ASL410
2nd Semester 2007-2008
Major Exam

Total Points: 30 **May 1, 2008.**
Weightage for final Grade: 30% **3:30 PM to 5:30 PM. Room VI301**

Instructions: You may consult any books or notes in your possession. ***Borrowing any material from others during the test is strictly prohibited.*** Write all answers on Major Exam Answer Book provided. If necessary, a continuation book can be provided.

1. Consider a 10 ms^{-1} wind blowing towards the north 10 meters above the surface of the ocean at 45°N Latitude.
   a. What is the *direction* and *magnitude* of the surface current? **(3 Points)**
   b. Compute the depth of the Ekman Layer. **(2 Points)**

2. Consider a parcel of water moving in the ocean :
   a. Write the full momentum equations (in x-y-z coordinates) that describe this motion. **(2 Points)**
   b. Now assume that the flow is horizontal, there is no friction, and that Coriolis is the only force acting on the parcel. Specify which terms you would drop from the full equations (and why) and write the resulting set of momentum equations. **(2 Points)**
   c. Show that these equations can be combined to yield the equation for a harmonic oscillator. **(2 Points)**
   d. Write the finite difference form of the above equation using the Trapezoidal implicit scheme. **(2 Points)**

3. You have been given a project that requires you to construct a second order accurate scheme for the 2-dimensional Laplacian operator.
   a. Write a finite difference approximation for the operator. **(3 Points)**
   b. Write the conditions that need to be satisfied for a second order accurate scheme assuming a non-uniform grid. **(3 Points)**
   c. What is the minimum number of grid points needed to satisfy these conditions? **(1 Point)**

4. In the following table match the items **a-j** in **Column A** with the corresponding description given by items **I-x** in Column B. Each correct answer gets 1 point. **(Total 10 Points)**

Column A	Column B
a. The semi-Lagrangian approach	**i.** Involve writing the integral form of the governing equations and then discretizing them
b. The analysis cycle	**ii.** Are a result of the spatial variation of the Coriolis parameter

c. Ensemble forecasting	**iii.** Employ a B-Grid staggering.
d. A parameterization	**iv.** Is the process by which the dispersion of inertia-gravity waves leads to geostrophic balance.
e. Cyclostrophic Flow	**v.** Is an intermittent data assimilation system typically performed 4 times a day
f. Rossby Waves	**vi.** Is an approximation to an unknown term by one or more terms or factors
g. Data Assimilation	**vii.** Calculates where the parcel arriving at each grid point came from in the previous time step.
h. Geostrophic Adjustment	**viii.** A balance between the pressure gradient force and the centrifugal force.
i. Finite Volume methods	**ix.** Is aimed at improving the forecast skill.
j. Typical ocean models	**x.** Is aimed at accurately producing initial conditions through a combination of observations and short-range forecasts

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