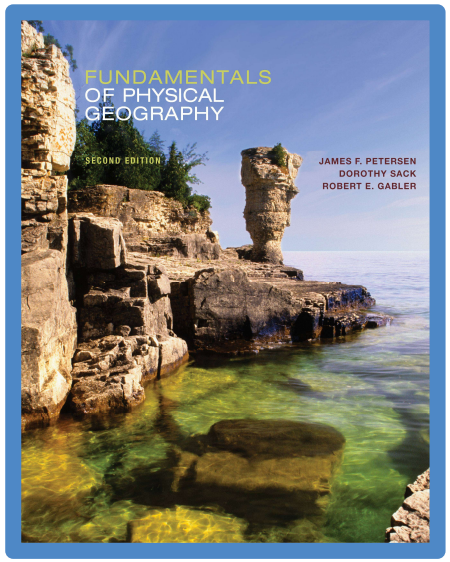
Fundamentals of Physical Geography 2e

Air Masses and Weather Systems

6



- Peterson
  - Sack
    - Gabler

Air Masses

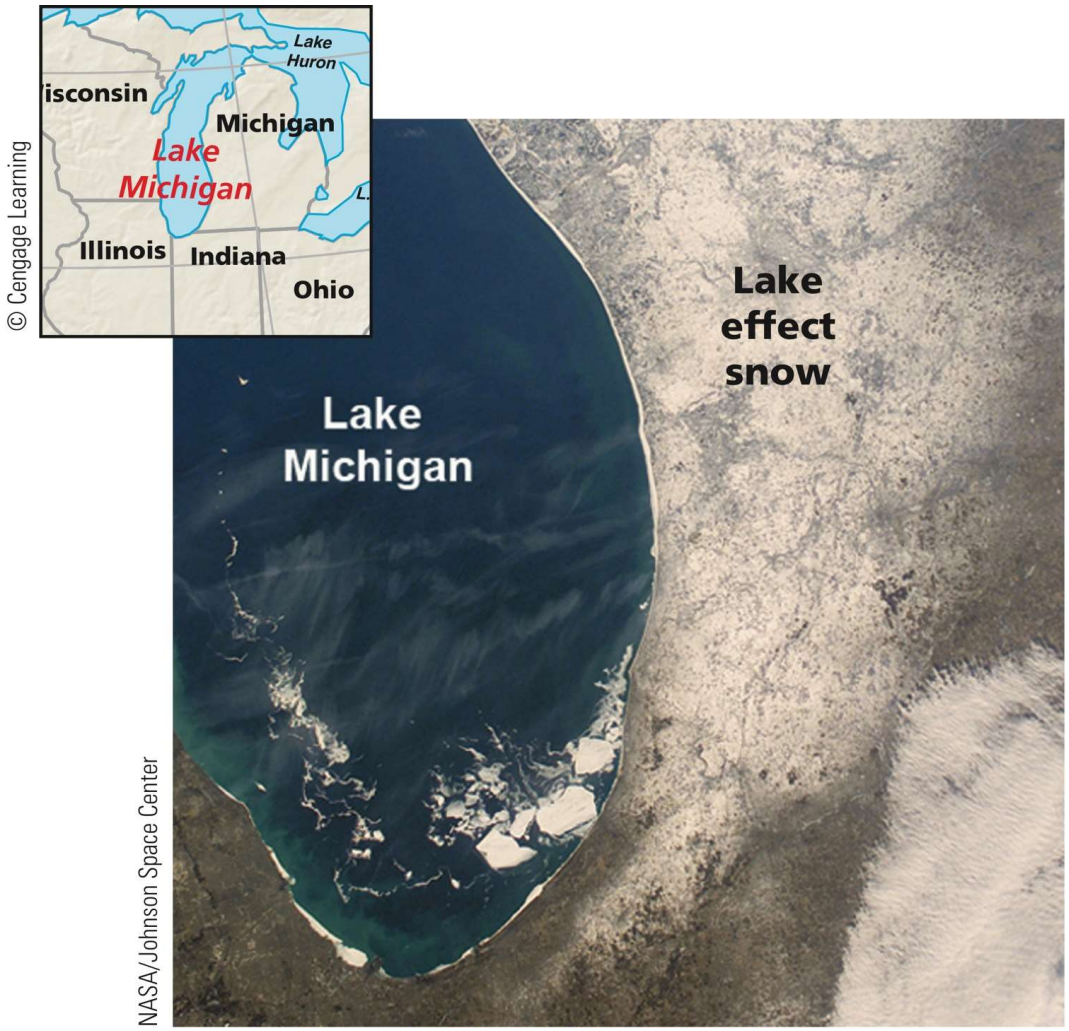
- Air mass: large body of air
  - Temperature and humidity characteristics are similar
- Source region: two-letter code
  - 1st letter: *m* = Maritime (sea)
    c = Continental (land)
  - 2nd letter: *E* = Equatorial (very warm)
    T = Tropical (warm)
    P = Polar (cold)
    A = Arctic (very cold)

Air Masses (cont'd.)

- Air mass types (Table 6.1)
  - Maritime Equatorial *(mE)*
  - Maritime Tropical *(mT)*
  - Continental Tropical *(cT)*
  - Continental Polar *(cP)*
  - Maritime Polar *(mP)*
  - Continental Arctic *(cA)*

Air Masses (cont'd.)

- Air mass modification and stability
  - Air mass interacts with landmasses or water bodies
    - Gaining or losing thermal energy or moisture
  - Gain or loss of thermal energy, humidity, or both
    - Air mass becomes more stable or unstable
  - *mT* air mass moves onshore in winter
    - May produce fog or light precipitation



What two main factors contribute to increased precipitation caused by the lake effect?

Air Masses (cont'd.)

- North American air masses
  - *cA*, *cP*, *mP*, *mT*, and *cT*
  - Storms and precipitation events
    - Collisions of unlike air masses
- Continental Arctic *(cA)*: very cold and very dry
  - Pushes south of Canadian border in winter
  - Produces record-setting cold temperatures

Air Masses (cont'd.)

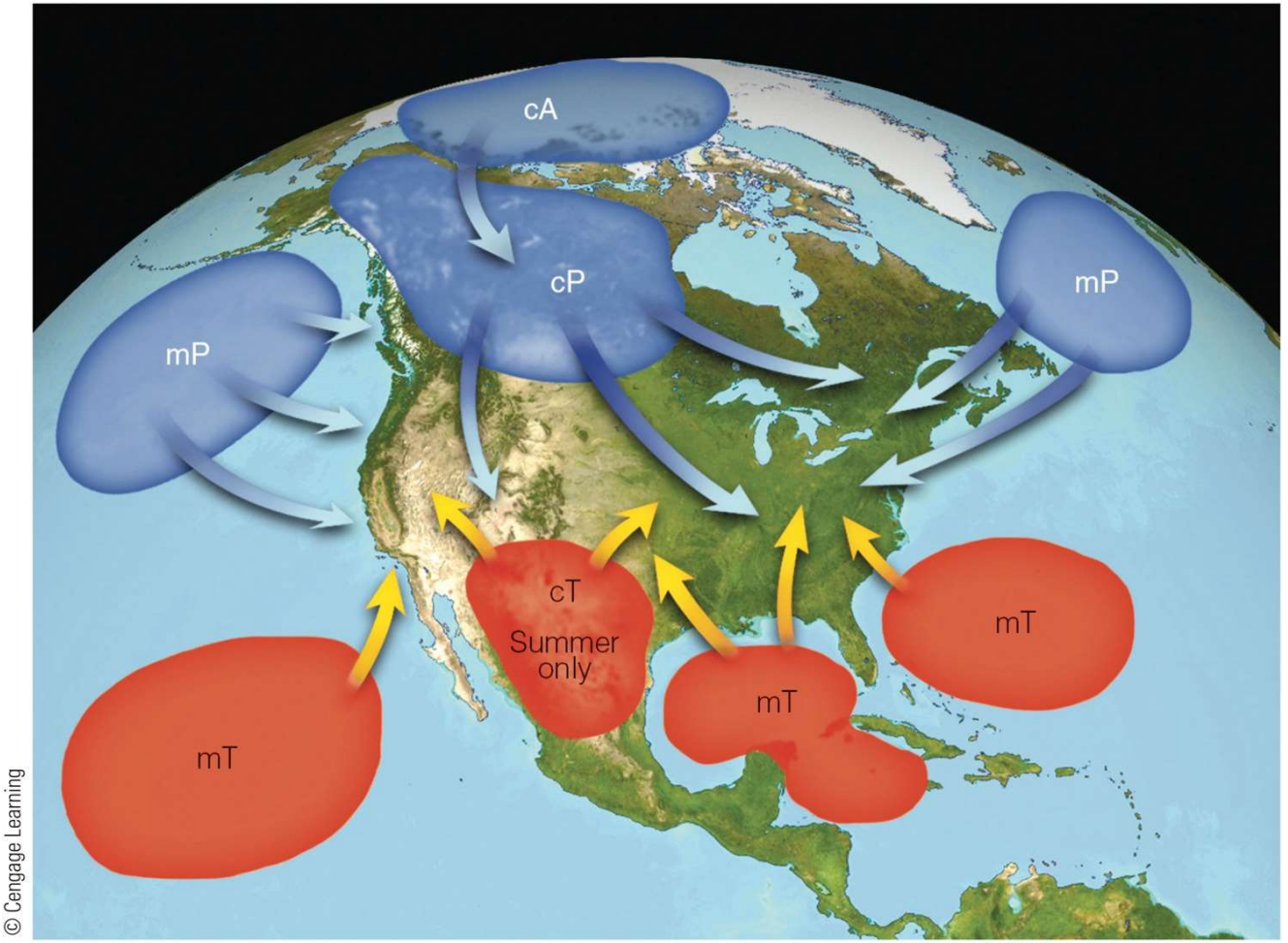
- Continental Polar *(cP)*: cold and dry
  - Can migrate into Midwest and South
  - Produces colder-than-average temperatures
  - Rarely affects West Coast
- Maritime Polar *(mP)*: damp and cool
  - Impacts weather in northwestern United States
    - Cloudy conditions and precipitation
  - What conditions result in *nor'easters*?

Air Masses (cont'd.)

- Maritime Tropical *(mT)*: very warm and very humid
  - Source regions: long days and intense insolation during summer
  - Southeastern and eastern U.S.
    - Hot, humid summers and strong thunderstorms
  - South-central U.S.
    - Clashes with *cP*: frontal precipitation in winter

Air Masses (cont'd.)

- Continental Tropical *(cT)*: very hot and dry
  - Develops over large, homogeneous land surfaces in the arid subtropics
    - Form in summer over deserts of southwestern United States
  - Hot, dry, and clear weather



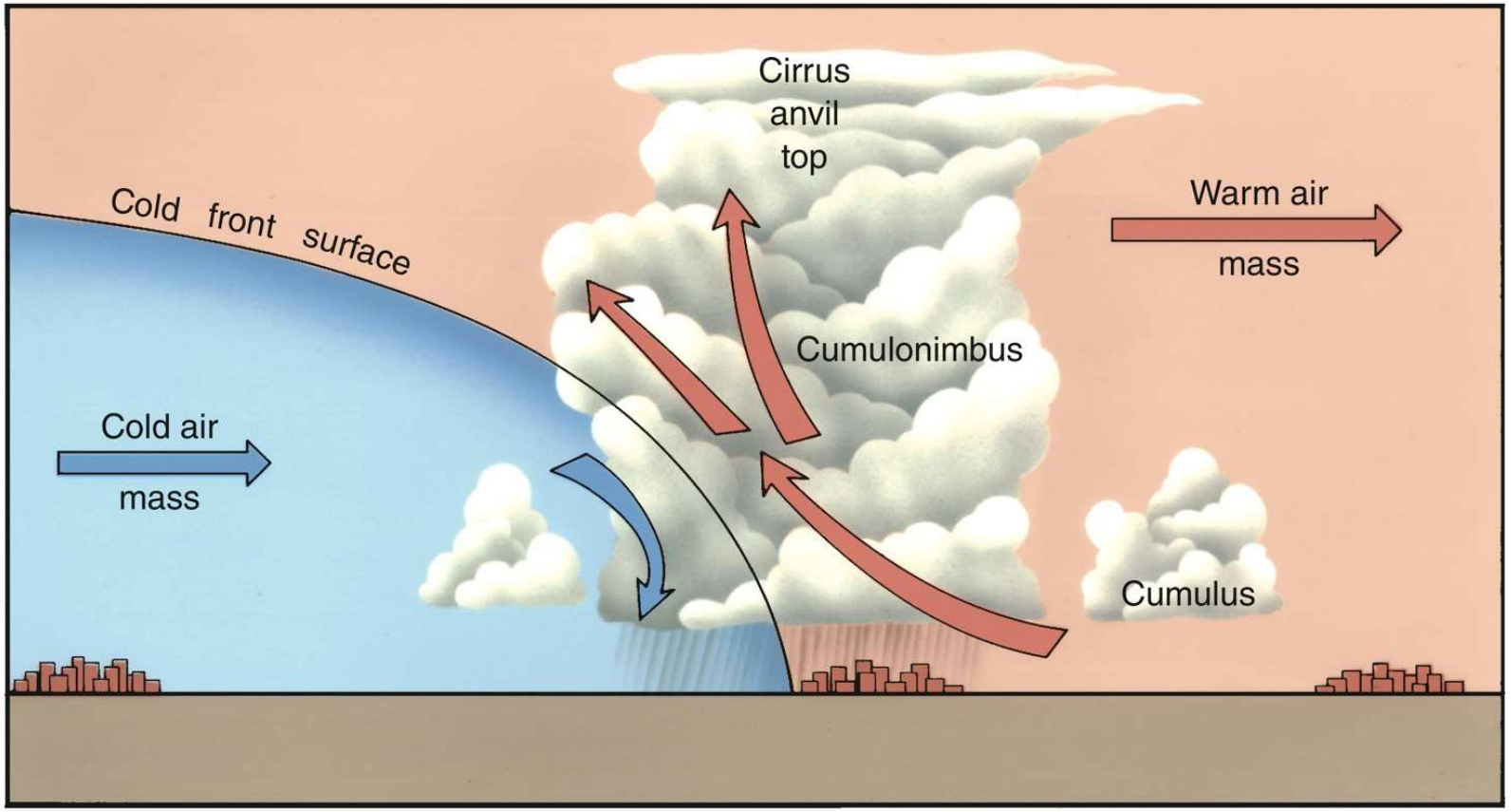
Use Table 6.1 and this figure to determine which air masses affect your location. Are there seasonal variations?

Fronts

- Clash of unlike air masses
- Sloping boundaries
  - Frontal uplift
- U.S. and southern Canada
  - Located in a zone between source regions for five different air masses
- What determines the steepness of frontal surface?
- Frontal zone: three-dimensional surface

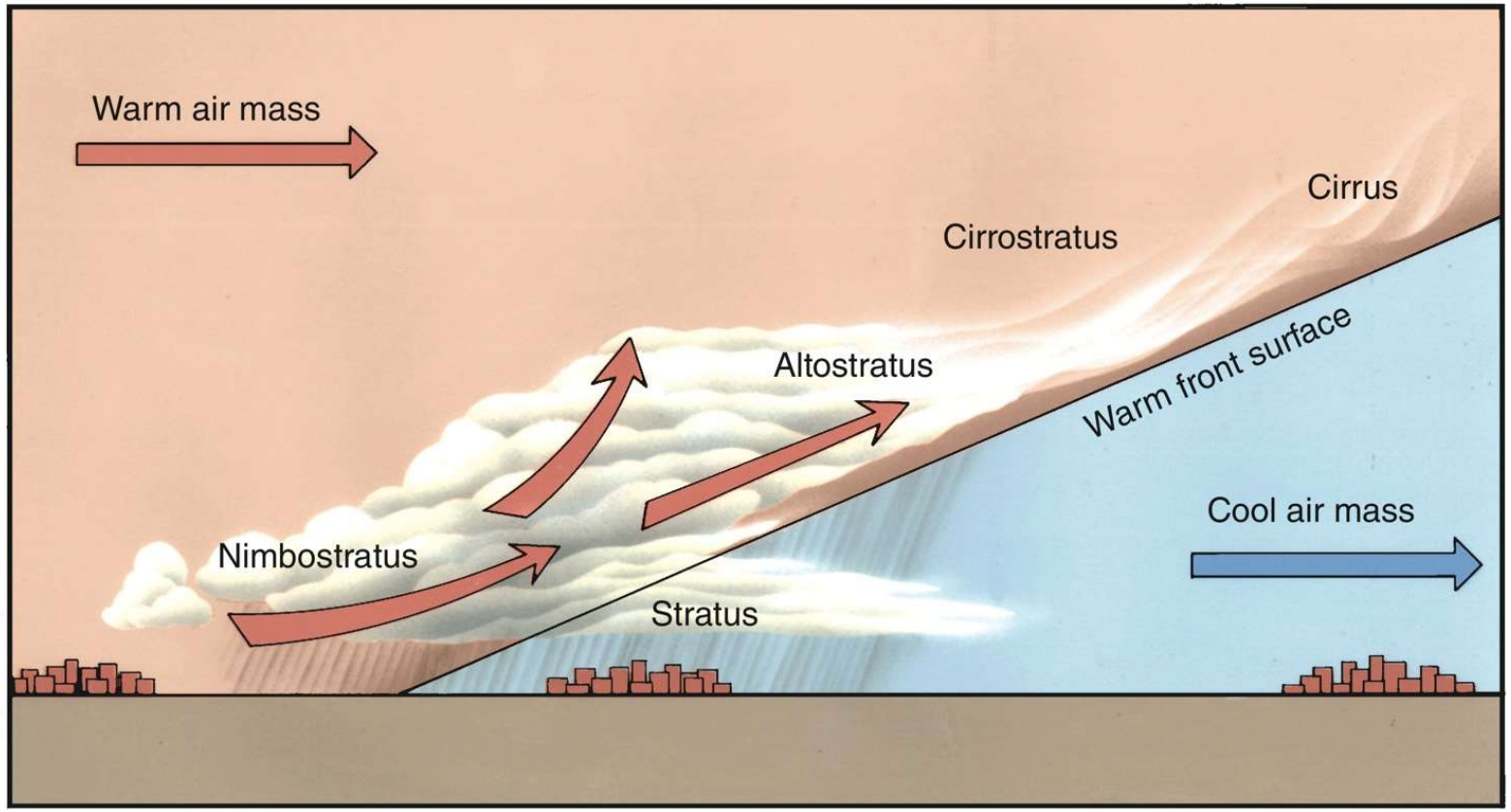
Fronts (cont'd.)

- Cold front
  - Cold air mass moves in on a warmer air mass
    - Warm air rises
  - Steep slope
  - Squall lines
    - Thunderstorms aligned along a cold front
  - Associated with:
    - Strong weather disturbances
    - Sharp changes in temperature, air pressure, and wind



Fronts (cont'd.)

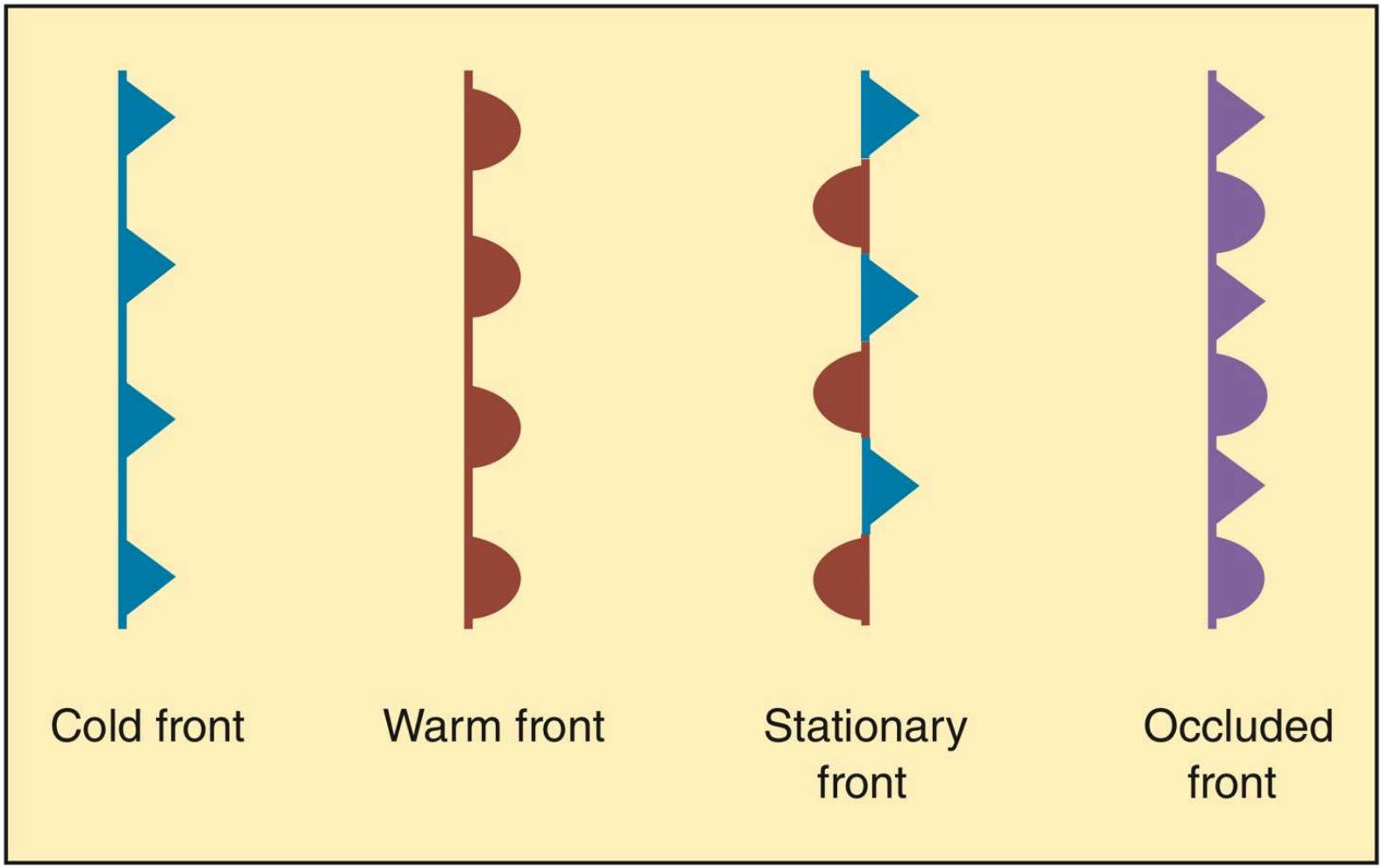
- Warm front
  - Warm air moves in on cooler air
    - Slowly pushes against the cold air and rises over the colder air
    - Gentle slope
    - Weather changes: less abrupt than with cold fronts



Compare Figures 6.3 and 6.4. How are they different? How are they similar?

Fronts (cont'd.)

- Stationary front
  - Frontal boundary between air masses fails to move
  - Weather conditions persist until the stationary front dissipates
- Occluded front
  - Faster-moving cold front overtakes a warm front
  - Occurs in the latter stages of a storm



Atmospheric Disturbances

- More general term than “storms”
  - Includes atmospheric conditions that cannot be classified as storms
- Anticyclone and cyclone
  - Cells of high and low pressure
    - Drift along the path of the prevailing westerly winds
  - Wind intensities
    - Depend on steepness of the pressure gradient

Atmospheric Disturbances (cont'd.)

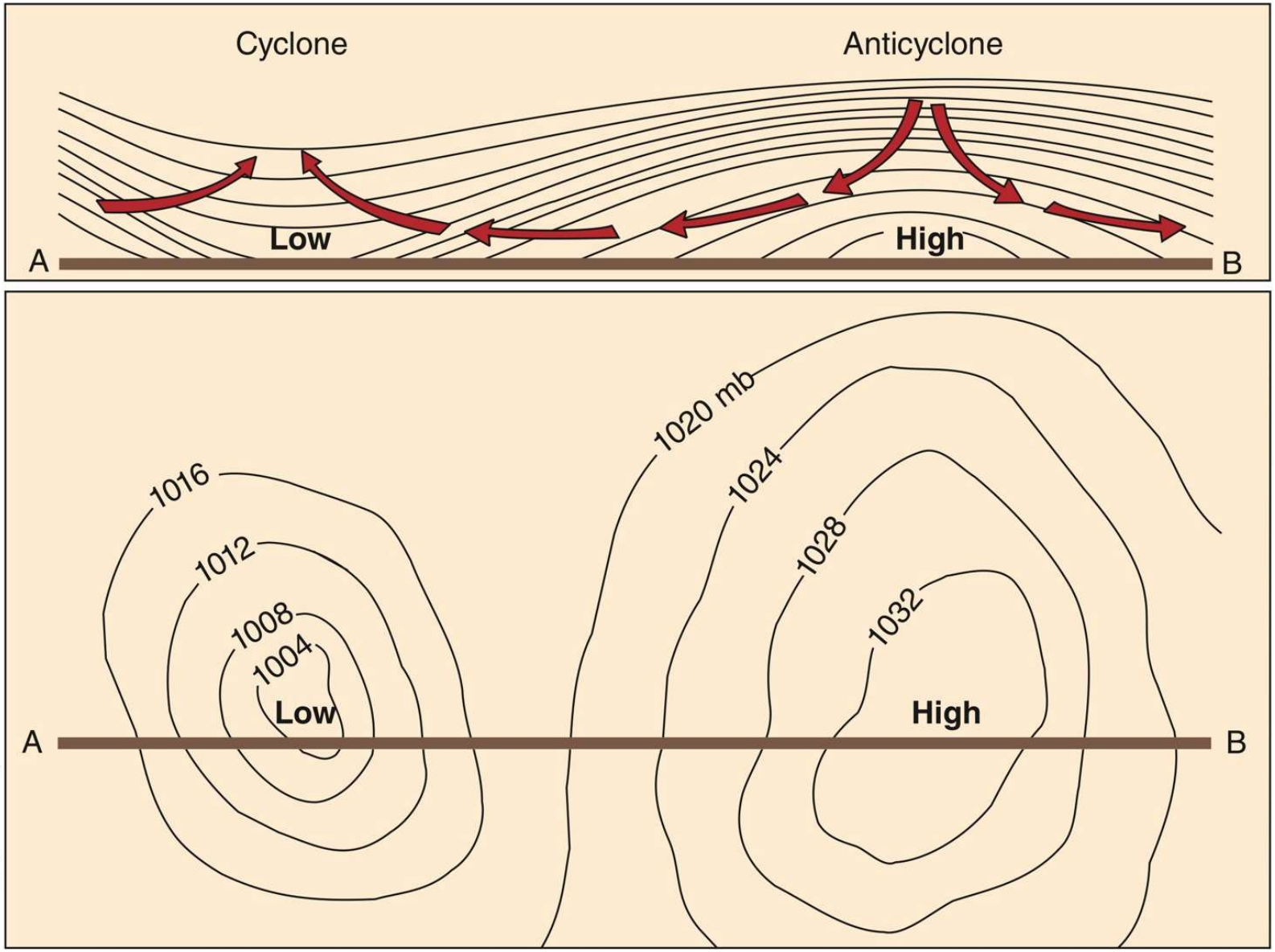
- Anticyclone
  - High pressure area
  - Diverging winds
  - Fair-weather system
    - Air subsidence in the center of an anticyclone
  - Sources
    - Northern Canada and the Arctic Ocean: polar outbreaks
    - Subtropical high pressure regions: dry and warmer weather

Atmospheric Disturbances (cont'd.)

- Cyclone
  - Low pressure area
  - Convergence uplift: cyclonic uplift
  - Clouds and precipitation
  - Varied and complex in formation and weather produced
- Mapping pressure systems
  - Cells of high and low pressure
    - Visualize as landforms: hill or mountain vs. basin

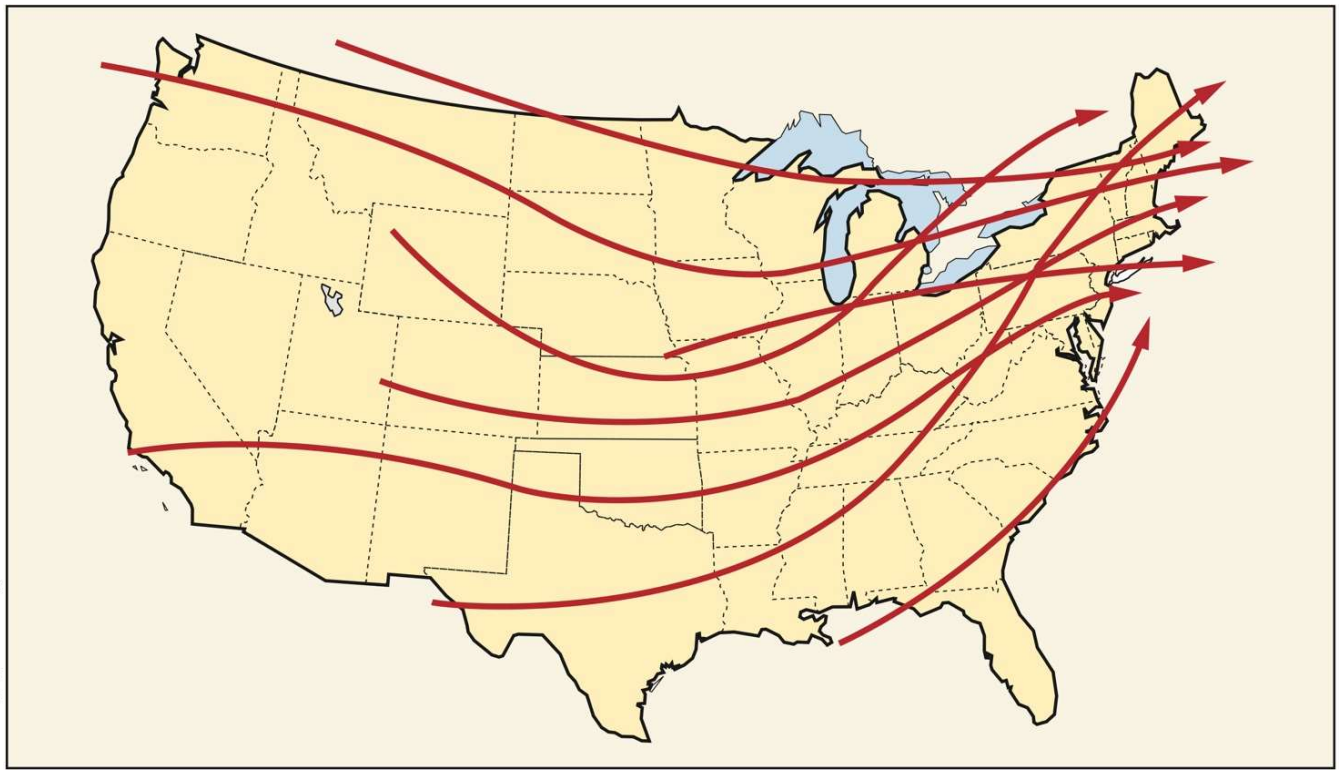
Atmospheric Disturbances (cont'd.)

- Surface weather maps
  - Concentric isobars
    - High: increasing pressure toward the center
    - Low: decreasing pressure toward the center



Atmospheric Disturbances (cont'd.)

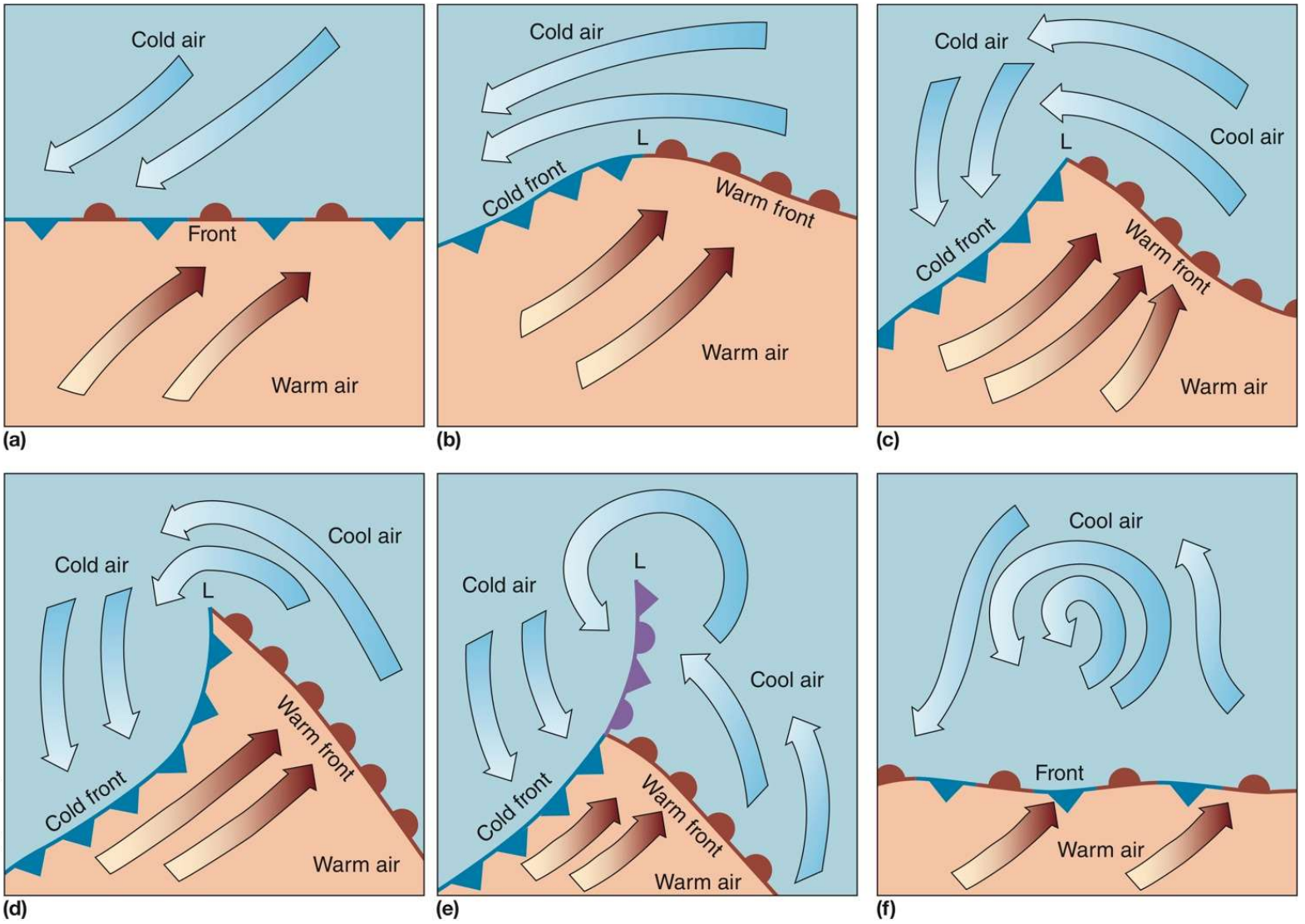
- General movement
  - Middle latitudes: guided by upper air westerlies (or the jet stream)
    - General west to east pattern
  - Storm tracks
    - Similar paths from year to year



What storm tracks influence your location?

Atmospheric Disturbances (cont'd.)

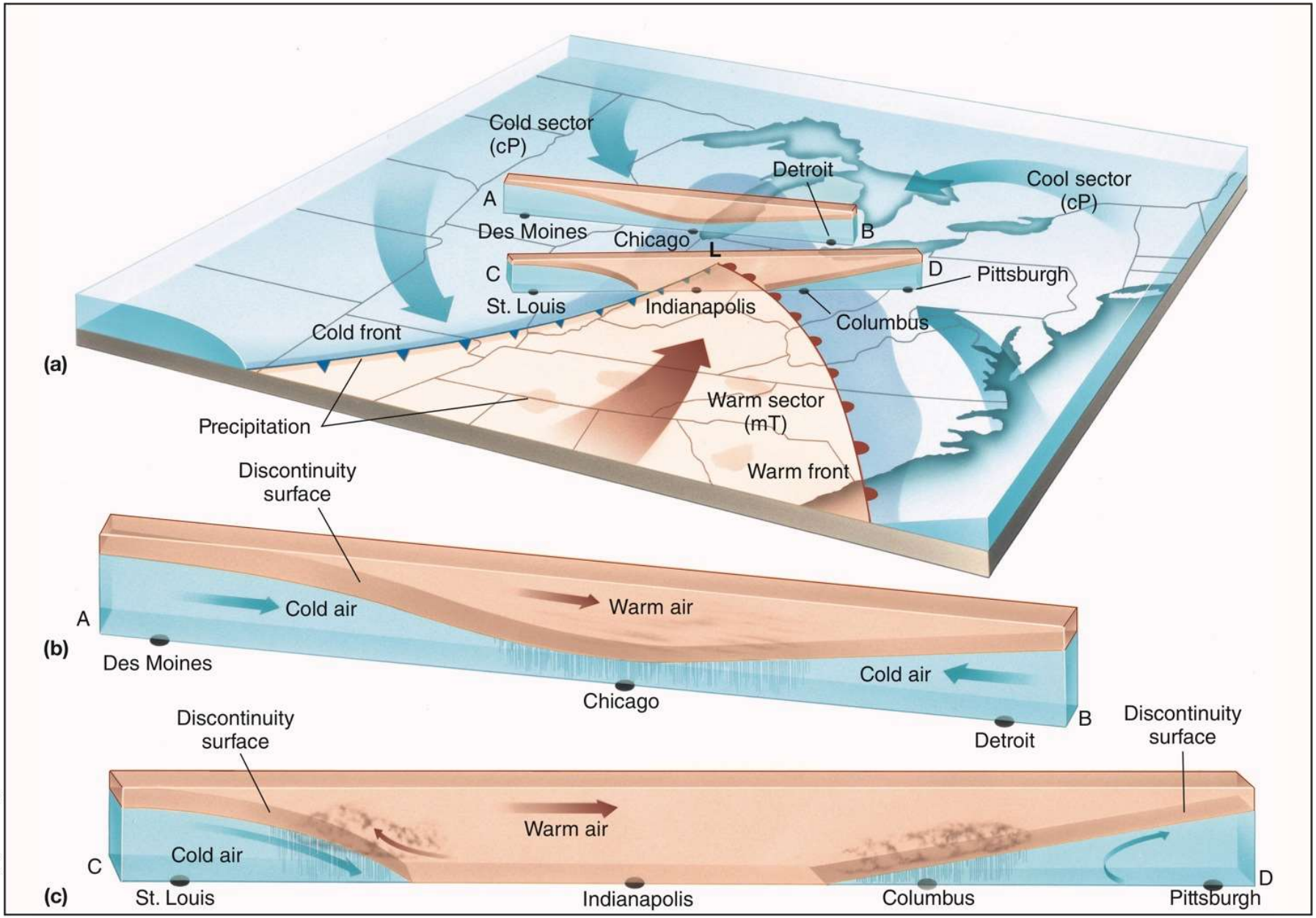
- Middle-latitude cyclones: extratropical cyclones
  - Migrating storms: clash between air masses
  - Highly variable weather
    - Storms vary in intensity, longevity, wind strength, amount and type of precipitation, etc.
  - Polar front
    - Polar air and warm subtropical air meet
    - Moves north and south with seasons
    - Stronger in winter than in summer



In (c), where would you expect rain to develop? Why?

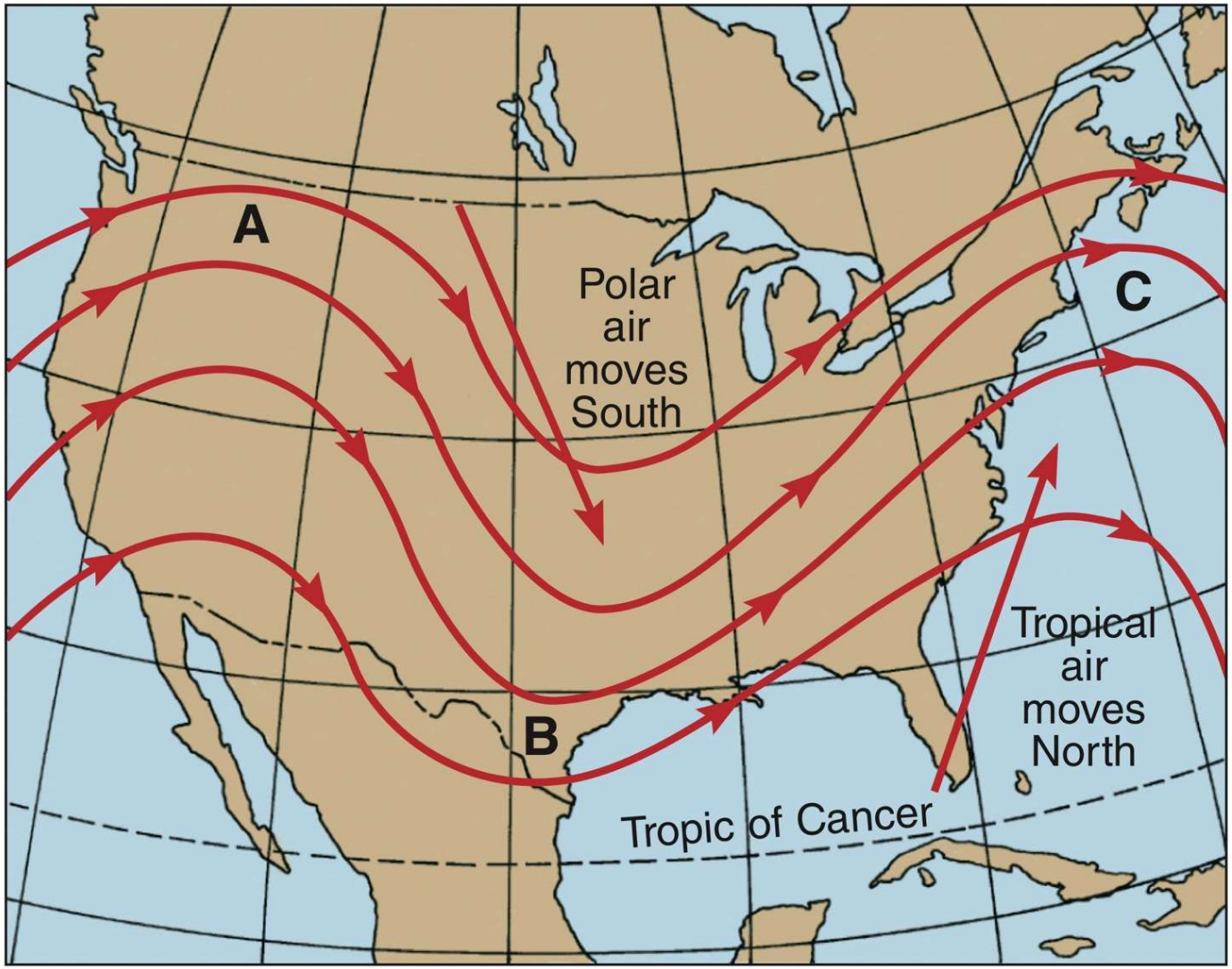
Atmospheric Disturbances (cont'd.)

- Cyclones and local weather
  - Weather in a particular location
    - Dependent upon portion of the middle-latitude cyclone over the location
  - Cyclonic system
    - Travels west to east

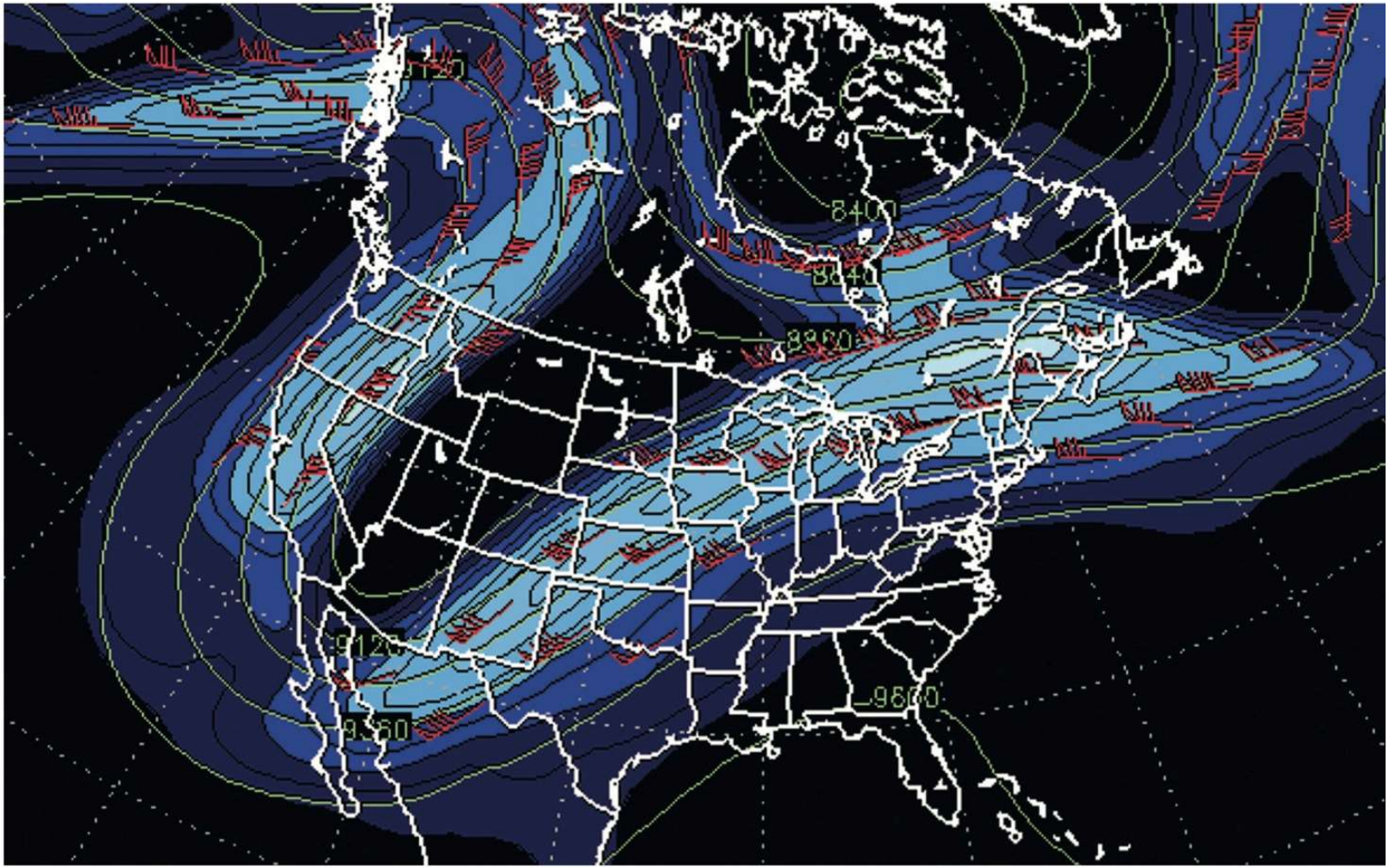


Atmospheric Disturbances (cont'd.)

- Upper air winds
  - Steer surface storm systems
  - Undulating, wave-like flow
    - Produce alternating pressure areas of ridges and troughs
  - Area of upper-level convergence
    - Region between ridge and trough
    - Influences storm development or dissipation; temperatures



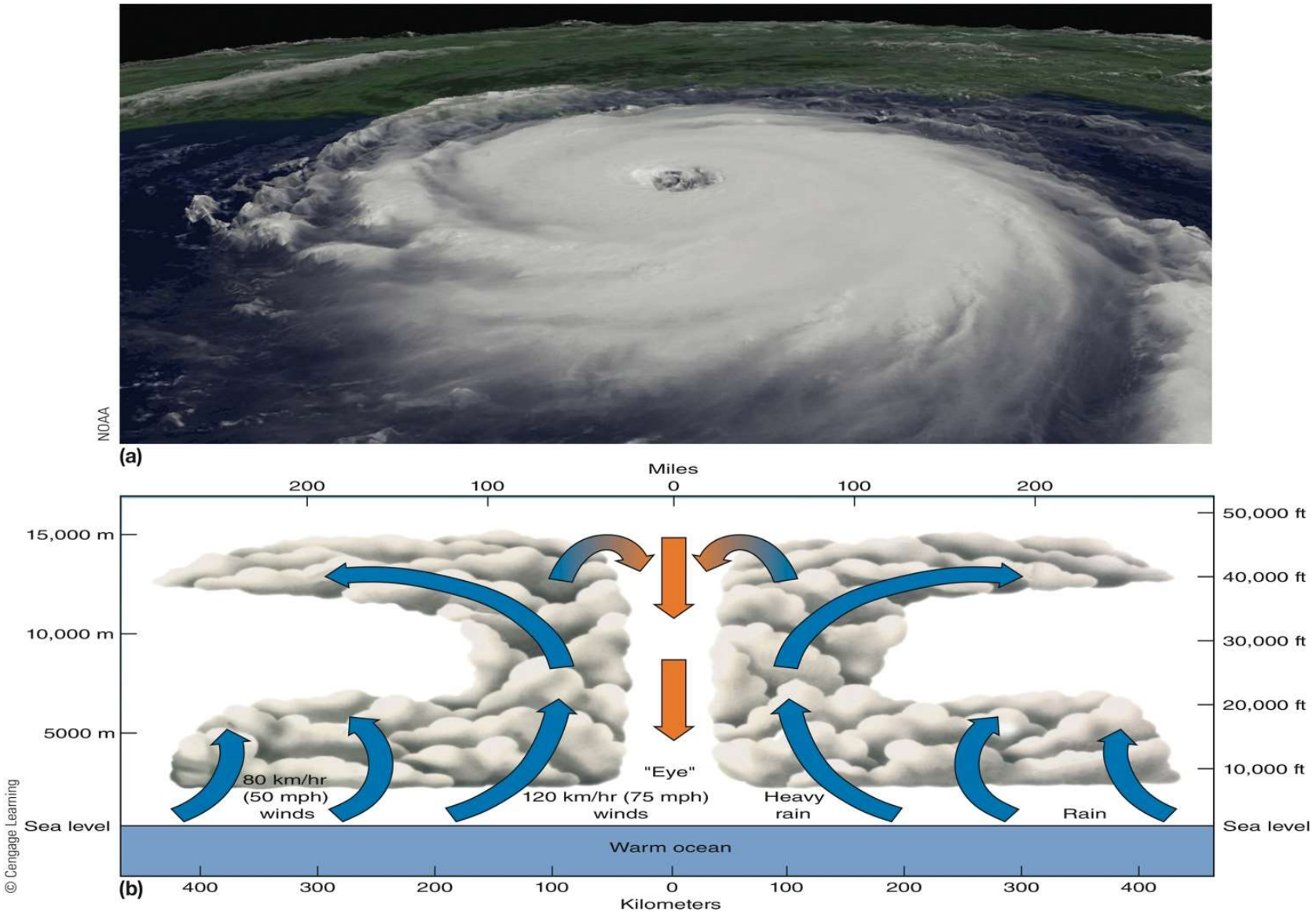
Where would you expect storms to develop?



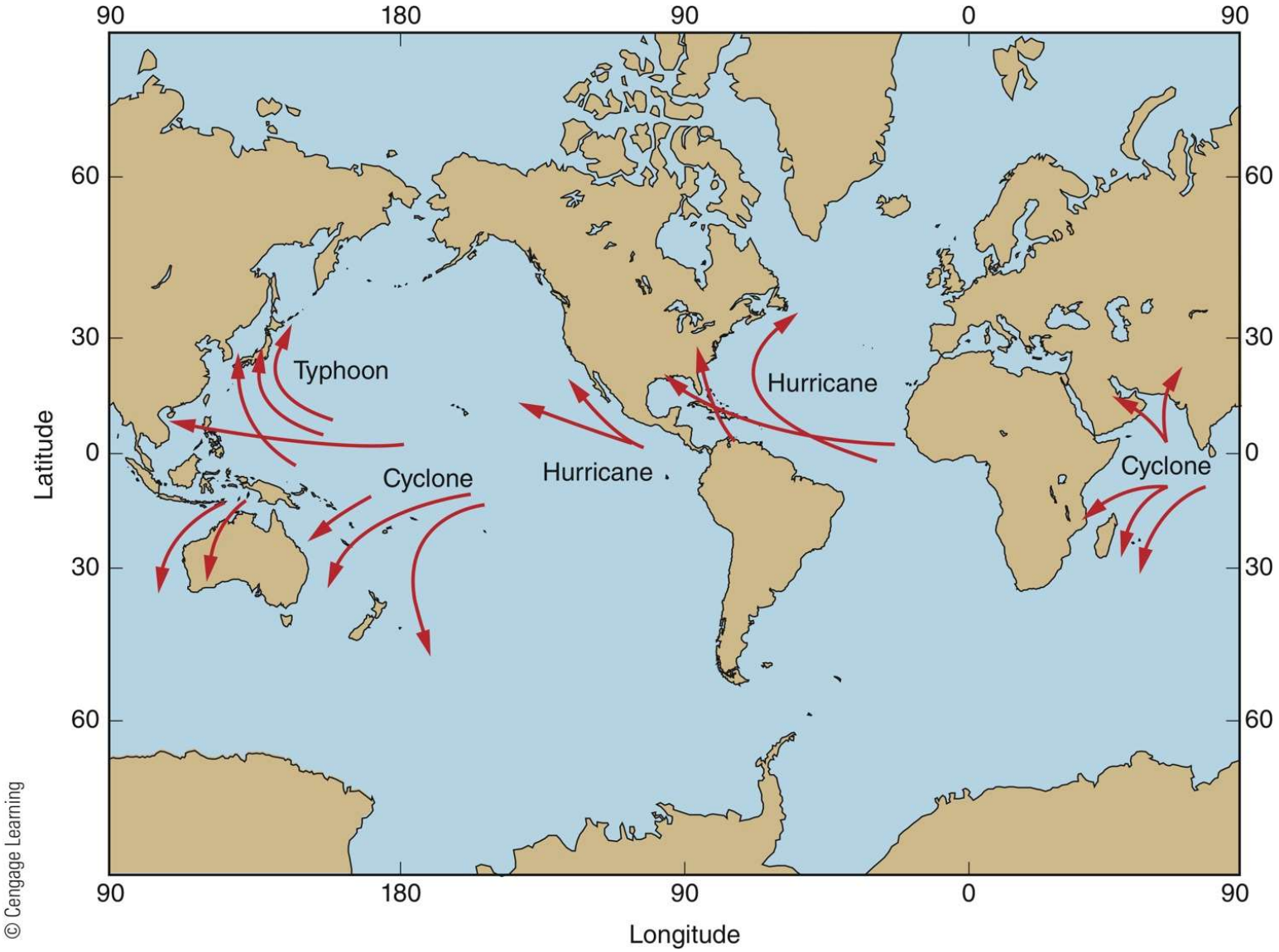
What kind of air mass is likely dominating the area dipping from Canada to Arizona?

Atmospheric Disturbances (cont'd.)

- Hurricanes
  - Circular cyclonic system
    - Wind speeds greater than 74 mph
    - Diameter: 100–400 miles
  - Develop in the low latitude oceans
  - Largest storm on Earth
  - Extremely low pressure at its center
    - Powerful high-velocity winds
  - Severe tropical cyclones; typhoons



Which features in the Katrina image can you match with the cross-sectional diagram?



Which coastlines in the subtropical or middle latitudes seem unaffected by these tracks?

Atmospheric Disturbances (cont'd.)

- Hurricane development
  - What factors explain why hurricanes occur most often in late summer and early fall?
  - Stages
    - Weak tropical disturbance: easterly waves
    - Name assigned upon tropical storm status: wind speeds 39–74 mph
    - What factors curtail the hurricane as it moves over land?

Atmospheric Disturbances (cont'd.)

- Hurricane intensities and impacts
  - Storm surges
  - Saffir–Simpson Hurricane Scale: 1 to 5
    - Hurricane intensity and potential damage
    - Refer to Table 6.2
  - Recent events
    - Hurricane Sandy (2012): category 1
    - Hurricane Katrina (2005): extensive damage and loss of life
    - Hurricane Ike (2008): widespread damage

Atmospheric Disturbances (cont'd.)

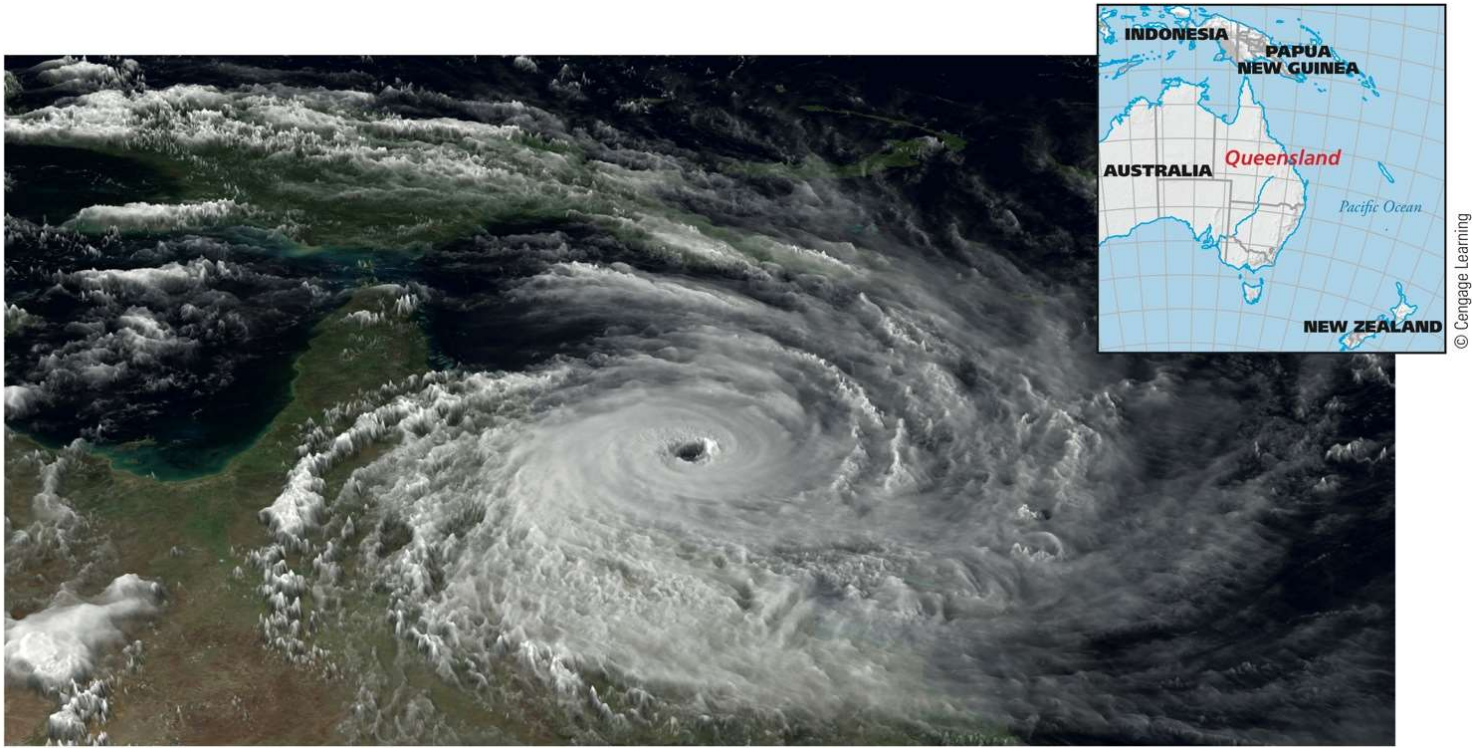
Scale Number	Central Pressure	Wind Speed	Storm Surge	Damage
Category	Millibars	MPH	Feet	
1	980	74-95	4-5	Minimal
2	965-979	96-110	6-8	Moderate
3	945-964	111-130	9-12	Extensive
4	920-944	131-155	13-18	Extreme
5	<920	>155	>18	Catastrophic

Table 6.2
Saffir—Simpson Hurricane Scale

SCALE NUMBER	CENTRAL PRESSURE	WIND SPEED		STORM SURGE		DAMAGE
(Category)	(Millibars)	(KPH)	(MPH)	(Meters)	(Feet)	
1	980	119–153	74–95	1.2–1.5	4–5	Minimal
2	965–979	154–177	96–110	1.6–2.4	6–8	Moderate
3	945–964	178–209	111–130	2.5–3.6	9–12	Extensive
4	920–944	210–250	131–155	3.7–5.4	13–18	Extreme
5	<902	>250	>155	>5.4	>18	Catastrophic

What can people who live in such regions do to protect themselves when a serious storm surge is threatening?

USGS



NOAA

Compare the circulation of Cyclone Yasi here with the image of Hurricane Sandy at the beginning of the chapter. Explain the major difference that you see.

Atmospheric Disturbances (cont'd.)

- Snowstorms
  - Occur in:
    - Middle- to high-latitude winters
    - High elevations
  - Heavy snowfall
  - Strong winds
- Blizzard
  - Winds 35 mph or greater
  - What are whiteout conditions?

NOAA/NWS

How far would you estimate the visibility to be in this area?

Atmospheric Disturbances (cont'd.)

- Thunderstorms
  - Accompanied by thunder and lightning
  - Lightning
    - Positive and negative charges within a cloud
    - Discharge when charge differential overcomes natural insulating effect of air
  - Thunder
    - Shock wave: heated air around the discharge expands explosively

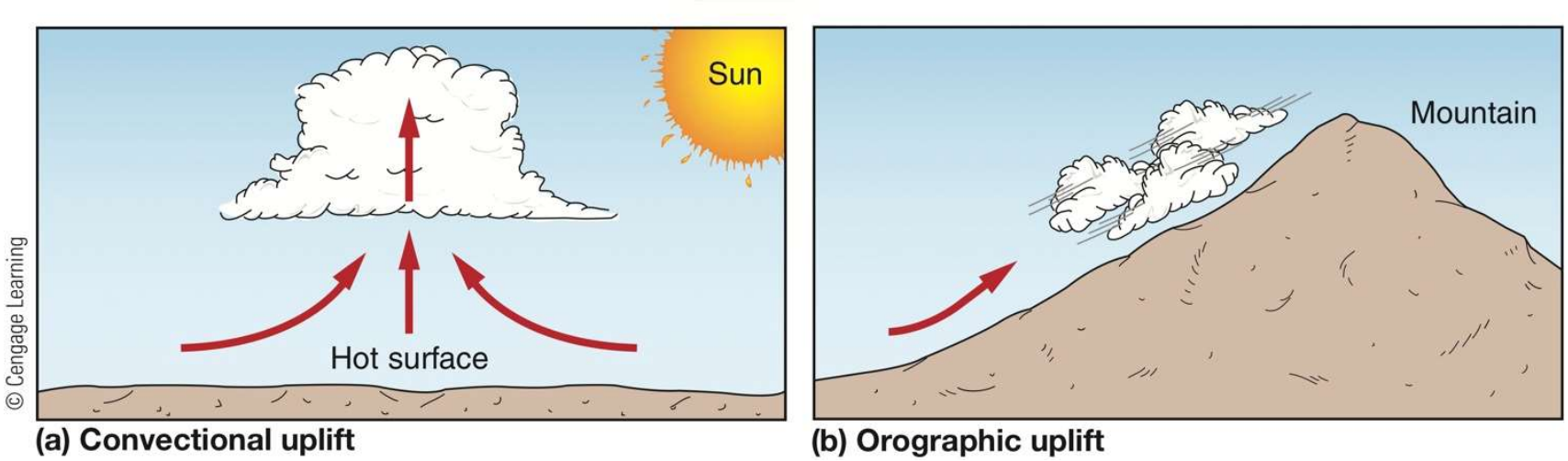
Where would you place a lightning bolt in this diagram?

Atmospheric Disturbances (cont'd.)

- Tornado spotters
  - Trained by the National Weather Service
  - Pinpoint tornado's location at a safe distance
  - SKYWARN networks
- Tornado chasers
  - Thrill seekers
  - Some study tornadoes in the interest of science

Atmospheric Disturbances (cont'd.)

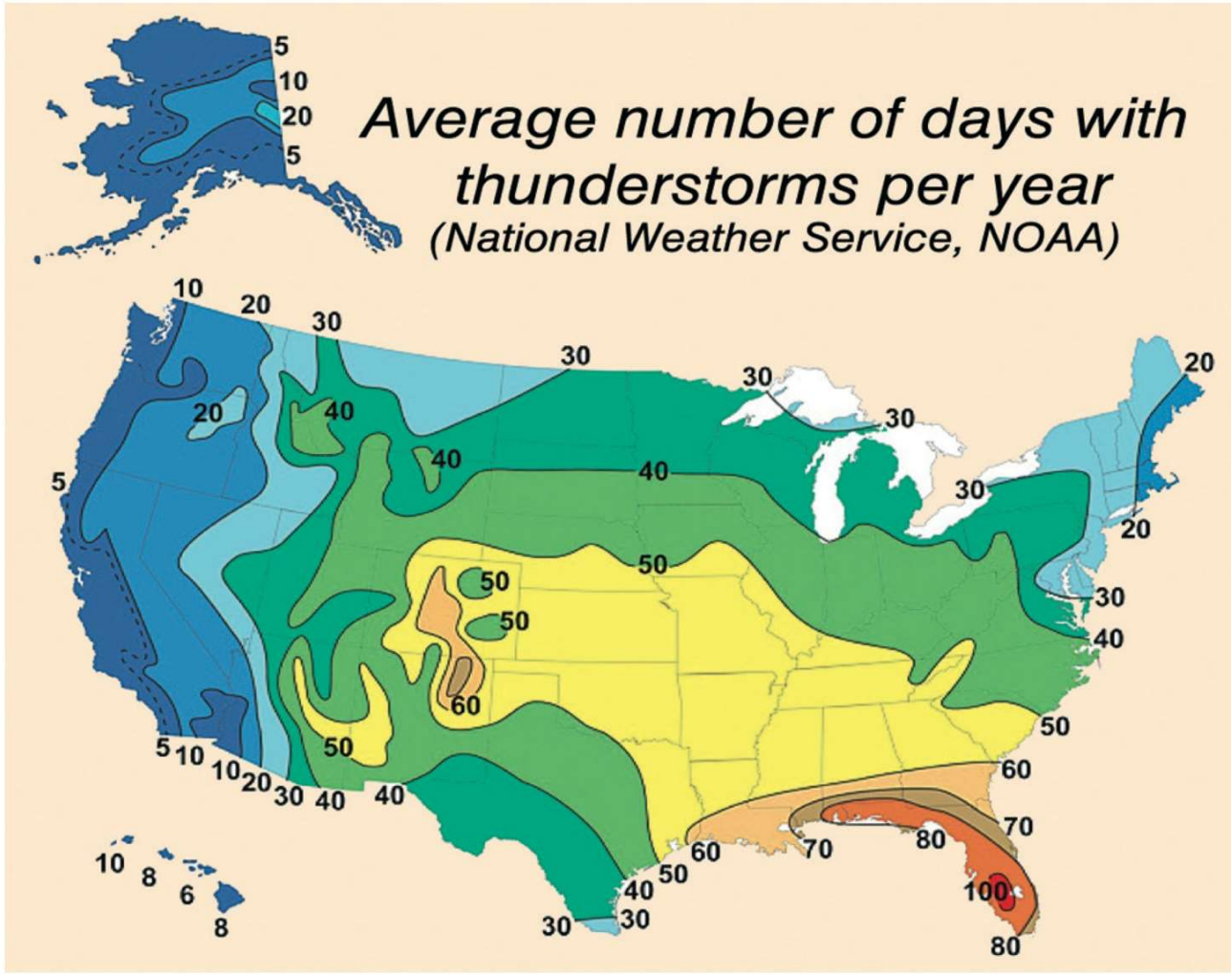
- Thunderstorms
  - Intense precipitation: rapid uplift of moist air
    - Thermal convection
    - Orographic uplift
    - Frontal uplift
  - What causes hail to form?
  - Convective thunderstorms
    - During warmer months and warmer hours of day



What are the other mechanisms of uplift that produce clouds and precipitation?

Atmospheric Disturbances (cont'd.)

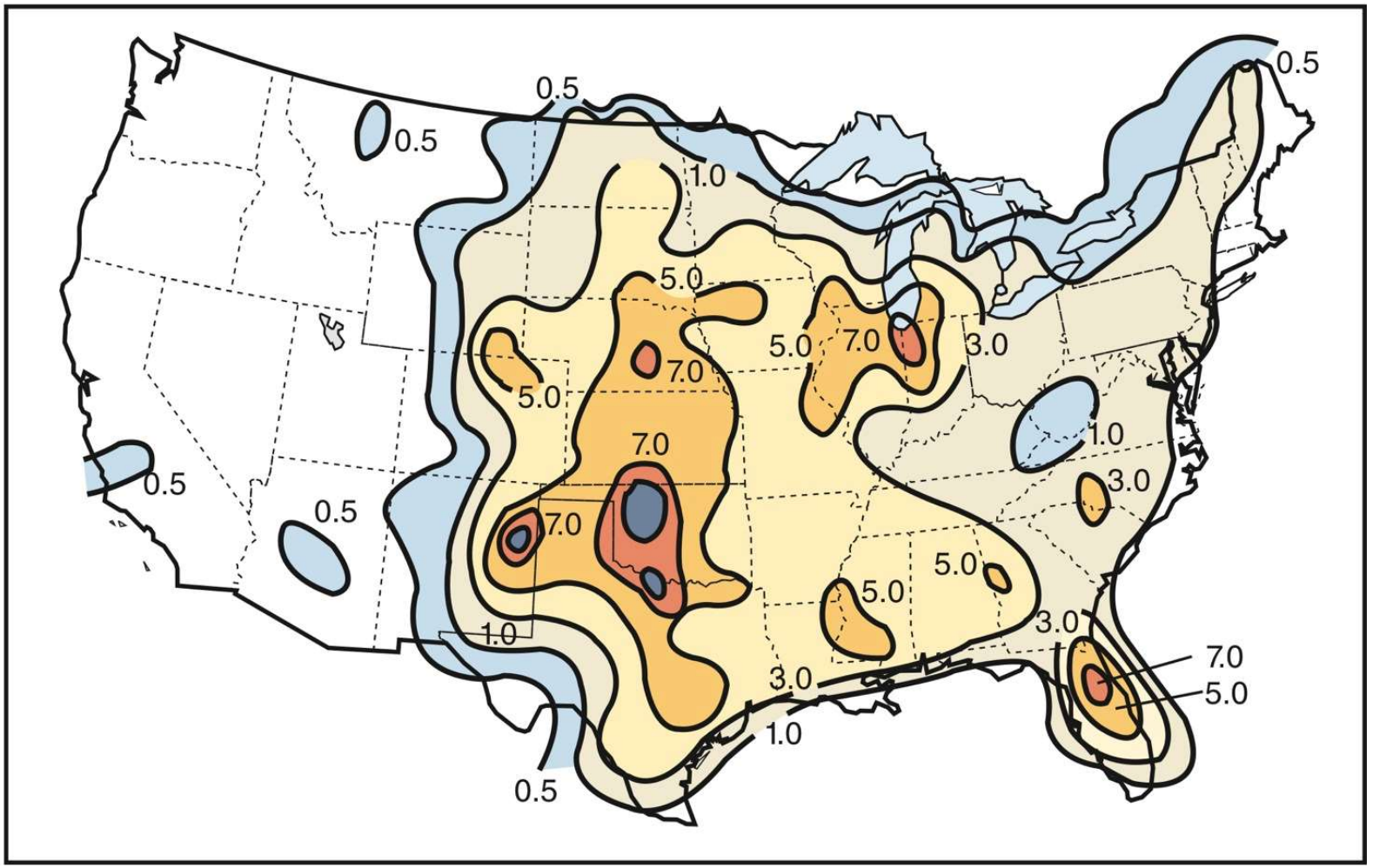
- Thunderstorms
  - Orographic thunderstorms
    - Occur over the Rockies, Sierra Nevada, and Appalachians
    - Summer afternoons
  - Frontal thunderstorms
    - Cooler air mass forces a warmer air mass to rise along a cold front
    - Squall lines can develop

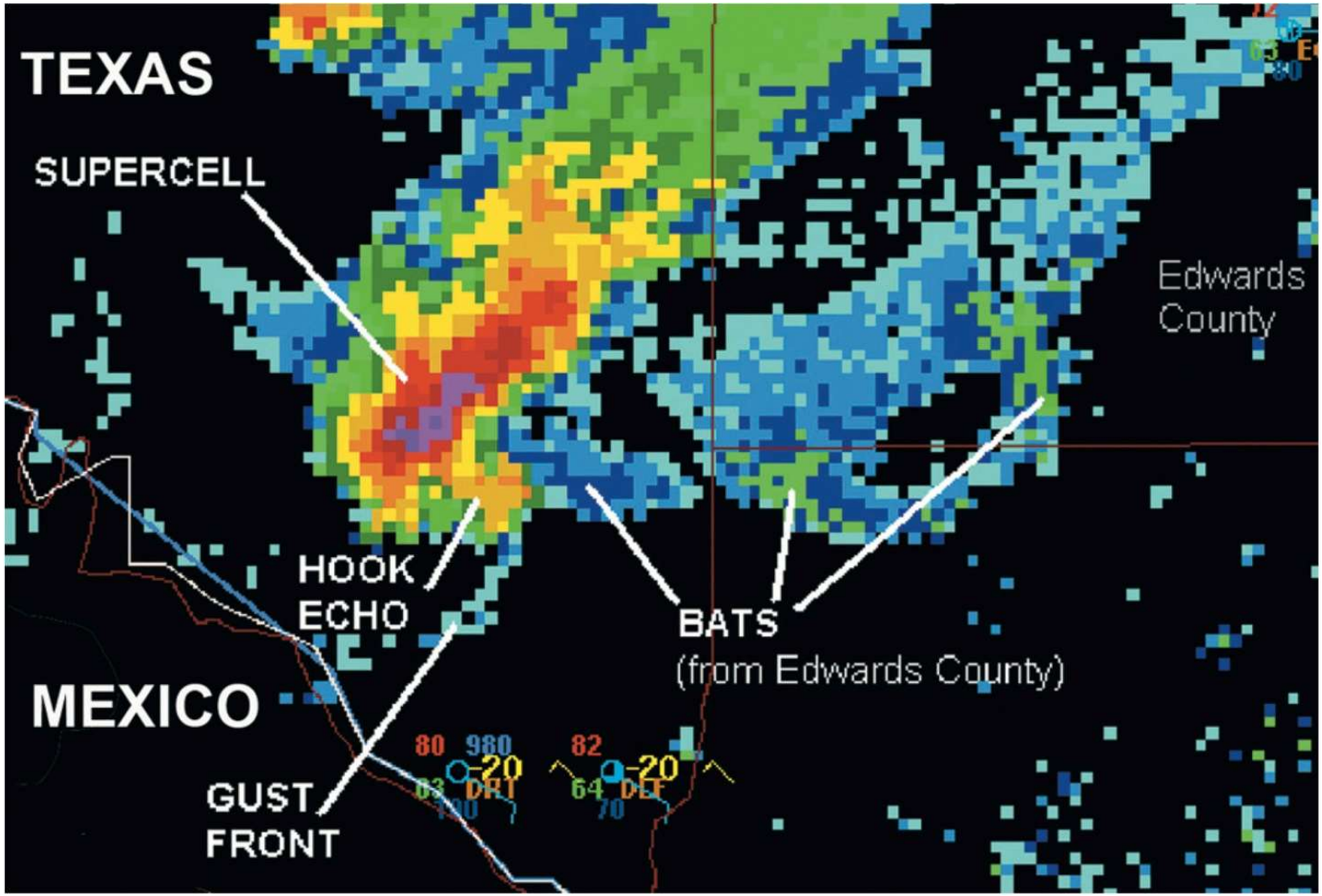


Can you explain the areas of highest and lowest occurrence in relation to the weather conditions and environments that exist at those locations?

Atmospheric Disturbances (cont'd.)

- Tornado
  - Small, intense cyclonic storm
    - Extremely low pressure, violent updrafts, and powerful converging winds
    - Occur with strong thunderstorms
  - Most violent storms on Earth
  - United States: most tornadoes in the world
    - Where is Tornado Alley?
  - Detection: Doppler radar
    - Hook-shaped pattern




TEXAS
SUPERCELL
Edwards
County
HOOK
ECHO
BATS
(from Edwards County)
MEXICO
GUST
FRONT
80 980
-20
DRT
82
-20
64 DEL
70

NWS/NOAA

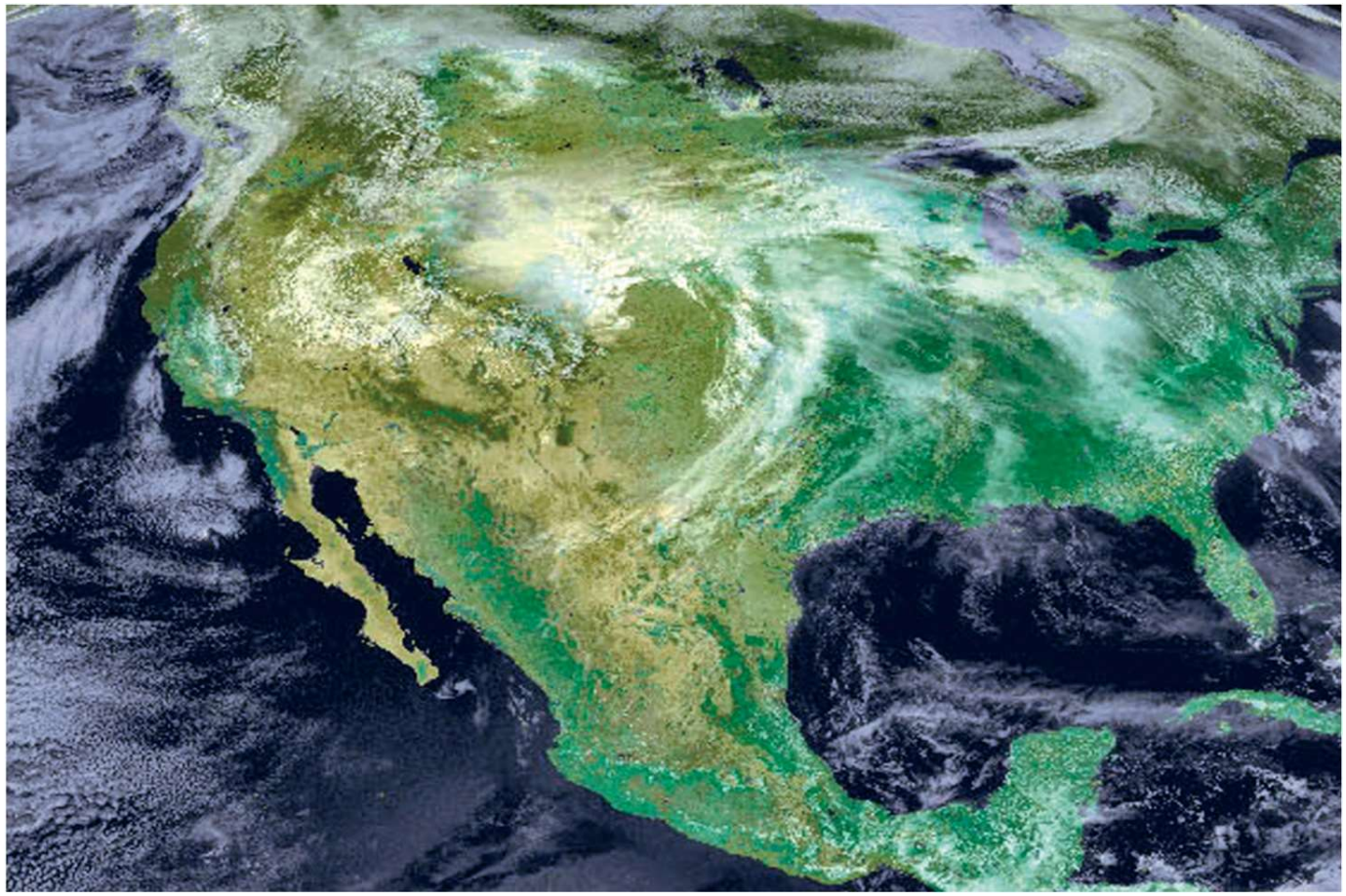
Atmospheric Disturbances (cont'd.)

- Tornado
  - Fujita Intensity Scale: F-scale
    - F0 through F5
  - Enhanced Fujita Scale (Table 6.3)
    - EF0 through EF5
  - What is a tornado outbreak?

Leo Anderson/FEMA

Weather Forecasting

- Aided by technology and equipment
  - Satellite imagery
    - Increased knowledge and surveillance
  - Computers
    - Real-time processing
    - Digital processing: statistical forecast models
    - Climate change models
- Combines science and art
  - Fact and interpretation; data and intuition



NASA/NOAA GOES and NOAAA AVHRR

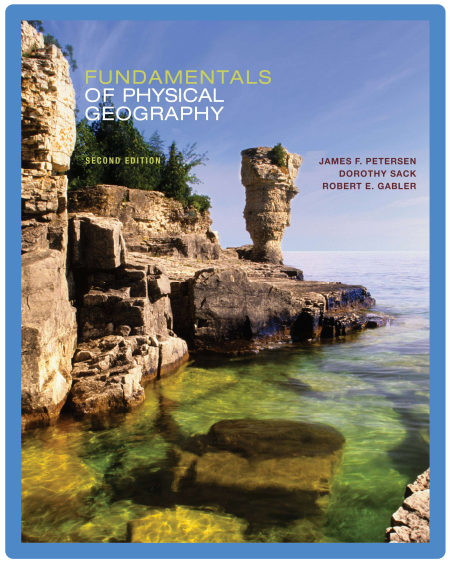
A classic middle-latitude cyclone is seen in this image. Can you identify the cyclone's cold, warm and cool sectors, and the cold, warm, and occluded fronts? In which general direction is this storm system moving?

Fundamentals of Physical Geography 2e

Air Masses and Weather Systems

6

<end of chapter>



- Peterson
  - Sack
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