

12.804 — Waves on a PV Front — Numerical Model

Purpose:

Study the properties of waves on one or more fronts separating regions of constant potential vorticity.

Numerical Model:

Select the frontal waves, num (1 and 2 fronts) link on <http://wind.mit.edu/~glenn/12.804>.

This programs are intended to solve the inversion problem

$$\nabla^2 \psi = q_0 + \sum \Delta_i \mathcal{H}(y - [Y_i + \eta_i(x, t)]) \quad (1)$$

with \mathcal{H} being the step-function and calculate the movement of the fronts

$$\frac{\partial}{\partial t} \eta_i = \frac{\partial \psi}{\partial y} \frac{\partial \eta}{\partial x} + \frac{\partial \psi}{\partial x}$$

Periodicity in x is assumed, with period 2π . This is equivalent to moving the points on the front as Lagrangian particles:

$$\dot{x}_j = -\psi_y(x_j, y_j) \quad , \quad \dot{y}_j = \psi_x(x_j, y_j) \quad (2)$$

The inversion of (1) is accomplished using a Green's function integral, approximated by a sum.

To Use:

You need to set the values for:

Y Vector of average y position of the interfaces (e.g., -0.3;0.3)

Δ Vector of PV steps across interfaces (e.g., -1;1)

u_0 Zonal flow in southernmost region (e.g., -0.3)

q_0 PV in the southernmost region (e.g., 0)

$\eta_1(x, 0)$ Initial perturbations to the fronts (e.g., 0.1*sin(x);0.1*sin(x))

Clicking on any of the [Click here to run](#) buttons will show you the background zonal flow and the evolution of the frontal positions.

To think about

- Find the dispersion relationship for waves on a single front empirically.
- How does nonlinearity affect the waves?
- What effect does q_0 have?
- Consider a wave on an atmospheric/ oceanic front from some data. Estimate the speed of travel you would expect to find and compare it to the actual evolution.
- Estimate the wavelength/width ratio required for the instability of a shear layer.
- What is the effect of additional large scale shear (q_0)?
- Unequal magnitude of PV jumps? Same sign?
- Multiple waves in initial conditions?
- Triangular jet (three fronts)?
- Modify the code to look at two vortices or a vortex and a front and try some experiments with that.

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