The Quasi-Diffusion method for solving transport problems in planar and spherical geometries

Abstract

- Quasidiffusion is used to solve linear transport problems, and converges rapidly with high accuracy
  - using a transport sweep
  - and a diffusion calculation
- more complex than Source Iteration (SI) method
- pros:
  - good for optically thick problems
  - good for problems with a scattering ratio close to unity
- cons:
  - every scalar flux must be positive at each point in the system
  - formulation of diffusion BCs for optimization not obvious

Introduction

- Quasidiffusion Advantages:
  - allows flexibility in the choices of differencing schemes for transport and diffusion
  - may be effective for multidimensional problems with non rectangular meshes
- Disadvantages:
  - angular flux iterates must be positive at each point in the system
    - otherwise eddington factors can become negative or infinite
      - results in unstable diffusion
  - optimizing diffusion BCs to optimize accuracy and speed of QD not obvious
  - produces two different solutions separated by truncation error
    - (1) scalar flux from the transport calculation
    - (2) scalar flux from diffusion
- Optimization of QD
  - Method that ensures positivity of flux solution
  - new diffusion BCs that lead to more accurate solution algorithms
  - Analytic forms of QD equation are discretized using positive differencing schemes
    - asymptotic exponential decay of discrete solution. = asymptotic exponential decay of the continuous discrete ordinates solution
    - guarantees that angular flux iterate is positive

Discussion

- QD are more rapidly convergent than SI for all meshes.
- No substantial difference in QD and DD-DSA convergence was observed for diffusive problems
- QD was faster than DSA for coarse meshes
  - if DSA used negative flux fixiups
- MQD = diffusion coefficient is modified in QD to exact asymptotic transport eigenvalue is preserved
  - is more accurate than DD for coarse grids