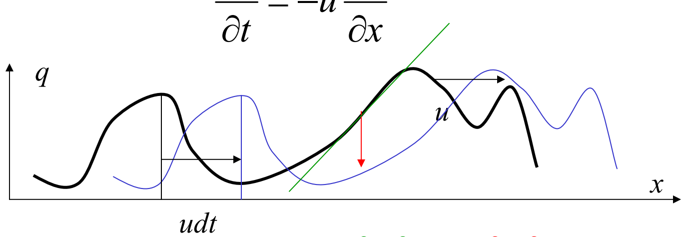
One-dimensional advection

Advection – physical interpretation

$$\frac{\partial q}{\partial t} = -u \frac{\partial q}{\partial x}$$



∂q/∂x > 0; ∂q/∂t < 0

Advection describes the transport of a quantity into parcel/region of air fixed in place.
i.e., a translation of the pattern (surface),
no modification following the motion

Total derivatives for Lagrangian view (following the motion)
Partial derivatives give Eularian view (fixed in space)

Today's assignment

Construct a finite difference model to test the dependence on the model accuracy on the details of the scheme. Test sensitivity of the model results to:

1. the Courant number (each of u, Δx, and Δt)
2. strength of time filter (zero is a good starting place)
3. different shaped initial distributions of *q*

$$\frac{\partial q}{\partial t} = -u\frac{\partial q}{\partial x}$$

$$q_i^{n+1} = q_i^{n-1} - 2u_i\Delta t\left(\frac{q_{i+1}^n - q_{i-1}^n}{2\Delta x}\right)$$

Consider difference between ***stability*** and ***accuracy***.

Things to consider in building model

- What type of finite difference scheme?
- What are the boundary conditions?
- What output do you need?
- How can you measure errors?
- What is "truth"?

What are 6 ways to double check the code!

Tasks

Code tasks:

- Write a subroutine to compute the tendency
- Write a subroutine to do the time stepping
- Output simulation results ("state") only at some fraction of time steps, and plot with IDL
- Output error diagnostics, and plot with IDL

Science tasks:

- Does the scheme conserve "mass"?
- Does the scheme conserve variance?
- What is the critical Courant number stability (try with/without a time filter)?
- Is the forward time difference truly unstable (as predicted)?