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3D Stochastic Medium Photon Transport using Imp IMC and Maestro

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Objective

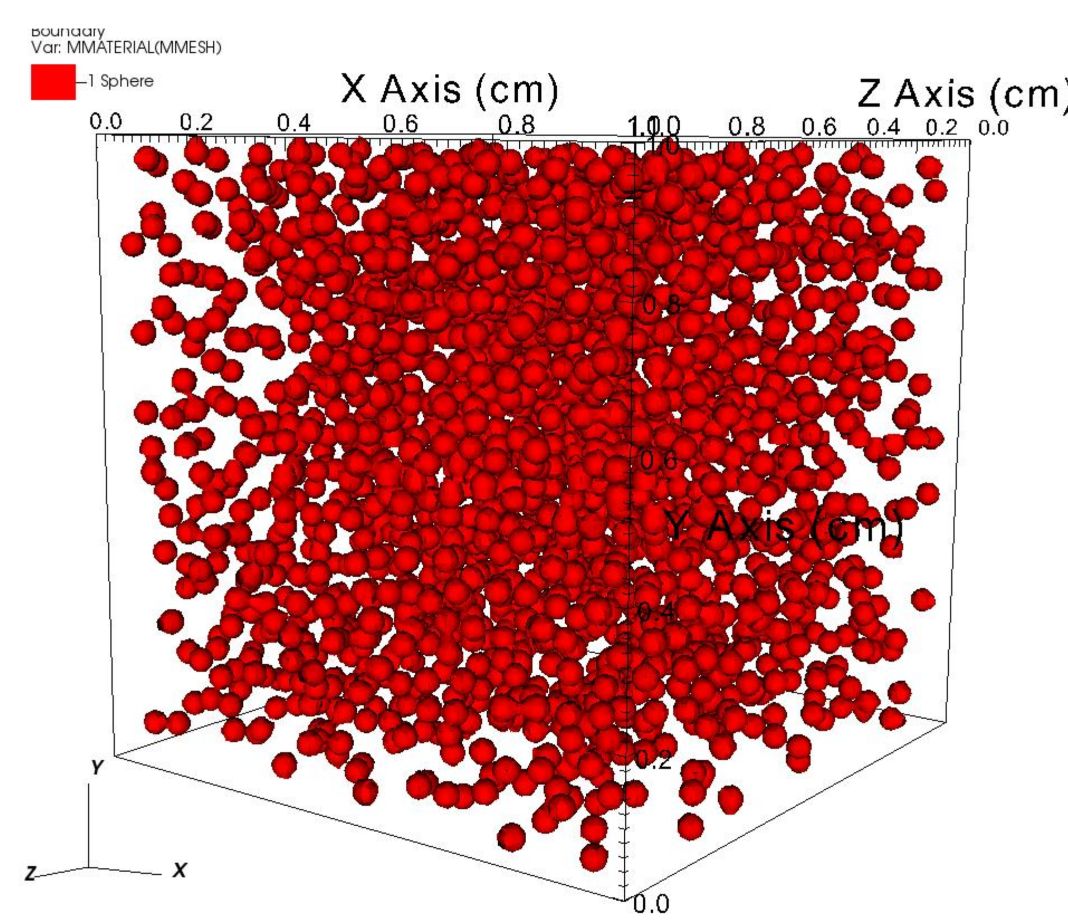
Evaluate the accuracy of approximate methods modeling stochastic medium transport in 3D Monte Carlo simulations of Thermal Radiative Transfer problems.

Background

- Physical systems have stochastic distribution of materials [1]
- The standard approach is atomic mixing:
  - A volume fraction weighted average of material properties
- Another approach is Chord Length Sampling (CLS) [2]:
  - Sample the starting material
  - Sample distance to next material region from an exponential distribution
  - Perform standard Monte Carlo simulation:
    - If a particle crosses a material boundary, switch material properties and sample a new distance to material region
  - Rinse and repeat
- For a fair comparison of methods, we generated benchmark solutions:
  - We sampled a realization of the stochastic medium
  - Conducted the simulation, obtaining the quantity of interest
  - Sampled another realization and repeated until we ran "enough" realizations

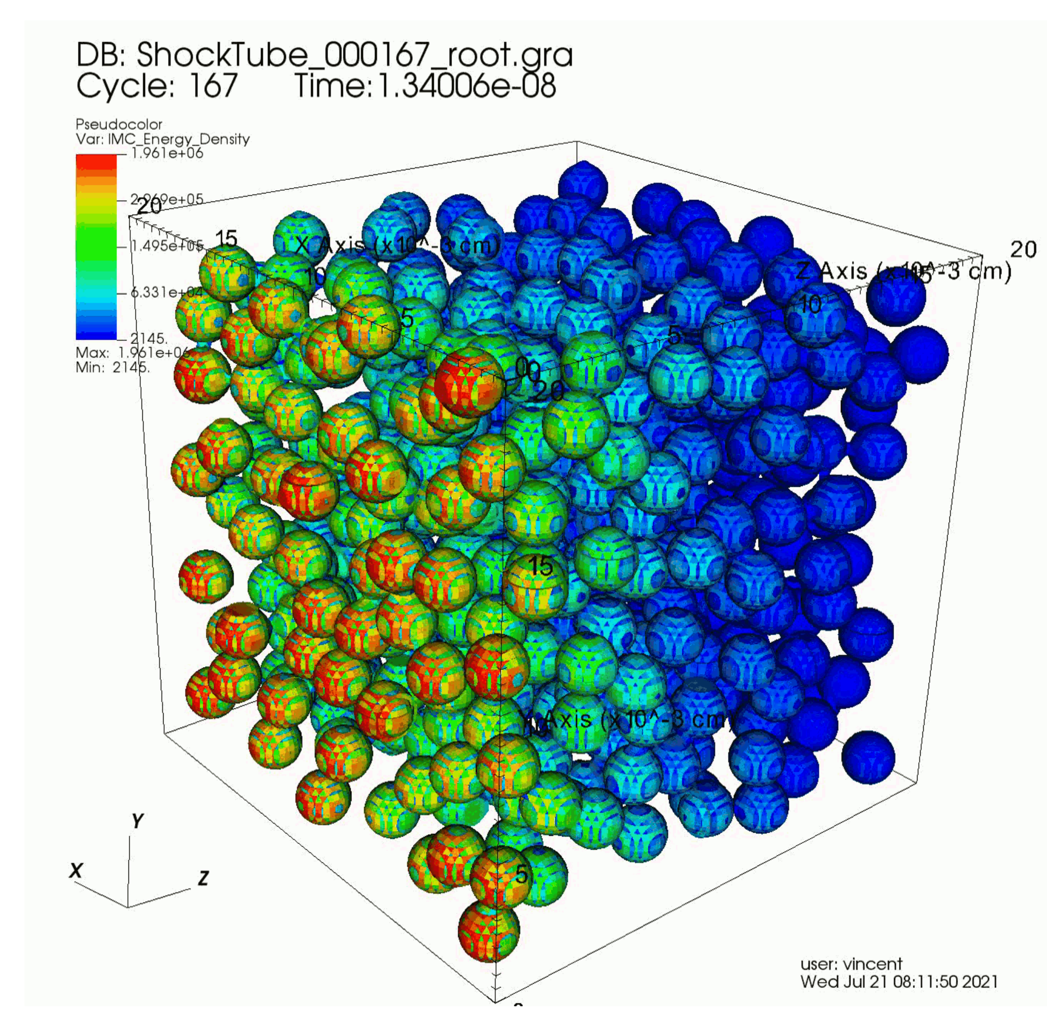
Results

Figure 1



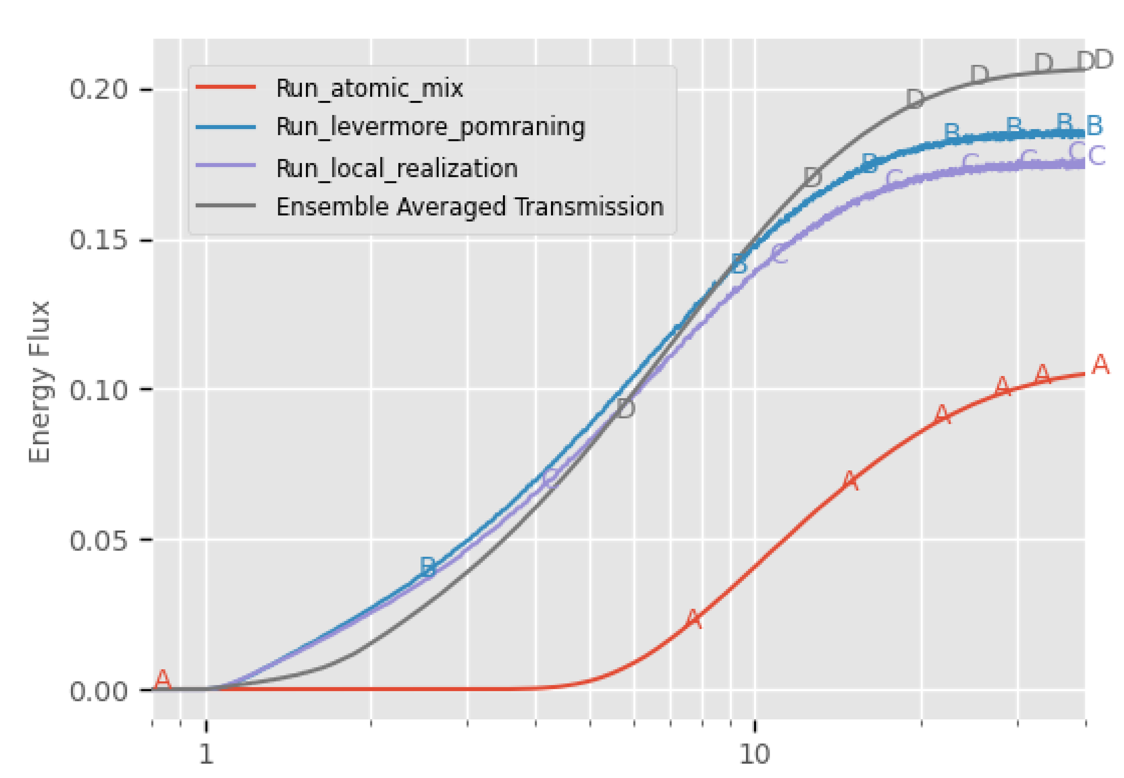
Geometry of the model we are simulating, based on the E3D problem from Olson, 2007 [1]

Figure 2



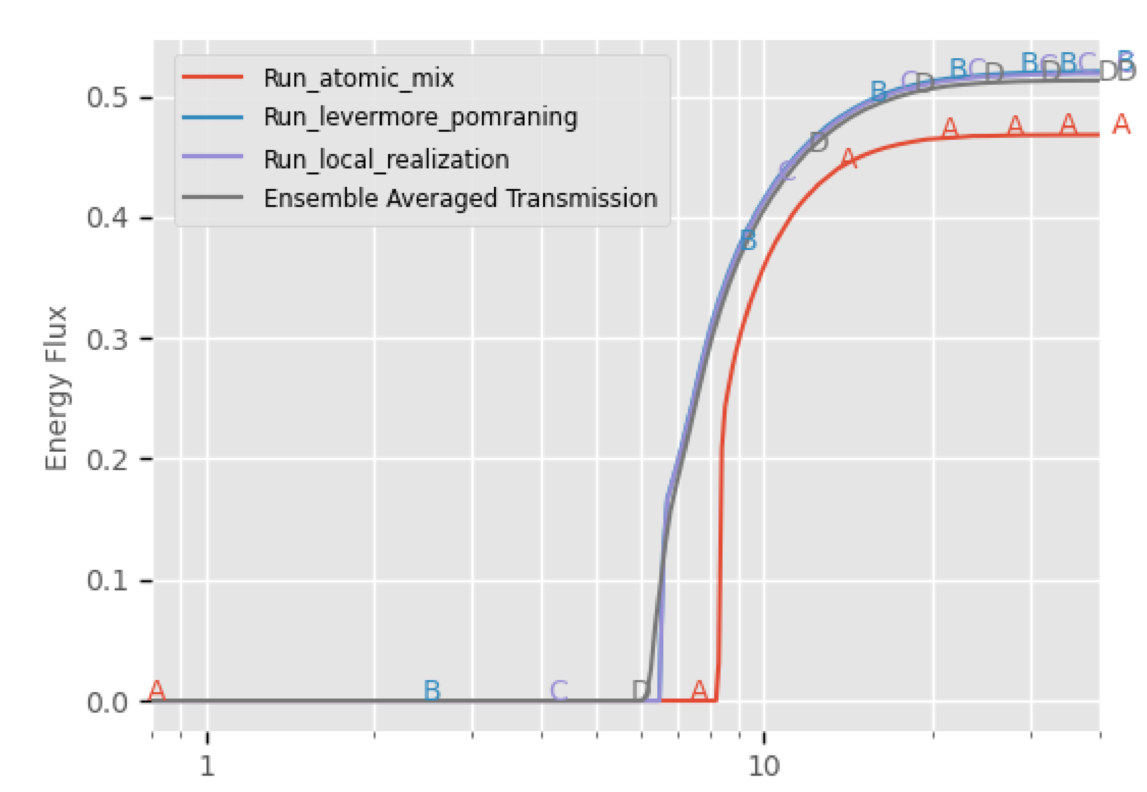
IMC energy density from the Shocktube3D model based on an experiment at NIF

Figure 3



Transmission factor for a constant opacity Marshak model for the equation of state E3D

Figure 4



Transmission factor for a constant specific heat temperature dependent opacity model E3D

Conclusions

CLS methods are able to accurately model 3D stochastic medium photon transport.

Future Work

- Write a conference paper to present these results, obtain feedback from others in the community
- Evaluate the standard deviation of the transmission factor
- Benchmark other quantities of interest

References

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2. G. B. ZIMMERMAN and M. L. ADAMS, "Algorithms for Monte-Carlo Particle Transport in Binary Statistical Mixtures," Trans. Am. Nucl. Soc., 64, 287 (1991).
3. G.L. Olson, "Gray Radiation Transport in Multi-Dimensional Stochastic Binary Media with Material Temperature Coupling," JQSRT, 104, pp. 286-298 (2007).

Acknowledgements

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