AMATH 581: Homework 4

November 18, 2018

Part (a)

$$\omega_t + [\psi, \omega] = \nu \nabla^2 \omega$$

$$\Rightarrow \omega_t = -\psi_x \omega_y + \psi_y \omega_x + \nu(\partial_x^2 + \partial_y^2)\omega$$

$$= -B\psi \cdot C\omega + C\psi \cdot B\omega + \nu A\omega$$

Use this as the rhs equation in ode45, where A, B, C are calculated as in HW 3.

Part (a) and (b)

$$ode45(\text{rhs\_equation}, \text{timespan}, \omega_0)$$

Inside of the rhs equation, we need to solve for ψ using:

- backslash: $\psi = A \backslash \omega$
- LU decomposition: do LU decomposition once in the main program: $[L, U, P] = lu(A)$, and pass L, U, P to the rhs equation:
  $y = L \backslash (P * \omega); \psi = U \backslash y;$
- FFT:

$$\tilde{\tilde{\psi}} = -\frac{\tilde{\tilde{\omega}}}{k_x^2 + k_y^2}$$

Part(b)

FFT:
k rescaled to 2pi domain:

$$L = 20; k_x = k_y = (2 * pi/L) * [0 : (n/2 - 1)\ (-n/2) : -1];$$

To avoid dividing by zero:

$$k_x(1) = 10^{-6}; k_y(1) = 10^{-6};$$