EP711: COMPUTATIONAL ATMOSPHERIC DYNAMICS EP711

Spring 2012, J. B. Snively

ERAU Daytona Beach Campus
Homework Assignment Project #2

For this assignment... Solve a system of two PDEs which together describe *linear* acoustic waves. In addition, provide a derivation of the acoustic wave equation in one-dimension, so that numerical solutions can be compared with analytical solutions.

1) As a starting point for your numerical solution, utilize the provided MATLAB example codes which describe advection and wave equation solutions via Lax and Lax-Wendroff schemes.

2) Construct a solution for a horizontally-propagating acoustic wave packet under typical ambient conditions at sea level. Assume that the environment is homogeneous, and neglect the effects of gravity.

Your code should be *flexible* so that you may specify the size of the domain, its resolution, and a desired Courant number which will then determine the required time step.

3) For the Lax method, analytically evaluate the von Neumann stability of the *system* of difference equations that you have solved, to confirm that the system is stable for CFL numbers ≤1, where the characteristic velocity is the speed of sound c_s. *Hint: Compare with Potter's stability analysis for a simple EM wave propagating in one dimension*.

4) Perform the following test runs:

- **a.** Simulate a 60Hz wave which is continuous throughout the spatial domain, with 10 wavelengths. Confirm that the wave can propagate in either direction if correctly specified via initial conditions.
- **b.** Simulate a 60Hz wave which is confined in a Gaussian packet (you may use the one in the example code) initially in the middle of the domain. Confirm that the wave can propagate in either direction if correctly specified via initial conditions.
- **c.** Simulate an initial Gaussian pressure pulse situated in the middle of the domain.
- **d.** Simulate an initial triangular pressure pulse situated in the middle of the domain, where the triangular pulse is ~1/5th the spatial scale of the domain.

For each case: Plot on the same axes the Lax, Lax-Wendroff, and analytical solutions after the wave has propagated fully through the domain 5 times for CFL=1 and two other CFL numbers which you find physically (or computationally) interesting.