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# Representation of the photon pathlength distribution in a cloudy atmosphere using finite elements

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A new method to derive the photon pathlength probability density function with respect to the photons geometrical path (PDF-GP) is proposed in this paper. This method is based on a finite elements fit of the true PDF-GP using a step function with equidistant intervals. The new method is evaluated based on reference PDF-GPs derived via Monte-Carlo radiative transfer simulations for different single and multilayer clouds with and without surface albedo. The finite elements method was found to perform better than classical Laplace inversion techniques. For the case of two-layer clouds with a thin cirrus cloud (optical thickness 0.5) above a low level cloud it is shown that the finite elements method is able to separate the contribution of both cloud layers to the total radiance and, in principle, allows to simultaneously infer cloud top heights of both cloud layers given that enough independent radiance observations at different gas absorption optical depths are taken.