UAS Standards, Reg, Law & Exam

FAA Regulations: Part 107

Lesson 3c – Weather Effects

Objectives of Weather

- To determine that the applicant is knowledgeable in sources of weather information
- To determine that the applicant is knowledgeable of the effects of weather on performance

Effects of Weather on Performance

- Density altitude
- Wind and currents
- Atmospheric stability, pressure, and temperature
- Air masses and fronts
- Thunderstorms and microbursts
- Tornadoes
- Icing
- Hail
- Fog
- Ceiling and visibility
- Lighting

Standard Atmospheric Conditions

- This is the reference condition for the atmosphere
- Standard air temperature and pressure at sea level is
  - 15° C and 1013.1 mbar or
  - 59° F and 29.92" Hg

Altitude

- Absolute Altitude – the height above ground level (AGL)
- True Altitude – the height above mean sea level (MSL)
- Density Altitude – how we measure the density of air
- Indicated Altitude – the height your altimeter shows you (when you're at sea level under standard conditions, indicated altitude is the same as true altitude)
- Pressure Altitude – the indicated altitude when the barometric pressure scale is set to 29.92-in Hg (inches of mercury)

Density Altitude

- Density altitude is the altitude relative to the standard atmosphere conditions at which the air density would be equal to the indicated air density at the place of observation; it is the vertical distance above sea level in the standard atmosphere at which a given density is to be found; in a sense, it is the altitude at which your UAS "feels" like it is flying
- The density of air is defined by the pressure altitude and ambient temperature and can have a significant effect on your aircraft's performance; when the density altitude is high, you will experience reduced aircraft performance
- High density altitude – the air is less dense, and your propellers become less efficient
- As the density altitude increases, the performance of your UAS decreases
- Remember "Density Altitude" is about Altitude and its affect on air pressure and density
  - High altitude = lower pressure hence lower air density
  - Low altitude = higher pressure hence higher air density

Density Altitude – Conditions

- Temperature also affects density altitude
- Warm air is less dense than cold air
- Higher density altitude occurs at
  - Higher elevations
  - Lower atmospheric pressures
  - Higher temperatures
  - Higher humidity
- Lower density altitude occurs at
  - Lower elevations
  - Higher atmospheric pressures
  - Lower temperatures
  - Lower humidity

Density Altitude – Impacts on UAS

- Higher density altitude
  - Thinner, less dense air
  - Reduced aircraft performance
- Lower density altitude
  - Thicker, denser air
  - Increased aircraft performance

Weather Factors and Performance – Wind and Currents

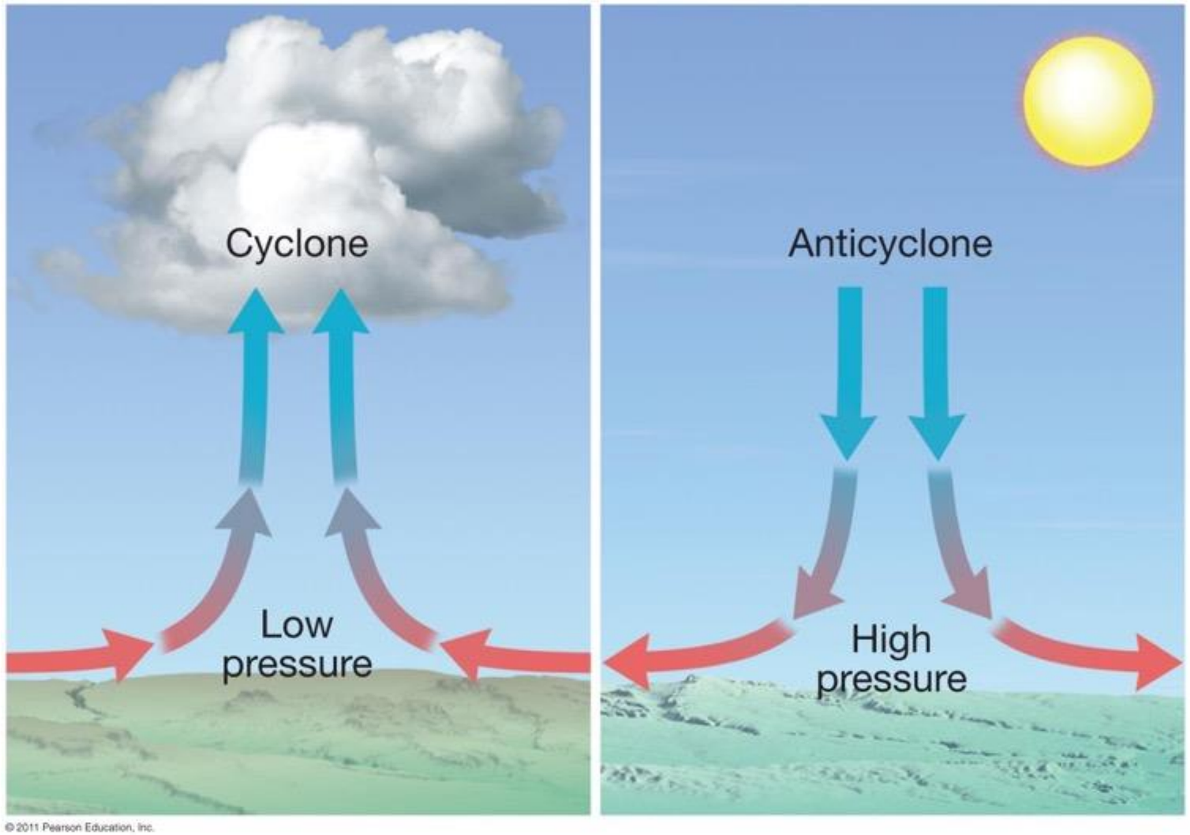
- Focus on local conditions where you will be flying
- Pressure gradient force
- Friction
- Coriolis effect

The Nature of Wind

- For large-scale atmospheric patterns winds are determined by
  - Pressure gradient force
  - Friction
  - Coriolis effect
- For local conditions, the Coriolis Effect is not a concern, so we will only concern ourselves with
  - Pressure gradient force
  - Friction

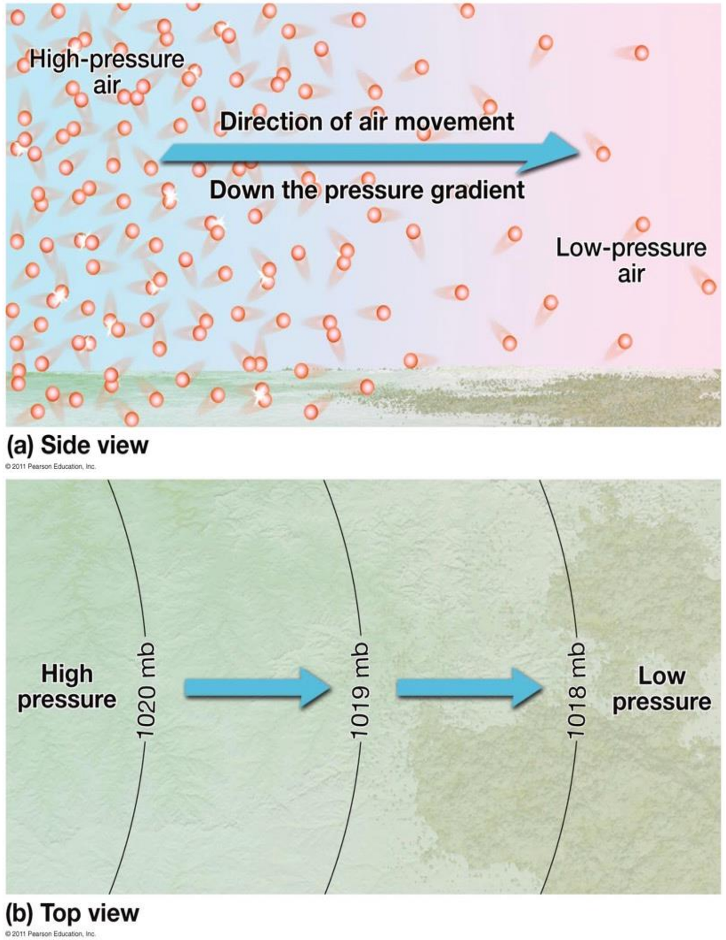
The Nature of Wind – Vertical Motions

- Surface convergence and low pressure indicate rising motion
- Surface divergence and high pressure indicate sinking motion
- Rising motion results in clouds and storms
- Sinking motion results in sunny skies



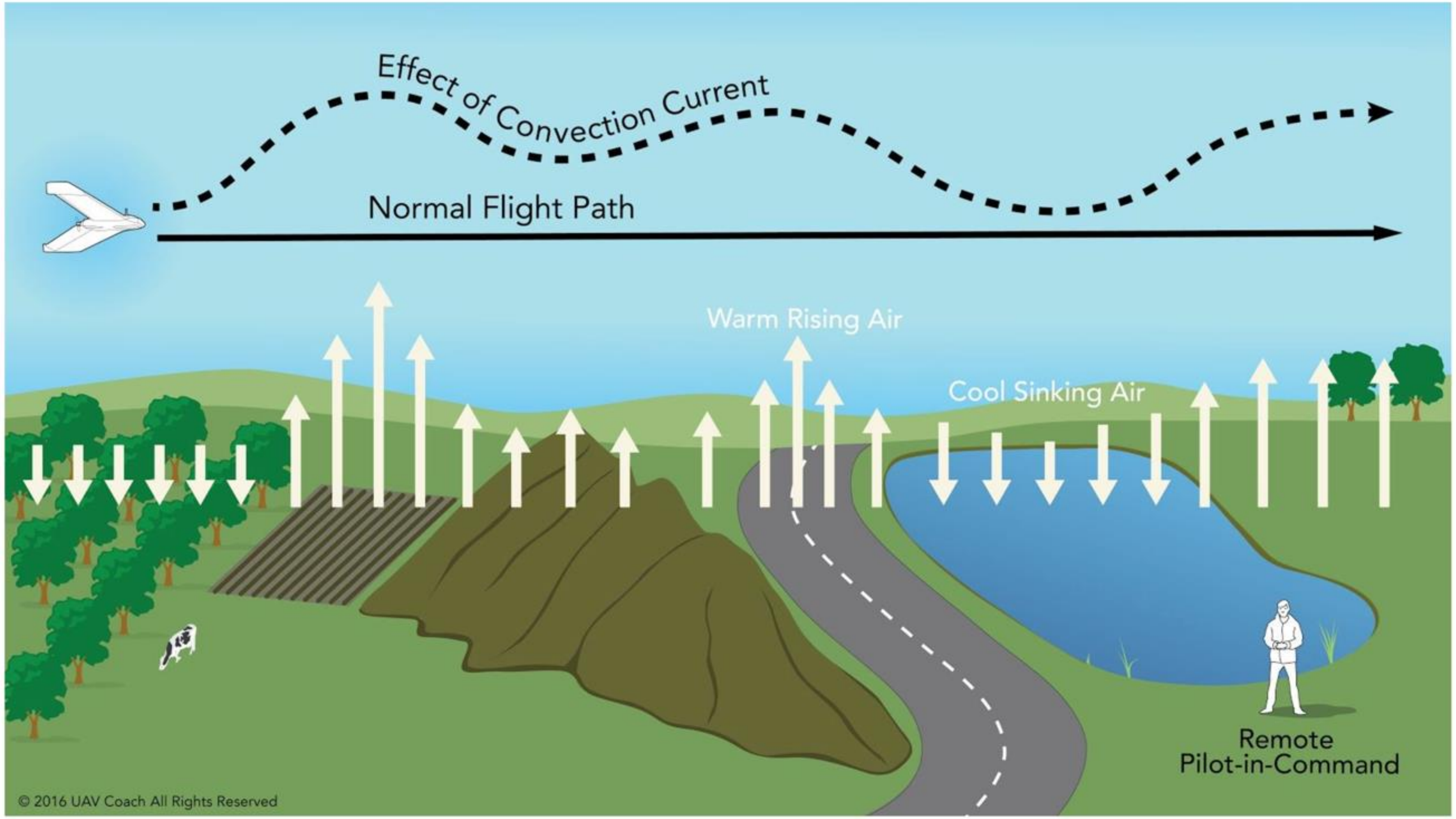
Pressure Gradient

- Origination of wind
  - Uneven heating of Earth's surface creates temperature and pressure gradient
  - Direction of wind results from the pressure gradient
  - Winds blow from high pressure to low pressure



Convective Currents

- Different surfaces radiate heat in varying amounts
  - Plowed ground, rocks, sand, and barren land give off a large amount of heat
  - Water, trees, and other areas of vegetation tend to absorb and retain heat
- This uneven heating of the air creates small areas of local circulation called convective currents



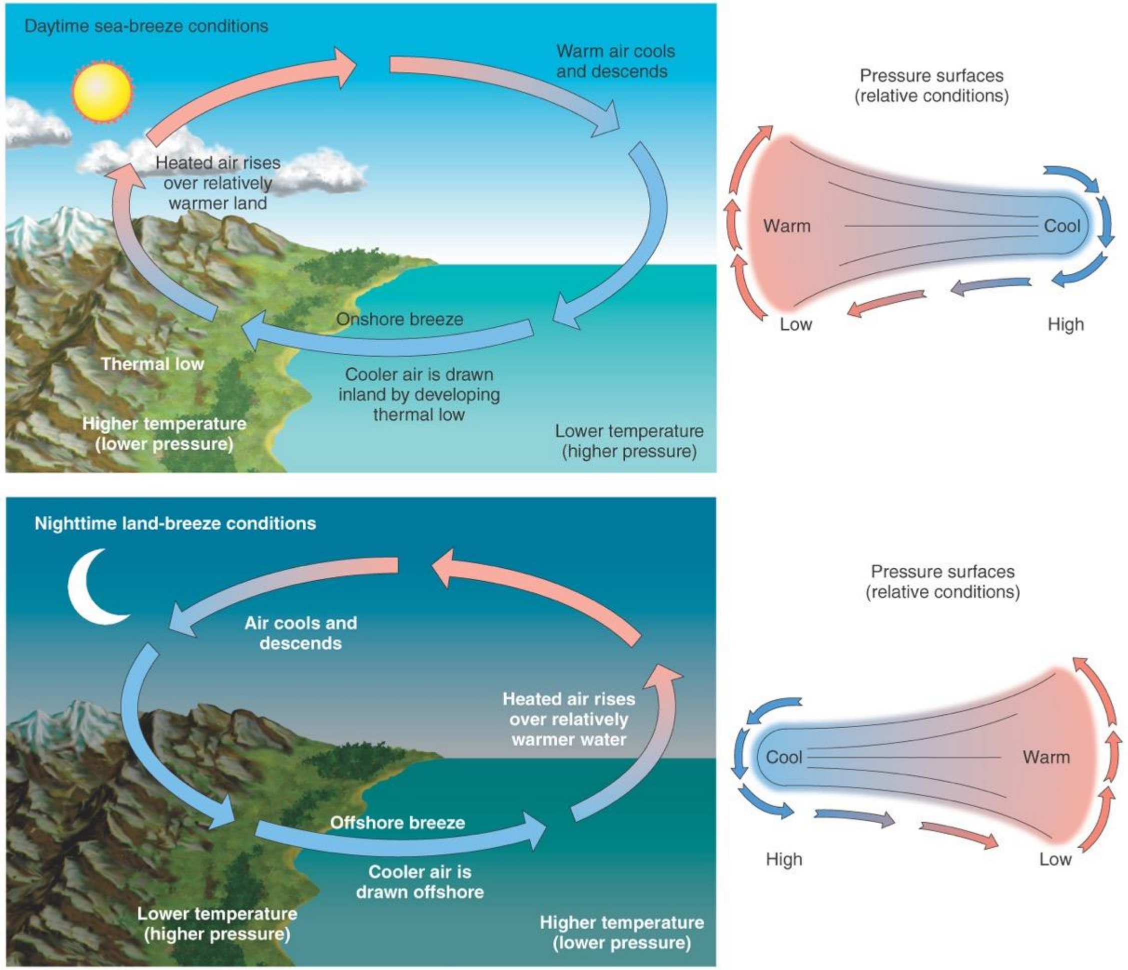
Convective Currents

- Convective currents cause that bumpy, turbulent air sometimes experienced when flying at lower altitudes during warmer weather
- On a low-altitude flight over different types of surfaces, updrafts are likely to occur over areas like pavement or sand, and downdrafts often occur over water or expansive areas of vegetation like a group of trees

Convective Currents – Land-Sea Breezes

- Differential heating and cooling is particularly prevalent near the shores of large bodies of water
- During the day, the land heats up faster than the water, so the air over the land becomes warmer and less dense. It rises and is replaced by cooler, denser air flowing in from over the water
- At night the opposite is true; the land cools faster than the water, so the warmer air over the water rises and is replaced by the cooler, denser air from the land; this creates an offshore wind call a land breeze

Convective Currents – Land-Sea Breezes



Obstructions and Wind

- Obstructions on the ground can affect the flow of wind, and this can be an unseen danger
- Ground topography and large buildings can break up the flow of the wind and create wind gusts that change rapidly in direction and speed
- Types of obstructions – anything that affects the movement of the air by deflecting it around above or below its original path
- Examples of obstructions
  - Manmade structures such as large buildings and bridges
  - Natural obstructions such as mountains, bluffs, and canyons
- All of these can cause dangerous turbulence

Turbulence

Local conditions

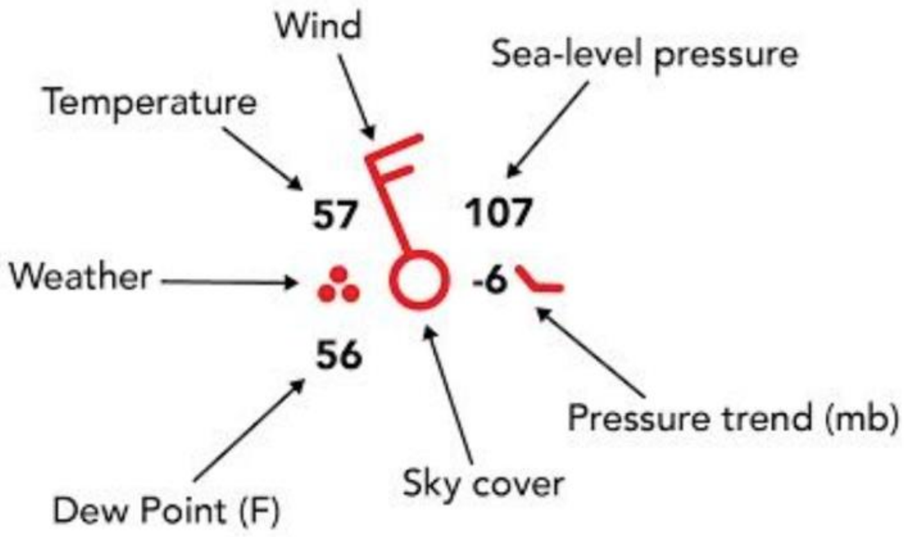
Regional conditions

Wind and Pressure Representation on Surface Weather Maps

- Surface weather maps provide information about fronts, areas of high and low pressure, and surface winds and pressures for each station
- This type of weather map allows pilots to see the locations of fronts and pressure systems, but more importantly, it depicts the wind and pressure at the surface for each location

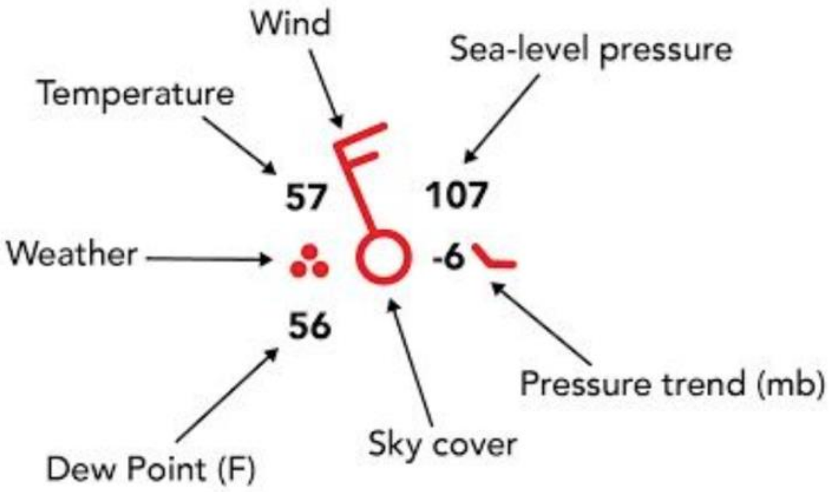
Weather Map Symbols

- Symbols on the weather map depict various conditions of surface weather
  - H – high pressure
  - L – low pressure
  - Frontal systems
  - Wind
  - Weather stations
  - Pressure (station model and isobars)



Wind Speed and Direction on Weather Map

- Winds are described by the direction from which they blow
- “Arrow” indicates where the wind is coming from and the “Feathers” indicate the speed of the wind

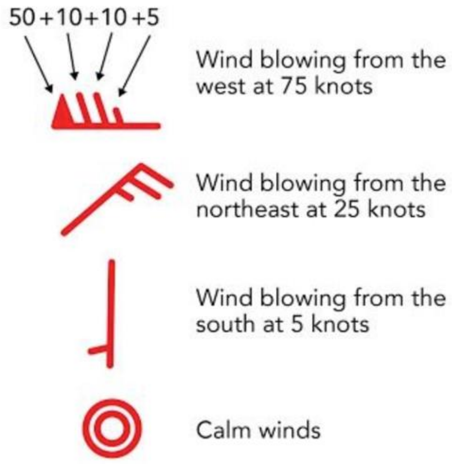


WIND

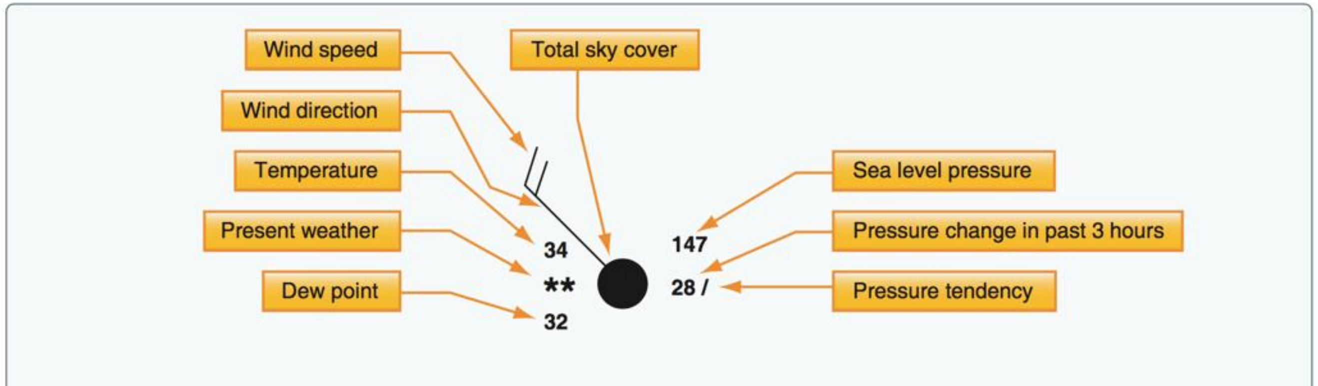
Wind is plotted in increments of 5 knots (kts), with the outer end of the symbol pointing toward the direction from which the wind is blowing. The wind speed is determined by adding up the total of pennants, lines, and half-lines, each of which has the following individual value:

Pennant: 50 kts
Line: 10 kts
Half-Line: 5 kts

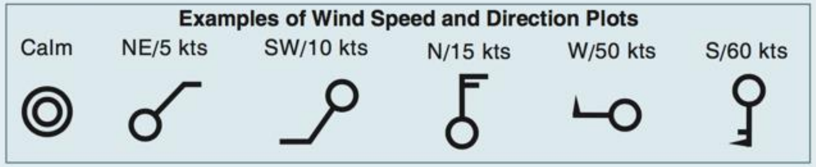
If there is only a circle depicted over the station with no wind symbol present, the wind is calm. Below are some sample wind symbols:



Weather Station Model Symbols



1. Total sky cover:	**Overcast**
2. Temperature/dew point:	**34 °F/32 °F**
3. Wind:	**From the northwest at 20 knots** (relative to true north)



4. Present weather:	**Continuous light snow**
5. Sea level pressure:	**1014.7 millibars** (mb) Note: Pressure is always shown in 3 digits to the nearest tenth of a millibar. For 1,000 mb or greater, prefix a "10" to the 3 digits For less than 1,000 mb, prefix a "9" to the 3 digits
6. Pressure change in past 3 hours:	**Increased steadily or unsteadily by 2.8 mb**

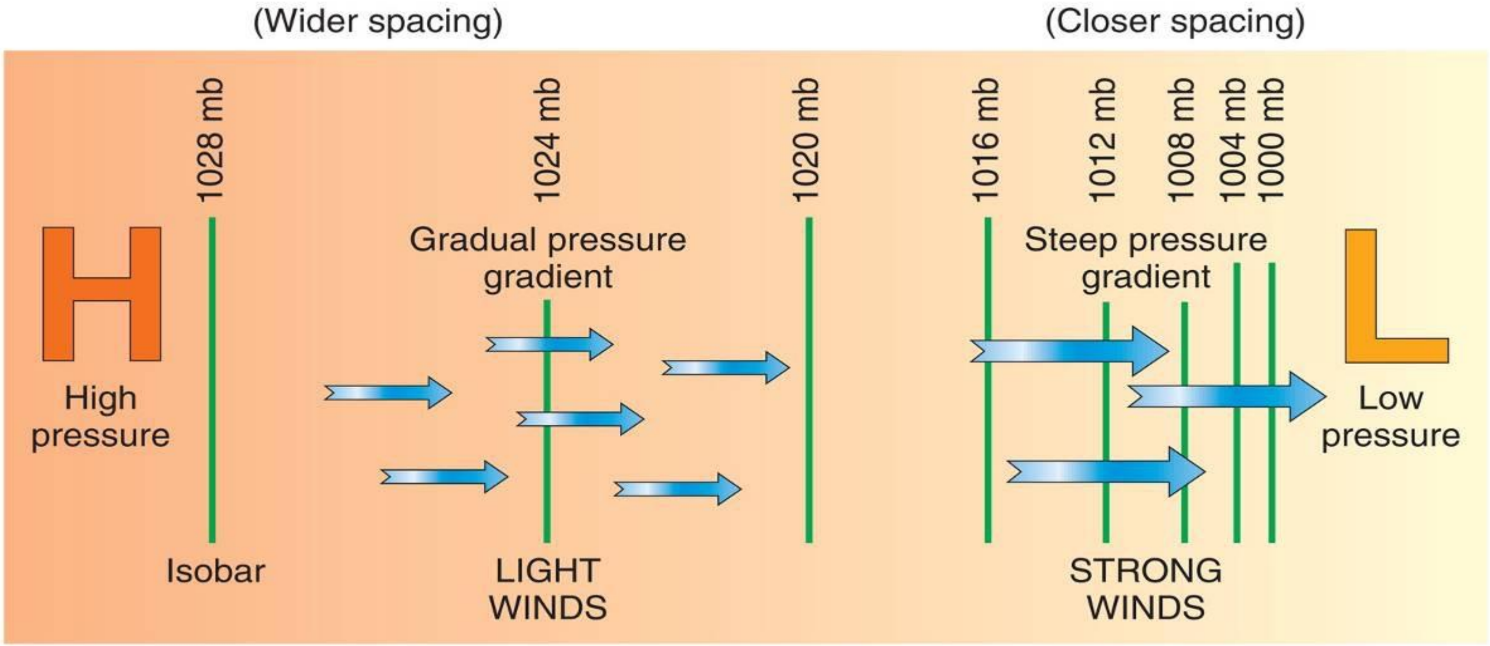
Figure 13-11. *Sample station model and weather chart symbols.*

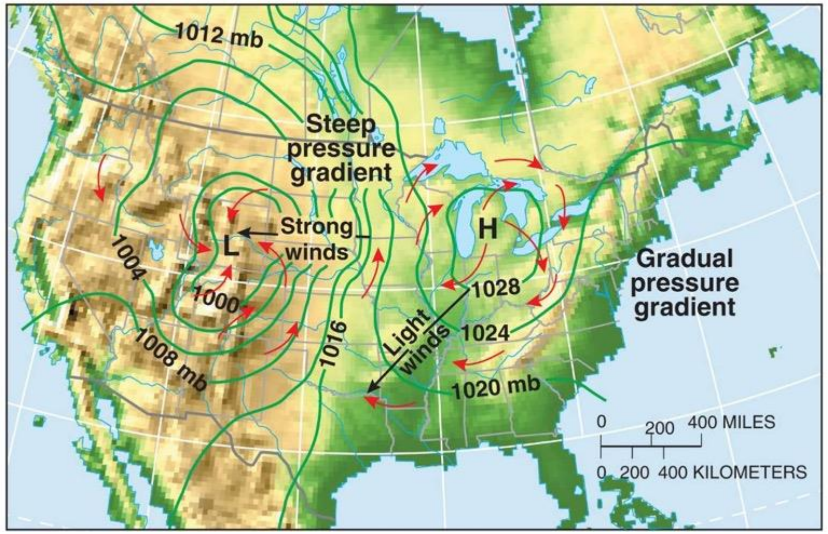
Source: Pilot Handbook of Aeronautical Knowledge

Wind and Isobars

- Isobars are similar to contour lines on a topographic map that indicate terrain altitudes and slope steepness
- Isobars that are close together indicate a steep wind gradient where strong winds prevail
- Shallow gradients, on the other hand, are represented by isobars that are spaced far apart and are indicative of light winds

Wind and the Pressure Gradient





Weather Factors and Performance

- Every physical process of weather is accompanied by (or is the result of) a heat exchange
- The stability of the atmosphere correlates with its ability to resist vertical motion
  - A stable atmosphere makes vertical movement of air difficult
  - An unstable atmosphere allows an upward or downward disturbance to grow into a vertical (or convective) current
- Instability can lead to significant turbulence, extensive vertical clouds, and severe weather

Adiabatic Heating and Cooling

- When air rises, it expands and cools, and when air descends, it compresses, and the temperature increases
- This temperature change, which takes place in all upward and downward moving air, is known as adiabatic heating and adiabatic cooling
- This is the change in pressure and therefore the temperature of air that is rising or descending