Homework #5
Introduction to physical oceanography

1. Calculate and plot the particle trajectories for an inertial oscillation under the influence of bottom friction. We calculated the v velocity in class, and you need to calculate the u velocity and then the particle trajectories from the velocities. Follow a similar procedure to that we used to calculate particle trajectories from velocities for inertial oscillations with no friction. You may make reasonable assumptions regarding the initial velocity field.

2. Search textbooks (open university book is a good start) and the web for two different coastal upwelling zones.

   (a) Describe (optionally: plot) the sea surface temperature and sea surface color (from satellite data, explain what does surface color represent) near the coast for these areas.

   (b) Explain why the color and SST look the way they do. Deduce the wind direction in these two areas.

3. Scale selective friction: Suppose the velocity at $t = 0$ is given by

$$u(t=0,x,y) = U\cos(kx+ly); \qquad v(t=0,x,y) = -U\cos(lx+ky).$$

   with $k = 2\pi/10km$, $l = \pi/20km$, $U = 0.1m/sec$. Assume that the Coriolis acceleration vanishes, and that the governing equations are simply

$$u_t = K_h(u_{xx}+u_{yy}) \qquad v_t = K_h(v_{xx}+v_{yy})$$

   (a) What is the physical balance represented by these equations?

   (b) Plot the velocity field at $t = 0$ in the (x,y) plane using the "quiver" Matlab function.

   (c) Solve for the velocities u and v as function of time.

   (d) Explain what is the physical meaning of the parameters k and l.

   (e) Find the decay time scale of the velocity field as function of k and l.

4. **Optional challenge problem, Inertial oscillations in the presence of a pressure gradient:** Consider a flow satisfying the following equations,

$$\begin{aligned} u_t - fv &= -\frac{1}{\rho_0}p_x - Ju \\ v_t + fu &= -Jv \end{aligned}$$

   assume that p_x is a constant pressure gradient, independent of time and space, and that at $t = 0$ the velocities are $u = u_0$ and $v = 0$.

   (a) Find the velocity field as function of time.

   (b) Provide a physical explanation explaining your results.