Hybrid Solution Methods for the Radiative Transport Equation

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Optical Tomography based on the Diffusion Approximation (DA) is a well established field of research. Despite the success of the DA in modelling optically thick regions, it is well known that under certain conditions it is no longer valid, in particular, near sources and interfaces, and in low scattering or high absorption regions. Under these circumstances, attention has turned to the more accurate, and computationally more expensive Transport Equation, which in optics is usually referred to as the Radiative Transfer Equation (RTE). A very large body of literature exists for solving this equation with differing computational complexity.

A general method for the RTE involves the representation of the angular variation as well as the spatial variation in terms of an implicit or explicit basis. Full solutions to the transport equation which require a large number of angular basis functions become prohibitively expensive. However, the detailed representation of the angular variation may not be required over the whole domain. In this paper we consider a system where the angular order of basis is adapted, leading to a reduction in the overall system size.

We compare some alternative strategies:

1. a hybrid DA/RTE approach where two different models are explicitly developed and coupled with an interface condition

2. a variable order basis methods where the angular variation is developed in orthogonal basis functions. The coupling of different orders is achieved by truncating the basis expansion at different orders, which imposes a Dirichlet condition on a set of implicit interfaces.

We show results in particular for the parts of domains close to sources, and to non-scattering void regions.