Name ___________________________

Date _____________________________

ERTH 465
Fall 2017

Lab 2

Review of Basic Techniques

(Due Beginning of Class, Thursday 14 September)

1. All labs are to be kept in a three hole binder. Turn in the binder when you have finished the Lab.

2. **Show all PROCEDURE**. No credit given if only answer is provided.

3. Unless otherwise noted, you may work together. But remember, YOU are the one who will be responsible for understanding the material for exams and when you are out in the profession. So STRIVE to understand what you are doing. Don't let someone else do your thinking for you.

1. Determine the value of a degree of longitude in km at 40ºN latitude (trigonometry).

2. Vector Calculus Notation

It is often the case that gradients of dependent variables along the various coordinate axes appear in equations. For example, in ERTH 260 we discussed the three dimensional pressure gradient acceleration, with the following component magnitudes for each of the coordinate axes:

$$-\frac{1}{\rho}\partial p \Big/ \partial x,\ -\frac{1}{\rho}\partial p \Big/ \partial y,\ \text{and } -\frac{1}{\rho}\partial p \Big/ \partial z \qquad (1)$$

But, since acceleration is a vector, the three dimensional pressure gradient acceleration can be expressed as components:

$$\text{Pressure Gradient Acceleration} = -\left[\left(\frac{1}{\rho}\partial p \Big/ \partial x\right)\vec{i} + \left(\frac{1}{\rho}\partial p \Big/ \partial y\right)\vec{j} + \left(\frac{1}{\rho}\partial p \Big/ \partial z\right)\vec{k}\right] \qquad (2)$$

where i, j and k are the unit vectors along the x, y and z axes.

A notational convenience and short hand involves collapsing the gradients and the unit vectors into an "operator", which when multiplied vectorially to a dependent variable produces the expression analogous to the one above.

This is called the Del Operator and is given as:

$$\nabla = \left(\frac{\partial}{\partial x}\vec{i} + \frac{\partial}{\partial y}\vec{j} + \frac{\partial}{\partial z}\vec{k}\right) \qquad (3)$$

The operator then can transform any scalar dependent variable to a vector by performing a simple "multiplication", which in terms of a simple operation involves inserting the given dependent variable into the numerator of each partial derivative. For example, if the dependent variable is A then its gradient would be expressed as

$$\nabla A = \left(\frac{\partial A}{\partial x}\vec{i} + \frac{\partial A}{\partial y}\vec{j} + \frac{\partial A}{\partial z}\vec{k}\right)$$

Simplify equation (2) by substitution of equation (3). Use next page to answer.

3. (a) Give the PHYSICAL INTERPRETATION of each term of equation (cartesian coordinate) below, where V is the three dimensional wind vector:

$$\frac{DT}{Dt} = \frac{\partial T}{\partial t} + \vec{V} \bullet \vec{\nabla} T \qquad (1)$$

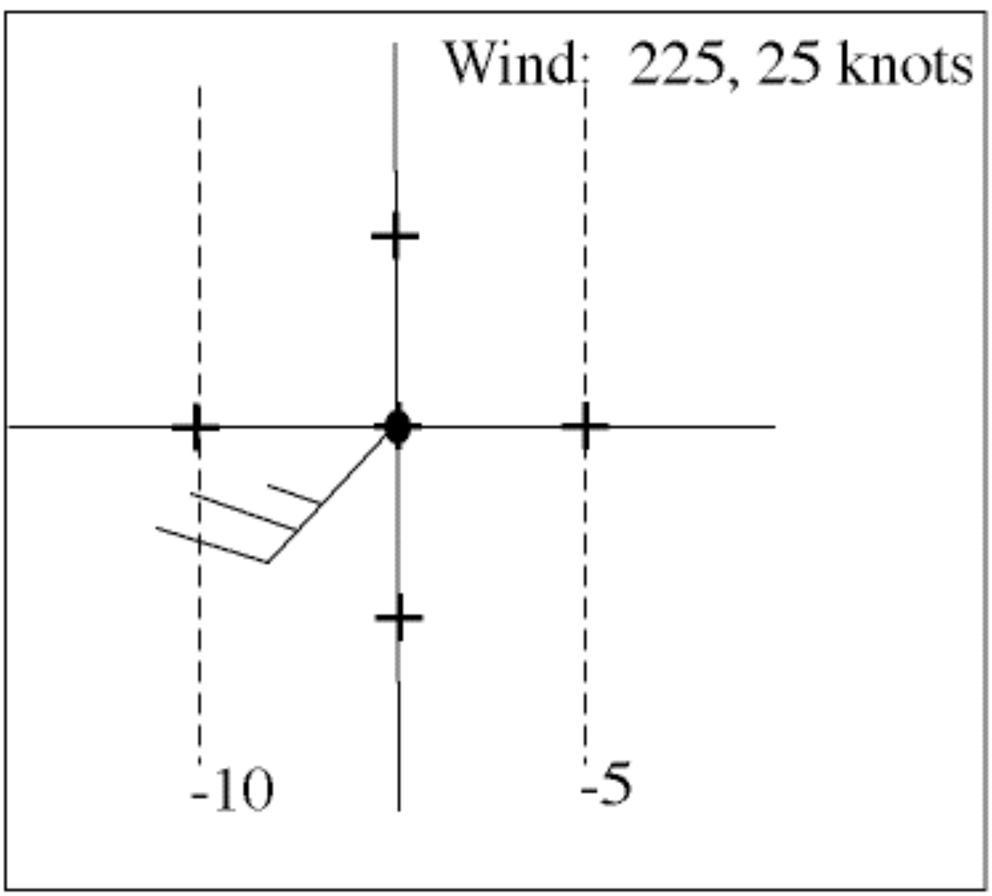
A B C

(b) Name each term in equation.

(c) Solve the equation for the local tendency.

(d) Expand term "C".

(e) Assume that **DT/Dt = 0** for the chart given and that there **is no vertical motion**. Determine the local temperature tendency at the station reporting the wind of 225°, 25 knots, shown in the diagram below. External grid points indicated by crosses are 100 km distant from station, nominally placed at center of implied x-y coordinate cross. Isotherms are north-south.



4. (a) Physically interpret the terms to the right of the equals sign in equation (2) (basic calculus)

$$DIV_h = \frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} \qquad (2)$$

$$u_g = -\frac{g}{f}\frac{\partial z}{\partial y} \qquad (3a)$$

$$v_g = \frac{g}{f}\frac{\partial z}{\partial x} \qquad (3b)$$

(b) Equations (3a,b) are the geostrophic wind components. Put (3a,b) into (2) to determine the divegence of the geostrophic wind. Assume g and f are constants. I realize we have not discussed divergence, or horizontal divergence. But this question involves you working with the mathematical operations, not the meteorological interpretation.

5. Obtain a plot of the NAM initialization of surface pressure with 1000-500 mb thickness at initialization time for 12 UTC 5 September 2017.

(a) Write out the script you executed on the command line to obtain this.

(b) Append -p on the command line after the command to print a black and white copy to turn in with this lab.

6. (a) Use the script modgrib -p to print out a copy of the 500 mb heights for 12 UTC 7 September 2017.
   (b) Annotate troughs and ridges as we did in ERTH 260.

7. For the sounding distributed (KOAX 12 UTC 31 August 2010), determine the
   (a) LCL, LFC and CAPE and CIN areas for 12 UTC (first copy);
   (b) CT, and CCL (second copy)

Make sure you draw everything neatly and use the correct color conventions.