An Adaptive Mass Conservative Multi-tracer Efficient Semi-Lagrangian Advection Scheme

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Abstract: Advection is a dominant process in atmospheric and oceanic dynamics. Adaptive mesh refinement (AMR) is a promising approach for accuracy improvement without the need to uniformly refine the whole domain. We present a novel 2-D adaptive mass conservative multi-tracer-efficient semi-Lagrangian scheme. Our method is based on the flux-form semi-Lagrangian scheme in ECHAM [3]. The goal is to implement AMR only in tracer transport and modify coarse resolution results based on AMR results such that we do not need to change other formulations in ECHAM.

The AMR uniformly divides a cell into four sub-cells and doubles the resolution. To organize the mesh on different refinement level on rectangular grid, a hash table is used [2]. This data structure needs fewer memory and is easier to manage than the widely used tree structure [1].

We will demonstrate how to alleviate problems that arise from hanging nodes by a mixture of 1-D and 2-D schemes. Multi-tracer efficiency is achieved because the same departure position can be used for all tracers in the same time step. Due to the complexity and efficiency needs in climate models, simple mesh refinement criteria are applied and results are shown from several test cases.

References

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