Mie codes and their input / output

- Publicly available Mie codes:
  - http://www.giss.nasa.gov/staff/mmishchenko/t_matrix.html (f77)
  - http://www.scattport.org/index.php/light-scattering-software/mie-type-codes (Fortran, Python, Matlab, C++, …)
  - BHMIE – written by Born & Huffman, modified by Draine @ Princeton

- Typical inputs: wavelength, radius of the sphere, complex refractive index

- Example outputs: phase matrix elements, ϖ, g, coefficients of the scattered field (a,b)

Effective Radius & Variance

$$\langle r \rangle = \frac{\int_0^\infty r\, n(r)\, dr}{\int_0^\infty n(r)\, dr}$$

Mean particle radius – doesn't have much physical relevance for radiative effects

$$r_{eff} = \frac{\int_0^\infty \pi r^3\, n(r)\, dr}{\int_0^\infty \pi r^2\, n(r)\, dr}$$

For large range of particle sizes, light scattering goes like πr^2. Defines an "effective radius"

$$\nu_{eff} = \frac{\int_0^\infty (r - r_{eff})^2\, \pi r^2\, n(r)\, dr}{r_{eff}^2 \int_0^\infty \pi r^2\, n(r)\, dr}$$

"Effective variance"

$n(r) = const\ \mathrm{r}^{\frac{1-3b}{b}}\, e^{-\frac{r}{ab}}$ Modified Gamma distribution

a = effective radius

b = effective variance

Common Particle Size Distributions

Extinctions, absorptions and scatterings by all particles simply add- volume coefficents

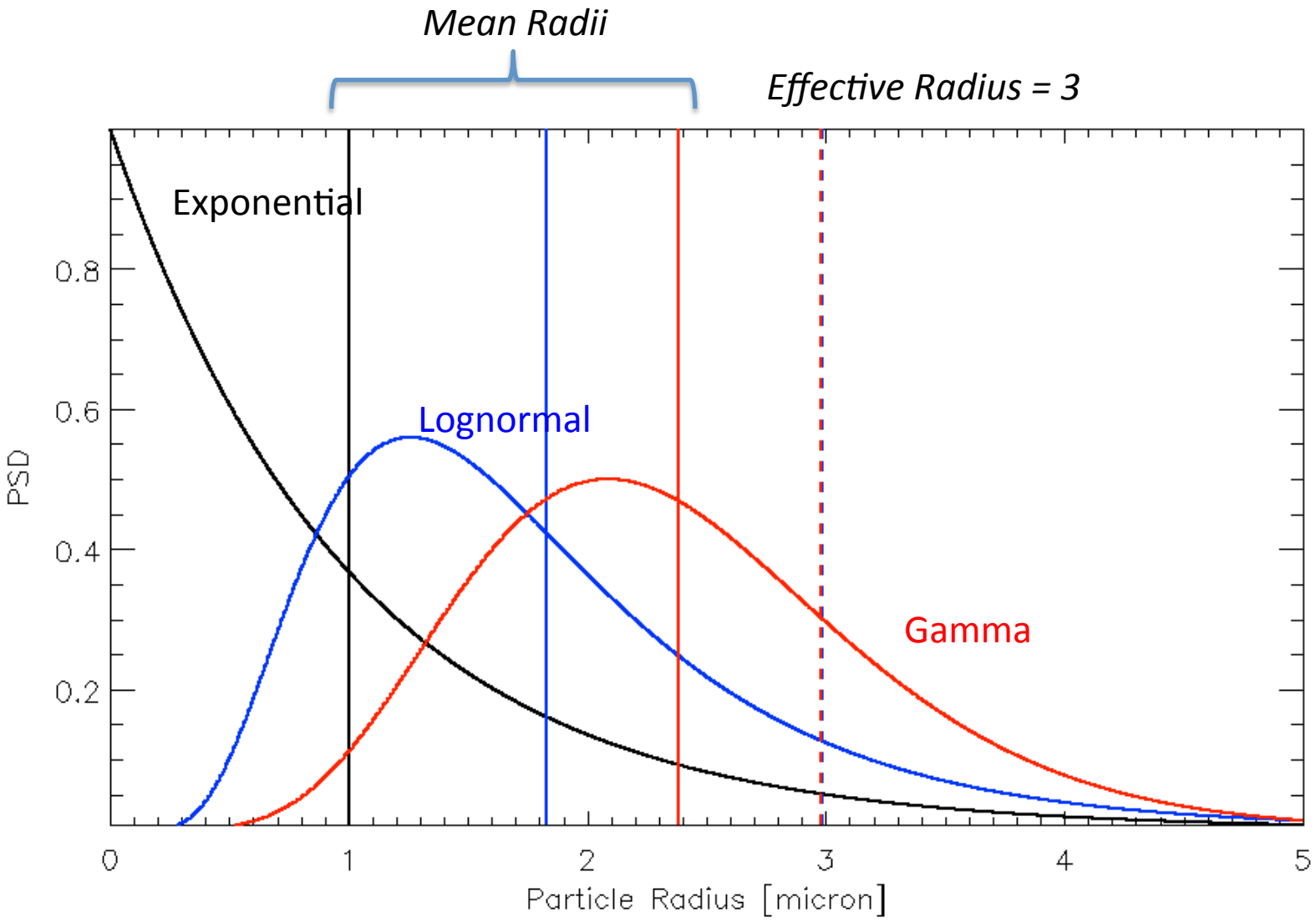
$$\beta_{e,a,s}(\lambda) = \int_0^\infty n(r)\pi r^2 Q_{e,a,s}(r,\lambda)dr$$

n(r)= the particle size distribution
particles per unit volume
per unit size

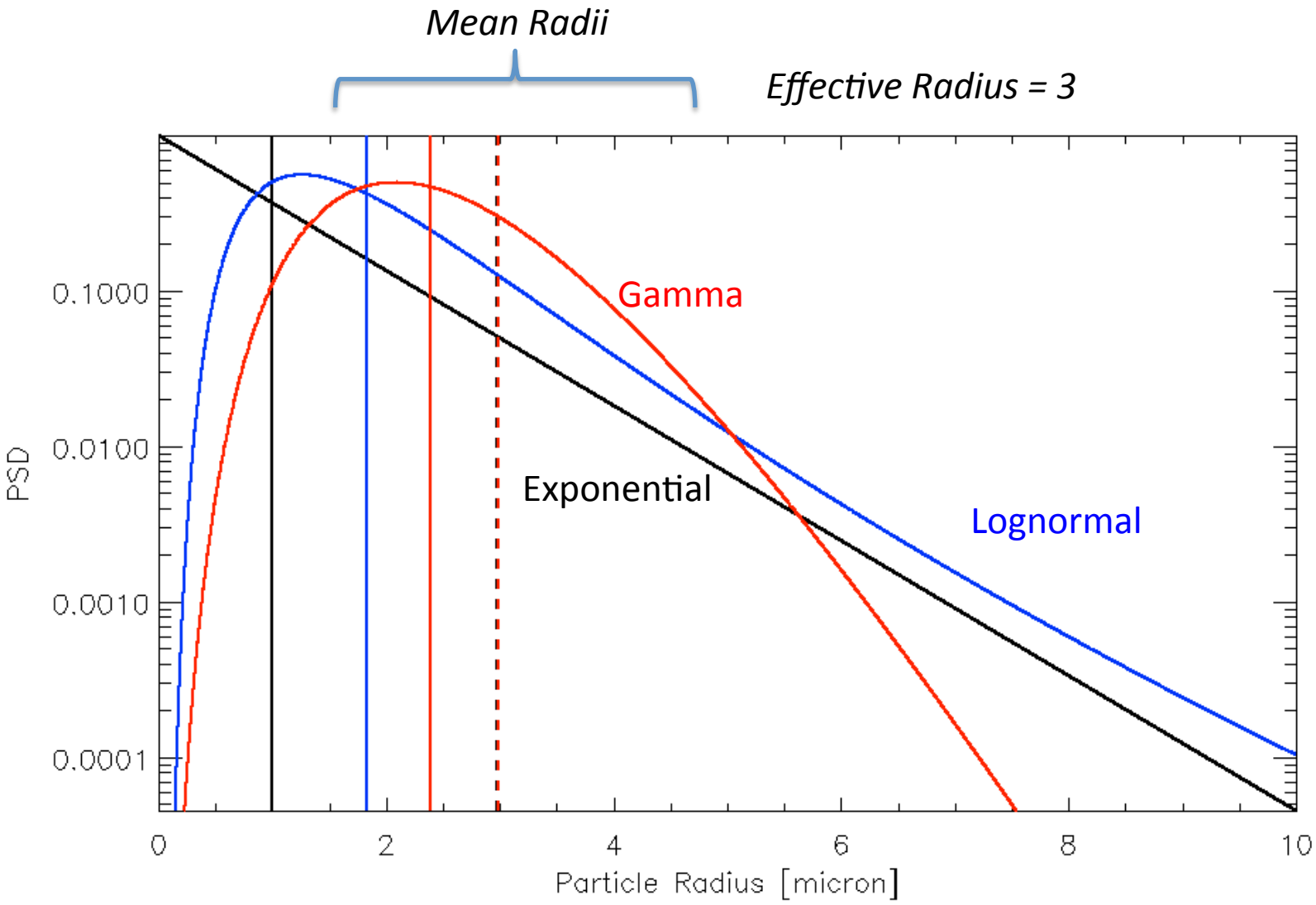
$$n(r) = \frac{N}{r_m} e^{-r/r_m}$$ Exponential distribution (rain)

$$n(r) = const\ \mathrm{r}^{\frac{1-3v_e}{v_e}} e^{-\frac{r}{r_e v_e}} = const\ \mathrm{r}^{\mu} e^{-\Lambda r}$$ Gamma distribution (clouds)

$$n(r) = \frac{N}{r\sigma\sqrt{2\pi}} \exp\left(-\frac{(\ln r - \mu)^2}{2\sigma^2}\right)$$ Lognormal distribution (aerosols, sometimes clouds)

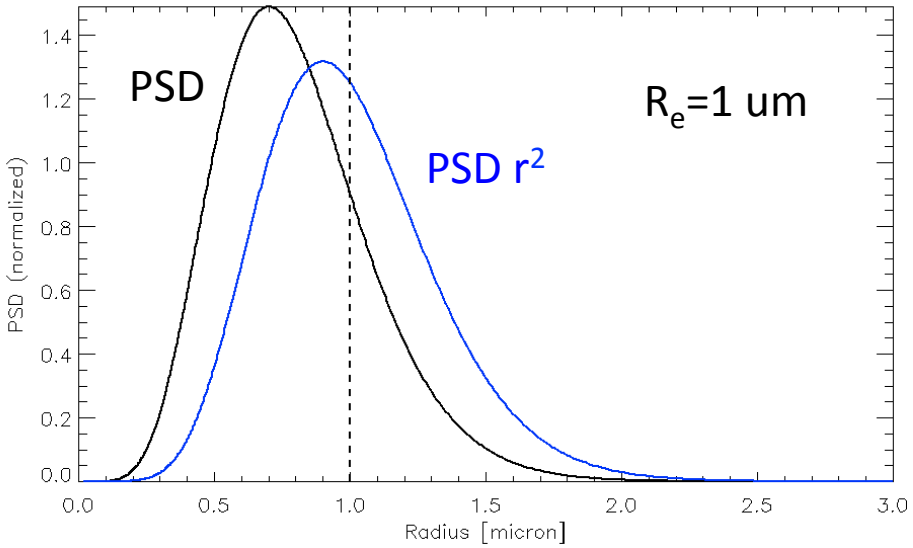


All PSDs are normalized (same area under curves)



- Lognormal & Exponential have long tails!
- (this is why their means are lower)

Effect on Phase Functions



- Smooths out wiggles
- Forward scattering peak slightly bigger!