Interface-Aware Sub-Scale Dynamics Closure Model

Andrew Barlow[a], Ryan N. Hill[b], Mikhail Shashkov[b,*]

[a] *Computational Physics Group, AWE Aldermaston, Berkshire, RG7 4PR, UK*
[b] *X-Computational Physics, XCP-4, Los Alamos National Laboratory, Los Alamos, NM 87545, USA*

SUMMARY

Closure models are used in multimaterial Lagrangian and arbitrary Lagrangian-Eulerian (ALE) hydrocodes to close the system of equations modeling simulations where more than one material may be present in a computational cell. Such multimaterial cells arise when the flow field is remapped onto a new computational mesh. A Lagrangian calculation involving a multimaterial cell is therefore unavoidable. Within the multimaterial cell, individual material properties are usually maintained, with a closure model defining how these properties evolve over the Lagrangian calculation.

The interface-aware sub-scale dynamics (IASSD) closure model is proposed to accurately deal with the evolution of material parameters. The model assumes knowledge of the multimaterial cell topology to determine the sub-cell interactions between materials. Relative volume exchanges between any two interacting materials in the cell are combined with bulk changes in material volumes (arising from the overall change in the multimaterial cell volume and material volume fractions) to provide updates satisfying positivity and pressure equilibration constraints. Flux corrected transport (FCT) [1] style limiting is employed to optimise the relative volume exchanges.

The IASSD closure model has been implemented in a multimaterial ALE hydrocode [2]. An overview of the implemented scheme is given. Justification of the underlying model is laid out, together with a summary of the overall algorithm. Initial results are presented for one- and two-dimensional test cases featuring two- and multi-material cells. Comparison is made against the equal volumetric strain (constant volume fraction) model and Tipton's [3] pressure relaxation scheme. The numerical results show good behaviour in the evolution of multimaterial cell variables, with final values close to those of the neighbouring pure cells.

REFERENCES

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*Correspondence to: shashkov@lanl.gov