components, increasing the accuracy of the model fit to the coefficients, or fitting to a smaller range of optical properties. That said, the error for the model applied to biologically relevant optical properties ($g{\geq}0.6$ and $1{<}m{<}2$) was less than 1%. The same procedure that was presented here can be used for modeling other ranges of g and m in order to obtain improved accuracy.

As mentioned in section 3, absorption is not included in the models described in this manuscript. However, in biological tissue, absorption varies dramatically with wavelength and is typically small for $\lambda{>}600$nm. Therefore, the technique described here can be utilized to measure scattering properties in the non-absorbing wavelength regions. Absorption can then be characterized by understanding the path length distribution for varying optical properties and measuring the backscattering for varying wavelengths. From Fig. 7, we can conclude that absorption primarily alters the intensity of backscattering at larger radial distances and has a minimal effect at $r \ll l_a$. This is due to shorter path lengths at smaller radial distances resulting in less attenuation of the scattered rays (The Beer-Lambert law). In cases where absorption cannot be neglected, a traditional diffusion approximation model of absorption in order to quantify the backscattering contribution can be used. In this case, the isotropic scattering portion [$P_{g\ =\ 0}$ from Eq. (7) to (9)] can be modeled with standard diffusion approximation equations for reflectance [18,19].

In conclusion, the models presented in this work allow for accurate prediction of the impulse response function, *P(r)*, to a random medium with a tissue-relevant range of optical properties and without the need for performing a large number of Monte Carlo simulations. Only three simulations are required including a simulation for isotropic scattering and two simulations for anisotropic scattering ($g = 0.9$ with *m* of 1.5 and 1.01). A Henyey-Greenstein based *P(r)* model is simpler in that it only requires two Monte Carlo simulations; however, it may not be as comprehensive of a model for tissue characterization. Finally, we presented a methodology for obtaining phantoms that have the potential to closely mimic optical properties of tissue, including the backscattering at small length-scales. The ability to predict the backscattering distribution at subdiffusion length scales holds promise for using techniques such as LEBS to measure optical properties of tissue (such as *g*, *m* and *ls**) by measuring *P(r)*. These results may also allow for faster, simpler and more accurate solutions to the inverse problem of measuring optical properties from tissue by providing an alternative for existing inverse Monte Carlo methods [5,6,11,22,23]. The three simulation and coefficient equations necessary for predicting P(r) will be made available online for public use. Furthermore, there are currently no existing empirical or theoretical models that allow for the prediction of the backscattered light at subdiffusion length scales without the need for performing repetitive and time intensive Monte Carlo simulations. The high degree of accuracy of the presented models and experimental illustration of a *P(r)* measurement from the Whittle-Matérn phase function at *r<ls** indicate that the presented models and experimental phantom will be useful for characterizing the optical properties of biological samples.