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On Linearisation, Importance Sampling and Adaptive Variance Reduction Techniques Applied to Solutions of Fredholm Integral Equations in Atmospheric Optics

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The Monte Carlo method in particle transport simulation stems from the context of nuclear reactor physics and was ported to atmospheric optics by G.I. Marchuk in the early 1980s. In comparison with analytical methods, the Monte Carlo method is conceptually simple and is able to describe the underlying physics with arbitrary accuracy.

Radiation transport (RT) in atmospheric optics is described by a Fredholm integral equation of the second kind. In applying the Monte Carlo method to solutions of the RT equation (RTE), sequential importance sampling in combination with the so called local estimate method established itself as the dominant technique. When calculation certain functionals of the RTE the importance sampling technique is applied.

I will show, how importance sampling is used in order to obtain 1st and 2nd derivatives and exact corrections for simulating certain physical details such as the so called vector Ring effect. Furthermore I will give a small outlook how the importance sampling weight fluctuations can be addressed by using a variance reduction technique, the so called weight window method recently developed in nuclear physics.

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