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A Fully Lagrangian Advection Scheme for Dirichlet Boundary Conditions

A numerical method for passive scalar and self-advection dynamics, *Lagrangian rearrangement*, is proposed. This fully Lagrangian advection algorithm introduces no artificial numerical dissipation or interpolation of parcel values. In the inviscid limit, it preserves the infinity of Casimir invariants associated with parcel rearrangement. In the two-dimensional case presented here, these invariants are arbitrary C^1 functions of the vorticity and concentration fields. The initial parcel centroids are evolved in a Lagrangian frame, using the method of characteristics. At any time this Lagrangian solution may be viewed by projecting it onto an Eulerian grid using a rearrangement map. The resulting rearrangement of initial parcel values is accomplished with a weighted Bresenham algorithm, which identifies quasi-optimal, distributed paths along which chains of parcels are pushed to fill in nearby empty cells. The error introduced by this rearrangement does not propagate to future time steps.

For simplicity, the Lagrangian rearrangement algorithm was initially developed for periodic boundary conditions. In this work we discuss the extension of the method to Dirichlet boundary conditions.