or bands oriented parallel to the mean flow.
As the sea breeze moves toward these HCR's, the vertical motions will be enhanced where the air is rising in the above sketch. This could lead to more significant convective development along the sea breeze front.

5. What is an inland sea breeze? What situations might produce one? How does the circulation of an inland sea breeze vary during the course of a daylight period? Sketches might help here.

Sol) Inland sea breeze : an area where there are ∇T which are stronger than normal. There may arise due to soil type, soil moisture, vegetative cover, cloudy areas vs. clear areas, etc.
During daylight, low level flow is from the cooler areas to the warmer areas, just as in coastal sea breeze. Lower pressures occur in the warm location while higher pressures form in cooler areas.



– return flow sets up aloft ; convection may form in area of enhanced convergence, vertical motion.
– most intense during late afternoon ; small area of ↑, larger area of ↓
– vertical motion pattern becomes asymmetric late in afternoon

6. List at least six factors that influence lake effect snow systems (LES). Comment briefly on each factor.

Sol)
- Instability : The deeper the mixed layer ⇒ steeper lapse rate ⇒ more instability ⇒ more favorable for LES
Also, if $T_{lake} > T_{850}$ by 13°C ⇒ more favorable for LES as lapse rate approaches dry adiabatic.
- fetch : The longer the fetch over a lake → more favorable for LES
- Wind shear : the less the directional shear & the less the speed shear ⇒ more favorable for LES
optimal : directional shear < 30°
if directional shear > 60°, probably will not have LES
- upstream moisture : the more upstream moisture ⇒ easier for saturation + condensation to take place.
- presence of upstream lakes : Same effect as upstream moisture.
If flow passes over an upstream lake, more favorable for LES downwind of second lake