METR 104: Our Dynamic Weather (w/lab)	**Lab Exploration #5: Winds &z Pressure Patterns**	Dr. Dave Dempsey Dept. of Geosciences Dr. Oswaldo Garcia, & Denise Balukas SFSU, **Fall 2012**

(5 points)
(*Lab Section 1:* Wed., Nov. 14; *Lab Section 2:* Fri, Nov. 16)

Objectives. By the end of this lab exploration, you should be able to:

- Develop generalized, qualitative relationships between winds (both speed and direction) and atmospheric pressure patterns, based on a set of observations:
  - near the earth's surface
  - higher in the troposphere ("aloft")
- Estimate the direction and relative strength of the horizontal pressure-gradient force (PGF) at specific locations on a contour map of pressure
- Recognize limitations of using PGF patterns to deduce wind patterns
- Understand the logical terms "prove", "confirm" or "support", "disconfirm" or "not support", and "disprove", and apply them to evaluate statements about relations between winds and pressure patterns based on a set of observations.

Materials. Maps of pressure and winds:

- Figure 1: Sea-level pressure isobars and surface winds for 00Z October 19, 2012
- Figure 2: Sea-level pressure isobars and surface winds for 12Z October 21, 2012
- Figure 3: Pressure isobars and winds aloft (in mid-troposphere around ~18,000–19,000 ft., where the pressure is around 500 mb) for 12Z November 10, 2012

Background. Concepts to be covered in lab beforehand (see handout, "Some Important Points about Winds and Pressure Patterns"):

- *Pressure* and *force*
- Contour lines of constant pressure (*isobars*) on a weather map
  - sea level pressure
  - pressure aloft (e.g., in mid-troposphere)
- Features of pressure patterns
  - high and low pressure areas
  - *horizontal pressure gradient*
    - relation between pressure gradient and the spacing and orientation of isobars
    - relation between pressure gradient and net force on air (*pressure gradient force*) due to pressure differences between places

Also:

- The meaning of the four terms below, from the logic of evidence (see the accompanying handout, "Proof, Confirmation, Disconfirmation, and Disproof: Reasoning from Evidence in Science"):

  - *prove*
  - *confirm* (or *support*)
  - *disprove*
  - *disconfirm* (or *not support)*

General Instructions: For the questions below, refer to the accompanying **Figures 1**, **2**, and **3**. Respond in writing to the questions and turn in your responses at the end of the lab session.

The Pattern at the Earth's Surface

Figure 1 shows contour lines of sea level pressure (*isobars*), together with observed surface winds represented using the common stem-and-barb convention. (See "The Station Model" if you need to review this. Recall that the station is located at the *head* of the stem, at the opposite end of the stem from the barb(s).) The observations were made at 00Z October 19, 2012. **Figure 2** shows the same thing, at 12Z October 21, 2012.

We can figure out the direction and relative strength of the pressure-gradient force at any particular place based on the orientation and relative spacing of the isobars there.

Question (1): *For each of the statements **(a)** and **(b)** listed below, decide whether the information on **Figures 1** and **2:***

- *disproves the statement*
- *disconfirms the statement*
  (that is, doesn't support it, with perhaps a few exceptions)
- *confirms the statement*
  (that is, supports it, with perhaps a few exceptions)
- *proves the statement, or*
- *lacks any obvious bearing on the statement*

For each statement, explain your conclusion.

Statement (a): *The pressure-gradient force alone determines the wind direction.*

(*Hint*: Pick several different places in the pressure pattern over land where there are wind observations. Determine the direction of the pressure gradient force at those places. Then, assuming that statement (a) is true, determine what direction the wind should be blowing, and compare that direction with the observed wind direction.)

Statement (b): *Winds are usually faster where the pressure gradient (and hence the pressure-gradient force) is larger.*

(For this question, compare land areas with other land areas but not with ocean areas. Also, things might get more complicated in mountainous areas, so try to avoid those.)

Question (2): *If it is possible based on these observations, what generalization might you make about the wind direction relative to the orientation of the isobars, especially over land areas?*

(For example, does the wind generally blow parallel to the isobars? Or perpendicular to isobars toward lower, or toward higher, pressure? Or across isobars toward their lower, or higher, pressure side, but not perpendicular to them—instead, angled clockwise, or counterclockwise, from the perpendicular direction?)

The Pattern Aloft

Figure 3 shows the pattern of pressure in mid-troposphere, at an altitude of 18,000-19,000 feet (about 5-6 kilometers) above sea level. At this altitude the pressure is around 500 mb, roughly half of typical sea level pressures. (As a side note, roughly half of the molecules of air in the atmosphere—and therefore half of the total mass of air in the atmosphere—lies below this level and the other half lies above it.)

The contour lines on **Figure 3** aren't actually isobars, but we can treat them as if they were. If they were actually isobars, then the pressures would be around 500 mb and the contour interval would be about 10 mb. **Figure 3** also shows winds observed at this level by radiosonde balloons launched from the earth's surface. The winds are represented using the standard stem-and-barb convention.

The pressure pattern aloft (that is, significantly far above the surface of the earth, as in **Figure 3**) is often quite different from what it is at the surface.

Question (3): *How might you generalize the relation between wind direction and the orientation of isobars at this level aloft (if there seems to be any relation)? Does this differ from your answer to Question (2) above?*

Question (4): *At the level aloft shown in* ***Figure 3****, does there seem to be any connection between wind speed and the magnitude of the pressure gradient? If so, what is it?*

Question (5): Summary conclusion: *At either the surface or aloft, does the pattern of pressure-gradient force alone (which we can determine from the pressure pattern) seem adequate to explain the observed pattern of winds (both speeds and directions)? Explain.*