General Meteorology	**Laboratory #10**
Name ____________________________	Date ________________
Partners __________________________	Section ______________

Geostrophic Winds

Purpose:

Use the concept of geostrophic winds to predict the wind speed at 500 mb.

Equipment:

Station Thermometer	Min./Max. Thermometer
Anemometer	Barometer
Psychrometer	Rain Gauge
Psychometric Tables	Barometric Correction Tables

I. Surface observation. (Optional)

Begin the first 1/2 hour of lab performing a surface observation. Make sure you include pressure (station, sea level, and altimeter setting), temperature, dew point temperature, wind (direction, speed, and characteristics), precipitation, and sky conditions (cloud cover, cloud height, & visibility). From your observation generate a METAR and a station model.

A. Generate a METAR for today's observation

B. Generate a station model for today's observation.

II. Contour the geopotential heights at 500 mb

Included in this packet are three maps. The first is a map of the United States and the upper air sounding stations. The second is a record of the wind barbs at 500 mb for each sounding station. The third is a record of the geopotential heights of the 500 mb layer for each sounding station.

Using the geopotential heights data draw contours at 60 m intervals beginning at 5580 m. The value of the geopotential height is recorded to the right of the station's location. When you contour, use the dot representing the station's location not the location where the numerical value is recorded.

III. Geostrophic winds

As discussed in class, the geostrophic wind is where the wind flow is parallel to straight isobars. Under these conditions the Coriolis effect is balanced by the pressure gradient force. The text develops the following formula from this relationship.

$$V_g = \frac{1}{2\Omega\rho\sin\phi}\frac{\Delta p}{d}$$

Ω - Rotational speed of the earth *ρ - Density of the air*
ϕ - latitude *Δp - Change in pressure*
d - Distance over which the pressure change takes place

This formula can be used along with a constant height plot to determine the speed of the geostrophic wind. A more common plot than the constant height plot is the constant pressure plot. In our case we are using the 500 mb plot. The geostrophic formula must be modified so that the change in pressure can be express as a change in geopotential height. This can be done with the hydrostatic equation.

$$\frac{\Delta p}{\Delta z} = -\rho g$$

Δp - Change in pressure *Δz - Change in geopotential height*
ρ - Density of the air *g - Acceleration of gravity*

If we take the hydrostatic equation and solve for Δp, we can substitute it into the geostrophic wind equation. Doing so results in the following equation.

$$V_g = \frac{g}{2\Omega\sin\phi}\frac{\Delta z}{d}$$

Notice that the density of the air cancels in this equation. To calculate the geostrophic wind we will go through the following procedure.

1. Locate the station of interest and find the contour that lies on each side of it. Take the difference in geopotential height between the two contours and record this as Δz.
2. Measure the distance on your map between the two contours and compare that distance with a feature on the map of the United States provided. Chose a feature that is easily definable such as the length of one edge of a state. Now go to an atlas and measure the actual distance for that feature in kilometers. Convert the distance in kilometers into meters and record this as *d*.
3. Locate the station of interest in the atlas and determine its latitude. Record this latitude as ϕ.
4. The last two values are fixed. We will used $g = 9.8\ m/s^2$ and $\Omega = 7.3 \times 10^{-5}\ rad/s$.
5. Substitute in the determined values and calculate the speed of the geostrophic wind. The answer will be in meters per second. This must be converted to knots by the following conversion factor. *1 m/s = 1.94 knots*
6. Compare the geostrophic wind calculation with the actual wind measured at 500 mb at the station of interest.

DATA SHEET

I. Geostrophic wind at _________

Δz = _____________ d = _____________ ϕ = _____________

$V_{geostrophic}$ = ____________ V_{actual} = _____________

Are the two winds speeds comparable? Is one larger than the other? Explain whether these results are consistent with our understanding of the geostrophic wind.

II. Geostrophic wind at _________

Δz = _____________ d = _____________ ϕ = _____________

$V_{geostrophic}$ = ____________ V_{actual} = _____________

Are the two winds speeds comparable? Is one larger than the other? Explain whether these results are consistent with our understanding of the geostrophic wind.

III. Geostrophic wind at _________

Δz = _____________ d = _____________ ϕ = _____________

$V_{geostrophic}$ = ____________ V_{actual} = _____________

Are the two winds speeds comparable? Is one larger than the other? Explain whether these results are consistent with our understanding of the geostrophic wind.