

## Chapter 11: Air Masses and Fronts

Air mass classification  
 Air mass source regions  
 Air mass modification  
 Fronts  
 Cold Fronts  
 "Back door" cold fronts  
 Warm fronts  
 Occluded fronts  
 Dryline

### Air Masses: Defn and Formation (p. 286)

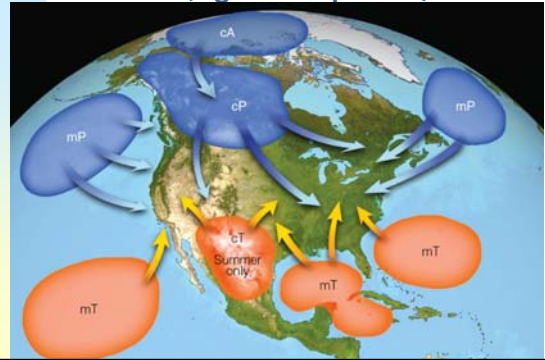
- Air mass: Large body of air that has similar horizontal temperature and moisture characteristics
- Air mass formation: Air must remain over a surface with nearly uniform conditions for days
- Air masses can form:
  - ◆ over ocean or fairly flat land; light winds needed.
  - ◆ rarely over mid-latitudes (too changeable)
  - ◆ not over mountains (not uniform)
- Usually marked by regions of high pressure, where winds are weak, but may be a "heat low"

### Types of Air Masses (Table 11.1, p. 287)

Source Region	Polar (P): Cool or cold surface	Tropical (T): Warm or hot surface
Continental (c): Dry	cP Cold, dry, stable	cT Hot dry, stable aloft; unstable surface air
Maritime (m): Moist	mP Cool, moist, unstable	mT Warm, moist; usually unstable

Extremely cold cP air is called continental Arctic (cA). Coldest and hottest air masses are continental: land has greater temperature extremes than water.

### Air Mass Source Regions and Their Paths (fig. 11.2, p. 287)



### What kind of air mass is this? (Fig. 11.1, p. 286) Temp from -15 to 27 deg F



Upper no. of each pair is temperature, lower no. is dew point in degrees F.

Answer: At least continental polar, perhaps started as continental arctic (cA).

### What kind of air mass is this? (Fig. 11.11, p. 295) Map for 29 June 1990 Temp from 90's to 108 deg F



Arrow marks jet stream. "H" marks position of upper-level subtropical high.

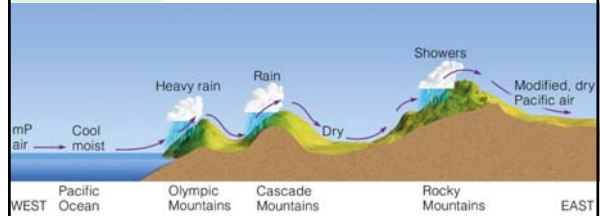
Continental tropical (cT)

### Air Mass Modification (pp. 287, 290-291)

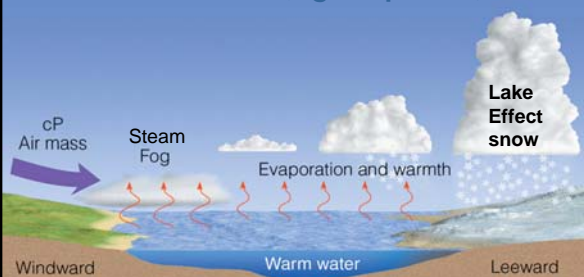
- Air masses influence areas into which they move (Read chapter opening, p. 285.)
- Air masses are continuously being modified from one type to another as they move from place to place.
  - ◆ For example, a cold air mass that reaches Florida is warmer than when it first came south from Canada.
  - ◆ When cold air moves over a warmer surface, it becomes unstable at least near the surface
  - ◆ When air moves over a cold surface, it is stabilized.

### Example of air mass modification: mP air becomes continental polar (fig. 11.7, p. 291)

- Maritime polar (mP) air blows onshore at NW US coast.
- Moisture rains out as air passes over mountain ranges, becoming continental (dry) polar (cool). Not as cold as air that reaches US from Canada. Recall that chinooks occur when warming of air by rain is significant.

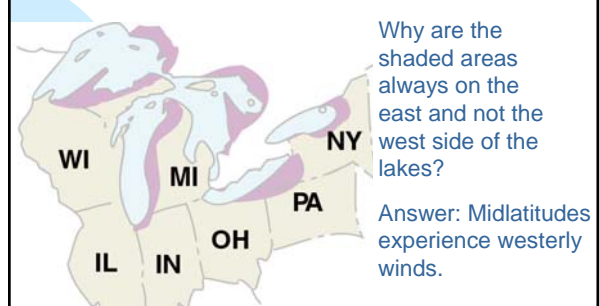


### Example of air mass modification: Lake effect snow (fig. 1, p. 289)



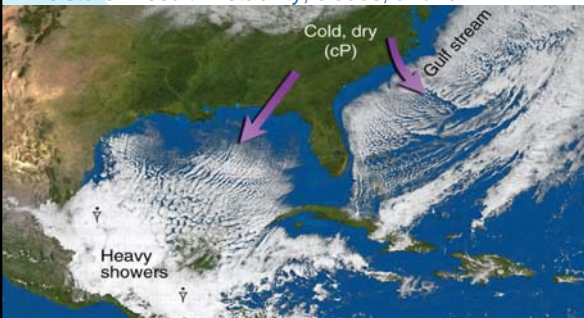
- Lake effect snow occurs in narrow band (from a few miles up to 30 miles wide) on the east, i.e., leeward (downwind), side of each Great Lake

### Fig. 2 (p. 289): Purple shading marks areas with heavy lake-effect snows



### Example of air mass modification: cP air becomes maritime over ocean (fig. 11.5, p. 290)

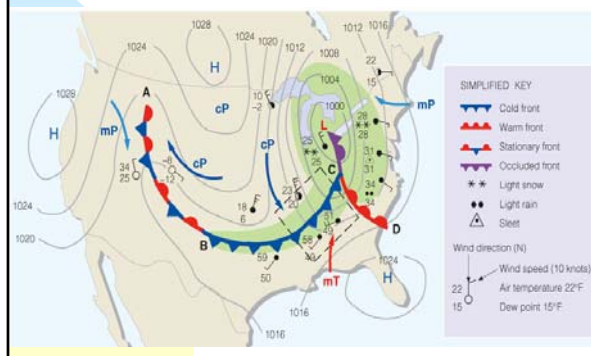
- cP air moves over warm Gulf & Atlantic and picks up moisture. Result: Instability, clouds, and rain.



### Fronts (pp. 296-306)

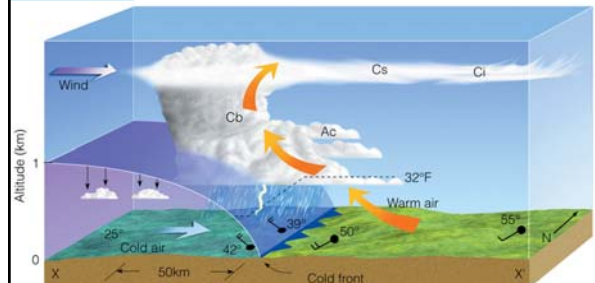
- Front = transition zone between two air masses
- Fronts occur in areas of low pressure ("troughs") with higher pressure on either side
- Stationary front = front with essentially no movement
- Cold/warm front = cold/warm air advancing.
- Occluded front = front extending N or NW from point where cold and warm fronts come together. They separate air with different degrees of coldness.
- All fronts have shallow slopes with cold air below and warm air above.
- Frontal concept (published in 1919) due to Norwegian team. Lead author Jacob Bjerknes later pioneered El Niño research in 1957.

### Weather Map with Fronts (fig. 11.12, p. 297)



### Cold Front (fig. 11.15, p. 299)

A steep cold front has a slope rising 1 unit up for 50 units back. Even that is nearly a horizontal boundary between cold air below and warm air above.



### Passage of cold front (table 11.2, p. 300)

Feature	Before	During	After
Winds	S or SW	Gusty, shifting	W or NW
Temperature	Warm	Sudden drop	Steady drop
Pressure	Steady fall	Minimum, then sharp rise	Steady rise
Clouds	Increasing Ci, Cs, Tcu or Cb	Tcu or Cb	Often Cu, Sc if ground warm
Precipitation	Short period of showers	Heavy rain or snow showers	Decreasing, then clearing
Visibility	Fair to poor in haze	Poor, followed by improving	Good except in showers
Dew point	High; remains steady	Sharp drop	Lowering

Ci=cirrus, Cs=cirrostratus, Tcu=towering cumulus (cumulus congestus), Cb=cumulonimbus, Cu=cumulus, Sc=stratocumulus

### "Back door" cold front (p. 329)

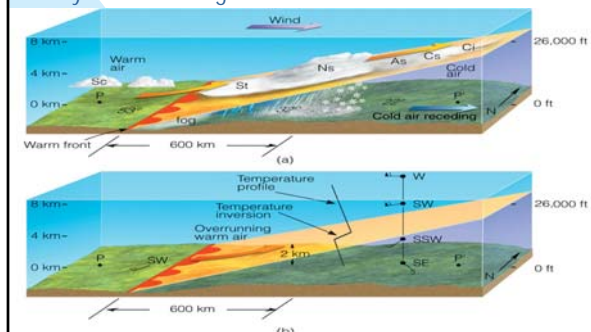
- Regular cold fronts usually move toward S, SE, or E, being pushed by westerly winds.
- "Back door" cold fronts move towards SW, being pushed by NE winds from CW flow of air around high.
- Occur sometimes along Atlantic coast



Fig. 11.17, p. 300

### Warm Front (fig. 11.19, p. 301)

Typical warm front slopes even less than a cold front. Usually slower moving than a cold front.



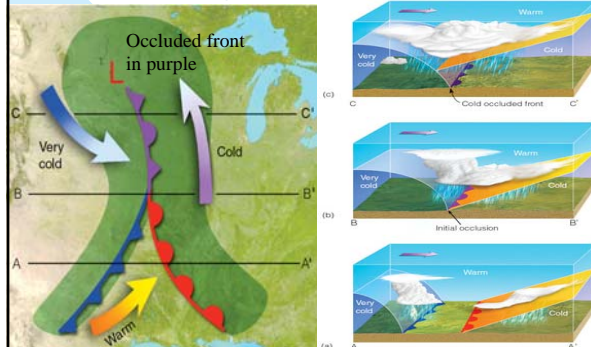
### Passage of warm front (table 11.3, p. 302)

Feature	Before	During	After
Winds	S or SE	Variable	S or SW
Temperature	Cool to cold	Steady rise	Warmer
Pressure	Usually falling	Leveling off	Slight rise, followed by fall
Clouds	Ci, Cs, As, Ns, St, fog. Maybe Cb in summer	Stratus type	Clearing with Sc. Maybe Cb in summer
Precipitation	Light to mod rain, snow, sleet	Drizzle or none	Usually none. Maybe light rain
Visibility	Poor	Poor, but improving	Fair in haze
Dew point	Steady rise	Steady	Rise, then steady

Ci=cirrus, Cs=cirrostratus, Cb=cumulonimbus, Cu=cumulus, Sc=stratocumulus, St=stratus

### Cold-occluded front (fig. 11.20, p. 304)

Transition zone between cP air to west & mP to east.  
Cold-occluded fronts impact the eastern US.

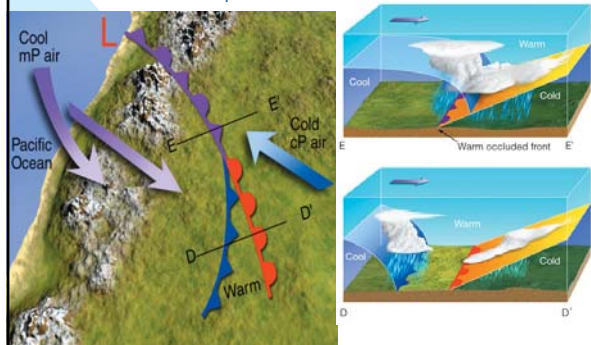


### Passage of occluded front (table 11.4, p. 305)

Feature	Before	During	After
Winds	E, SE, or S	Variable	W or NW
Temperature	Cold or cool	Dropping	Colder
Cold type	Cold	Rising	Milder
Pressure	Usually falling	Low point	Usually rising
Clouds	Ci, Cs, As, Ns	Ns, sometimes Tcu and Cb	Ns, As, or scattered Cu
Precipitation	Light, moderate, heavy precip	Light, mod, or heavy precip	Light to mod precip, clearing
Visibility	Poor in precip	Poor in precip	Improving
Dew point	Steady	Usually slight drop, esp if cold occluded	Slight drop, but may rise a bit if warm occluded

### Warm-occluded front (fig. 11.21, p. 304)

Transition zone between cool mP air to west & cold cP to east.  
Cold-occluded fronts impact the west coast of the US.



### Dryline (p. 303)

- Dryline ("dew-point front"): moisture boundary with continental tropical (cT: dry hot) air to west & maritime tropical (mT: moist warm) air to east.
- Occurs in spring or early summer in western half of TX, OK, and KS. Hot dry air from desert Southwest to west, moist warm from Gulf of Mexico to south.
- Severe thunderstorms can occur along drylines.
- Fig. 4 (p. 303) on next slide shows contrast in temperature, dew point, and wind direction across a dryline.
- We'll say more in chapter 14 about dryline thunderstorms (pp. 375-376).

### Fig 4 (p. 303): Dryline in red

