Problem Set 6
ATM 316: Dynamic Meteorology I
November 11, 2014
DUE Tuesday November 18 at beginning of class

1. a) A kicker misses a game-winning field goal and blames the Coriolis force. He kicks the football a horizontal distance of 50 m in 5 s. The football field is at latitude 45ºN. If he misses the right upright by 0.1 m, is his claim valid?

b) At what speed would the kicker have to kick the football in order to actually miss the upright by 0.1 m due to the Coriolis force?

> HINT: to answer these questions, suppose that the Coriolis force is the only force acting on the football as it travels from the kicker to the goal. Therefore the momentum equation for the football is
>
> $$\frac{dv}{dt} = -fu$$
>
> where the x direction is defined as along the field toward the goal, and $\frac{dv}{dt}$ is therefore the acceleration of the ball to the left or right.

2. a) Explain why it is impossible to have a high pressure area with counterclockwise geostrophic wind, or a low pressure area with clockwise geostrophic wind in the Northern Hemisphere. Draw a sketch of the forces to illustrate your argument.

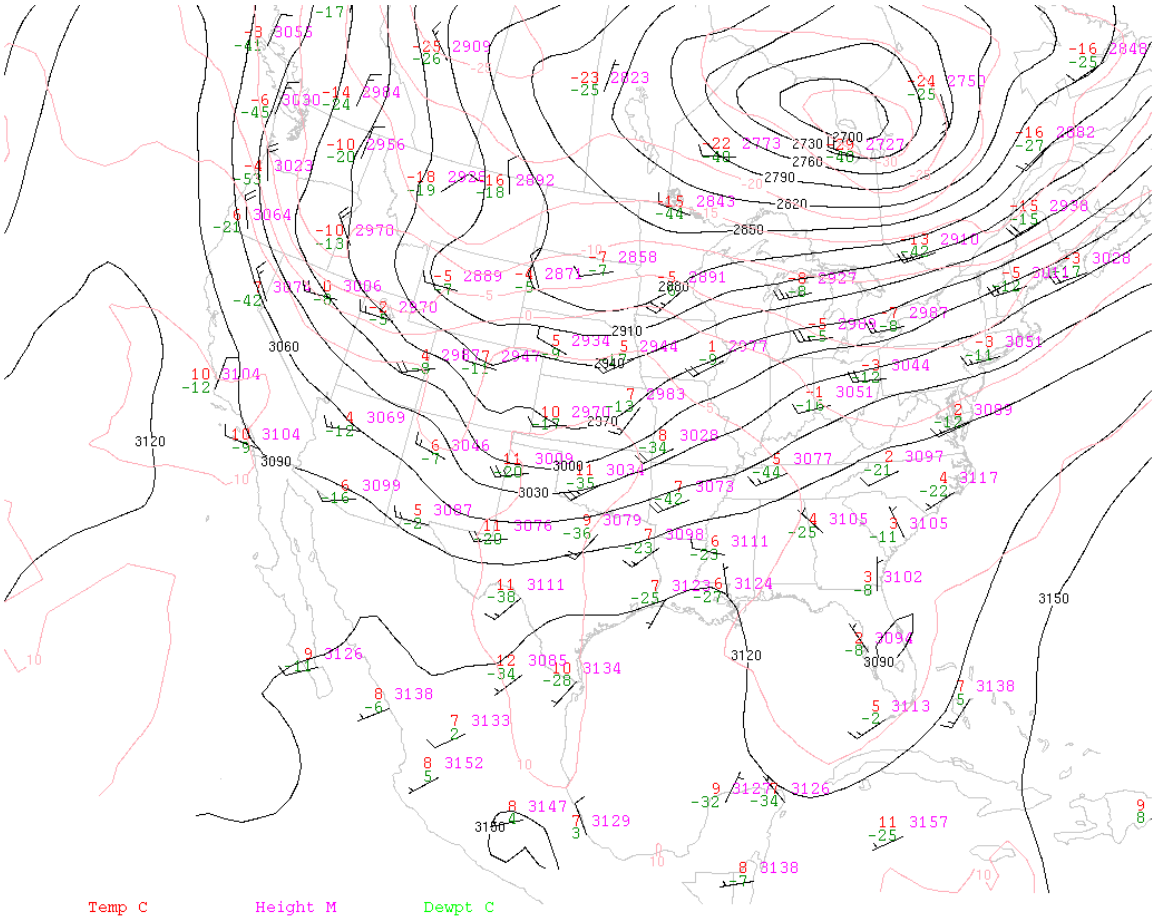
b) As viewed by an observer on Earth, an air parcel travels toward the west in the Southern Hemisphere, but does not acquire any meridional velocity. Sketch a plausible picture of what the forces acting on the parcel may look like only in the meridional (north-south) direction. Which way must the pressure gradient force be pointing?

3. **Prove that the Coriolis force does not change the speed of the wind, only its direction.** To show this, suppose that the Coriolis force is the only force acting an air parcel, so that the momentum equations are

$$\frac{Du}{Dt} = fv, \qquad \frac{Dv}{Dt} = -fu$$

The simplest way to prove that the wind speed is constant is to prove that the *square of the wind speed* is constant following the motion of an air parcel. You will need to apply the chain rule.

4. The map on the following page shows geopotential height in meters (black contours) and wind barbs on a constant pressure surface at 700 hPa. (Temperatures and dewpoints are also plotted in red and green). Choose any three locations on the map that look interesting to you. At each location, calculate the magnitude and direction of the geotrophic wind. Indicate clearly what information you are using from the map. Compare your calculated value to the observed value (wind barb) at each location.



RAOB 700 hPa Plot 11/10/14 12 Z and Eta 00 hr Heights/Temps

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