**AGRON 590**

**Fall 2014**

**Homework 2: Time differencing**

**Due Thursday, September 23**

In class we worked with the equations for inertial circulation, i.e.,

$$\frac{\partial u}{\partial t} = fv$$

$$\frac{\partial v}{\partial t} = -fu$$

We first looked at forward (Euler) time differencing:

$$u(t+\Delta t) = u(t) + \Delta t f v(t)$$

$$v(t+\Delta t) = v(t) - \Delta t f u(t)$$

We found that this method is unconditionally unstable.

Now try a variant which could be considered a "semi-implicit" approach:

$$u(t+\Delta t) = u(t) + \Delta t f v(t)$$

$$v(t+\Delta t) = v(t) - \Delta t f u(t+\Delta t)$$

Your assignment is to solve this system numerically using any computational platform you like (a Fortran program, Microsoft Excel, or other platform). In memory of Carl-Gustav Rossby we will assume the latitude corresponds to Stockholm, Sweden.

1. Solve for a period of one calendar day. Use a time step $\Delta t = 600$ seconds (10 minutes). Plot the evolution of your results and describe how the system evolves.

2. Is this method numerically stable, or unstable? Explain. If it is stable, what is the largest $\Delta t$ you can use before the solution becomes unstable? If it is unstable, can you make it stable by reducing the time step? Answer these questions by testing with different time steps.