Reynolds number

$$Re = \frac{Vl}{\nu}$$

$V = 10mph \approx 4.47m/s$ (daily average mean per - https://weatherspark.com/averages/31809/Tucson-Arizona-United-States)

$l = 1m$

$\nu = 16 \times 10^{-6} m^2/s$

$$Re = \frac{Vl}{\nu} = 2.8 \times 10^5$$

Fried length (lecture 10 slide 12)

$$r_0(\lambda) = r(500nm) \times \left(\frac{\lambda}{500nm}\right)^{6/5}$$

$$r_0(1550nm) = r(500nm) \times \left(\frac{1550nm}{500nm}\right)^{\frac{6}{5}} = 0.583m$$

And (lecture 10 slide 3)

$$r_0 = 3.18 l_0$$

$$l_0 = \frac{0.583m}{3.18} = 0.183m$$

Index Structure Constant (Reference Field Guide to Atmospheric Optics pg. 11)

$$C_n^2 = 10^{-13} m^{-2/3}$$

Index Structure Function (value for $L_0$ estimate from Field Guide to Atmospheric Optics pgs. 10-13)

$$D_n(r) = C_n^2 r^{2/3} \qquad l_0 \ll r \ll L_0 \quad \rightarrow \quad 0.183m \ll r \ll 10m$$

$$r \approx 1m$$

$$D_n(r) = \left(10^{-13} m^{-2/3}\right)(1m)^{2/3} = 4.64 \times 10^8$$

Velocity Structure Function (Reference Field Guide to Atmospheric Optics pg. 8)

$$D_v(r) = C_v^2 r^{2/3} \qquad l_0 \ll r \ll L_0 \quad \rightarrow \quad 0.183m \ll r \ll 10m$$

$$r \approx 1m$$

$$C_v^2 = 2\epsilon^{2/3}$$

The value for $\epsilon$ is found (Reference Field Guide to Atmospheric Optics pg. 8, "Inner Scale" section)

$$l_0 = \left(\frac{\nu^3}{\epsilon}\right)^{1/4} \quad \rightarrow \quad \epsilon = \frac{\nu^3}{l_0^4} = \frac{(16 \times 10^{-6} m^2/s)^3}{(0.183m)^4} = 3.65 \times 10^{-12} m^2/s^3$$

Then

$$C_v^2 = 2(3.65 \times 10^{-12} m^2/s^3)^{2/3} = 3.8 \times 10^{-8} m^{4/3}/s^2$$

And

$$D_v(r) = \left(3.8 \times 10^{-8} m^{4/3}/s^2\right)(1m)^{2/3} = 3.8 \times 10^{-8} m^2/s^2$$

Phase Structure Function(lecture 7 slide 17)

$$D_\phi(r) = 6.88(r/r_0)^{5/3}$$

$$D_\phi(r) = 6.88\left(\frac{1m}{0.583m}\right)^{5/3} = 16.91$$

Isoplanatic Angle

$$\theta_0 = r_0/z$$

If we let $z = 51km$ to simulate mountain top to mountain top….

$$\theta_0 = \frac{0.583m}{51000m} = 11.43 \times 10^{-6} rads \approx 2.36\ arcsec$$

Scattering Angle

$$\theta_s = \frac{\lambda}{r_0} = \frac{1550nm}{0.583m} = 2.66 \times 10^{-6} rad \approx 0.55\ arcsec$$

Coherence Time

$$\tau_0 = \frac{0.314 r_0}{v} = \frac{0.314(0.583m)}{4.47m/s} = 0.041s$$

Greenwood Frequency(for later in the project)

$$f_g = \frac{1}{\tau_0} = 3.18\frac{v}{r_0} = 24.42Hz$$

Characteristic Functions

$$T_{char}$$

$$V_{char}$$

$$L_{char}$$

I'm ignoring these now unless we find some relevant use for them – they don't seem to be important, and only served as a rigorous definition for their corresponding structure functions. Let me know what you think.