The Concept of Pressure

- ***Pressure*** **is defined as the amount of force molecules exert per unit of surface area.**
  - **The standard unit of pressure in the United States is the millibar (mb).**
  - **Average pressure at sea level is 1013.2 mb.**
- **Air moves to create equilibrium between areas of high and low pressure.**
- **Using different terminology, the *pressure* at any point reflects the mass of atmosphere above that point.**
  - **As a result, as one moves higher in the atmosphere, the pressure decreases.**
- **'Sea level pressure' is the pressure that would exist if the observation point were at sea level.**
  - **It allows us to analyze pressure at different observation points, taking into account differences in elevation.**
- **Pressure decreases rapidly at low elevations, and less so at higher elevations.**

Measurement of Pressure

- **A barometer is an instrument that measures pressure.**
- **A device that keeps a record of pressure with respect to time is called a barograph.**

The Distribution of Pressure

- **An 'isobar' is a line that connects points which have exactly the same sea level pressure.**
- **On U.S. weather maps, isobars are drawn at four millibar intervals.**
- **The 'pressure gradient' represents the rate of change in pressure.**
  - **Isobars which are drawn closely to each other show a steep pressure gradient (rapid change in pressure with distance).**
  - **Isobars which are drawn far apart from each other represent a weak pressure gradient.**
- **Pressure gradients are the catalyst for the movement of air which is known as 'wind'.**
  - **Due to the 'Pressure Gradient Force' (PGF), air always flows from high pressure to low pressure, irrespective of location on Earth.**
  - **The higher the pressure gradient force, the stronger the wind will be.**
- **Earth is in a state called 'hydrostatic equilibrium', where the upward vertical pressure gradient force is counterbalanced by the downward force of gravity.**

The Coriolis Force

- **We have already observed that wind flows from areas of high pressure to areas of low pressure.**
- **However since the Earth rotates on its axis, a complication is added into our analysis.**
- **Since the Northern Hemisphere rotates in a counterclockwise direction, an object launched from the North Pole to the Equator (along the same line of longitude) will appear to be deflected to the right *as seen from where the object originated*.**
    - **This is known as the 'Coriolis Force'.**
        - **As one moves poleward, the magnitude of the Coriolis Force increases.**
        - **The magnitude of the Coriolis Force increases with wind speed.**
- **Important points to remember with regard to the Coriolis Force:**
    - **All moving objects are deflected as a result of the Coriolis Force. The deflection is to the right in the Northern Hemisphere, and to the left in the Southern Hemisphere. Remember, this 'deflection' is *seen from where the object originated*.**
    - **The magnitude of the Coriolis Force is zero at the Equator and increases all the way to the North and South Pole.**
    - **The Coriolis Force affects objects moving over long distances. Therefore it doesn't affect water draining in a bathtub.**

Near-Surface Winds

- **Because of friction, winds *do not* flow parallel to the isobars.**
    - **Instead, they cross the isobars at an angle as they go from high pressure towards low pressure.**
    - **Winds are deflected to the right in the Northern Hemisphere and to the left in the Southern Hemisphere.**

Cyclones, Anticyclones, Troughs, and Ridges

- **Sea level pressure across the globe is distributed into a small number of large high- and low- pressure regions.**
- **Areas of high pressure are known as 'anticyclones'.**
    - **Winds rotate clockwise around anticyclones in the Northern Hemisphere.**
        - **The Coriolis force deflects air to the right and the air spirals out of anticyclones.**
    - **In the Southern Hemisphere, the flow is counterclockwise.**
- **Areas of low pressure are called 'cyclones'.**
    - **In the Northern Hemisphere, air flows around cyclones in a counterclockwise fashion into the cyclone.**

    - **In the Southern Hemisphere, the air flows clockwise.**
- **It *appears* that in cyclones, the air moves toward the left as it moves toward the low, but such is not the case.**
    - **At any one time, the pressure gradient force directs a parcel of air to the center of the low, but the Coriolis force immediately directs it to the right. This process continually repeats itself until the parcel of air reaches the center of the low.**
- **Air moving into cyclones at the surface has to move upward when reaching the center of the low.**
    - **The air cannot move into the ground.**
- **Air, which moves out from the center of anticyclones at the Earth's surface is replaced by sinking air.**
- **When a high-pressure center does not have a closed, circular shape, it is called a 'ridge'.**
- **When a low-pressure center does not have a closed, circular shape, it is called a 'trough'.**

Measuring Wind

- **Wind direction is given from the direction from which the wind blows.**
- **Wind directions are determined from a 'wind vane'.**
- **Wind speeds are given by an 'anemometers'.**

Helpful Links:

http://ww2010.atmos.uiuc.edu/(Gh)/wwhlpr/anticyclone.rxml?hret=/guides/maps/sfc/slp/sfcslp.rxml

http://ww2010.atmos.uiuc.edu/(Gh)/wwhlpr/low_pressure_center.rxml?hret=/guides/maps/sfc/slp/sfcslp.rxml

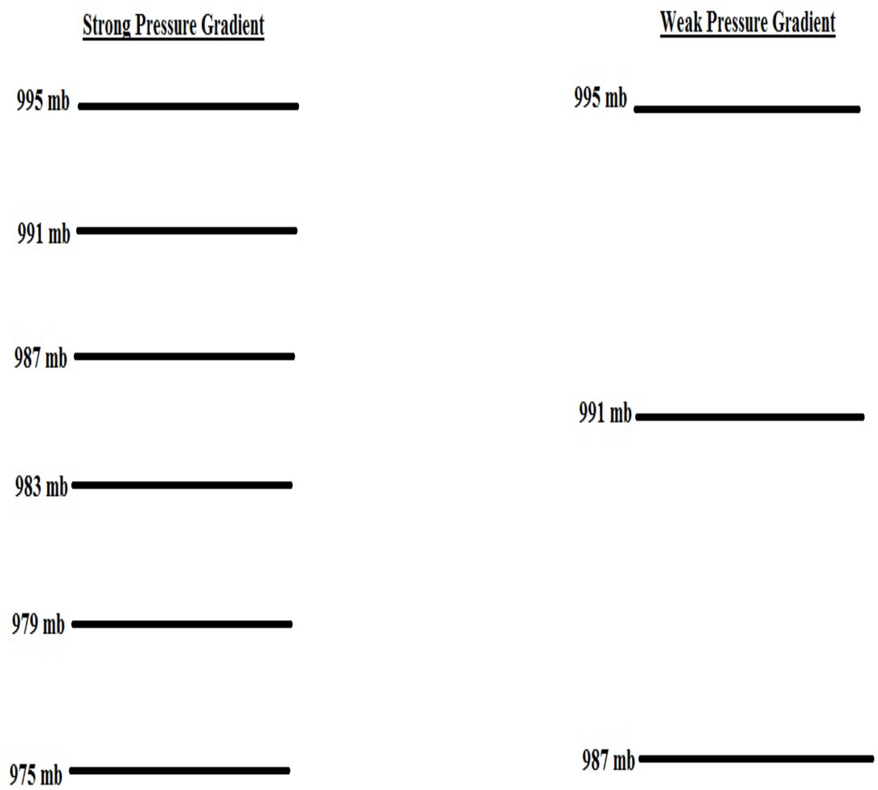
http://ww2010.atmos.uiuc.edu/(Gh)/wwhlpr/isobars.rxml?hret=/guides/maps/sfc/slp/sfcslp.rxml

http://ww2010.atmos.uiuc.edu/(Gh)/wwhlpr/pressure_gradient.rxml?hret=/guides/maps/sfc/slp/sfcslp.rxml

http://ww2010.atmos.uiuc.edu/(Gh)/guides/mtr/fw/pgf.rxml

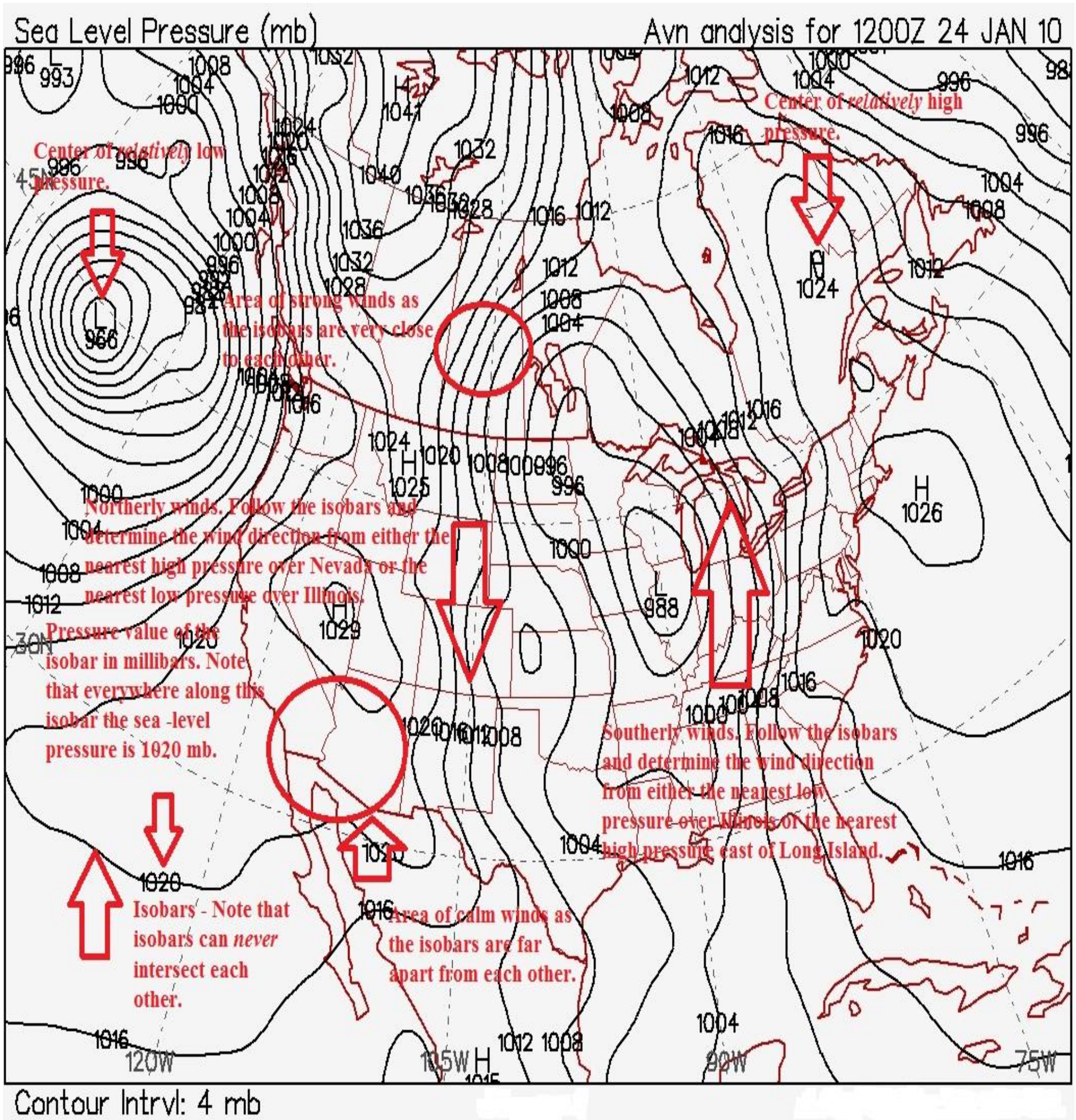
http://ww2010.atmos.uiuc.edu/(Gh)/guides/mtr/fw/crls.rxml

https://www.weather.gov/jetstream/ll_analyze_slp [Practice for plotting isobars]



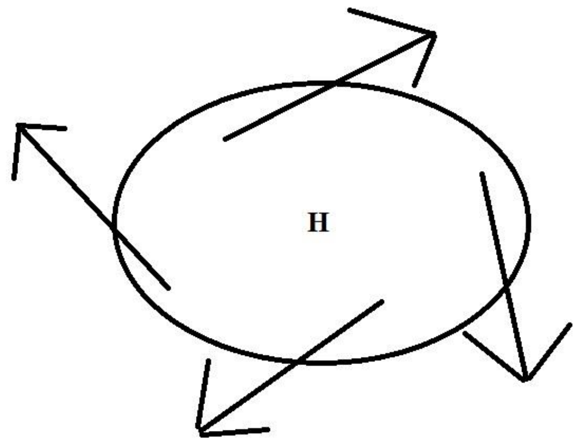
$$\text{Pressure Gradient} = \frac{\text{Change in pressure}}{\text{Distance}}$$

The stronger the pressure gradient, the stronger the winds are.


Sea Level Pressure (mb)
Avn analysis for 1200Z 24 JAN 10
Center of *relatively* low pressure.
Center of *relatively* high pressure.
Area of strong winds as the isobars are very close to each other.
Northerly winds. Follow the isobars and determine the wind direction from either the nearest high pressure over Nevada or the nearest low pressure over Illinois.
Pressure value of the isobar in millibars. Note that everywhere along this isobar the sea -level pressure is 1020 mb.
Southerly winds. Follow the isobars and determine the wind direction from either the nearest low pressure over Illinois or the nearest high pressure east of Long Island.
Isobars - Note that isobars can *never* intersect each other.
Area of calm winds as the isobars are far apart from each other.
Contour Intrvl: 4 mb

Air flow around high pressure in the Northern Hemisphere

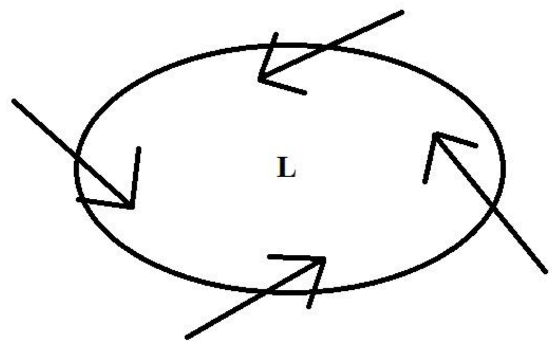
[Oval represents an isobar]



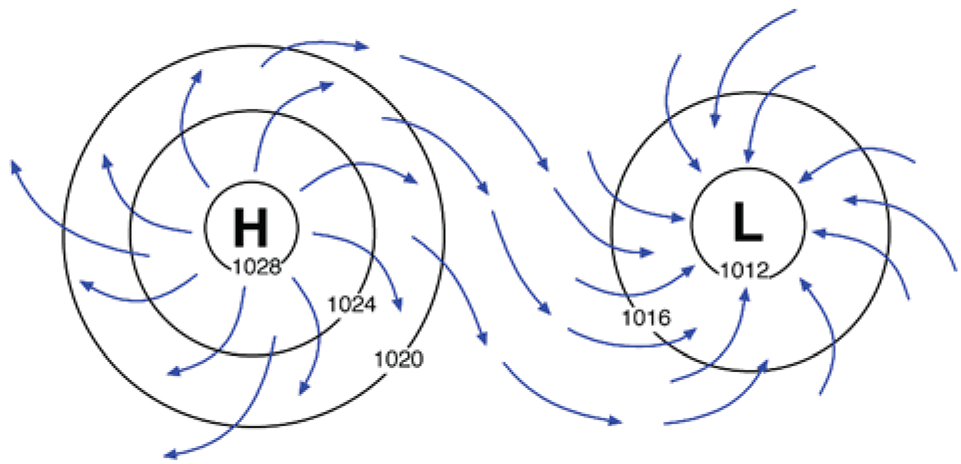
Airflow is clockwise and away from high pressure.

Airflow around low pressure in the Northern Hemisphere

[Oval represents an isobar]



Airflow is counterclockwise and toward low pressure.



Credit: http://mrcc.isws.illinois.edu/living_wx/winds/index.html