# Air Masses
# AOSC 200

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Topics for today:

Air Masses
Fronts

Lecture 20
Nov 5 2019





## Air Masses

What is an air mass?

Large body of air whose temperature and humidity are the same in any horizontal direction

Can cover huge areas (hundreds of thousands sq mi)

Influenced by the surface over which they form (source region)

Longer the air stays over source region the more it takes on characteristics of that region

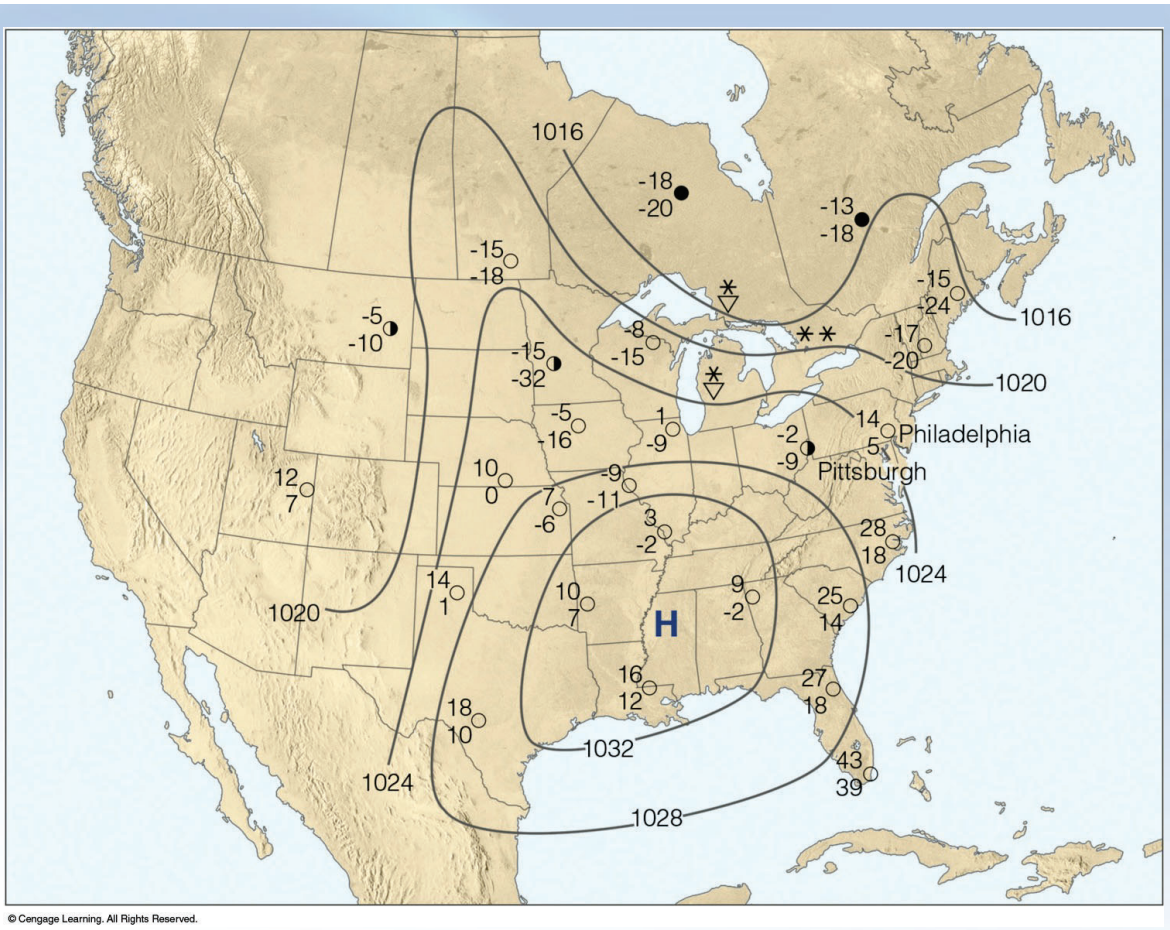
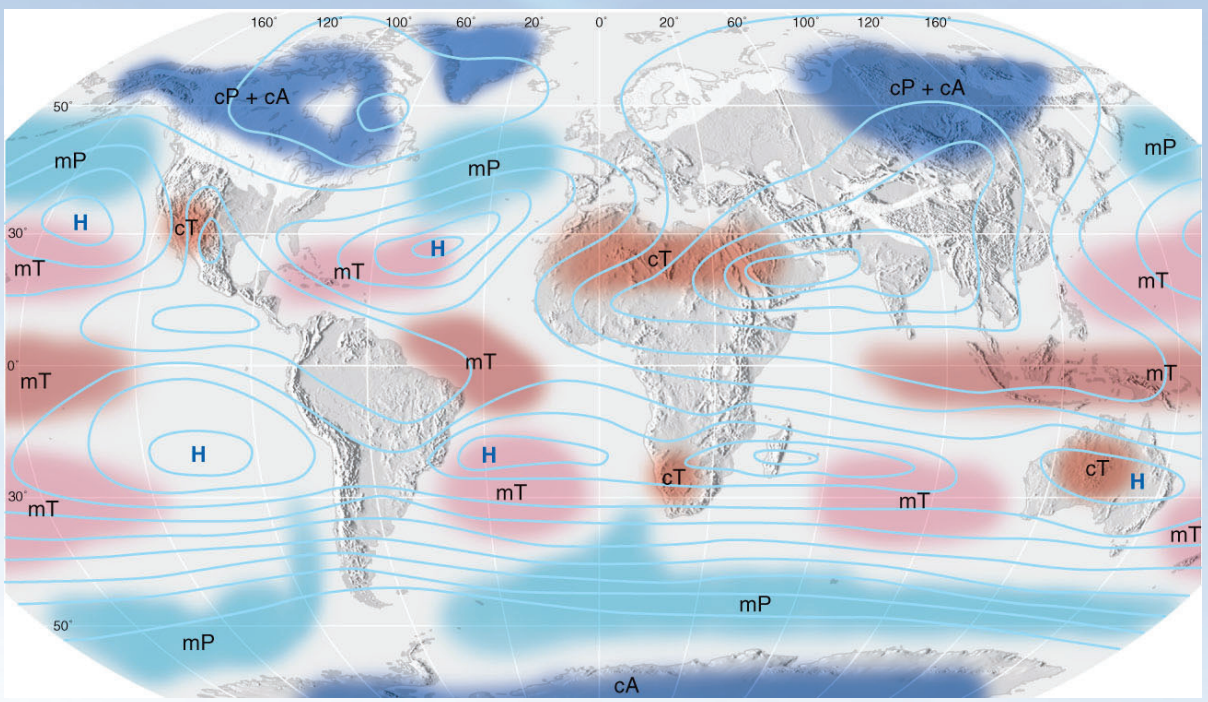





**Fig 8.1:** ***Essentials of Meteorology***



# Air Mass Source Regions




**Characteristics of air mass depends on source region**

**Fig 9-3** *Meteorology: Understanding the Atmosphere*

# Air Mass Source Regions

**TABLE 8.1 Air Mass Classification and Characteristics**

| SOURCE REGION | ARCTIC REGION (A) | POLAR (P) | TROPICAL (T) |
|---|---|---|---|
| *Land* | *cA* | *cP* | *cT* |
| Continental (c) | extremely cold, dry, stable; ice- and snow-covered surface | cold, dry, stable | hot, dry, stable air aloft; unstable surface air |
| *Water* | | *mP* | *mT* |
| Maritime (m) | | cool, moist, unstable | warm, moist; usually unstable |



**Remember: Continental = dry**
**Maritime = moist**

**First letter: surface category**
**Second letter: location category**

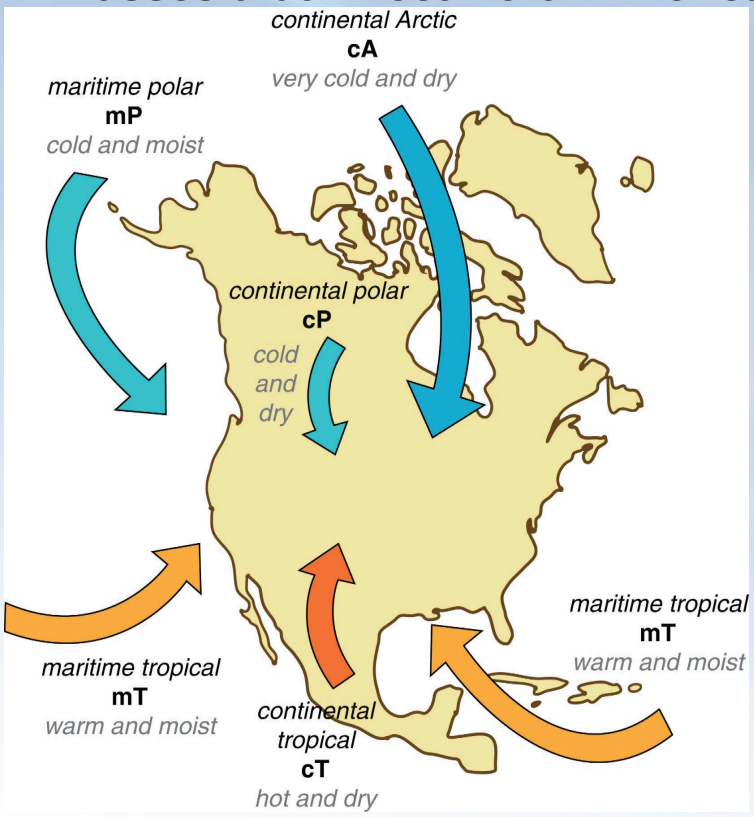
**cT = *c*ontinental *T*ropical**

Table 8.1: *Essentials of Meteorology*





# Air Masses that Affect North America




**Arrows indicate general direction of air flow**

**Fig 10.1** *Weather: A Concise Introduction*

## Continental Polar (cP) and Continental Arctic (cA) Air

Cold to extremely cold and dry air masses

cP air comes from Canada and can head as far south as Florida

cA forms over frozen Arctic bringing bitterly cold temperatures

Sometimes called “Siberian Express”

Strong winds and blowing snow can lead to blizzards




## Maritime Polar Air (mP)

Form over oceans at high latitudes, cool to cold and humid

In winter, mP from Pacific begin as cP from Siberia

These systems run into west coast mountains and dump lots of snow (orographic forcing)

On East coast, mP brings in moist air from Atlantic over land where it meets with cP air

Can lead to large snowfalls!!!

# Maritime Polar Air (mP)

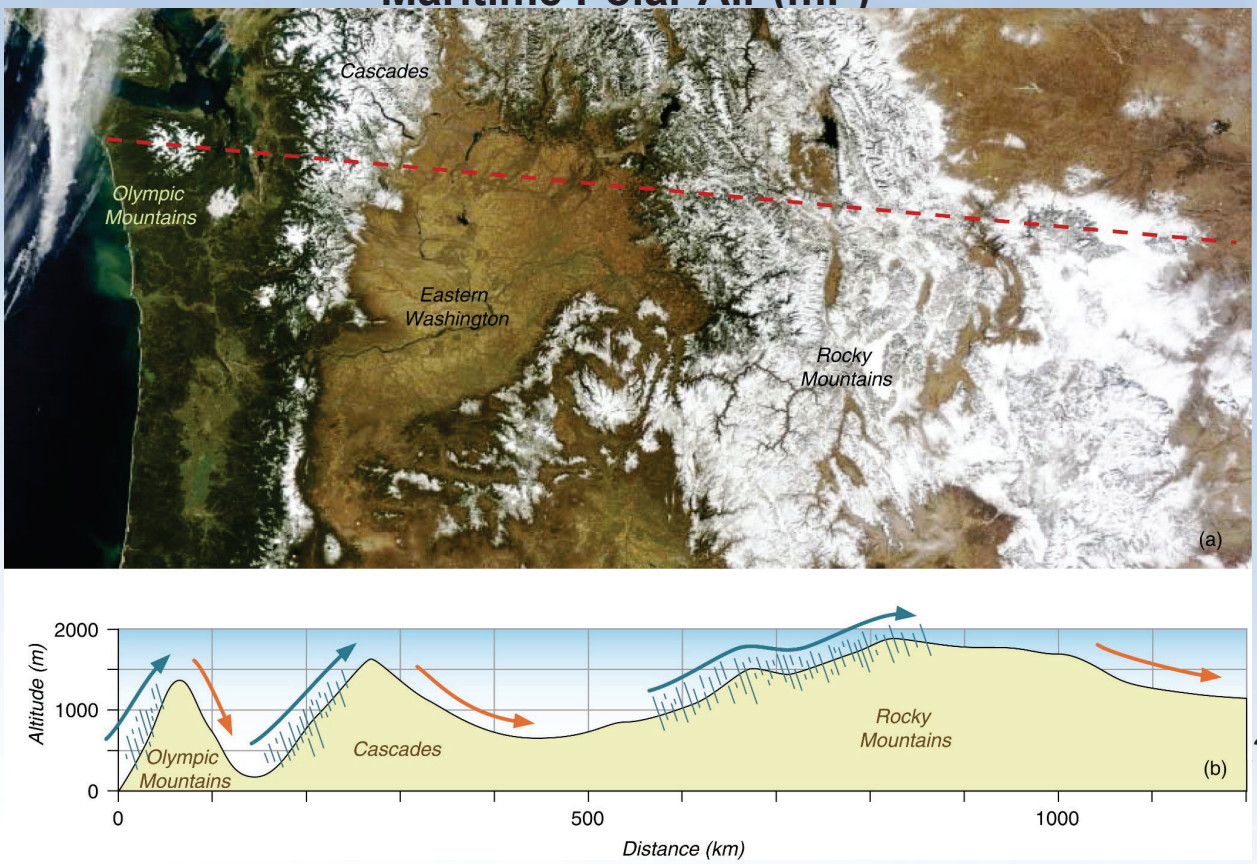



**Fig 6.9** *Weather: A Concise Introduction*





# Maritime Polar Air (mP)

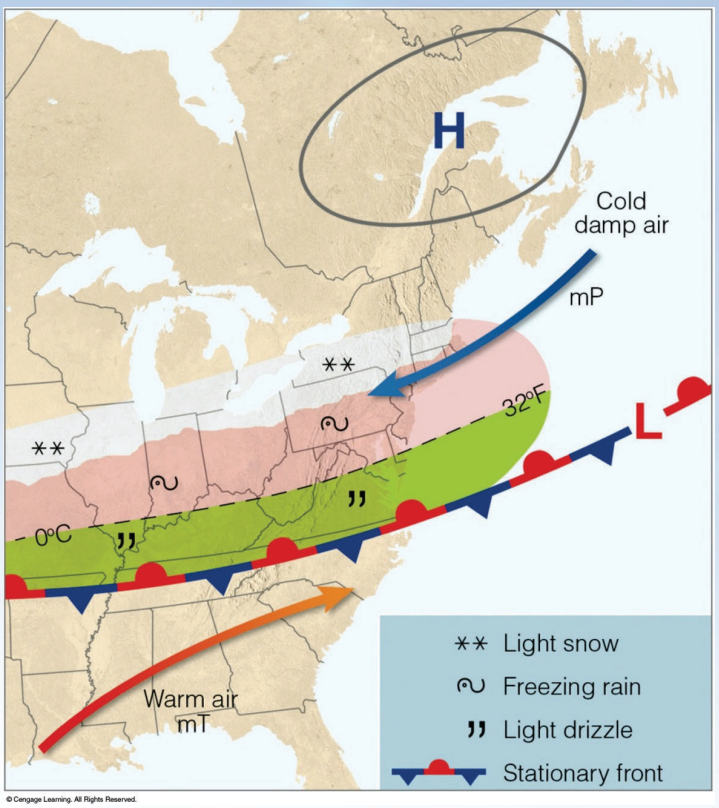
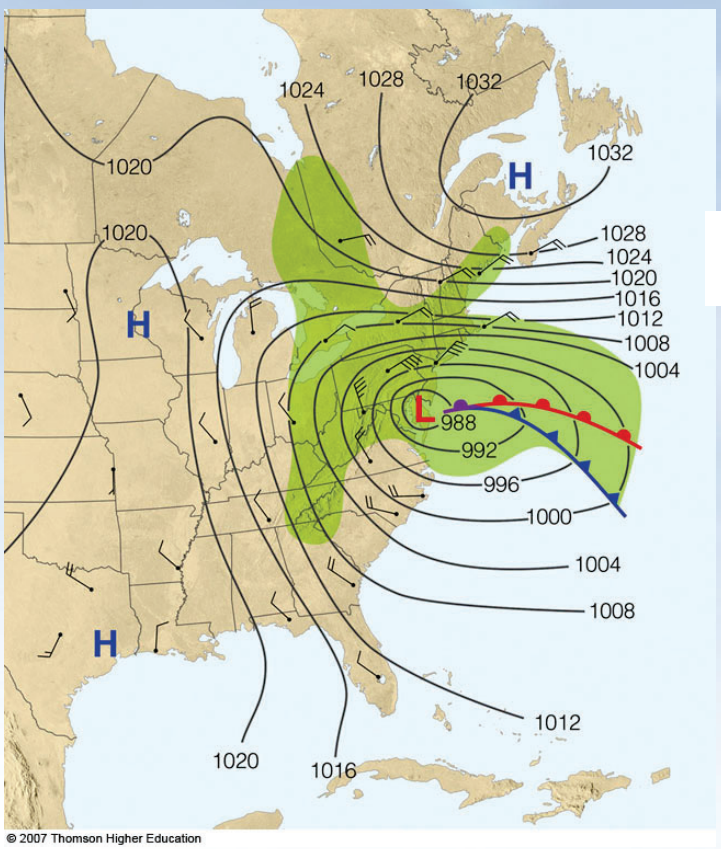



**Table 8.8:** ***Essentials of Meteorology***

# Maritime Polar Air (mP), Dec 11, 1992




**"Nor'easter": cyclone that moves to the Northeast**

Table 8.U3: ***Essentials of Meteorology***





# Maritime Tropical Air (mT)

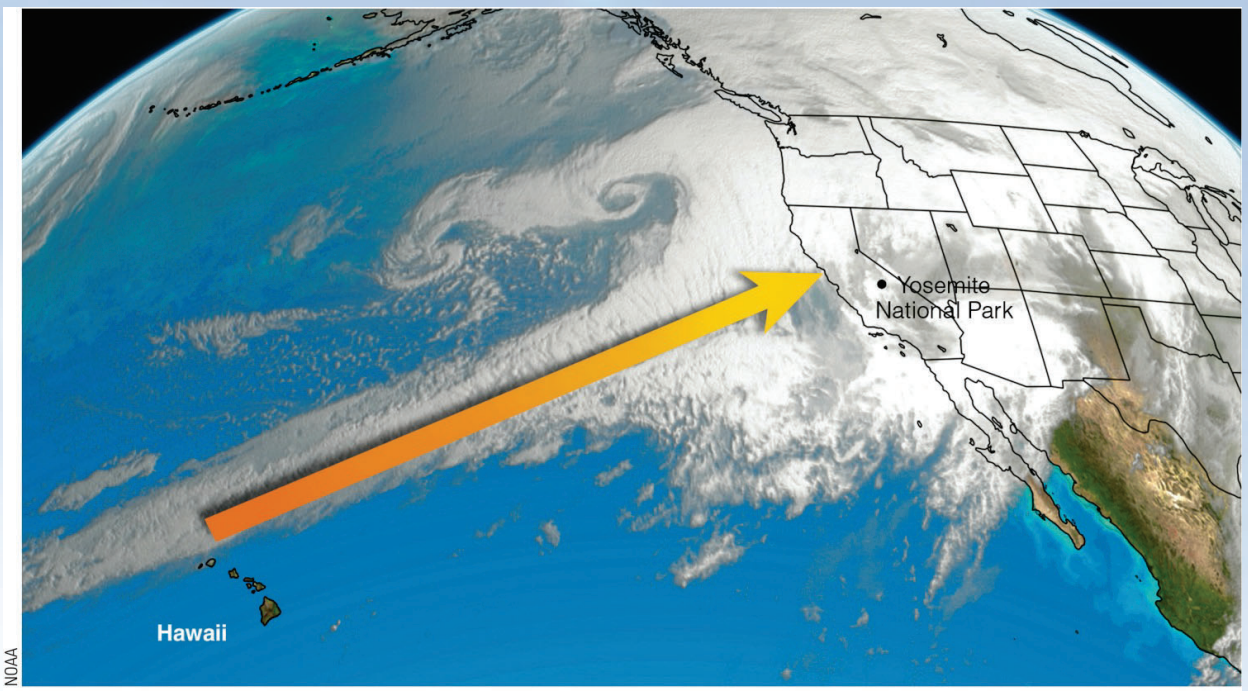
**Eastern U.S. strongly affected by mT air that forms over Gulf of Mexico, Caribbean Sea, and subtropical western Atlantic Ocean**

**Stable air mass leads to oppressive heat wave**

**Wintertime precipitation over Central and Eastern U.S. due to uplift of mT air over cold air masses**

**Western U.S. strongly affected by mT air from Pacific**

# Maritime Tropical Air (mT)



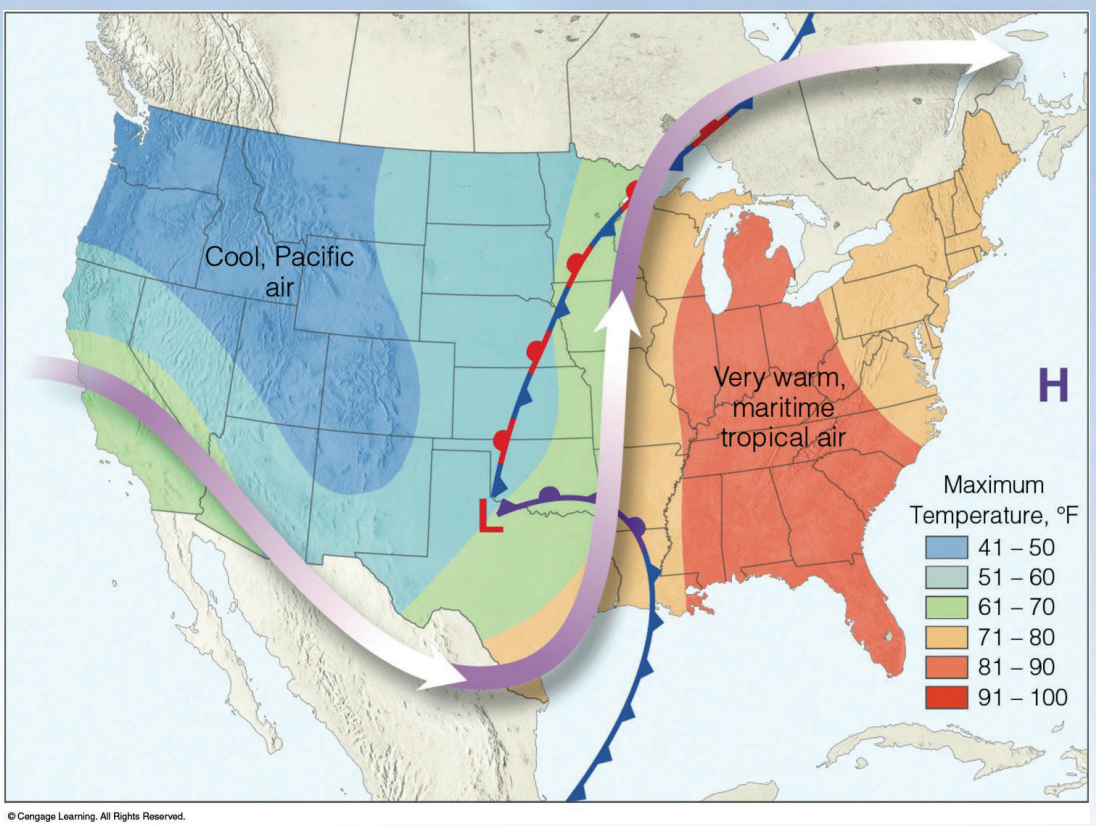

**"Pineapple Express" Jan 1, 1997**



**Fig 8.9: *Essentials of Meteorology***



# Maritime Tropical Air (mT)

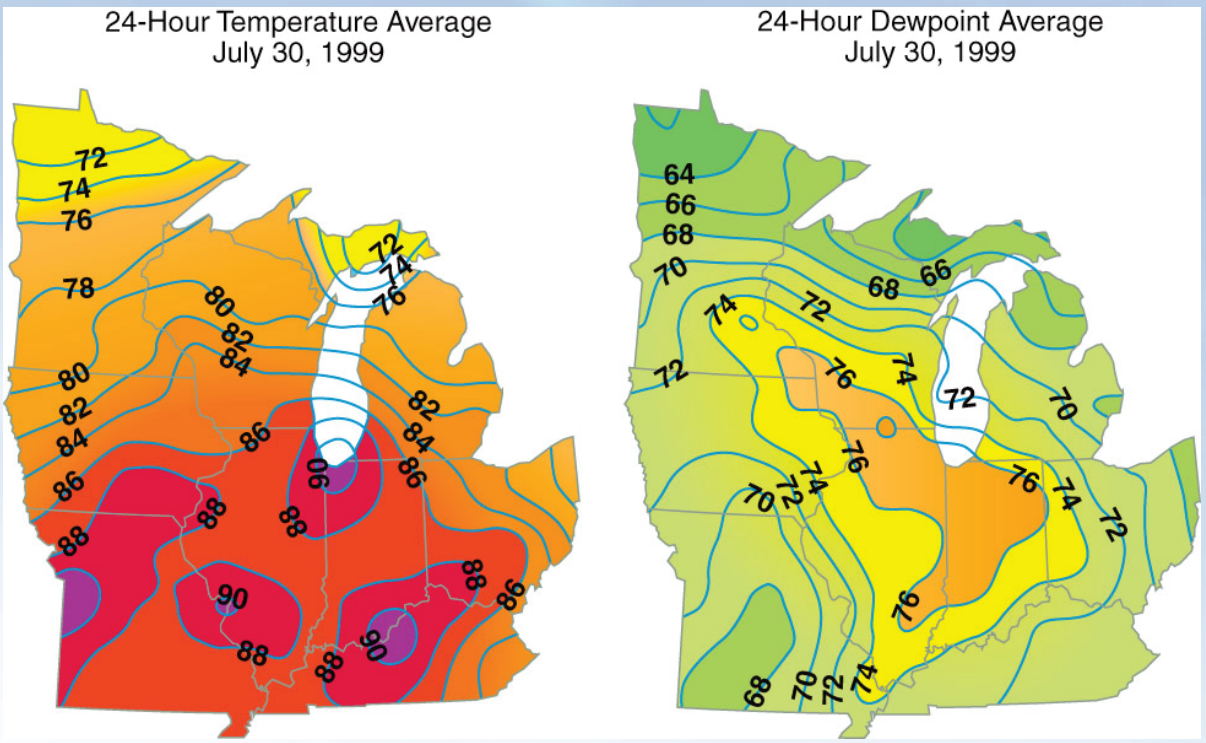



**March 2012**



**Fig 8.11: *Essentials of Meteorology***

# Maritime Tropical Air (mT)




**Heat wave in 1999 led to 232 deaths**

**Fig 9-8** *Meteorology: Understanding the Atmosphere*





# Continental Tropical Air (cT)

**Form over tropical and subtropical deserts and plateaus**

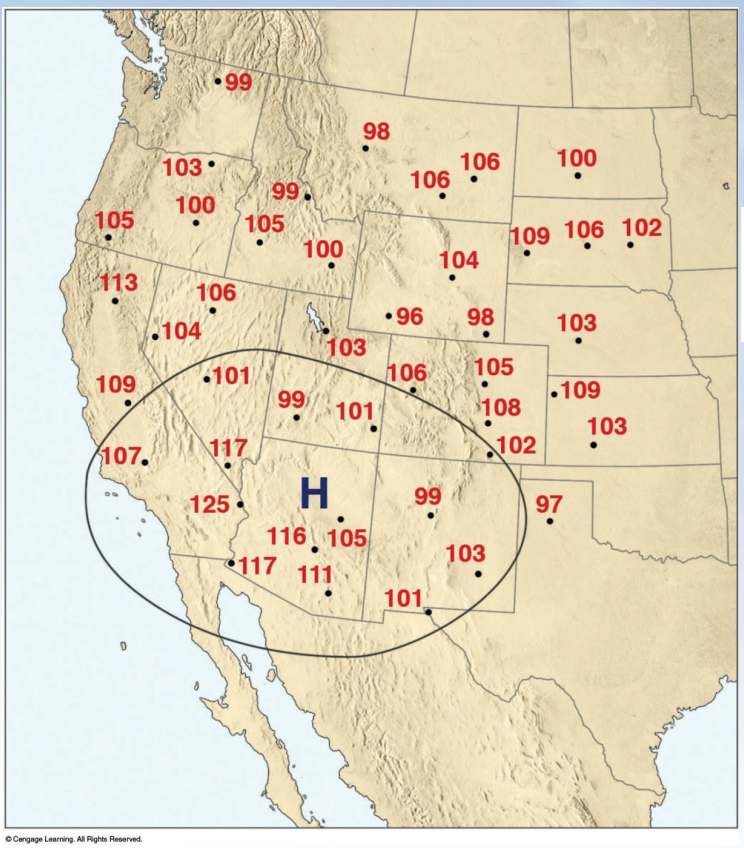
**In North America, formed in southwest and N. Mexico**

**Air mass is hot and dry**

**When cT and mT air meet, contrast between systems is called the "dry line"**

**In summer, large supercell storms often form at dry line, conducive to tornado development**

# Continental Tropical Air (cT), July 14-22, 2005



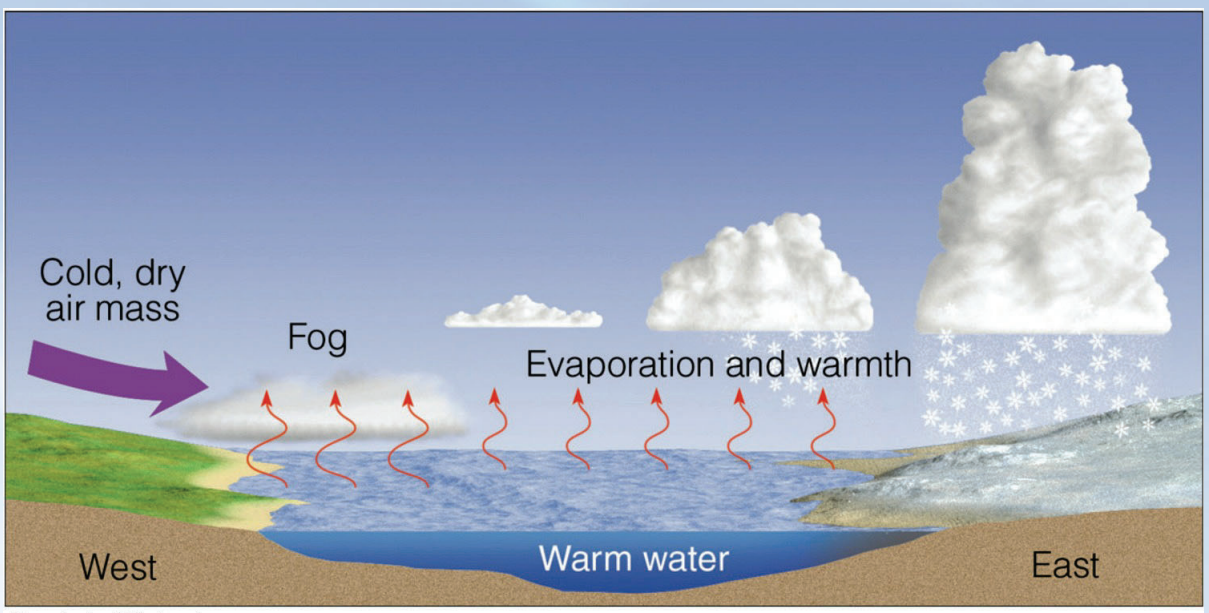

**Sinking upper level air (Hadley Cell) is shown (H), leading to hot, dry conditions at surface**



**Fig 8.12: *Essentials of Meteorology***



# Lake Effect Snow




**Cold Polar or Arctic air blows over warm water and picks up moisture and drops snow on downwind side of lake**

**Snow can fall in distinct bands**



**Fig 8.U2: *Essentials of Meteorology***

# Lake Effect Snow

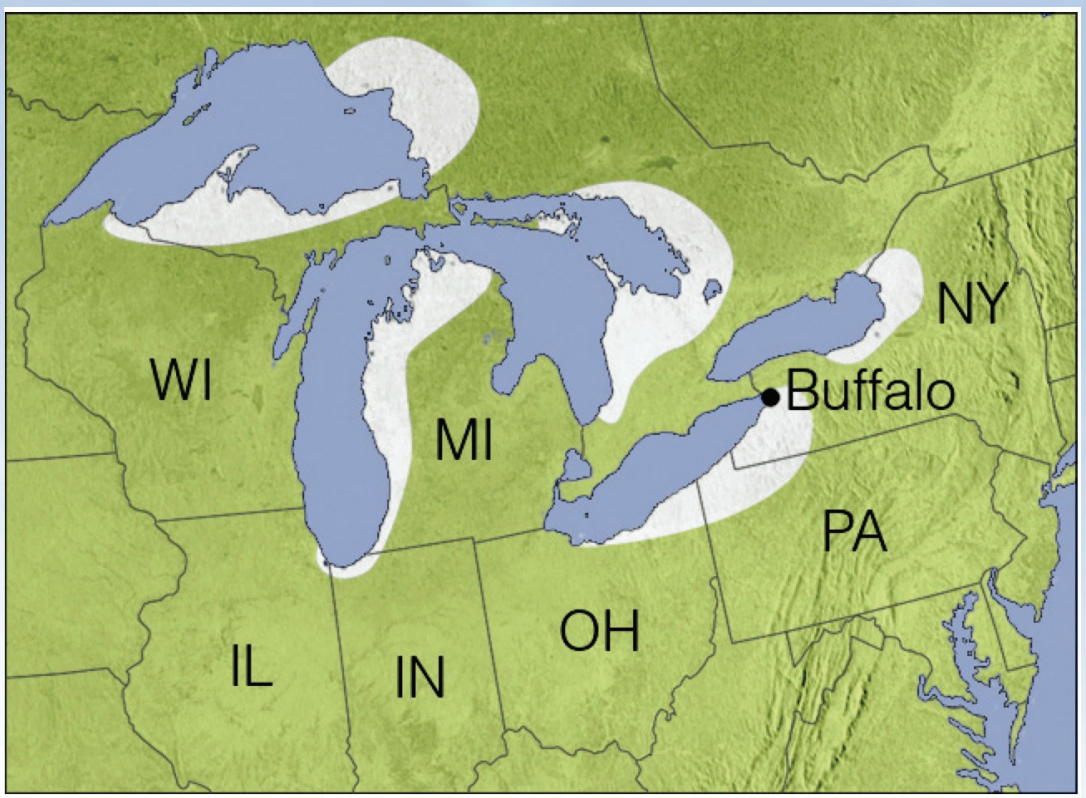




Fig 8.U1: ***Essentials of Meteorology***





# Fronts

**Front: transition between two air masses**

**The upward extension of the front is called the "Frontal Zone"**

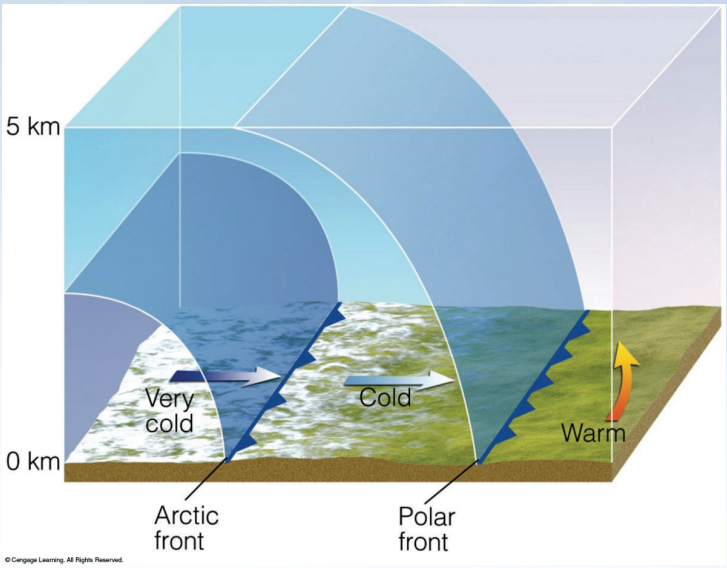




Fig 8.13: ***Essentials of Meteorology***

# Fronts

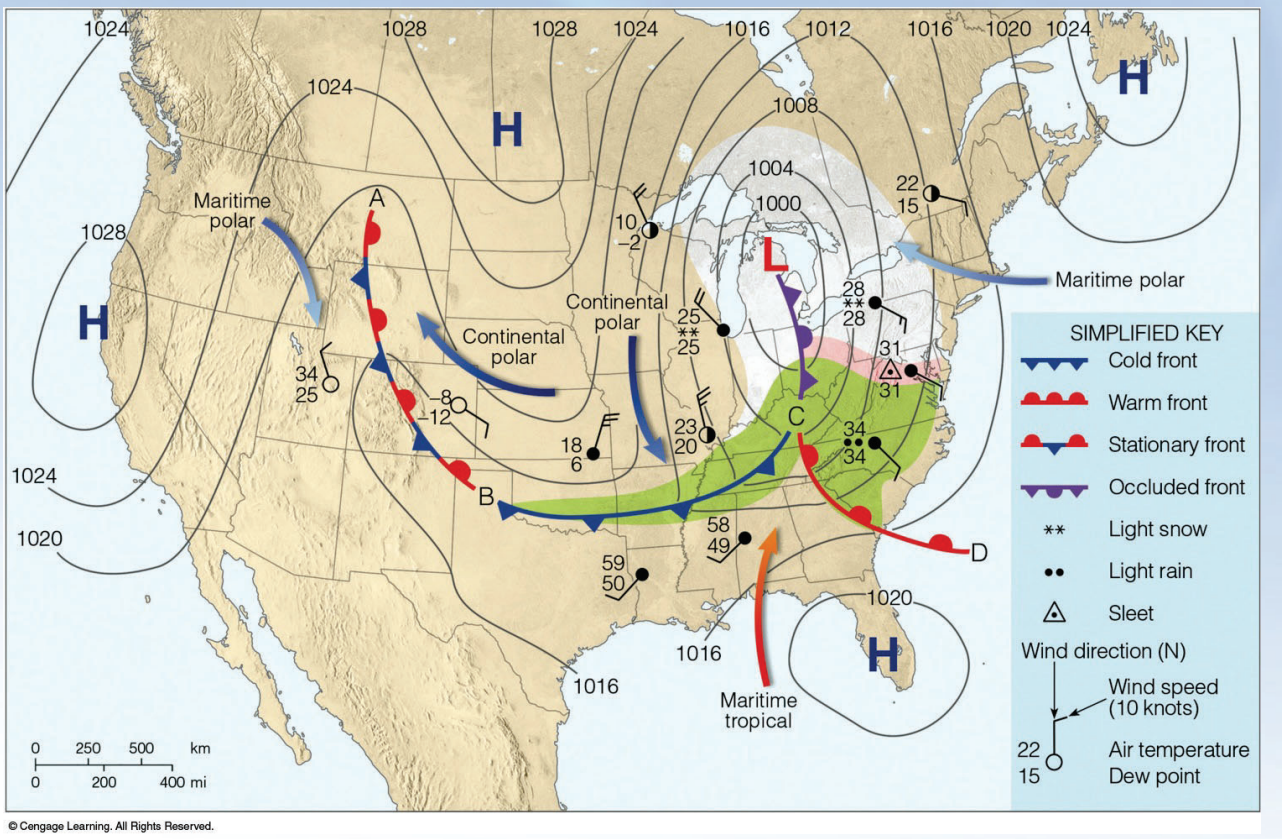
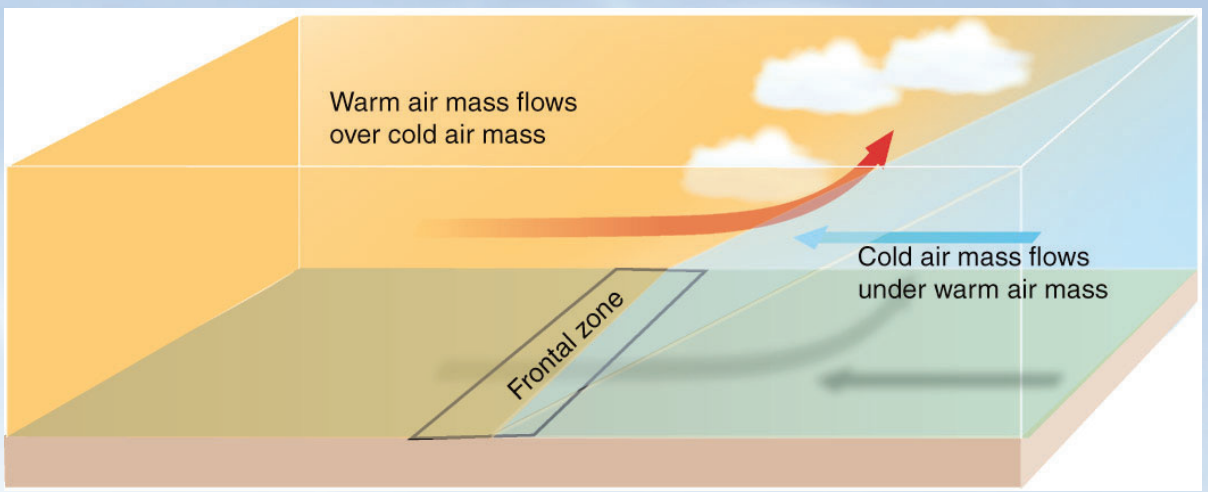



**Fig 8.14:** ***Essentials of Meteorology***





# Fronts




## Warm air flows over cold air mass… why?

**Fig 9-11** *Meteorology: Understanding the Atmosphere*

# Cold Fronts

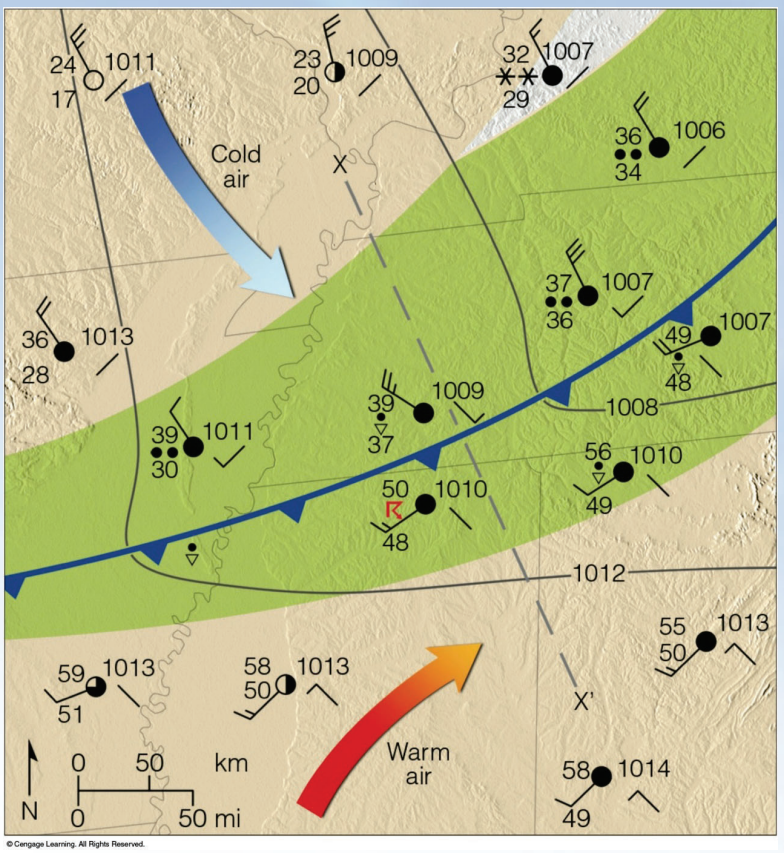
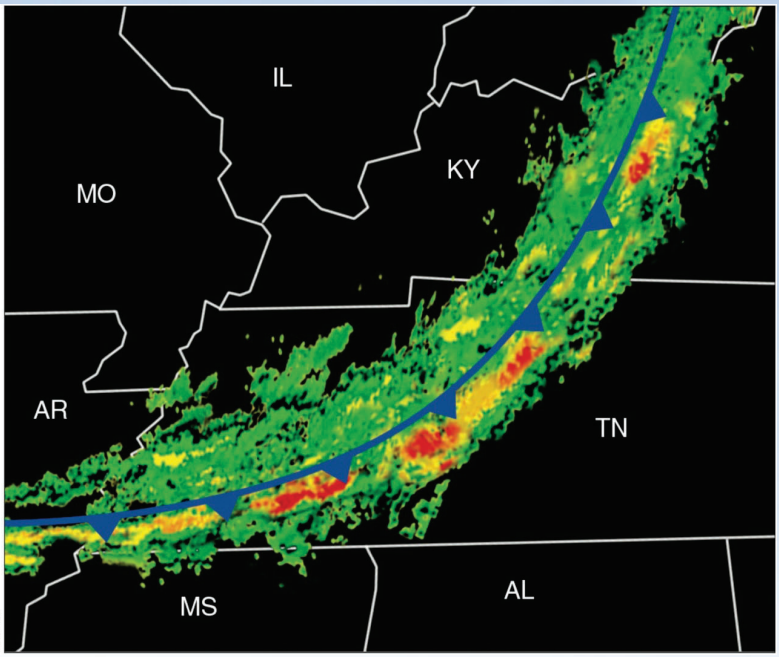



Fig 8.15: ***Essentials of Meteorology***





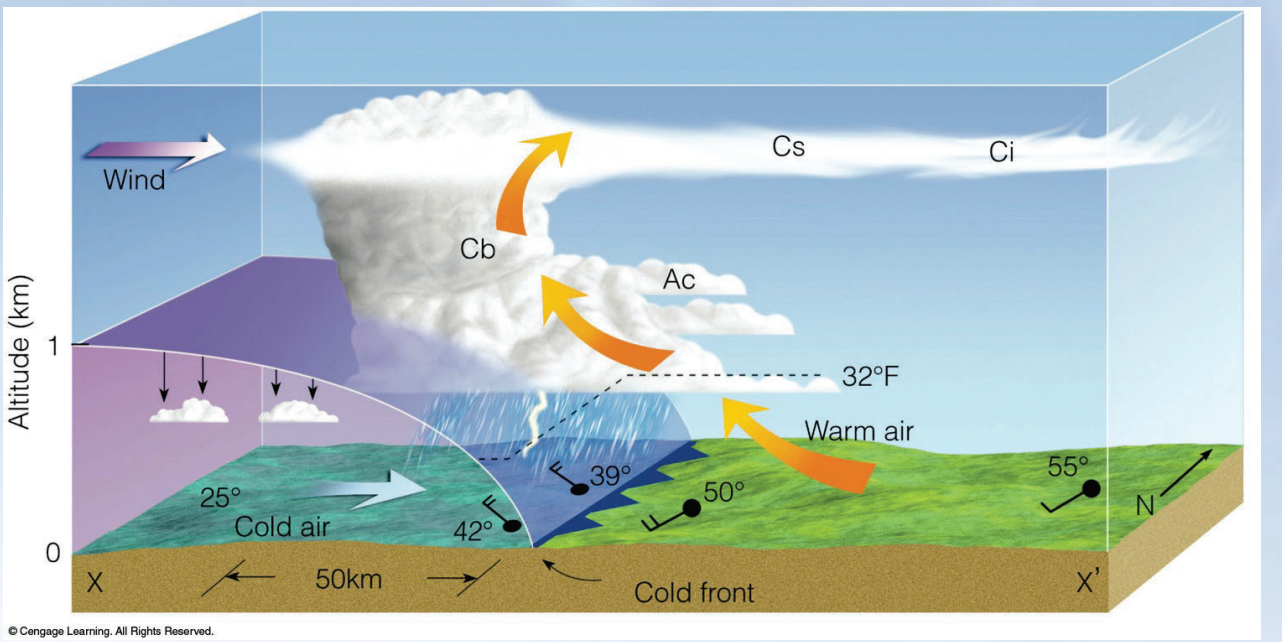
# Cold Fronts




**Doppler image of precipitation along a cold front**

Fig 8.16: ***Essentials of Meteorology***

# Cold Fronts





**Represented as blue triangles pointing toward warm air**

**Travels ~25 knots**

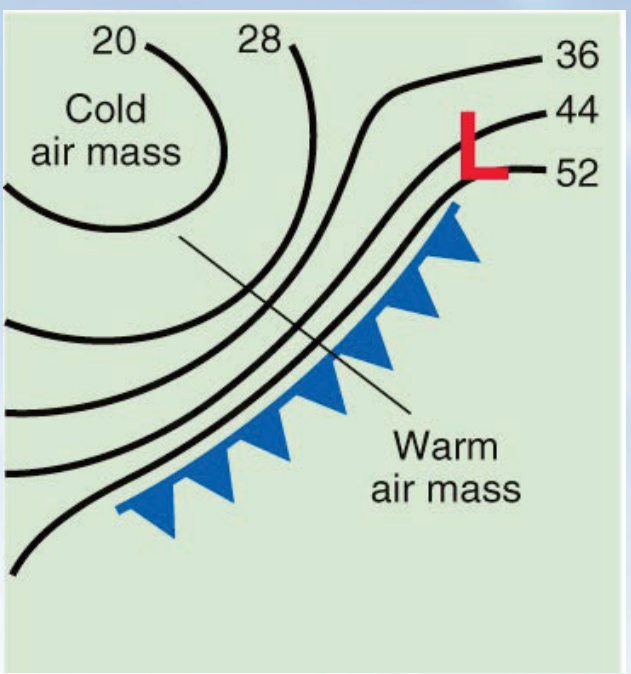
**Warm air forced up, cools, releases latent heat, leads to storms**

**Fig 8.17:** ***Essentials of Meteorology***





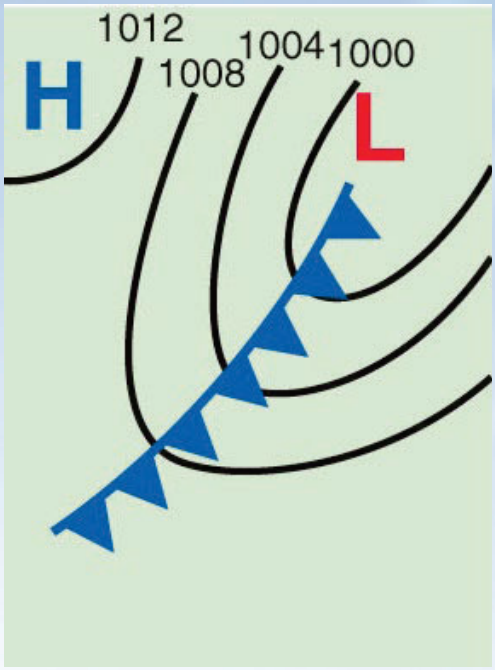
# Cold Fronts




**As cold front moves through, temps. hold steady then drop**

**Fig 9-13** *Meteorology: Understanding the Atmosphere*

# Cold Fronts




**As cold front moves through, temps. hold steady then drop**

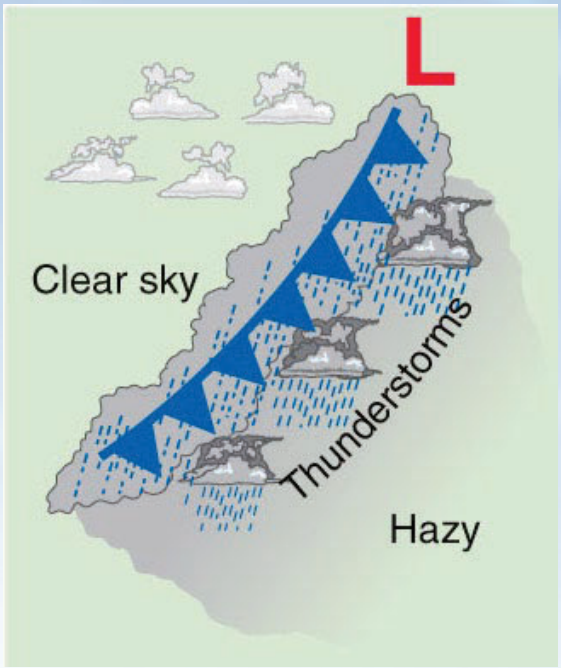
**Pressure drops then rises after front passes**

**Fig 9-13** *Meteorology: Understanding the Atmosphere*





# Cold Fronts



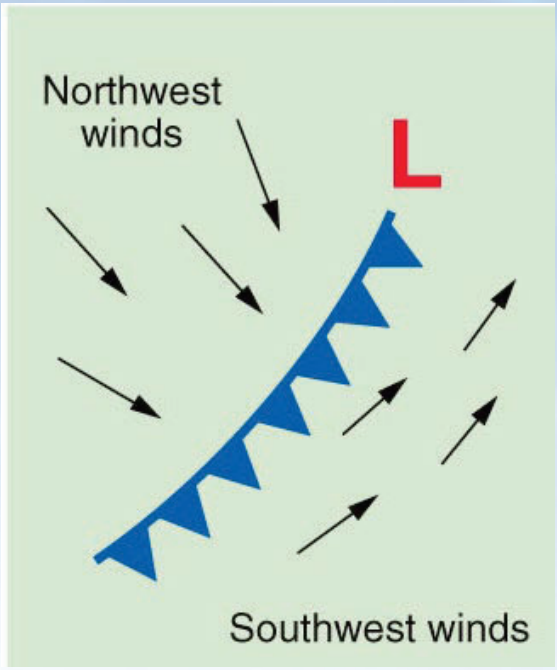

**As cold front moves through, temps. hold steady then drop**

**Pressure drops then rises after front passes**

**Precipitation forms along leading edge of front, "squall line"**

**Fig 9-13** *Meteorology: Understanding the Atmosphere*

# Cold Fronts




**As cold front moves through, temps. hold steady then drop**

**Pressure drops then rises after front passes**

**Precipitation forms along leading edge of front, "squall line"**

**Winds shift from southwest to northwest**

**Cold fronts generally move to the south, southeast, or east**

**Fig 9-13** *Meteorology: Understanding the Atmosphere*





# Cold Fronts

**TABLE 8.2 Typical Weather Conditions Associated with a Cold Front in Winter in the Northern Hemisphere**

| WEATHER ELEMENT | BEFORE PASSING | WHILE PASSING | AFTER PASSING |
|---|---|---|---|
| Winds | South or southwest | Gusty, shifting | West or northwest |
| Temperature | Warm | Sudden drop | Steadily dropping |
| Pressure | Falling steadily | Minimum, then sharp rise | Rising steadily |
| Clouds | Increasing Ci, Cs, then either Tcu* or Cb* | Tcu or Cb | Often Cu, Sc* when ground is warm |
| Precipitation | Short period of showers | Heavy showers of rain or snow, sometimes with hail, thunder, and lightning | Decreasing intensity of showers, then clearing |
| Visibility | Fair to poor in haze | Poor, followed by improving | Good, except in showers |
| Dew point | High; remains steady | Sharp drop | Lowering |

*Tcu stands for towering cumulus, such as cumulus congestus; whereas Cb stands for cumulonimbus. Sc stands for stratocumulus.



**Table 8.2:** ***Essentials of Meteorology***

# Warm Fronts

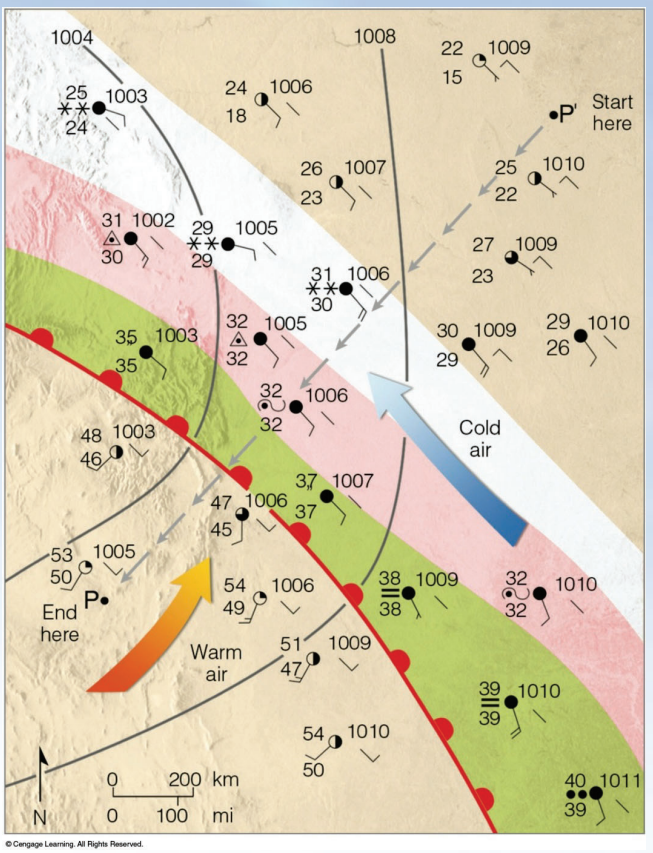
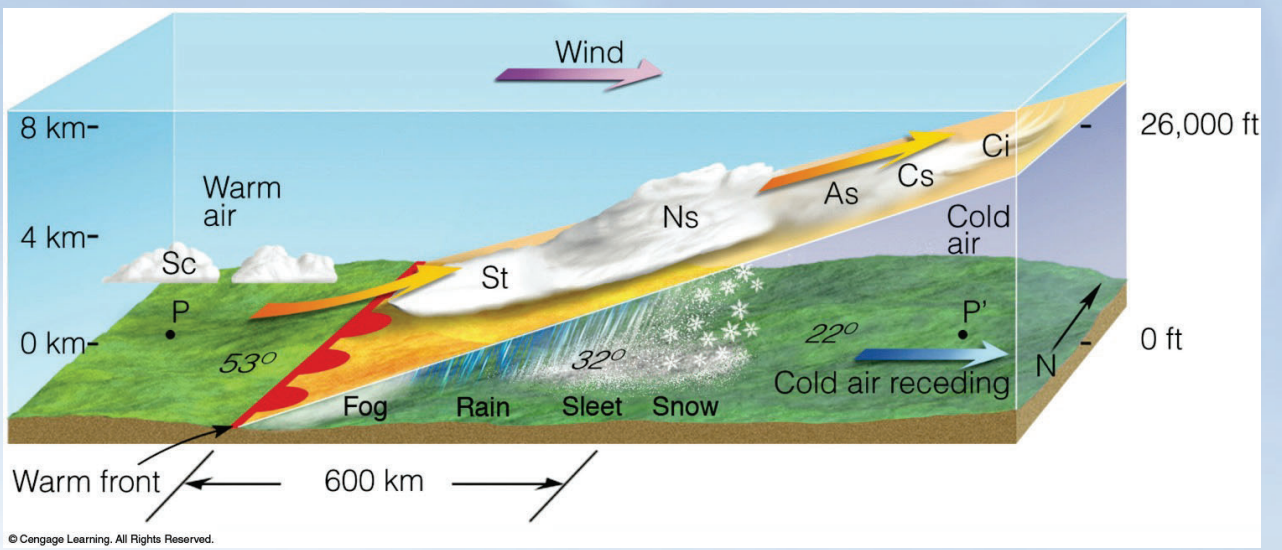



**Fig 8.19:** ***Essentials of Meteorology***





# Warm Fronts




**Represented as red semi-circles pointing toward cold air**

**Travels ~10 knots**

**Warm air slides over cold air and slowly cools.**

**Clouds form starting with cirrus, then various layers of stratus**

**Fig 8.20:** ***Essentials of Meteorology***

# Warm Fronts

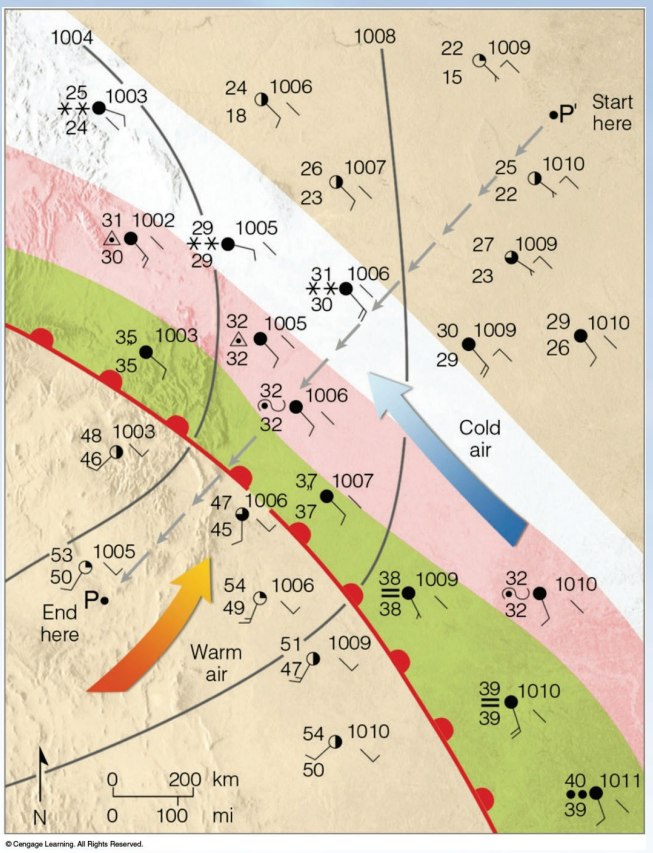
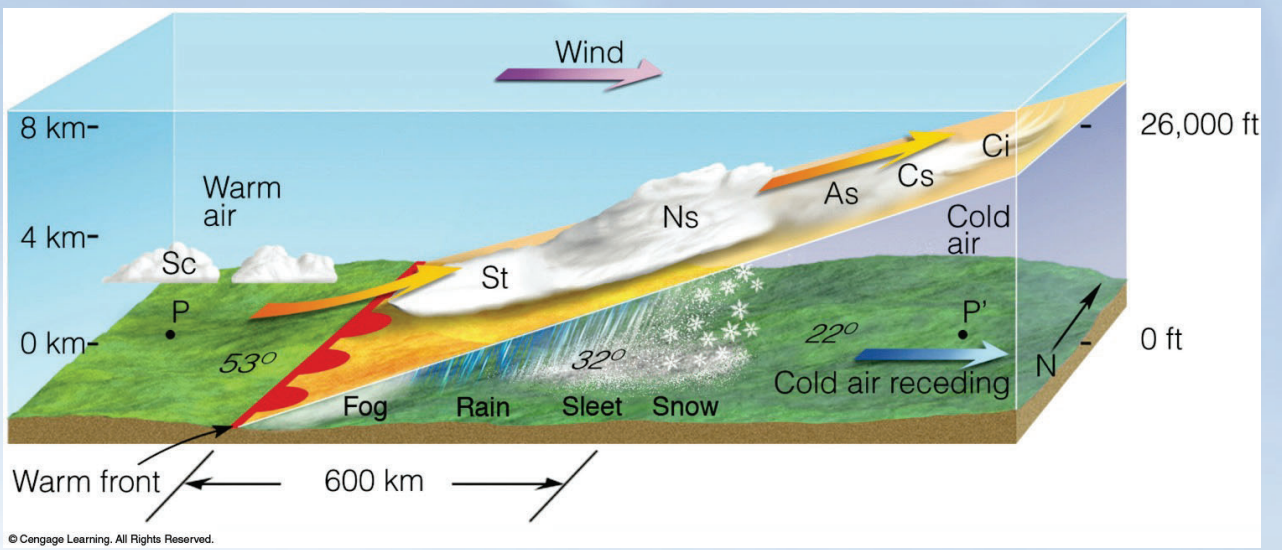



**Fig 8.19:** ***Essentials of Meteorology***





# Warm Fronts




**Winds change from south or southeast to south or southwest**

**Fig 8.20:** ***Essentials of Meteorology***

# Warm Fronts

**TABLE 8.3 Typical Weather Conditions Associated with a Warm Front in the Northern Hemisphere**

| WEATHER ELEMENT | BEFORE PASSING | WHILE PASSING | AFTER PASSING |
|---|---|---|---|
| Winds | South or southeast | Variable | South or southwest |
| Temperature | Cool to cold, slow warming | Steady rise | Warmer, then steady |
| Pressure | Usually falling | Leveling off | Slight rise, followed by fall |
| Clouds | In this order: Ci, Cs, As, Ns, St, and fog; occasionally Cb in summer | Stratus-type | Clearing with scattered Sc, especially in summer; occasionally Cb in summer |
| Precipitation | Light-to-moderate rain, snow, sleet, or drizzle; showers in summer | Drizzle or none | Usually none; sometimes light rain or showers |
| Visibility | Poor | Poor, but improving | Fair in haze |
| Dew point | Steady rise | Steady | Rise, then steady |

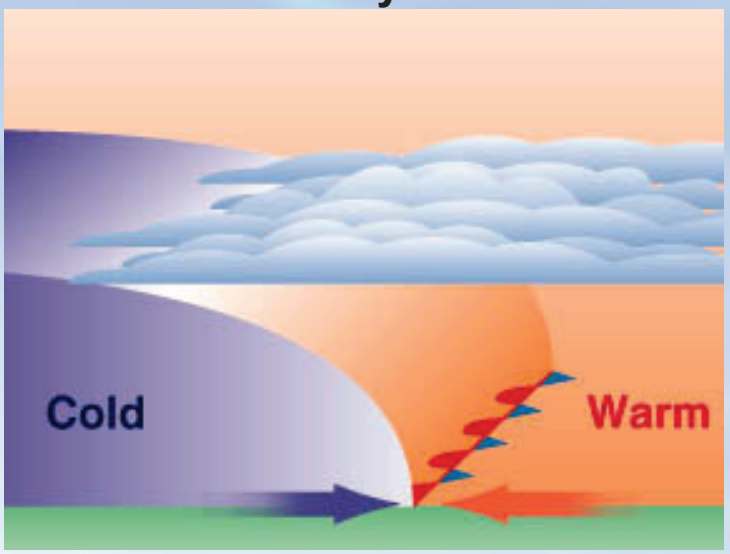


Table 8.3: ***Essentials of Meteorology***





# Stationary Fronts



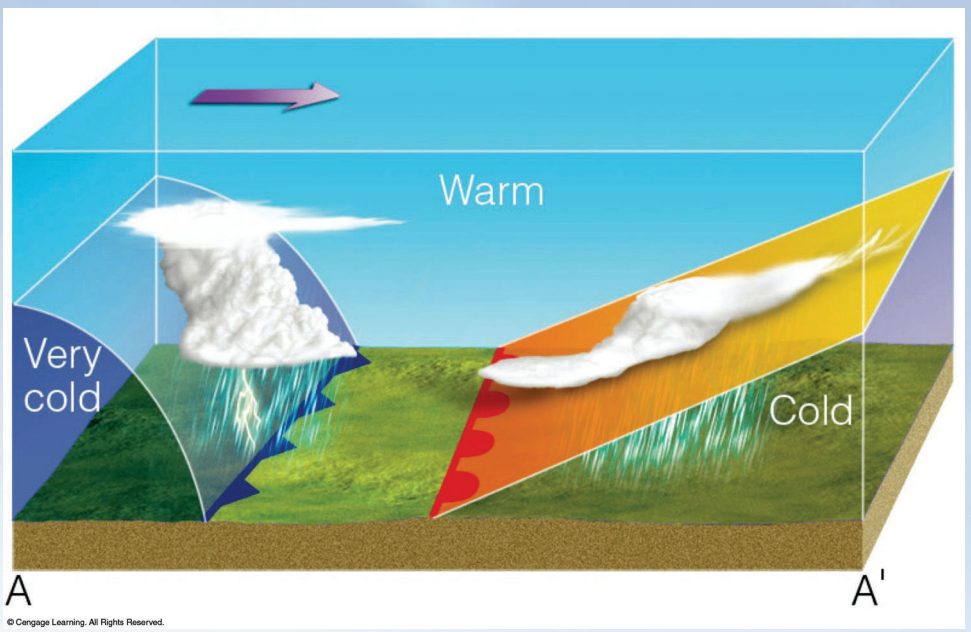

**Represented as red semi-circles and blue triangles**

**Front doesn't move**

**Winds blow along front but in opposite directions**

# Occluded Fronts (cold type occlusion)

cP




mP

**Cold front moves faster than warm front, may catch warm front**

**Warm air is forced up over both cold/very cold air masses**

**May have mix of clouds similar to both cold and warm fronts**

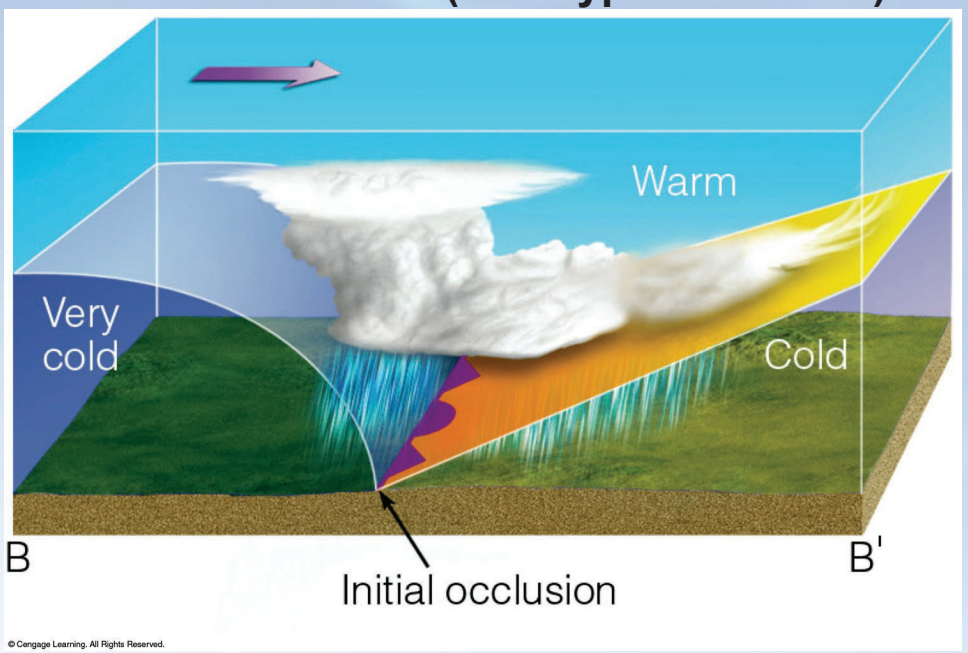


**Fig 8.22: *Essentials of Meteorology***



# Occluded Fronts (cold type occlusion)

cP




mP

**Cold front moves faster than warm front, may catch warm front**

**Warm air is forced up over both cold/very cold air masses**

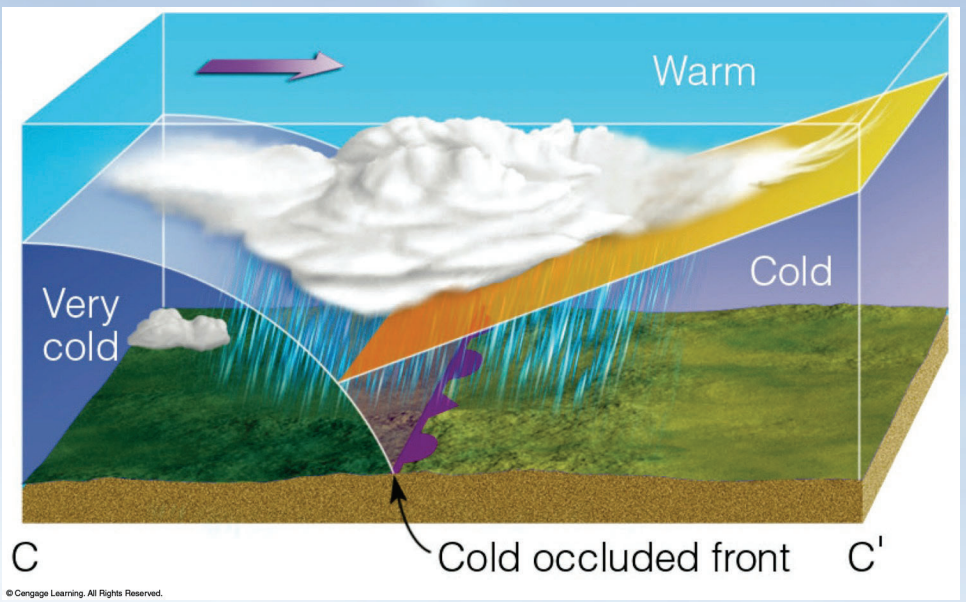
**May have mix of clouds similar to both cold and warm fronts**



**Fig 8.22: *Essentials of Meteorology***

# Occluded Fronts (cold type occlusion)

cP





mP

**Cold front moves faster than warm front, may catch warm front**

**Warm air is forced up over both cold/very cold air masses**

**May have mix of clouds similar to both cold and warm fronts**

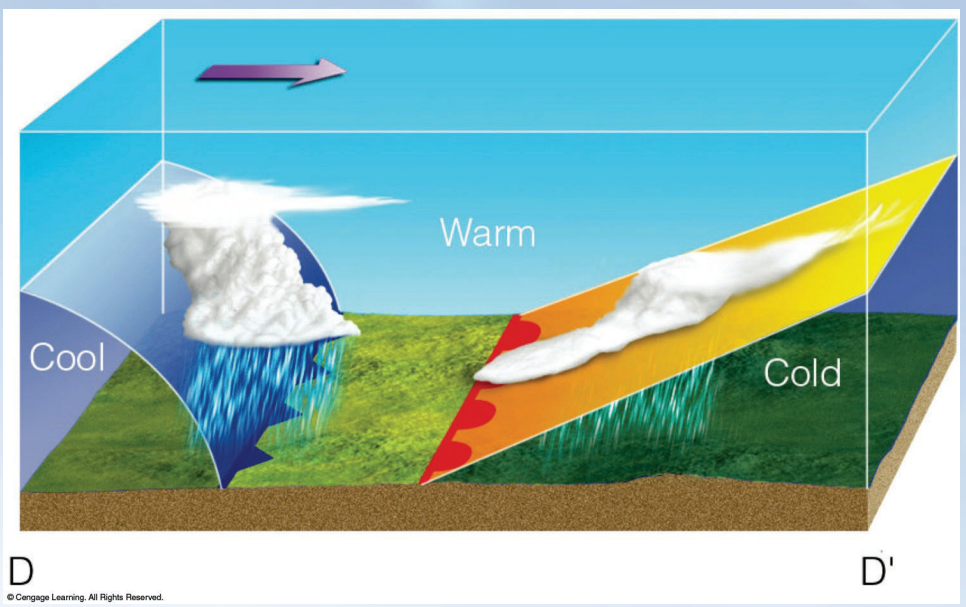


**Fig 8.22: *Essentials of Meteorology***



# Occluded Fronts (warm type occlusion)

mP





cP

**Cold front moves faster than warm front, may catch warm front**

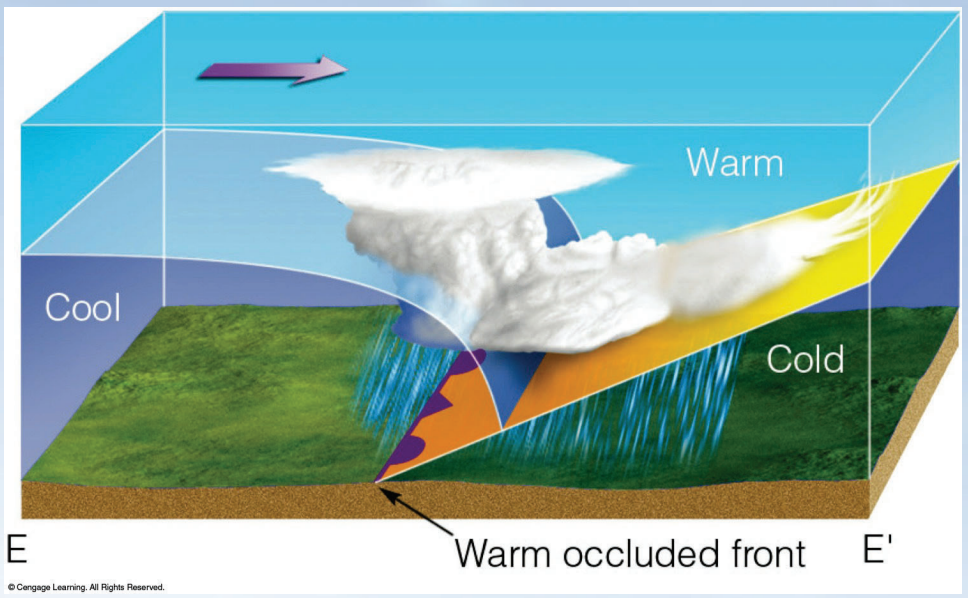
**Cool air is forced up over cold air mass**

**May have mix of clouds similar to both cold and warm fronts**



**Fig 8.22: *Essentials of Meteorology***

# Occluded Fronts (warm type occlusion)




**mP** **cP**

**Cold front moves faster than warm front, may catch warm front**

**Cool air is forced up over cold air mass**

**May have mix of clouds similar to both cold and warm fronts**



**Fig 8.22: *Essentials of Meteorology***



# Occluded Fronts

**TABLE 8.4 Typical Winter Weather Most Often Associated with Occluded Fronts in North America**

| WEATHER ELEMENT | BEFORE PASSING | WHILE PASSING | AFTER PASSING |
|---|---|---|---|
| Winds | East, southeast, or south | Variable | West or northwest |
| Temperature<br>(a) Cold-type occluded<br>(b) Warm-type occluded | <br>Cold or cool<br>Cold | <br>Dropping<br>Rising | <br>Colder<br>Milder |
| Pressure | Usually falling | Low point | Usually rising |
| Clouds | In this order: Ci, Cs, As, Ns | Ns, sometimes Tcu and Cb | Ns, As, or scattered Cu |
| Precipitation | Light, moderate, or heavy precipitation | Light, moderate, or heavy continuous precipitation or showers | Light-to-moderate precipitation followed by general clearing |
| Visibility | Poor in precipitation | Poor in precipitation | Improving |
| Dew point | Steady | Usually slight drop, especially if cold-occluded | Slight drop, although may rise a bit if warm-occluded |





**Table8.4: *Essentials of Meteorology***