Parallel, grid-adaptive computations

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Abstract

In modern scale-encompassing simulations of space weather events, the large-scale behaviour of the solar/heliospheric/magnetospheric plasma is typically treated by fluid approaches. Even when a magnetohydrodynamic (MHD) view on the dynamics is adopted (e.g., see [1]), the simulations benefit from automated grid-adaptivity or Adaptive Mesh Refinement (AMR), which must be implemented in a highly computationally efficient, parallel manner. I will highlight generic strategies for allowing massively parallel, block-tree adaptive simulations in any dimensionality. We provide implementation details reflecting the underlying data structures as used in the open-source `MPI-AMRVAC` (see [2] and Keppens et al., 2012, Journal of Computational Physics **231**, 718-744). We discuss guidelines for data formats suitable for parallel I/O as well as for refinement strategies, paying attention to cover error estimators in use in many modern AMR frameworks. Example simulations focusing on reconnection events, coronal mass ejections, and sun-earth interactions from the literature are presented and discussed with particular attention to the AMR aspects.

References

[1] J.P. (Hans) Goedbloed, R. Keppens, and S. Poedts, *Advanced magnetohydrodynamics. With applications to laboratory and astrophysical plasmas*, Cambridge University Press, 2010.

[2] `http://homes.esat.kuleuven.be/~keppens`