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Geosci. Model Dev., 7, 2951-2968, 2014
www.geosci-model-dev.net/7/2951/2014/
doi:10.5194/gmd-7-2951-2014

A Lagrangian advection scheme with shape matrix (LASM) for solving advection problems

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Abstract. A new Lagrangian advection scheme with shape matrix (LASM) is proposed to take advantage of the extreme low numerical diffusion of the Lagrangian methods. The tracer is discretized into finite parcels, which move along the downstream trajectories. Different from other Lagrangian schemes, the parcel shape is simulated explicitly by a linear transformation matrix. By doing so, the aliasing error in the Lagrangian schemes is largely reduced without introducing substantial interparcel mixing in the pure advection stage, because the flow information will be respected when remapping tracer density onto the fixed model grids. An adaptive interparcel mixing algorithm is constructed to ensure the validity of the linear approximation of the parcel shape, where the mixing is only triggered when it is necessary and resembles the physical mixing. The total tracer mass on the parcels is conserved exactly. The new scheme is validated by using several test cases.

Citation: Dong, L., Wang, B., and Liu, L.: A Lagrangian advection scheme with shape matrix (LASM) for solving advection problems, Geosci. Model Dev., 7, 2951-2968, doi:10.5194/gmd-7-2951-2014, 2014.

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Published on 29 Jul 2014

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