Kelvin-Helmholtz Instability
Time development of an inviscid shear layer, as it first wobbles then rolls up into a discrete vortex.
Corresponds to Kelvin-Helmholtz Instability example in paper AIAA-2014-2780, "Using Multi-Dimensional Linear Discretization Over Unsteady Convection Adapted Control Volumes", by Joan G. Moore and John Moore.

750 time step run of example (t=0 to 50) (CPU 42 minutes)

Unix instructions to run the example
Bring up a terminal window and cd to kh2d.example then
mkdir out
mkdir out/plotcc
mkdir out/plotcv
mkdir out/plotvort
../../a.m4d < in.kh2d.2steptest > out/print   to run just a 2 timestep test of the input
../../a.m4d < in.kh2d > out/print   to run the full calculation

Input/Output
The primary input file - in.kh2d, uses several other input files for specific tasks.
inn.grid7x7by.1 - set up a grid covering 0 to 7 in x and -3.5 to 3.5 in y with 0.1 spacing using the master geometry, geom.cartesian, set up for block pressure solution, then calculate other geometric arrays.
inn.init.kh2d.disturb - set the density(=1). Initialize the velocity as a tanh profile plus a small disturbance. Initialize pressure(=0) and the concentration equal to the vorticity of the initial velocity profile (undisturbed). Set parameters ITER and TIME.
inn.plotall.bars - plot initial concentration, vorticity (from velocity gradients) and control volumes together with the corresponding color bars. Gives out/plotcc/cc0.gif, out/plotvort/vort0.gif, out/plotcv/fgdv0.gif, and the corresponding color bars, out/barcc.gif, out/barvort.gif and out/barcv.gif. Uses inn.plotcc, inn.plotzvort and inn.plotcv.
inn.plotcc - plot the current concentration, cc, as color fill. 5 lines of velocity vectors are also included. (Results in dir. out/plotcc/)
inn.plotzvort - plot the current vorticity calculated from the velocity gradients

as color fill. The grid and 5 lines of velocity vectors are also included. (Results in dir. out/plotvort) Note since vorticity is a between-the-points variable it is plotted as uniform between the grid lines. The concentration cc is an on-the-points variable so linear interpolation is used when it is plotted.
inn.plotcv - plot the control volumes (in blue) for the central portion of the grid where the vortex forms. Also on the plot, cc as color fill, the grid (magenta) and velocity vectors (black). (Results in dir. out/plotcv)
inn.step.inv2d - take 1 time step using inn.subiter.inv2d for the (iterative) procedure to calculate velocity and pressure, then solve the conserved species equation for cc, dump convergence info to file out/converge, and use inn.dump and inn.plot for dumping arrays and making plots.
inn.subiter.inv2d - do 1 iteration for the down-time velocity and mean pressure for the time step. Dumps per-iteration convergence info to file out/converge.
inn.dump - dump current results to out/u#ITER
inn.plot - plot current concentration (inn.plotcc), vorticity (inn.plotzvort), control volumes (inn.plotcv) and convergence (inn.plotconv).
inn.plotconv - gives lineplot file out/convline. Then plots conv.gif which shows as a function of time, the maximum value of U2 (y-velocity), the maximum change in U2 over each timestep, and the estimated error in the maximum change in U2 over each timestep.

Compare results with those obtained by jgm.

Post-processing of output by jgm

mv out out.jgm. Delete plot files except those at ITERs: 0, 100, 200, 300, 400, 500, 600, 750. Delete dump files (u2, etc) except those at ITERs 200, 400, and 750. Rename file converge to converge.reduced and remove all but the first and last timesteps. (The file convline is complete.) Space for results reduced from 15.4Mb to 3.2Mb.

Suggestions for variations to try

Run the calculation with no initial disturbance added to the tanh profile for the velocity. (Set distmag in file in.kh2d to 0.) But before doing so, look at paper AIAA-2014-2780 and make an estimate of the time it will take (and therefore the number of timesteps) to increase the disturbance from roundoff errors, about 1.e-13, to 0.0001 (the current initial disturbance magnitude). Note that with no set initial disturbance, the vortex may form anywhere, depending on the roundoff errors.