Homework 2
ATM 645 Atmospheric Dynamics, Fall 2014
Math review applied to meteorology

1) To an observer on the ground the wind speed experienced as a hurricane passes over is equal to the wind speed due to the circulation of air around the hurricane plus the speed of movement of the hurricane. Assume that the circulation of the hurricane results in a 50 ms^{-1} wind blowing in a counterclockwise direction around the center of the hurricane at a distance of 10 km from the center of the hurricane and that the center of the hurricane is moving towards the north at 5 ms^{-1} .
(a) Sketch the wind vectors associated with the circulation of the hurricane only at two points 10 km due east and due west from the center of the hurricane.
(b) Sketch the vector that represents the motion of the center of the hurricane.
(c) What is the wind speed experienced by an observer who is 10 km due east of the center of the hurricane? 10 km due west of the center of the hurricane? Determine your answers graphically.
(d) Write the three vectors you sketched in parts (a) and (b) in component form, using the coordinate system shown in Figure 2.6 (see below).
(e) Use equations 2.1 and 2.2 (see below) to calculate the wind speed experienced by an observer who is 10 km due east of the center of the hurricane and one who is 10 km due west of the center of the hurricane. Do these results match your graphic solutions in part (c)?

GRADIENTS OF VECTORS

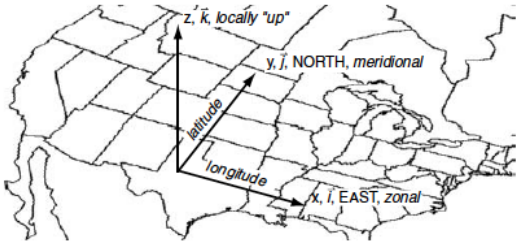

Figure 2.6 Coordinate system anchored on the Earth

$$\vec{u} = u_x\vec{i} + u_y\vec{j} + u_z\vec{k} \quad \text{and} \quad \vec{v} = v_x\vec{i} + v_y\vec{j} + v_z\vec{k}$$

$$\Rightarrow \vec{u} + \vec{v} = (u_x + v_x)\vec{i} + (u_y + v_y)\vec{j} + (u_z + v_z)\vec{k} \qquad (2.1)$$

$$\vec{u} - \vec{v} = (u_x - v_x)\vec{i} + (u_y - v_y)\vec{j} + (u_z - v_z)\vec{k} \qquad (2.2)$$

This problem & figures are from Lynch and Cassano, 2006.

2) Calculate the vector that results from the scalar product of $\vec{U} = 10\vec{i} + 3\vec{j} - 6\vec{k}$ and c = 1.5 . Sketch the original and new vectors.

3) Calculate the dot product and vector product of:
(a) an east wind blowing at 10ms^{-1} and a south wind blowing at 2ms^{-1};
(b) a south wind blowing at 4ms^{-1} and a north wind blowing at 6ms^{-1}.

4) Calculate the partial derivatives in the x, y, & z directions of the vector $\bar{u}(x,y,z,t) = (t^3xz)\bar{i} + (4\sin xt + 5y^3)\bar{j} + (2xy^2)\bar{k}$.