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Discussions

Interactive comment on "A new multiscale air quality transport model (Fluidity, 4.1.9) using fully unstructured anisotropic adaptive mesh technology" *by* J. Zheng et al.

Anonymous Referee #1

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review of manuscript "A new multiscale air quality transport model using fully unstructured..." by Zheng et al.

Summary: the authors present details of an adaptive grid-resolution approach to solving the classic tracer advection problem whereby locally movable higher resolution grids are employed in areas of tracer distribution where steep gradients and small features are better simulated with finer resolution. Overall the paper is sound and presents promising results. I suggest a couple minor comments related to the tests presented, and all the tests should be repeated using a nonzero (preferably a negative) background rather than zero background, since there is nothing special about zero, but many algorithms assign inappropriate significance to zero. Positive-definite

schemes are not necessarily useful with tracers with large backgrounds are present, and the value of this scheme increases if it can be shown to advect negative tracers. Please redo the 3rd test with a negative background.

Other minor points would improve the manuscript 1) In Eq (6) the "sup" operator is used. I am not familiar with this nomenclature. The authors should briefly qualitatively explain this operator and maybe provide a reference

2) at line 220 the authors note that computation efficiency is obtained by reducing the number of grid cells. However, this reduction is very dependent on the nature of the scalar fields being advected. For many air pollution scenarios, tracer fields can be very noisy with multiple point sources and advection feature, and it is possible that this adaptive grid will use considerably greater grids than a fixed grid approach. For example, in Fig. 1 if another tracer blob were added to the tracer field, or of one of the three shapes were removed, the number of grid cells would change dramatically.

3) At line 270 the authors describe the Staniforth swirling test. This is an interesting test where the advected tracer distribution becomes sheared into smaller and smaller swirls that become infinitesimally small as time progresses, and this raises an interesting question about comparing the "exact" solution with numerical approximations. As time goes to infinity, Walcek & Aleksic (their fig 13) show that the tracer distribution turns into an essentially unchanging button/pillow-like appearance. This "pillow" appearance might in fact be an EXACT solution, AT THE RESOLUTION OF THE NUMERICAL SIMULATION. When comparing their algorithm with fixed-grid modeling domain, the authors should average the "exact" solution over the identical averaging volumes used in the fixed or adaptive grid models. Even here, the adaptive grid should be averaged onto the same fixed grid and then compared. I think it unfair to compare simulations at different resolutions.

4) at line 300 the authors state that the regular grid contains 40000 grid cells. This simulation domain consists of a grid of 4x4 (16) swirling vortex circulations that are

materially isolated from one another. The initial tracer is spread over only six of those vortices, and all tracer mass remains within those six swirling cells. Therefore the regular grid really only needs 6/16 (or 3/8ths) of the 40000 cells to simulate this tracer evolution with time or 15000 cells. This is the true number of cells required for any non-adaptive grid. The authors should reduce the domain size for this test to be restricted to the six cells containing tracer mass. All of the remaining domain is only advecting a constant. Either reproduce this test using the reduced domain, or change the reference from 40000 cells to 15000 cells.

5) Again for the Staniforth test: Fig. 15 shows that the adaptive grid method is using considerably greater number of grid cells than the 15000 cells required (not 40000, see note above) by the fixed grid beyond a critical time, and this might even be a problem for this method. I assume the authors utilize some method for stopping grids from becoming infinitesimally small? Please explain how to stop this grid-adaptive method from going too small in size.

Interactive comment on Geosci. Model Dev. Discuss., 8, 4337, 2015.