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SAND2015-0194C

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Title:

A semi-Lagrangian transport method for kinetic problems: application to dense multi-phase flows

Authors & affiliations:

F. Doisneau[1], M. Arienti[1], J. C. Oefelein[1]*

[1]Combustion Research Facility, Sandia National Laboratories, Livermore, CA 94551

fdoisne@sandia.gov

Abstract: (Your abstract must use **Normal style** and must fit in this box. Your abstract should be no longer than 300 words. The box will 'expand' over 2 pages as you add text/diagrams into it.)

Kinetic problems are ubiquitous in physics and mechanical engineering (stellar nebulae, neutron populations, particle flows, sprays, rarefied gases). In addition to its numerous degrees of freedom, the kinetic equation can be strongly coupled to other systems, which constrains the choice of the resolution method.

As an alternative to Monte-Carlo methods, which are chosen for their ease in describing large phase spaces, Eulerian methods are considered if couplings are strong, e.g. through collisions or transfers to another phase. But both Lagrangian and Eulerian methods have drawbacks. On the one hand, Lagrangian methods are difficult to converge (statistical noise, under-resolved physical correlations) and to parallelize especially if they are two-way coupled to an Eulerian phase. On the other hand, Eulerian methods require a model for the correlations, generate a complex algebra, and require a dedicated transport method.

We therefore introduce a physical space transport method that allows the use of any Lagrangian or Eulerian closures for the phase space. The method is inspired by semi-Lagrangian schemes for Euler equations but it is even more relevant in disperse phase contexts, where pressure is weak or null. It avoids flux computations in the physical space so it is robust. It is deterministic so that it does not require efforts on convergence, noise control or post-processing. All the couplings are done under the form of Eulerian fields, which allows to anticipate the computational load and is efficient as regards parallel computing. Finally the method allows the connexion of any of the above descriptions, so it is possible to adapt the global approach to the problem's needs.

After validating the new transport method, we apply it to the case of a dense multi-phase flow: a fuel spray is computed after atomization in a Diesel engine combustion chamber. The large, parallel, strongly coupled computation proves the efficiency of the method.