QUIZ 3
ECE 816: Spring quarter 2009

An atmospheric layer is modeled as a continuous random medium having an average relative permittivity of unity and a fluctuating index of refraction. The medium is observed by a 10 GHz bistatic radar. The transmit and receive antennas are directed at 6 degrees above the horizon. The continuous random medium theory discussed in Chapter 16 of the text (as covered in class) is to be used in this problem. The waves are polarized such that $\sin\chi = 1$.

a) Find the Bragg wavenumber k_s.

Angle between the direction of incidence $(\hat{i})$ and observation $(\hat{O}) = \theta_s = 12°$. Hence, $\mathbf{k_s = 2k \sin\frac{\theta_s}{2} = 43.78\ rads}$

b) Assume the index of refraction variations have a Gaussian correlation function with a correlation length of 0.1 m. The radar measures an RCS per unit volume $\sigma = 10^{-3}$ m^{-1}. Determine the variance of the index of refraction that corresponds to this RCS per unit volume.

For a Gaussian correlation function $\Psi_n(k_s) = \frac{\langle n_1^2\rangle l^3}{8\pi\sqrt{\pi}} \exp\left(-\frac{k_s^2 l^2}{4}\right)$

From a given RCS per unit volume we have

$$\sigma = 2\pi k^4 (\sin^2\chi)\Psi_n(k_s) = 10^{-3}$$

Solve for $\langle n_1^2\rangle$, the variance is 4.45×10^{-7}