Problems for Week 8: Processing

1) Assume that you are trying to detect a weak signal in additive thermal receiver noise by coherently processing previously collected ice penetrating radar data. For each of the following coherent processing techniques, what will set the upper limit on the number of traces that you can coherently process and improve the signal to noise ratio.
   a. Pre-Stacking
   b. Unfocused Integration
   c. Focused SAR without range-migration
   d. Focused SAR with range-migration

2) Assume that you are trying to detect a weak signal in multiplicative speckle noise by incoherently processing previously collected ice penetrating radar data. For each of the following incoherent processing techniques, describe how the radiometric resolution is being improved and what trade in resolution and/or gain is being made order to achieve that improvement.
   a. Incoherent averaging of pulses
   b. Gaussian filtering of radargrams
   c. Multi-looking across Doppler bins
   d. Multi-looking in frequency (within a single chirped pulse)

3) Assume you have an ice penetrating radar system with a center frequency of 60 MHz, a bandwidth of 15 MHz, an aircraft speed of 100 m/s, a PRF of 6 kHz, a survey height of 500m, and azimuth resolution of 10m.
   a. Estimate the maximum number of looks with no pre-stacking?
   b. Estimate the maximum number of looks with pre-stacking of 32 traces?
   c. What is the difference between the pre-stacking and no pre-stacking cases in terms of additive noise, and multiplicative noise?

4) Sketch radargrams for a highly crevassed area with both shallowly and steeply sloping layers and
   a. No processing
   b. Doppler Filtering
   c. SAR Focusing

5) Assume that you are using an ice penetrating radar system with a 1 µs chirped pulse, a 15 MHz bandwidth, a 6 kW peak transmit power, a 6 kHz PRF, and pre-stacking of 32 traces. What new parameter settings would double the SNR relative to thermal receiver noise
   a. By changing the peak transmit power
   b. By changing the pulse length
   c. By changing chirp bandwidth
   d. By changing the pre-Stacking
   e. By using an un-chirped waveform and changing the PRF