Lab

9

Mid-latitude Cyclones & Air Masses

This lab will introduce students to the patterns of surface winds around the center of a midlatitude cyclone of low pressure. The types of weather associated with low-pressure systems will be examined as well as the differences and similarities among warm and cold fronts. In addition, this lab will discuss the air masses that influence the weather and climate of North America.

Air Masses and Fronts

An **air mass** can be defined as a large body of air which exhibits like characteristics. The two main characteristics that are found to be relatively uniform within air masses are **temperature** and **humidity**. Because air masses remain stationary for extended periods of time, they take on the temperature and moisture characteristics of the land or water surfaces below them. This is true for both the surface and upper air characteristics: they become a homogenous mass. The moisture characteristics are classified as maritime (humid) or continental (dry) depending if they were formed over water or land. The temperatures are classified as equatorial (very hot), tropical (hot), polar (cold) or arctic (very Cold), depending on the geographic region over which the body of air stagnated.

The following types of air masses result:

maritime equatorial (mE)	**continental tropical (cT)**
maritime tropical (mT)	**continental polar (cP)**
maritime polar (mP)	**continental arctic (cA)**

**Maritime arctic and continental equatorial air masses rarely occur and therefore are not listed.

Air Masses

What is an Air Mass?

- **An extensive body of air that has relatively uniform temperature and humidity derived from a <u>SOURCE REGION</u>**

Source Region

- **The place where an air mass "gets" its temperature and humidity characteristics**
- **Air needs to "sit" over this area to "get" humidity & temperature (air stagnates over this area and acquires characteristics)**
- Example:

  mT

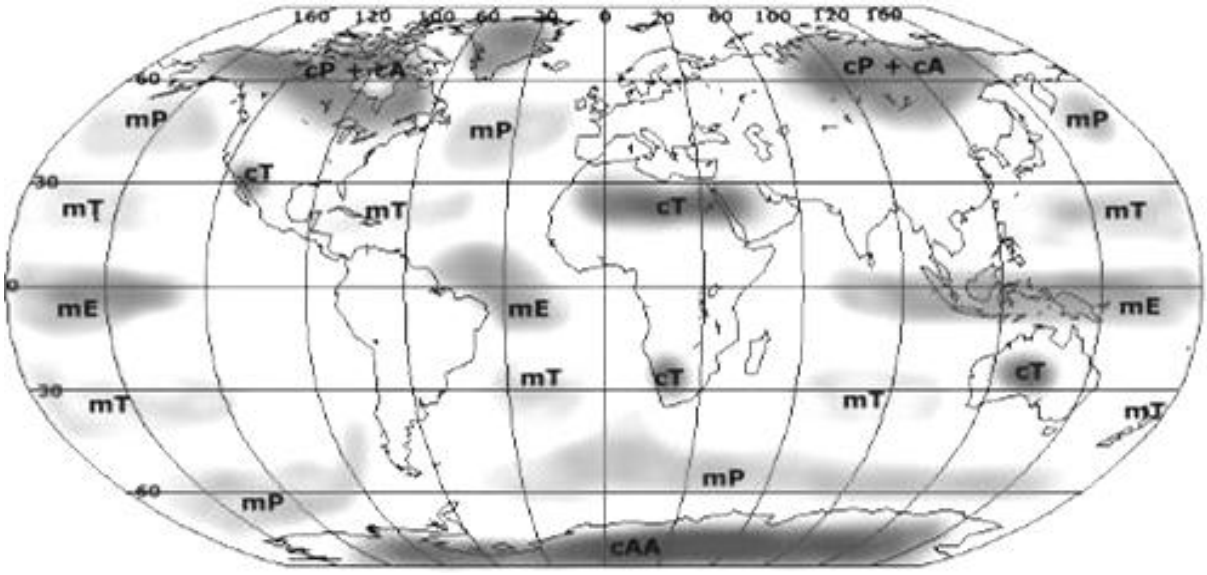
  Maritime
  Tropical
  (*Humid & Warm*)

Source Regions

- **Humidity**: Large uniform areas
  - Land = Continental = Dry
  - Water = Maritime = Humid
- **Temperature**: Latitude
  - Arctic = Very Cold
  - Polar = Cold
  - Tropical = Warm
  - Equatorial = Hot

- **Moisture:**
  - **m = Maritime (Humid)**
  - **c = Continental (Dry)**

- **Temperature**
  - **A = Arctic (Very Cold)**
  - **P = Polar (Cold)**
  - **T = Tropical (Warm)**
  - **E = Equatorial (Hot)**



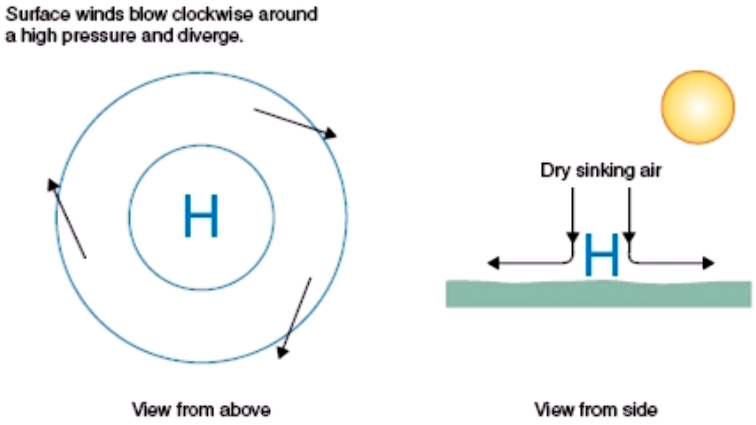
Air pressure at the surface is either **High** or **Low pressure.**

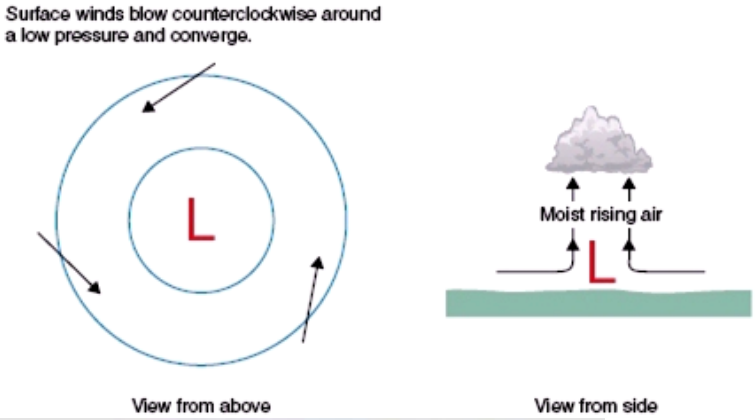
High pressure has air sinking from above and moving out from the center in a clockwise manner (**Cyclone)**

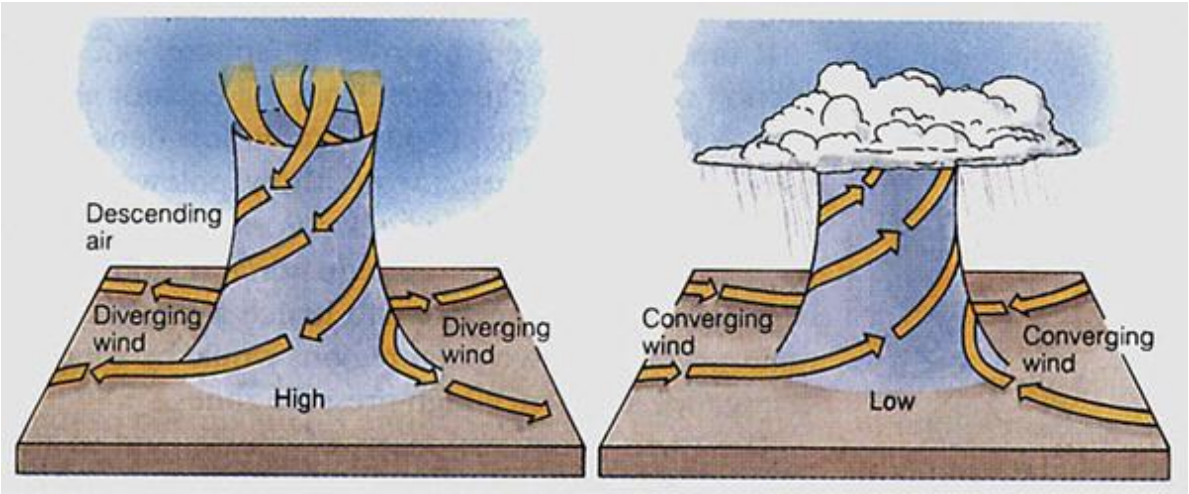
Low pressure has air rising and spinning into the low in a counter-clockwise manner **(Anti-Cyclone)**

This is why we get clear skies from high pressure (the air is sinking and warming, thus it can homd more water vapor, thus no clouds).

We expect to often see cloudy and rainy skies in low pressure because the air is rising and thus cooling and reaching saturation… then condensation begins forming clouds which often lead to precipitation.



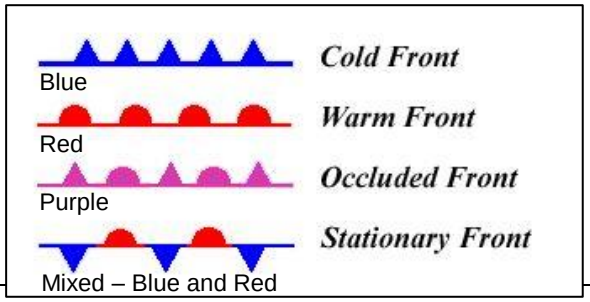




Also… Just a bit about FRONTS.

Fronts are named for the side that is overtaking the other. In a Cold Front, cold air is over taking warm air.

Front Symbols



Exercise #9 Lab Activity Name: _____

Air Masses Lab Section: _____

Please show your work. If necessary please use additional paper to show work.

Air Masses

✎ 1. Fill in each numbered circle indicating which source regions are producing each type of air mass influencing North America (mP, mT, cT, cP, cA).

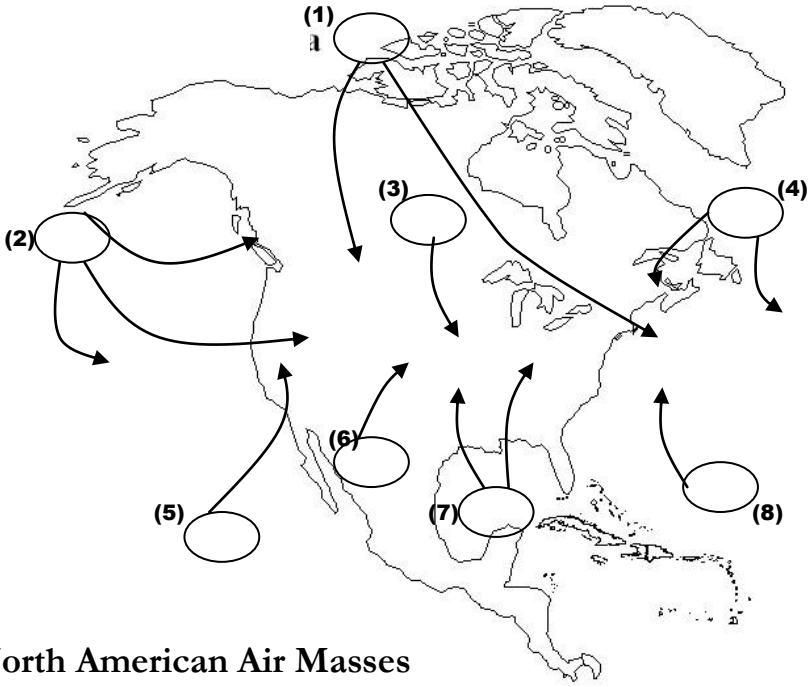
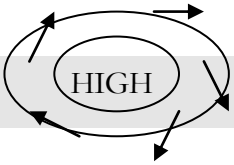


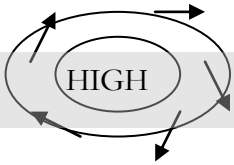
Figure 9.1 North American Air Masses

When two contrasting air masses come in contact with each other, a boundary is formed – we call this boundary a front. The fronts are found not only at the surface, but they extend aloft as well.

A cold dry cP air mass (with its source in Canada), has a high pressure area and is a clockwise out flowing wind circulation pattern.

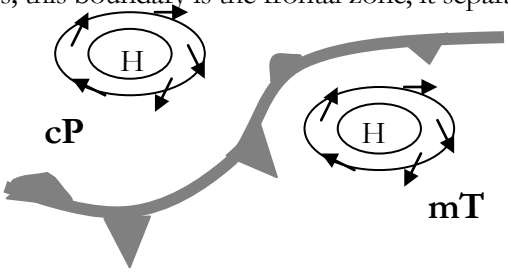
Cold & Dry		It moves SE towards the eastern US

A warm, moist mT air mass lies over the SE U.S. and the SW Atlantic Ocean of the Northern Hemisphere. This subtropical high pressure area has the same flow pattern as the Canadian high pressure region.

Warm & Moist 

It remains nearly stationary over its source.

When the cold high arrives in the vicinity of the sub-tropical high, a boundary forms between the two highs; this boundary is the frontal zone, it separates the cold, dry air from the warm, moist air.



If there is little movement involved, the boundary remains stationary and we have a stationary front. The air near the ground drifts across the surface isobars towards lower pressure. This air is warm and light – therefore, it rises. Convergence and lifting results in adiabatic cooling, condensation, clouds and eventually precipitation. Since the cold air almost always wins out in forward movement, a cold front develops, and in advance of it, a warm front. Along the frontal boundary, a low pressure area is spawned.

✎Using the air masses identified in Figure 9.1 answer the following questions:

✎2. In the winter, what kind of weather do you think will develop over New England if air masses **3)**, **4)** & **8)** all collide over the eastern United States and why?

✎ 3. In the late fall and winter, when air mass **1)** or **3)** moves along past the Great Lakes and towards the eastern US, what kind of weather would you expect in this region to the lee (east side) of the lakes?

✎ Explain why this phenomenon occurs.

✎ 4. When air mass **2)** arrives at the west coast of the US during late fall and winter it causes heavy _____ at the lower elevations of the mountains and tremendous amounts of _____ at the higher elevations.

✎ 5. Would you expect the same kind of weather in question 4 above to take place over the leeward (opposite the windward) side of the mountains? _____ Explain your answer utilizing your knowledge of the adiabatic process.

✎ 6. Southern California often experiences very severe rainstorms during the winter. Which air mass contributes most to this occurrence?

✎ 7. The very warm air masses of the US, along with high moisture content are the _____ air masses.

✎ 8. The hottest air mass of the US forms over the desert southwest. It is known as the _____ air mass. It develops due to very intense surface _____ from the sun.

✎ 9. Which air mass brings New England pleasant cool days with very low humidity during the summer?

✎ 10. While on vacation you observe some high thin cirrus clouds. Later you notice that there is a halo around the sun. Gradually the clouds lower and thicken to altostratus, then nimbostratus accompanied by steady rain. Finally you observe low stratus clouds and fog. What kind of front was approaching?

✎ 11. In the front above (question 10), warm moist air overruns the _____ air beneath it. The warm air rises slowly and is _____. _____ takes place and stratified _____ form.

✎ 12. A rather cold, dry high pressure system from Canada (associated with a cP air mass) moved southeastward towards the east coast of the US and came in contact with a warm, moist high pressure region (associated with a tropical maritime air mass) just off the east coast. The front that developed between them was a(n): **Draw the map symbol for that front.**

a) cold front
b) warm front
c) occluded front
d) stationary front

✎ 13. When a _____ front catches up to a _____ front and lifts all of the warm air aloft, what kind of a front results? **Draw the map symbol for that front.**

a) cold front
b) warm front
c) occluded front
d) stationary front

✎ 14. The west coast experienced some very severe early winter-like weather. Heavy rains, driven by gale force winds prevailed along the west coast. The Sierras and Cascades had blizzard conditions with up to four feet of snow. What types of air mass gave them that kind of weather?

✎ 15. Often New England receives nor'easters with considerable rainfall. The air masses that have supplied the needed moisture for these storms are _____ and _____ air masses.

✎ 16. Circle correct answer: Looking down on a Northern hemisphere low-pressure system (cyclone), surface winds blow **[(counterclockwise and inward) (clockwise and outward)].**