Problems for Week 9: Focusing

1) Assume that you imaging an isotropic scatter on the bed of an ice sheet using focused airborne ice penetrating radar data that has been focused with two different apertures L_1 and L_2 (where $L_1 < L_2$), spanning the scattering angles θ_1 and θ_2 at the bed, and resulting in focused bed echo strengths E_1 and E_2.
    a. Is E_1/E_2 greater-than, less-than, or equal-to L_1/L_2?
    b. Is θ_1/θ_2 greater-than, less-than, or equal-to L_1/L_2?
    c. If the bed does not scatter energy isotropically, will be E_1/E_2 larger, smaller, or the same?
    d. If the bed does not scatter energy isotropically, will be θ_1/θ_2 larger, smaller, or the same?

2) Assume that you have collected ice penetrating radar data collected with a center frequency of 60 MHz, from an airborne platform at a survey height of 500m and moving at 100 m/s to look at layers 1km below the surface.
    a. If the data is focused with a focusing aperture of 400m, what is the steepest englacial layer that will be reproduced in the ragargram?
    b. If the data is focused with a focusing aperture of 2km, what is the steepest englacial layer that will be reproduced in the ragargram?
    c. If the data is raw, what is the steepest englacial layer that will be reproduced in the ragargram?

3) Assume that you measure the range (R in meters) and phase (Φ in degrees) from a scatter on the ice surface 500 m below an airborne ice penetrating radar system with a center frequency of 60 MHz and a bandwidth of 15 MHz.
    a. What will be the change in range δR and change in phase $\delta\Phi$ when the aircraft moves 2 m along track?
    b. What will δR and $\delta\Phi$ be when the aircraft moves 20m along track?
    c. What will δR and $\delta\Phi$ be when the aircraft moves 200m along track?
    d. What will δR and $\delta\Phi$ be when the aircraft moves 2km along track?
    e. Estimate the focusing aperture length above which range-migration would be necessary in focusing.

4) What is the impact of range-migrated focusing on:
    a. Detecting shallowly sloping layers?
    b. Detecting steeply sloping layers?
    c. Along-track off-nadir surface clutter?
    d. Crass-track off-nadir surface clutter?
    e. Detecting a flat rough bed?
    f. Detecting a sloping rough bed?
    g. Echo strength reduction due to bed roughness?
    h. Range resolution?

5) If you are choosing a center frequency for an ice penetrating system and have two choices F_{C1} and F_{C2} where ($F_{C1} > F_{C2}$)
    a. Which will be more robust to scattering from a rough surface?
    b. Which has the potential for better post-focusing azimuth resolution?
    c. Which has the potential for better range resolution?
    d. Which will experience a greater gain in SNR as a result of focusing (relative to additive noise)?
    e. Describe the physical limit(s) on improved post-focusing azimuth resolution from changing the carrier frequency.