Subject: Notes from Today's Class
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To: Ed Waddington <edw@uw.edu>

Hi Ed,

Here are my notes from today:

Prepare some points on validation/verification for Weds class.

We then continued looking at Firedrake. We picked up by looking at how the discontinuous Galerkin method (DG) handles advection. Dan mentioned how the method is somewhat similar to the finite volume method.

After some introduction about how the method can be implemented (you can use upwinding or other techniques that work in finite volumes) and setting up the initial conditions, velocity field etc. we calculated the variable for a test function.

We use a condition to make sure that our timestep is small enough that the signal does not move through a single grid space in the time of one timestep.

The solution is OK, but we can improve it. Next, we looked at higher order functions to see if we can get a better solution.

But, this requires us to incorporate a 'cell flux' due to the interior of the cell.

Also now that the cells are more complex we need to take even smaller timesteps to not have the solution explode.

The solution is now better... but there is now an undershoot in some areas (the values went negative even though everything was positive beforehand). So this could produce unphysical results based on what the problem is that you are solving for.

Next we looked at how FireDrake can address nonlinear problems.

For this problem, we set up a problem with a nonlinear diffusion based on the slope of the solution and a similar linear diffusion solution. We set these up however, so that if the nonlinear one is working they will produce visibly different results.

To solve this we will use Newton line search to handle the nonlinear term.

Best,

Erich