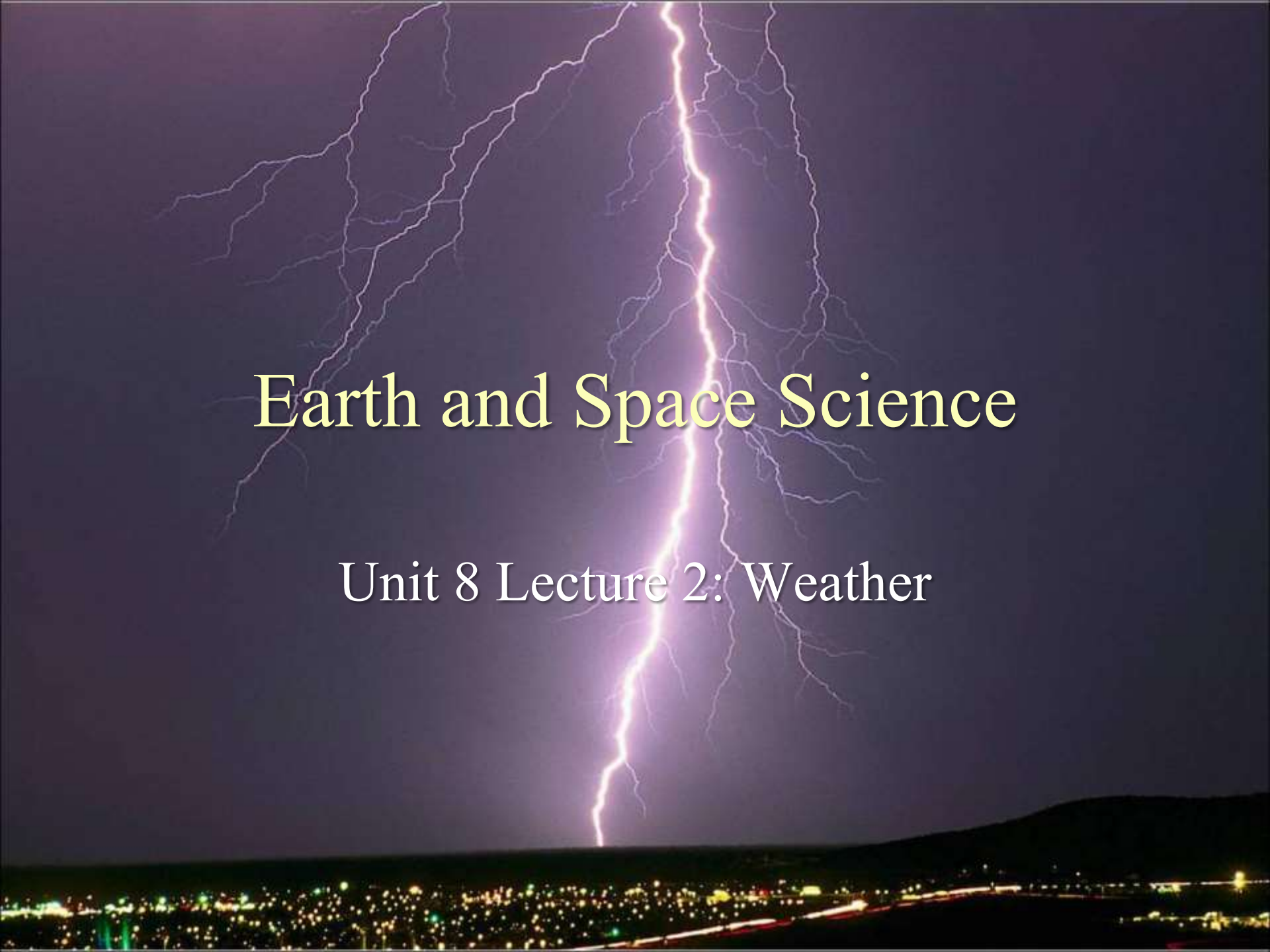
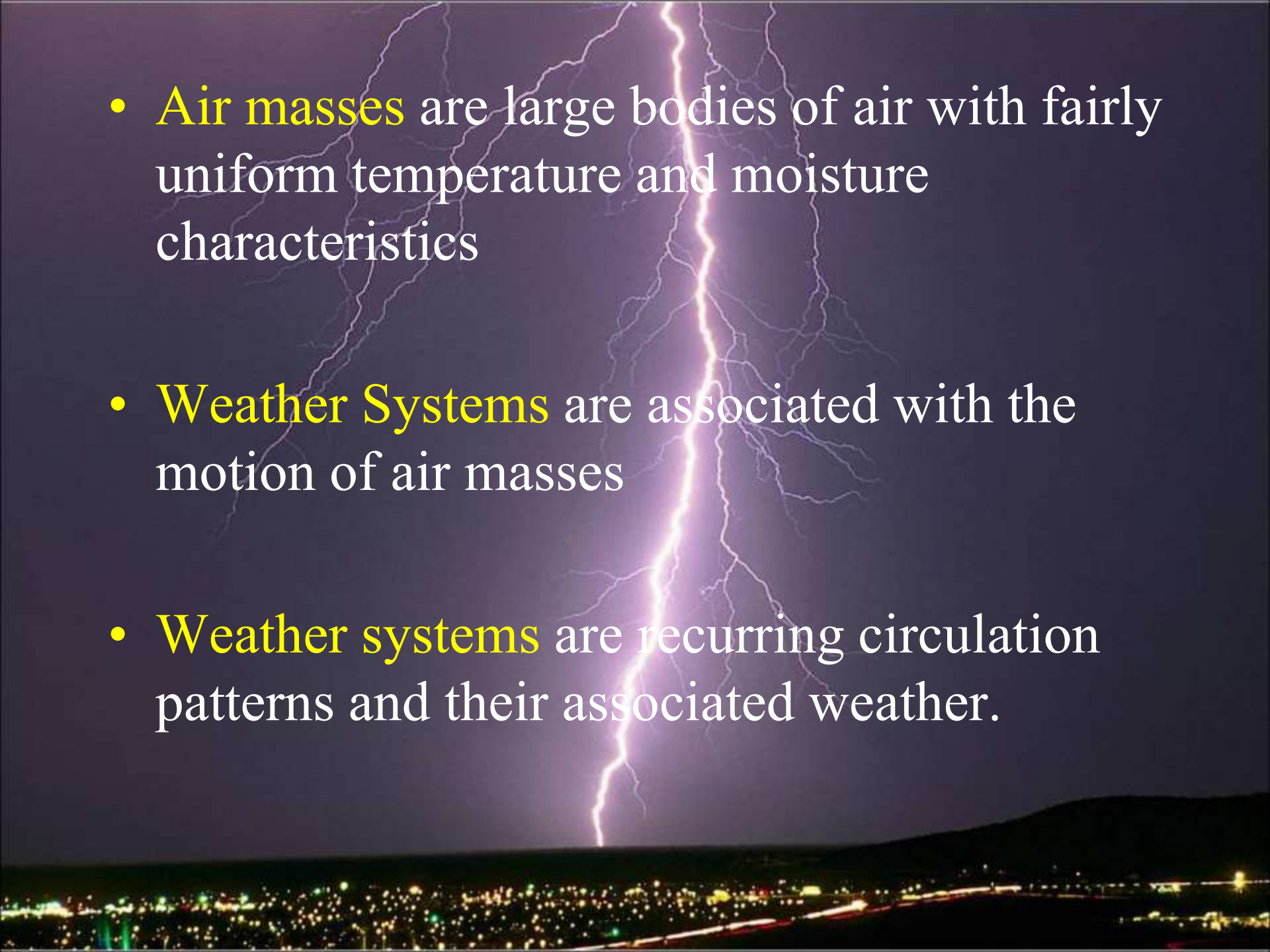


Earth and Space Science

Unit 8 Lecture 2: Weather

WEATHER

Weather, in all its cycles and clashes, arises from a simple fact: the sun heats some parts of the Earth more than others.



- Air masses are large bodies of air with fairly uniform temperature and moisture characteristics
- Weather Systems are associated with the motion of air masses
- Weather systems are recurring circulation patterns and their associated weather.

Air Masses

Classified by latitude and underlying surface

c = continental (dry)

m = maritime (wet)

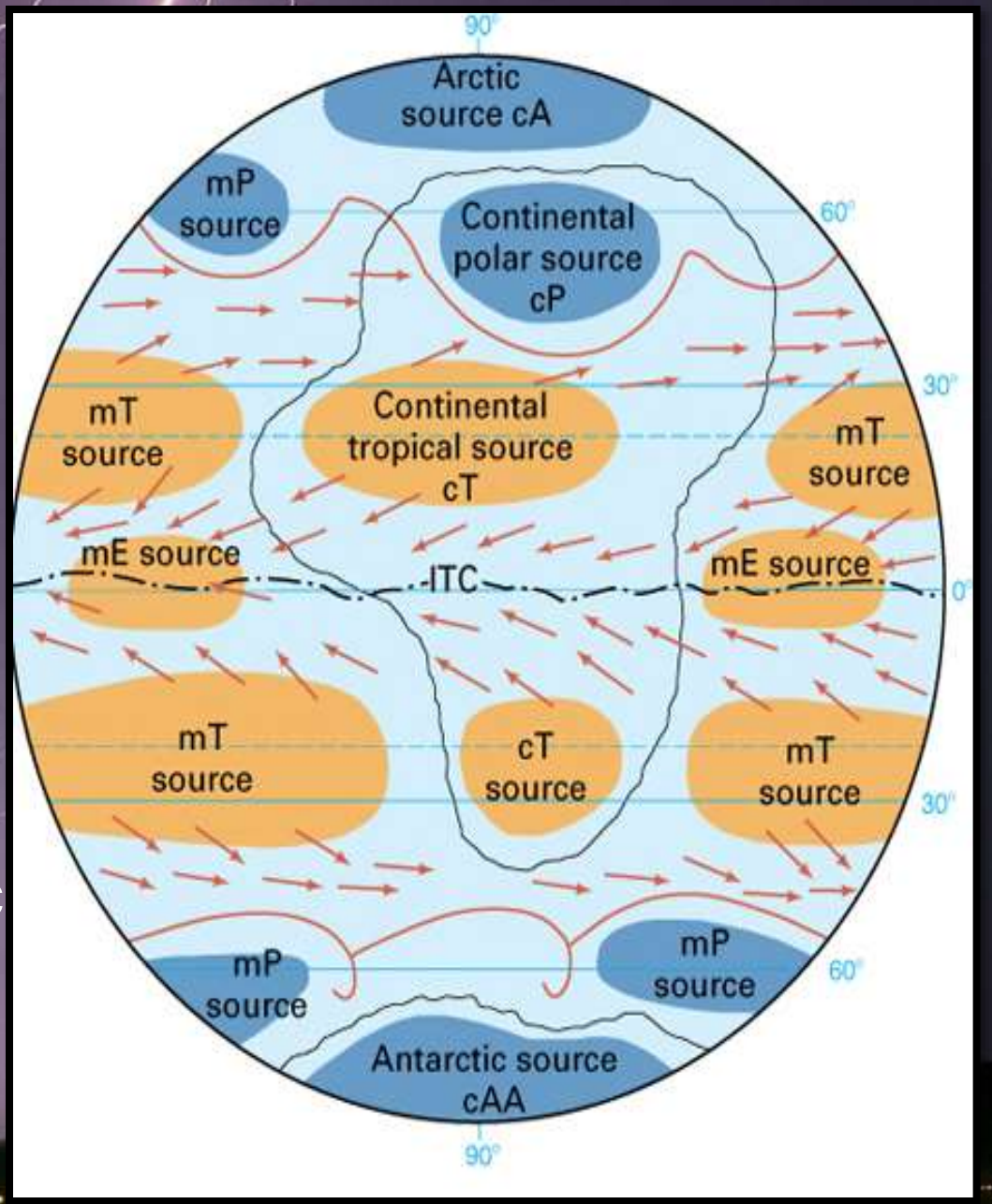
E = equitorial

T= tropical (warm)

P = polar (cold)

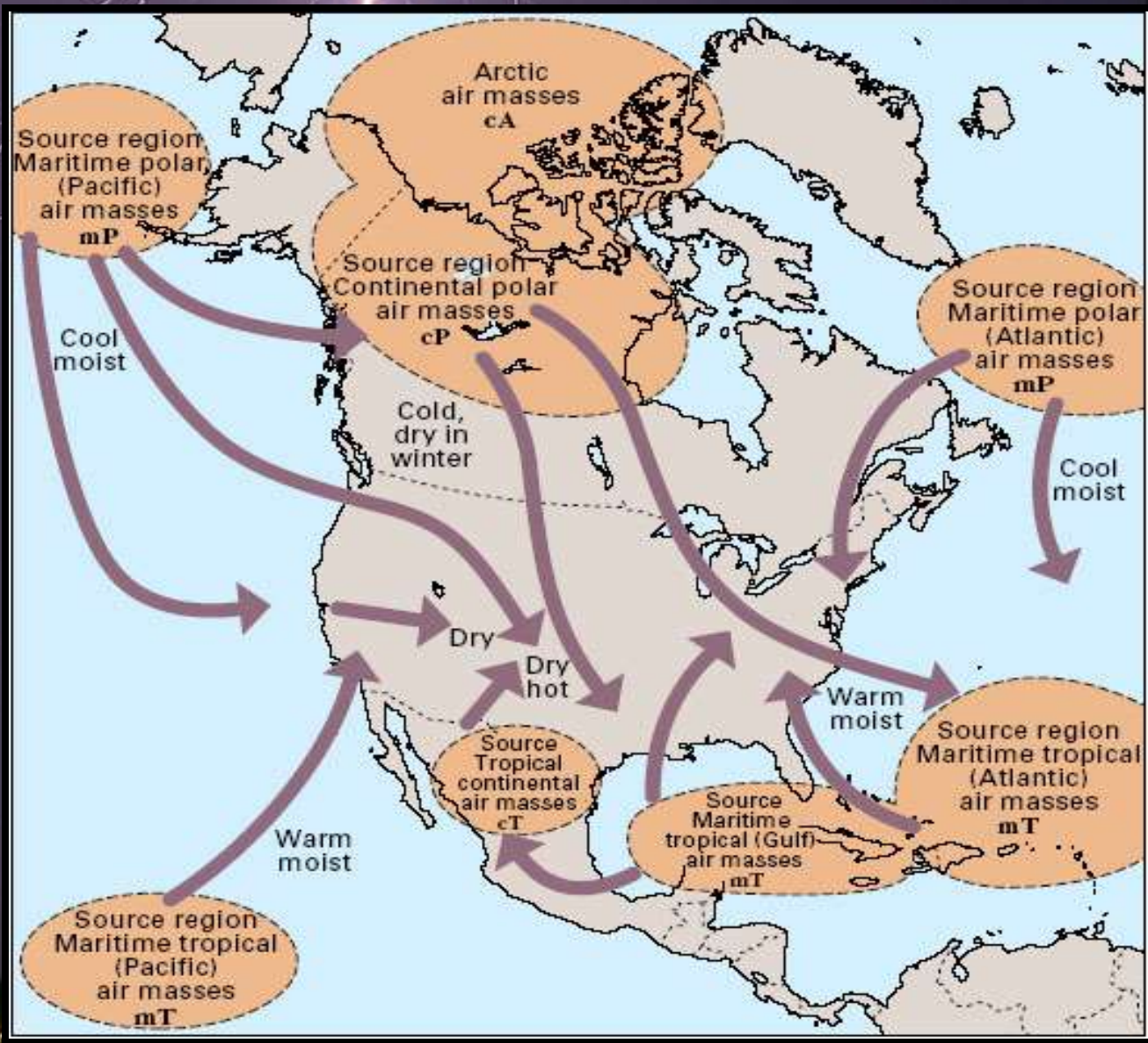
A = Arctic (cold) (from Arctic oceans and fringing lands)

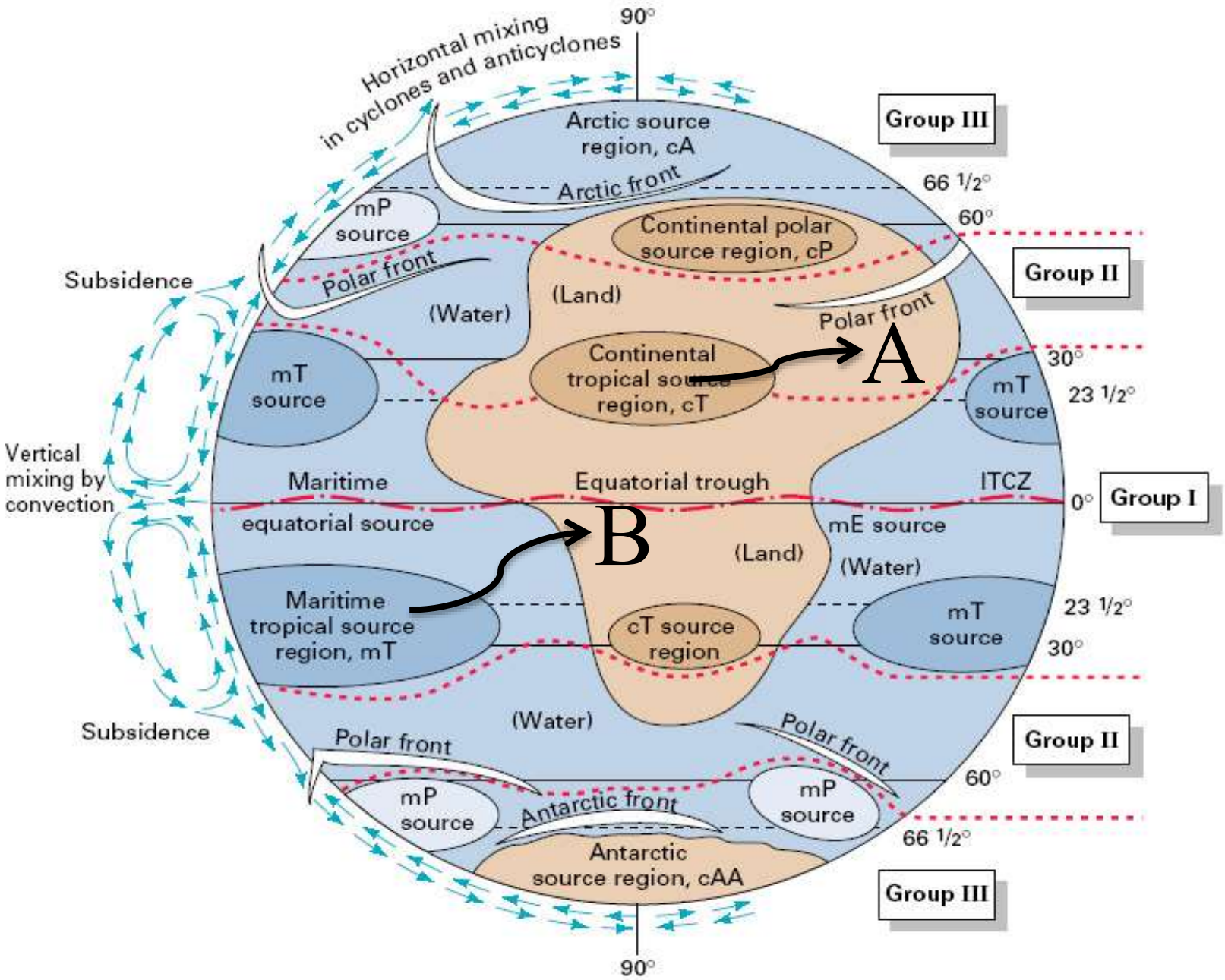
AA = Antarctic



North American Air Masses

Air masses acquire their temperature and moisture characteristics over their source regions




90°
Horizontal mixing in cyclones and anticyclones
Arctic source region, cA
Arctic front
Group III
66 1/2°
60°
mP source
Polar front
Continental polar source region, cP
Group II
Subsidence
(Land)
(Water)
Polar front
Continental tropical source region, cT
A
30°
mT source
mT source
23 1/2°
Vertical mixing by convection
Maritime equatorial source
Equatorial trough
ITCZ
0°
Group I
B
(Land)
mE source
(Water)
Maritime tropical source region, mT
cT source region
mT source
23 1/2°
30°
Subsidence
(Water)
Polar front
Polar front
Group II
60°
mP source
Antarctic front
mP source
66 1/2°
Antarctic source region, cAA
Group III
90°


Arctic Ocean
ALASKA
Hudson Bay
CANADA
Pacific Ocean
Atlantic Ocean
HAWAII
MEXICO
Gulf of Mexico
CUBA
BELIZE
GUATEMALA
EL SALVADOR
HONDURAS
NICARAGUA
WA
OR
CA
ID
NV
MT
WY
UT
AZ
CO
NM
ND
SD
NE
KS
OK
TX
MN
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MO
AR
LA
WI
IL
MS
MI
IN
KY
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GA
FL
SC
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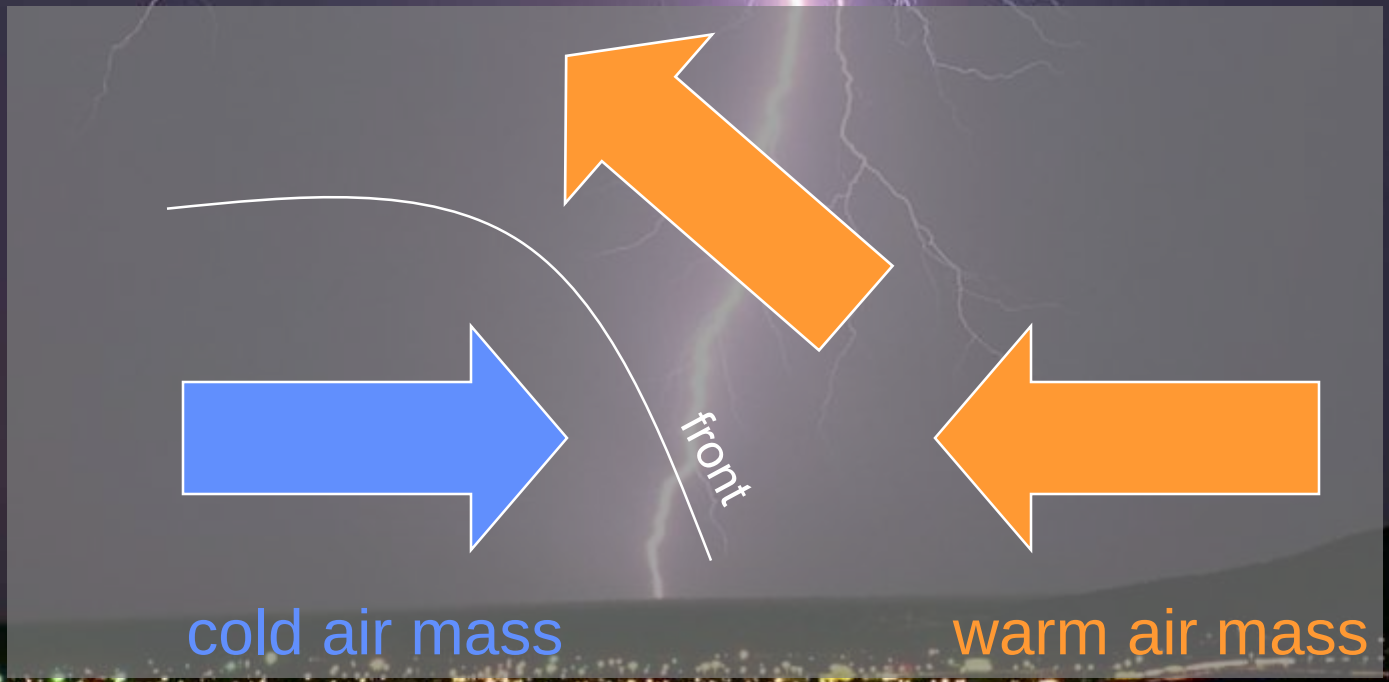
VA
PA
NY
ME

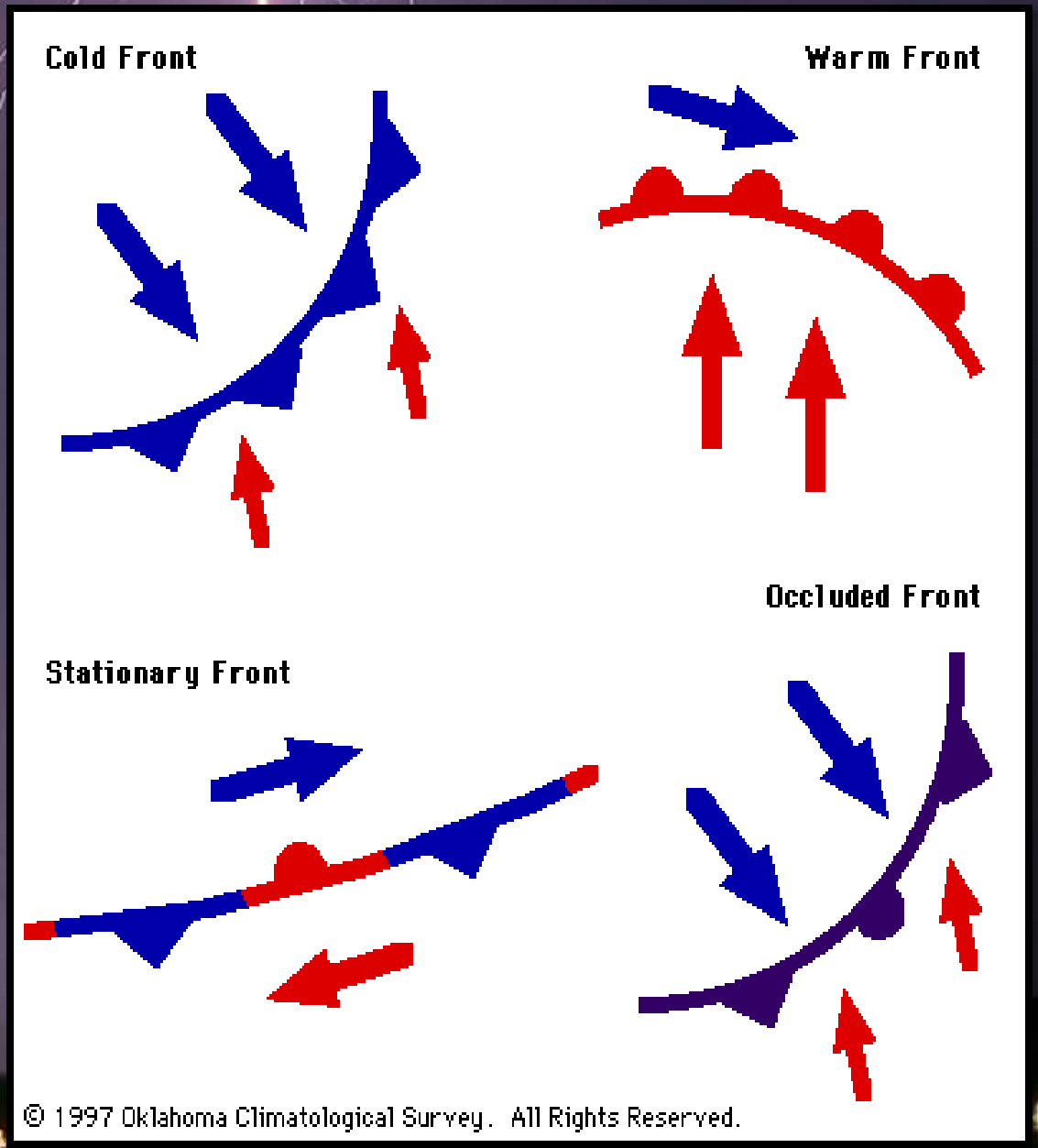
Frontal Activity

Front: sharply defined boundary between air masses. (where air masses with different temperatures come together)



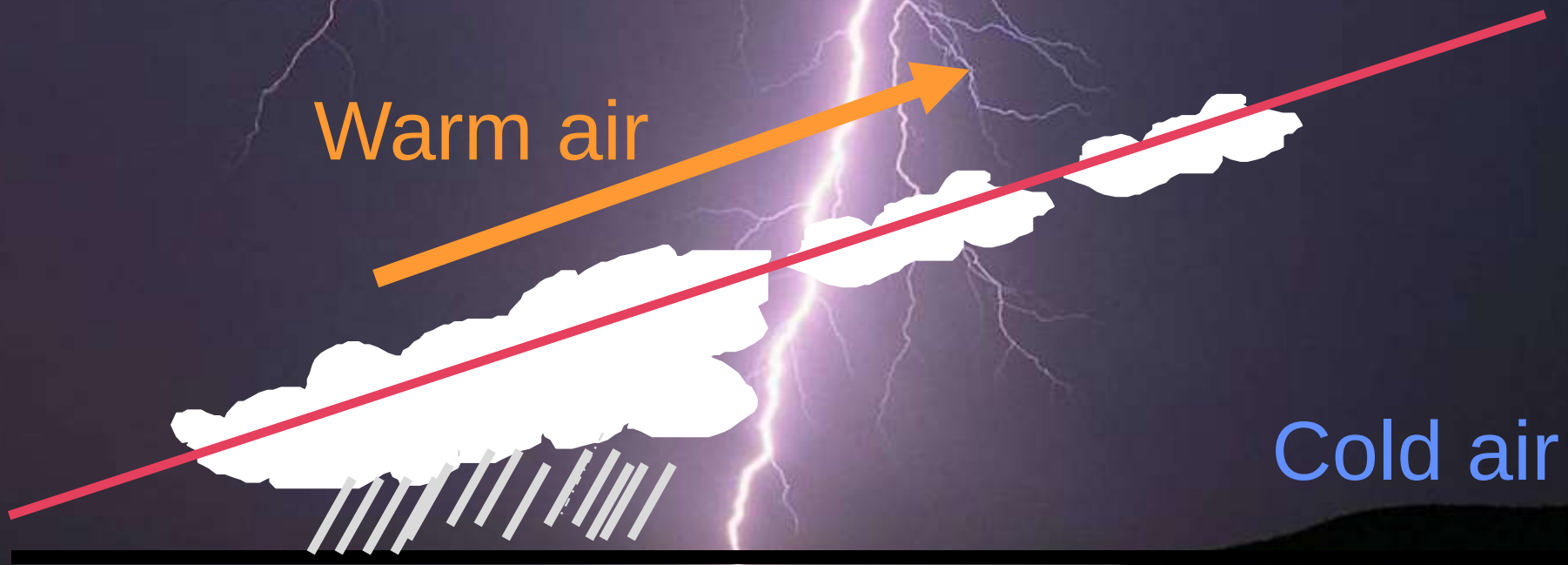
Weather Fronts

- Warm fronts
- Cold fronts
- Occluded fronts
- Stationary fronts



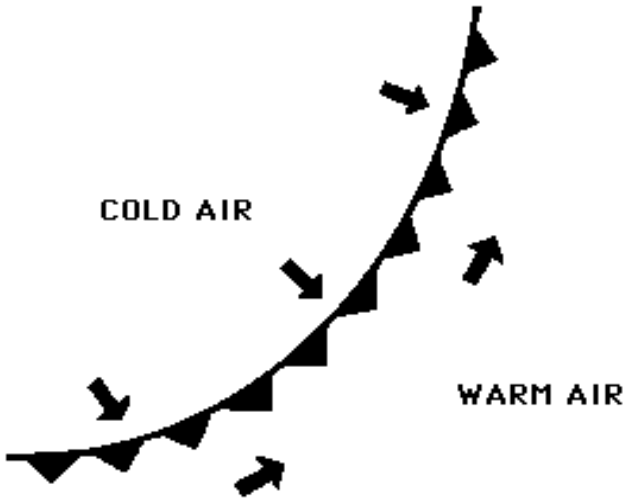
Warm Fronts

Warm air is ramped over the colder air resulting in cloud formation (condensation) and precipitation



Cold Fronts

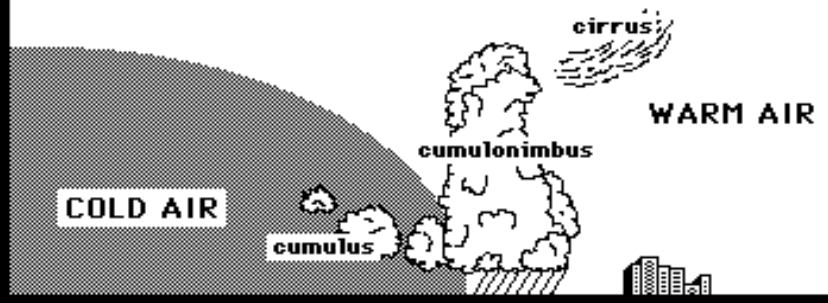
Cold air rapidly intrudes stationary warm air and quickly lifts it along a steep cold front resulting in cloud formation (condensation) and precipitation (often thunderstorms)

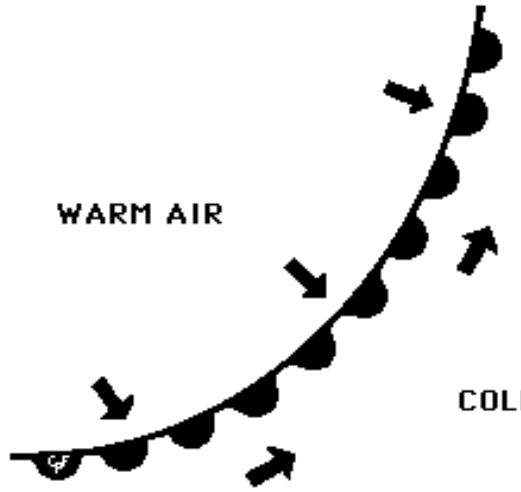


COLD FRONT

Cold fronts produce brief but violent weather. The speed of the front determines the nature of the storm. Watch for gusty winds, thunderstorms and the possibility of tornadoes.

MOVEMENT OF THE FRONT





WARM FRONT

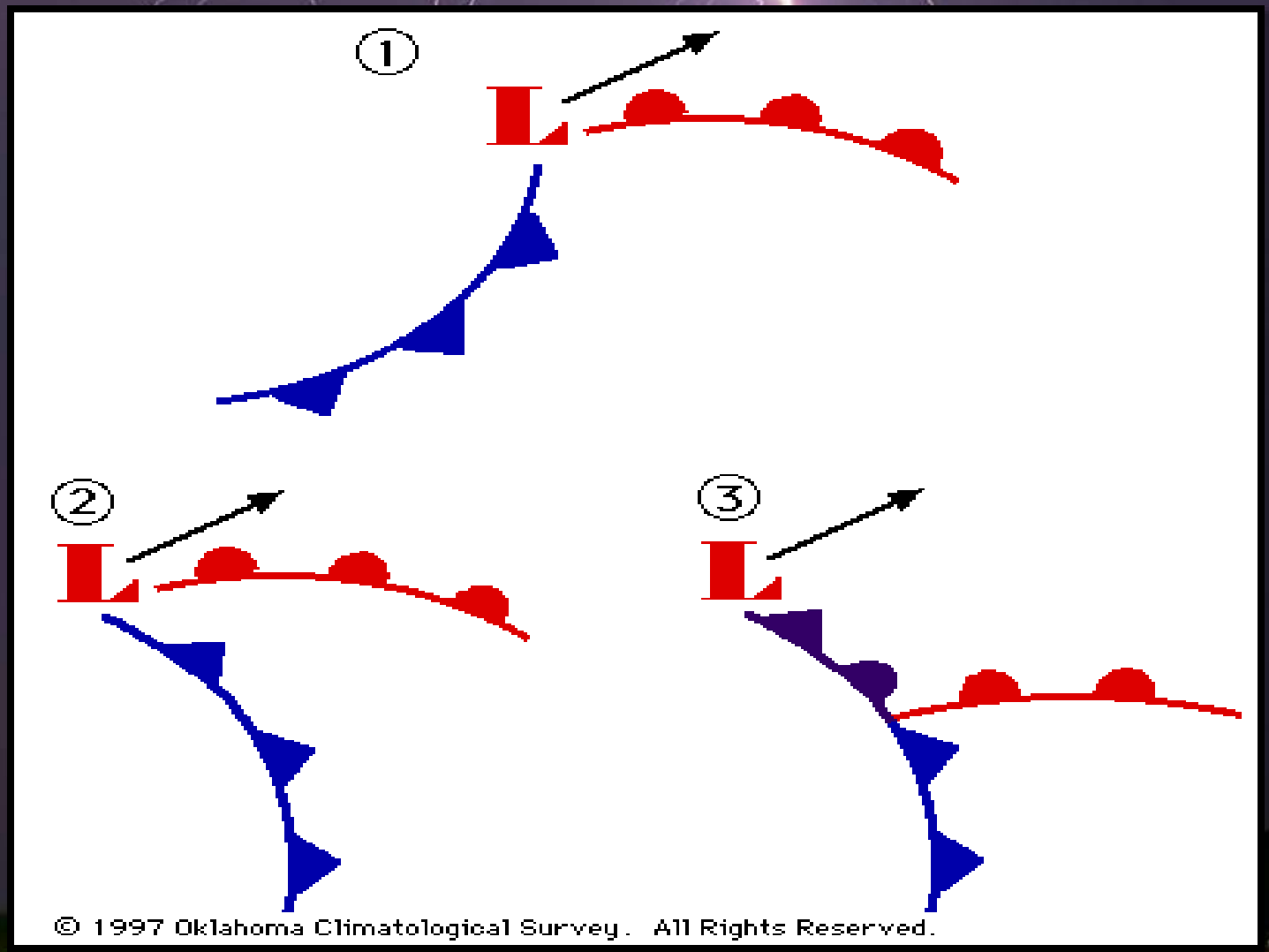
Warm fronts produce long lasting but usually less violent weather. They move slower than cold fronts which often overtake them. Watch for full sky stratus clouds.

MOVEMENT OF THE FRONT

Occluded Fronts

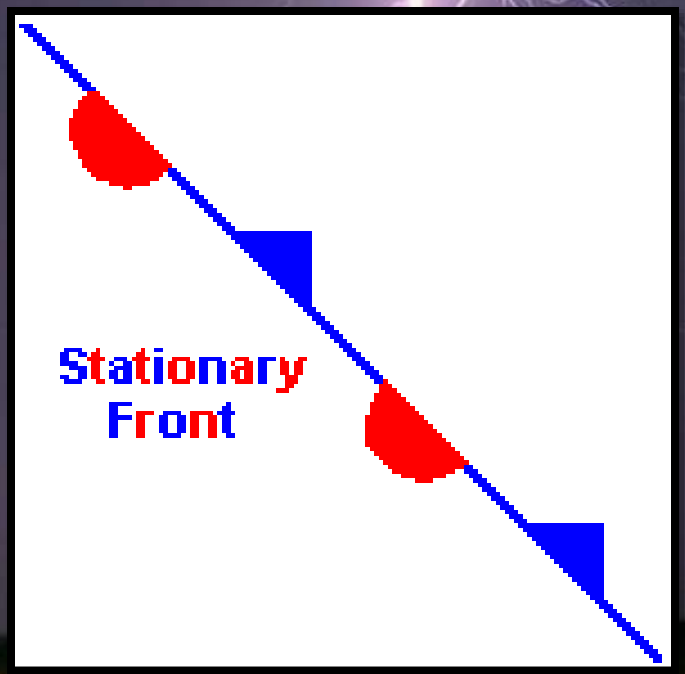
In an occluded front, a warm front is overtaken by a cold front. The warm air is pushed aloft and it is no longer in contact with the ground

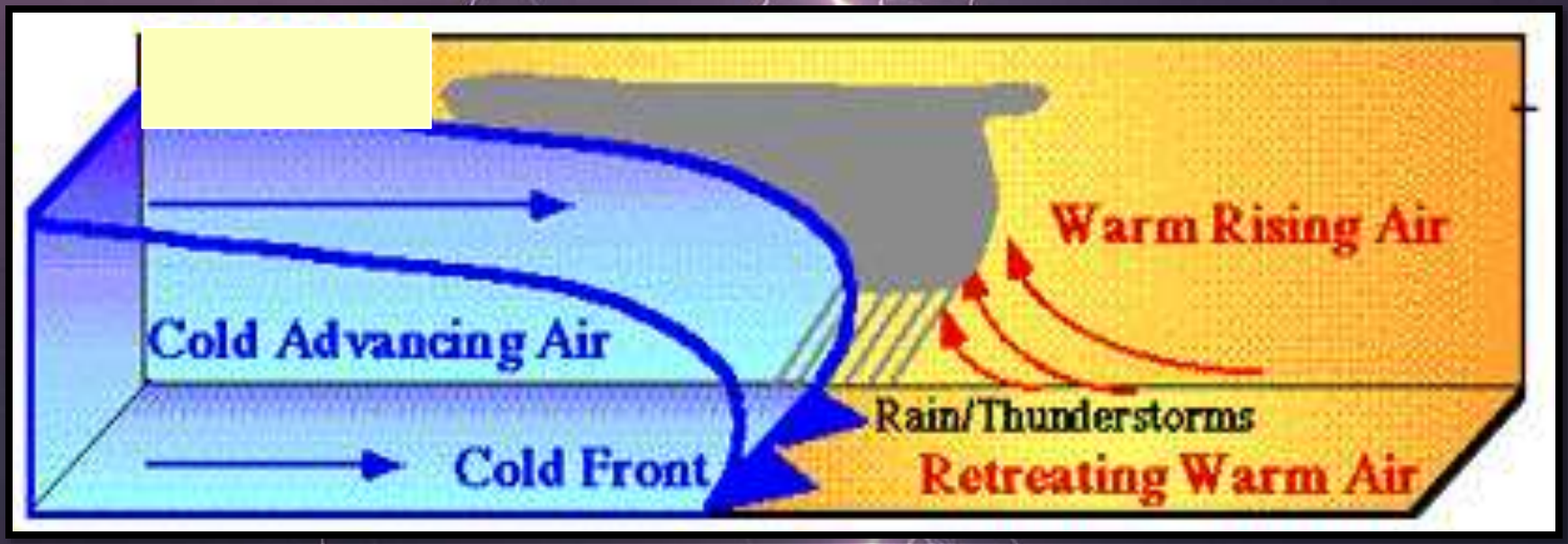
Occluded Front Development



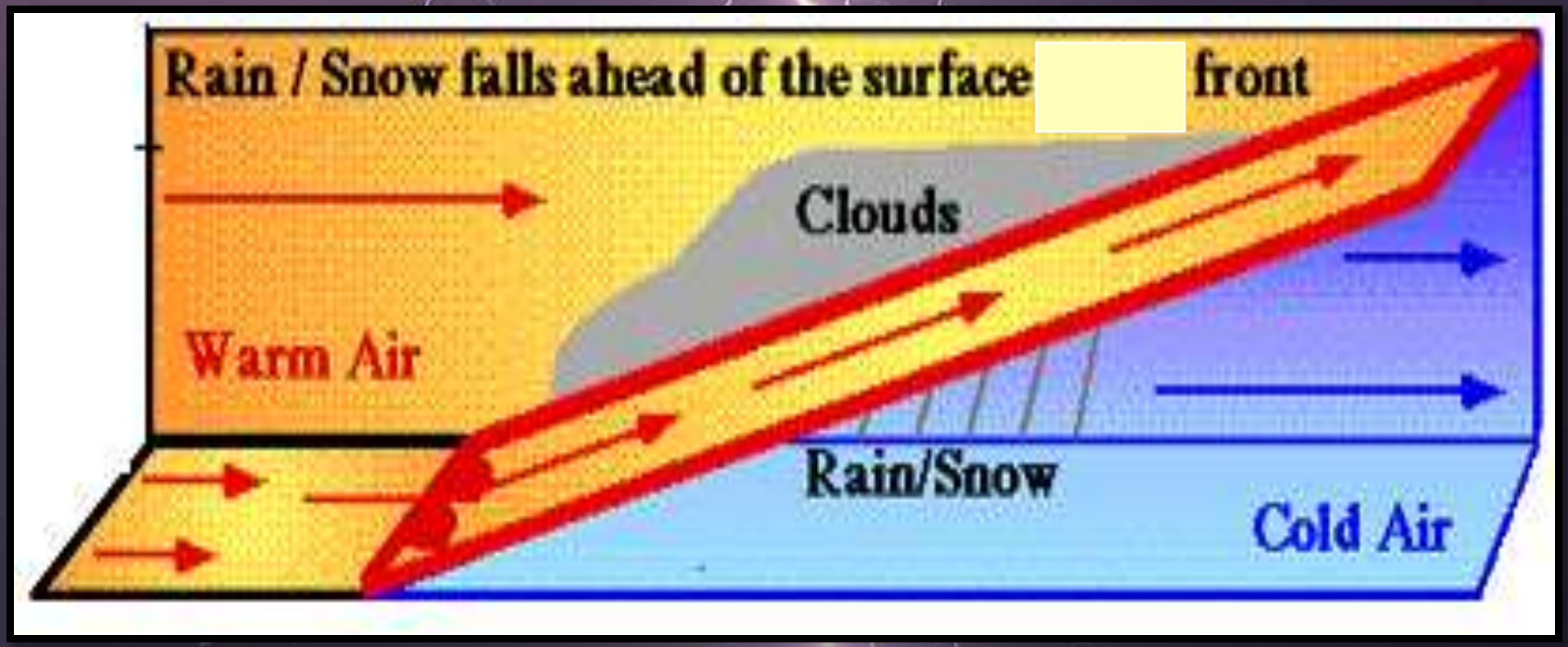
Stationary Front

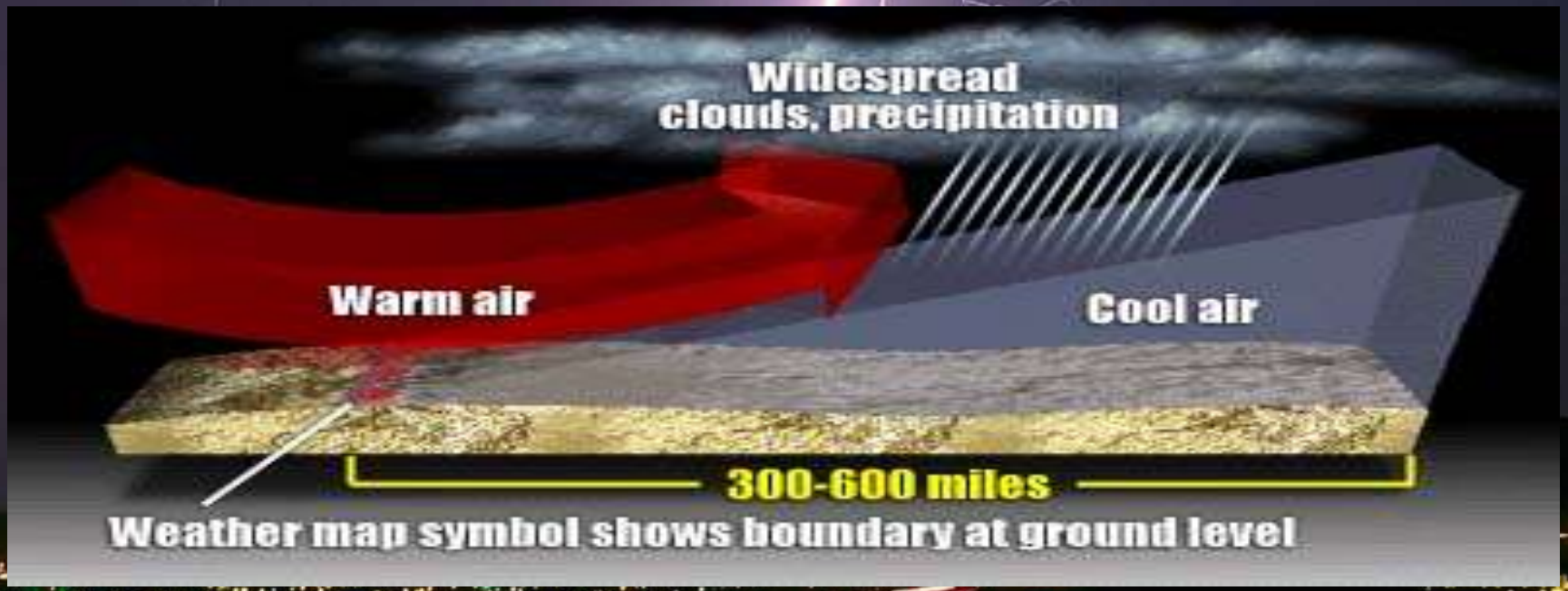
- Two air masses are in contact with little or no relative motion




Warm Rising Air
Cold Advancing Air
Rain/Thunderstorms
Cold Front
Retreating Warm Air


Advancing cold air mass.
As rising air cools, it can condense into clouds, precipitation.
Warm air
As front advances, warm air is pushed upward.


Rain / Snow falls ahead of the surface front
Clouds
Warm Air
Rain/Snow
Cold Air


Widespread
clouds, precipitation
Warm air
Cool air
300-600 miles
Weather map symbol shows boundary at ground level

Traveling Cyclones/Anti-Cyclones

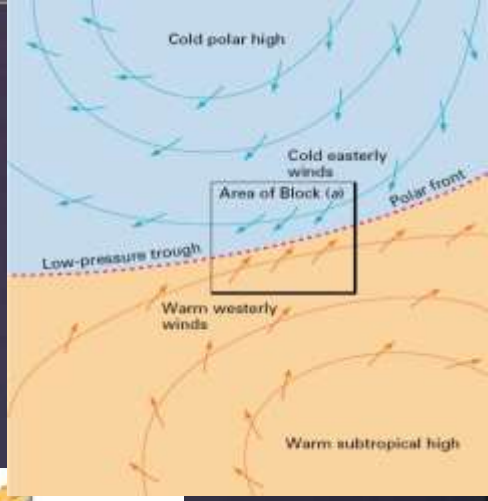
- Large features moving across the earth bringing changes in weather

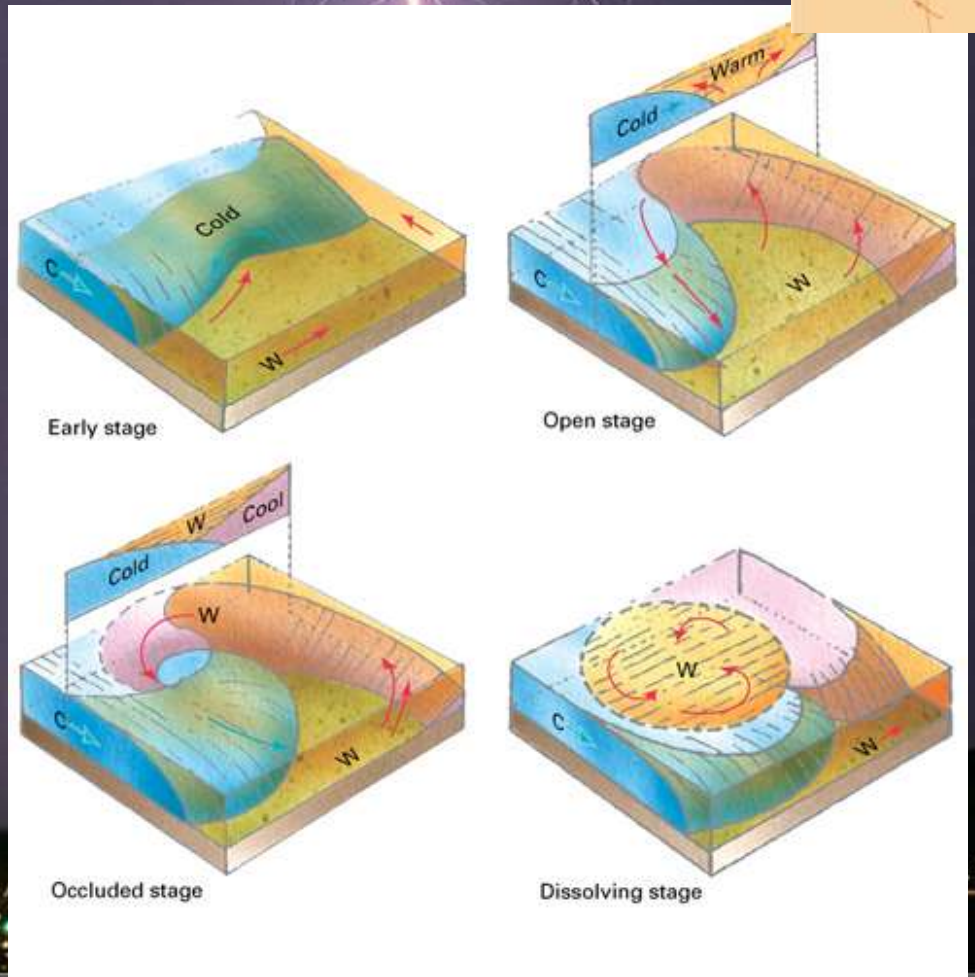
- Three types:
  - Wave cyclones
  - Tropical cyclones
  - Tornados

Wave Cyclones

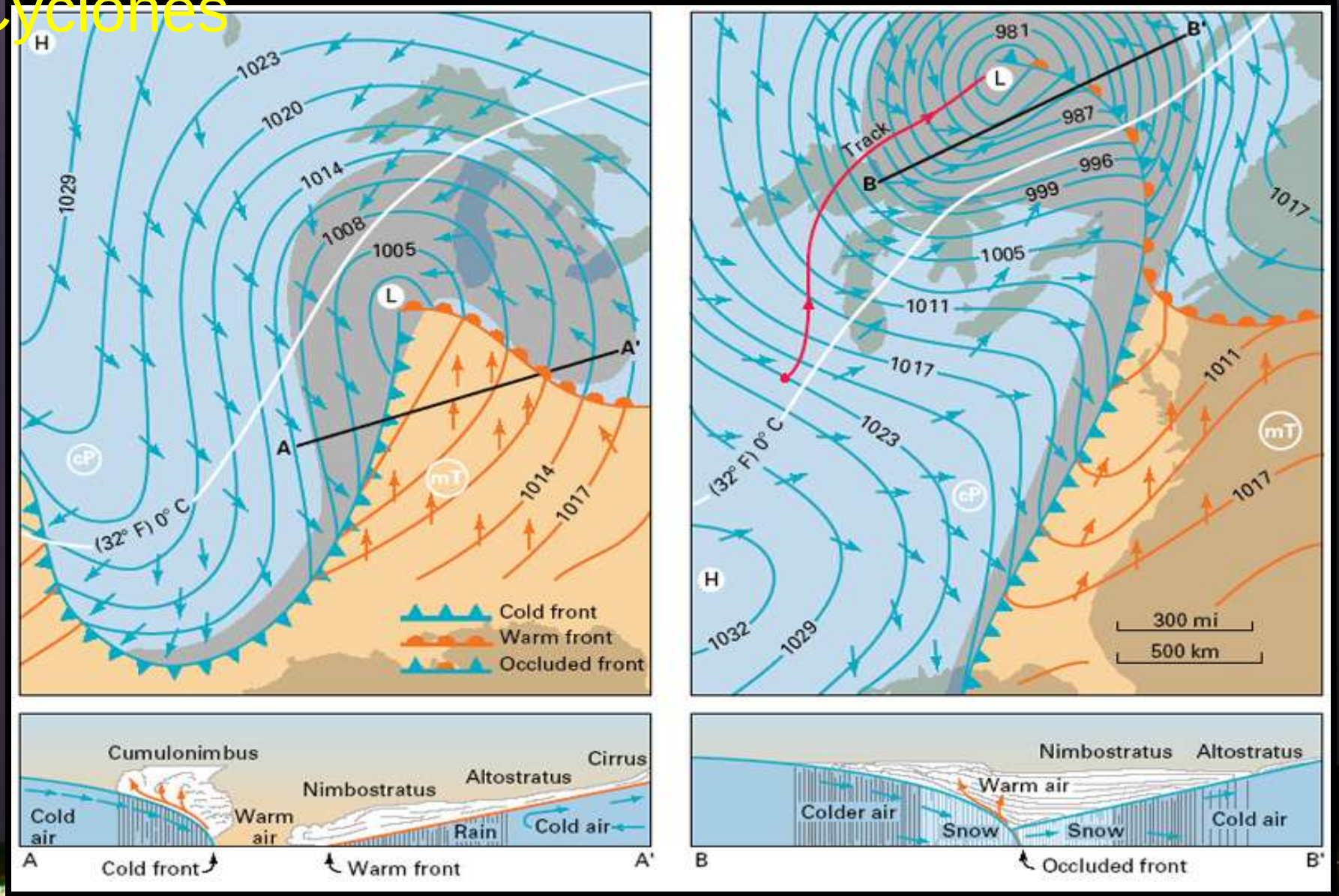
Large (1000 or more km) inspirals of air that repeatedly form, intensify and dissolve

Wave cyclones are the dominant form of weather systems in middle and high latitudes

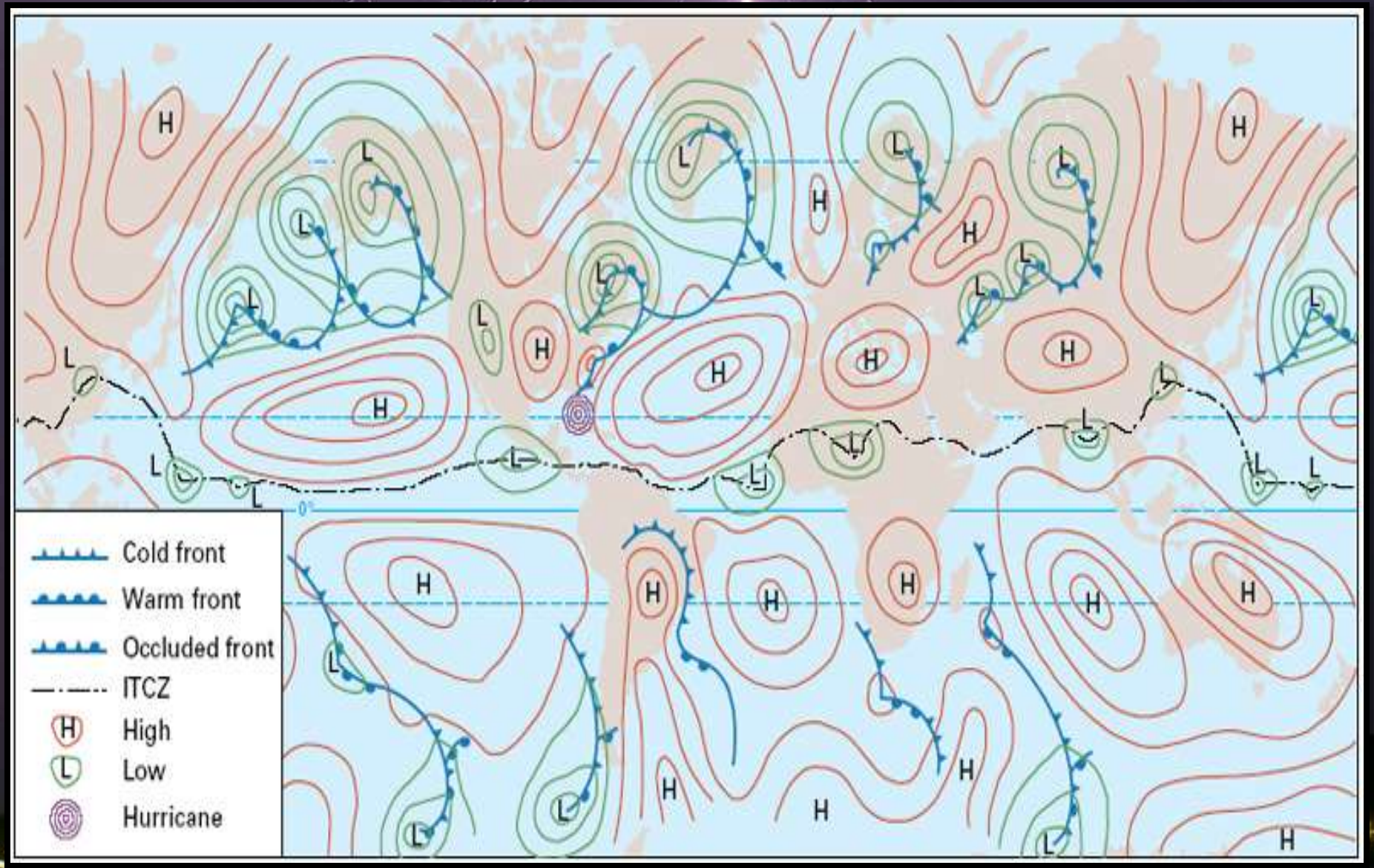




Weather Changes Associated with Wave Cyclones

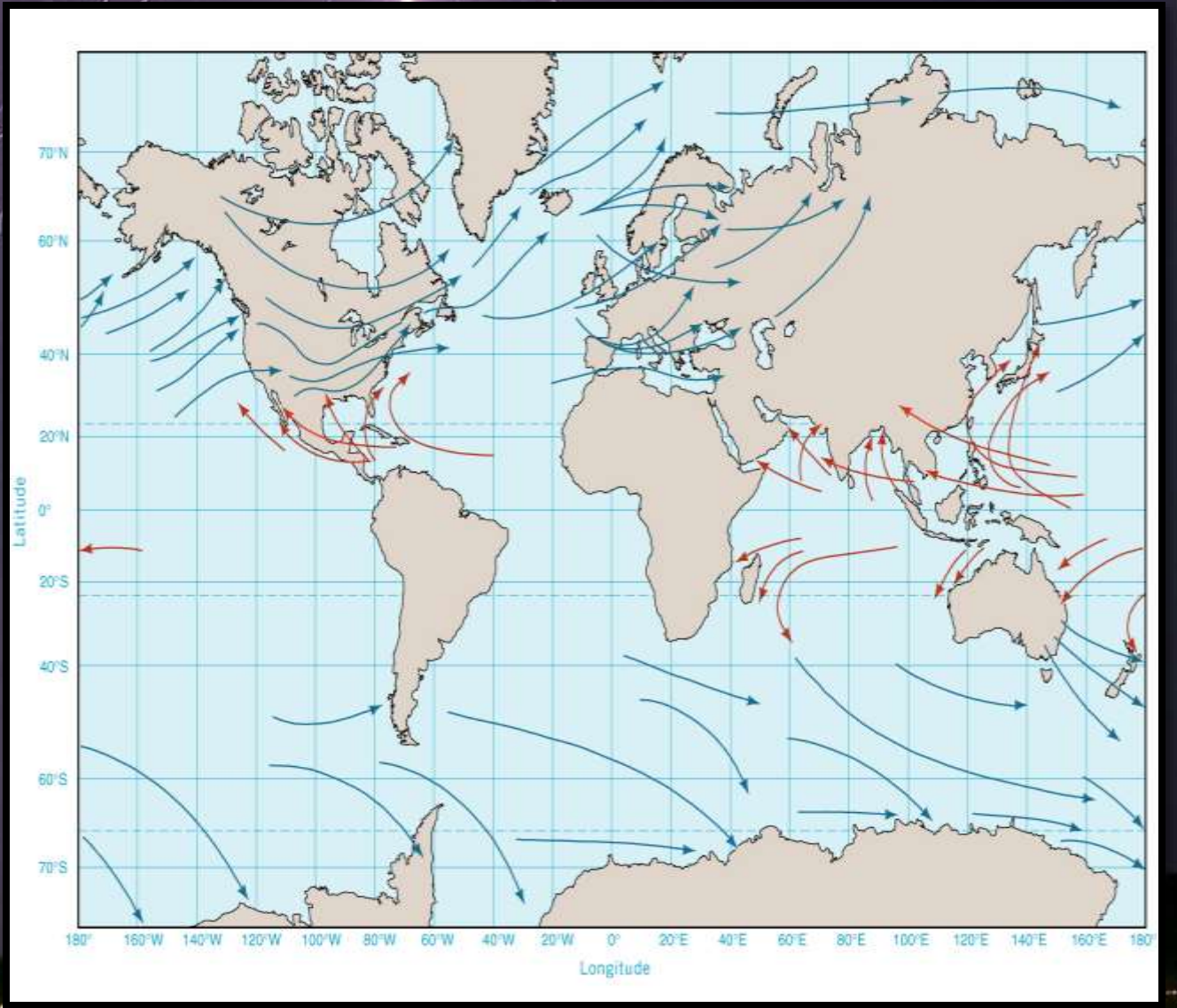


Traveling Cyclones and Anticylones on a daily weather map of the world



Cyclone Tracks

- Cyclones tend to form in certain areas and travel common paths
- Mid-latitude wave cyclones tend to travel eastward
- Tropical cyclones tend to move westward



Tornadoes

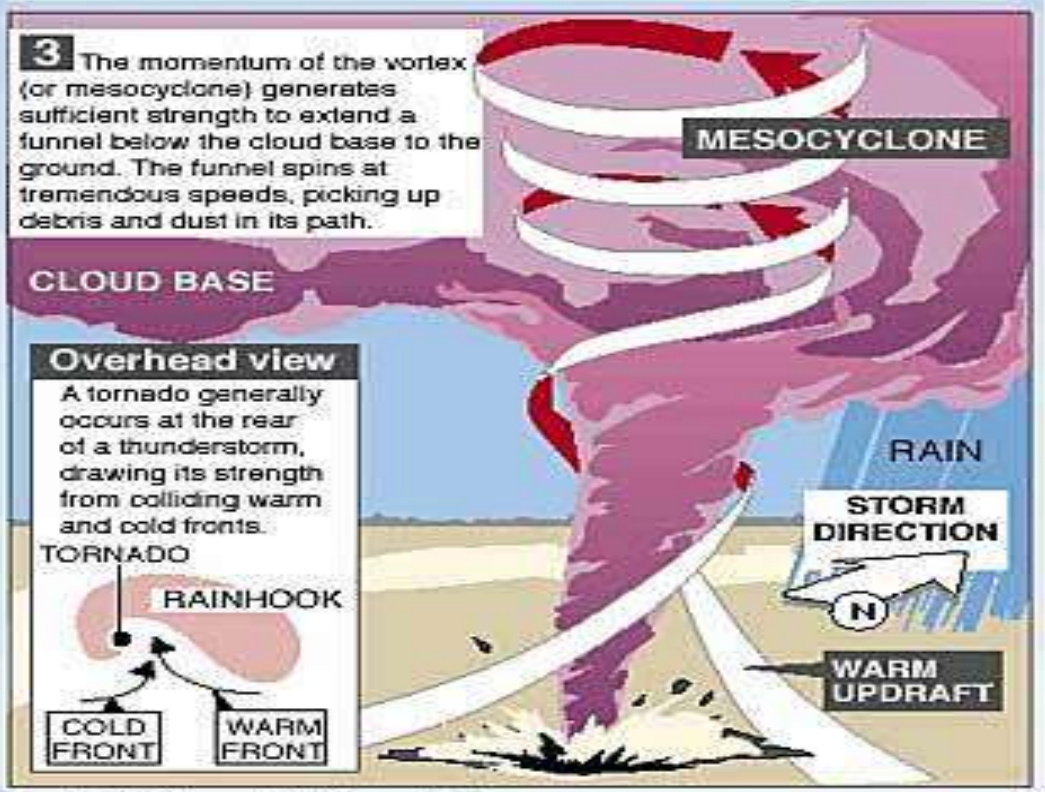
- Small intense cyclonic vertex
- Form under a certain set of weather conditions in which three very different types of air come together in a certain way:
  - Warm, moist air down low
  - Cool strong air up high
  - Strong wind shear (change in wind speed direction and height)
- Wind speeds may be as high as 100 meters per second (225 miles per hour)
- Measured by the Fujita scale

The birth of a tornado

1 Thunderstorms act as Earth's cooling agent by drawing hot, moist air from the ground. When temperatures vary greatly between the ground and atmosphere (as they do in summer), this air rises rapidly condenses and forms thunderheads.

2 This heated updraft collides with higher cold air and creates turbulent winds surrounding it. These winds are forced into a violent upward spin and are the beginnings of a tornado.

3 The momentum of the vortex (or mesocyclone) generates sufficient strength to extend a funnel below the cloud base to the ground. The funnel spins at tremendous speeds, picking up debris and dust in its path.



Source: Tim's Life Storm; National Geographic Magazine

AP

Tornadoes

1. Cold air coming down from Canada

2. Warm air coming up from the Gulf of Mexico

3. Rocky Mountains to the West (a downward west to east sloping terrain)

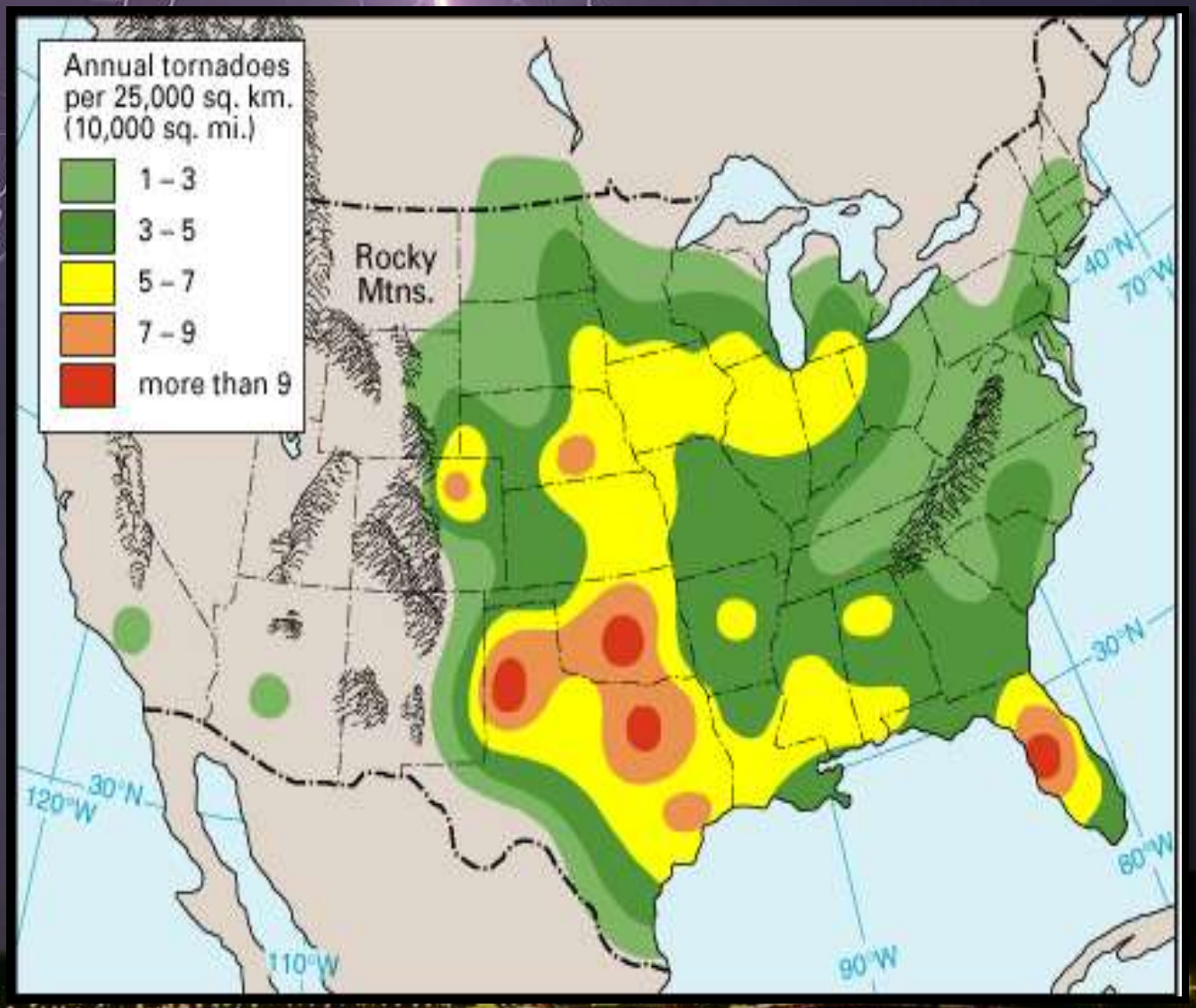


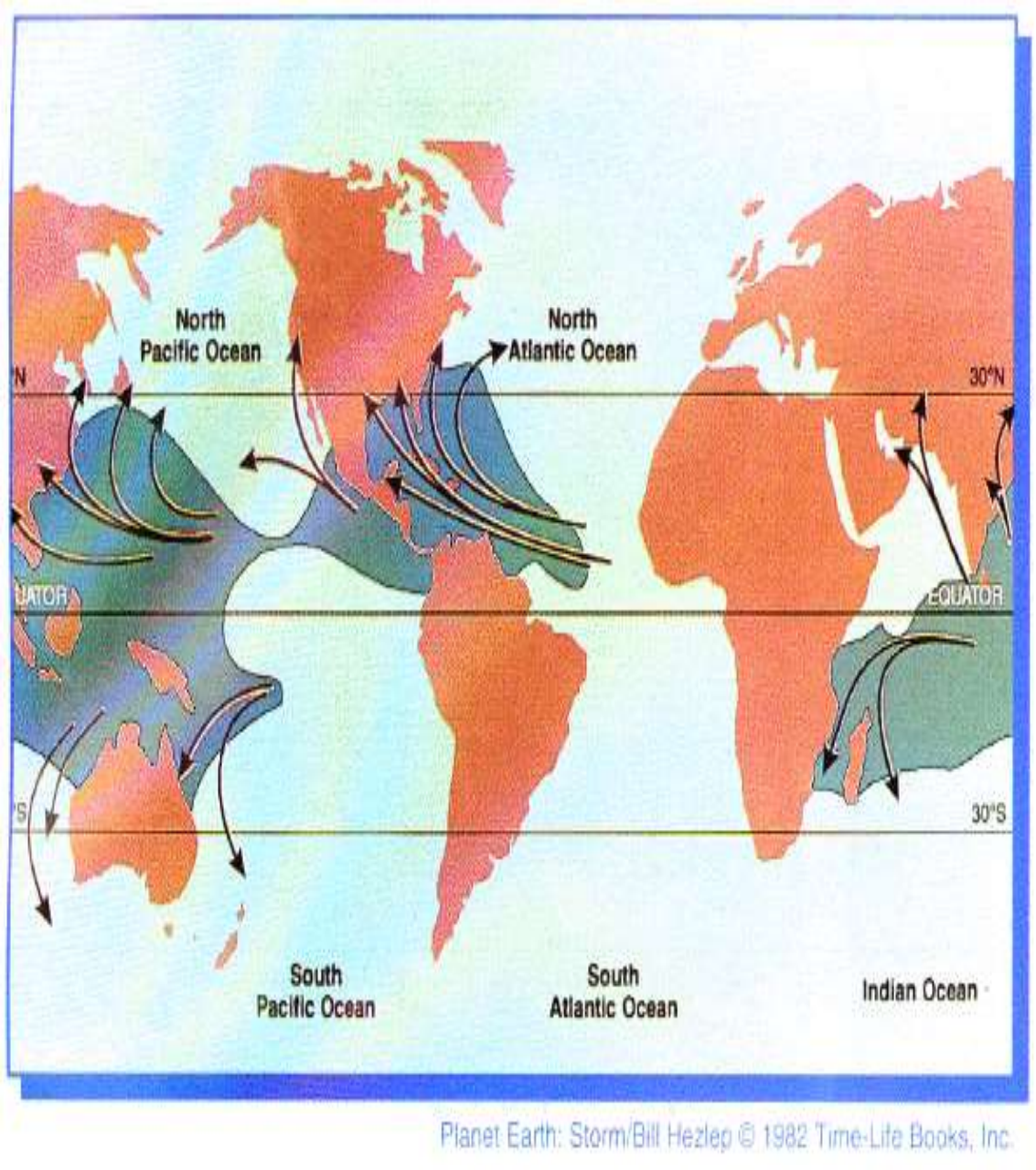

Photo courtesy of NSSL

Tropical Cyclones

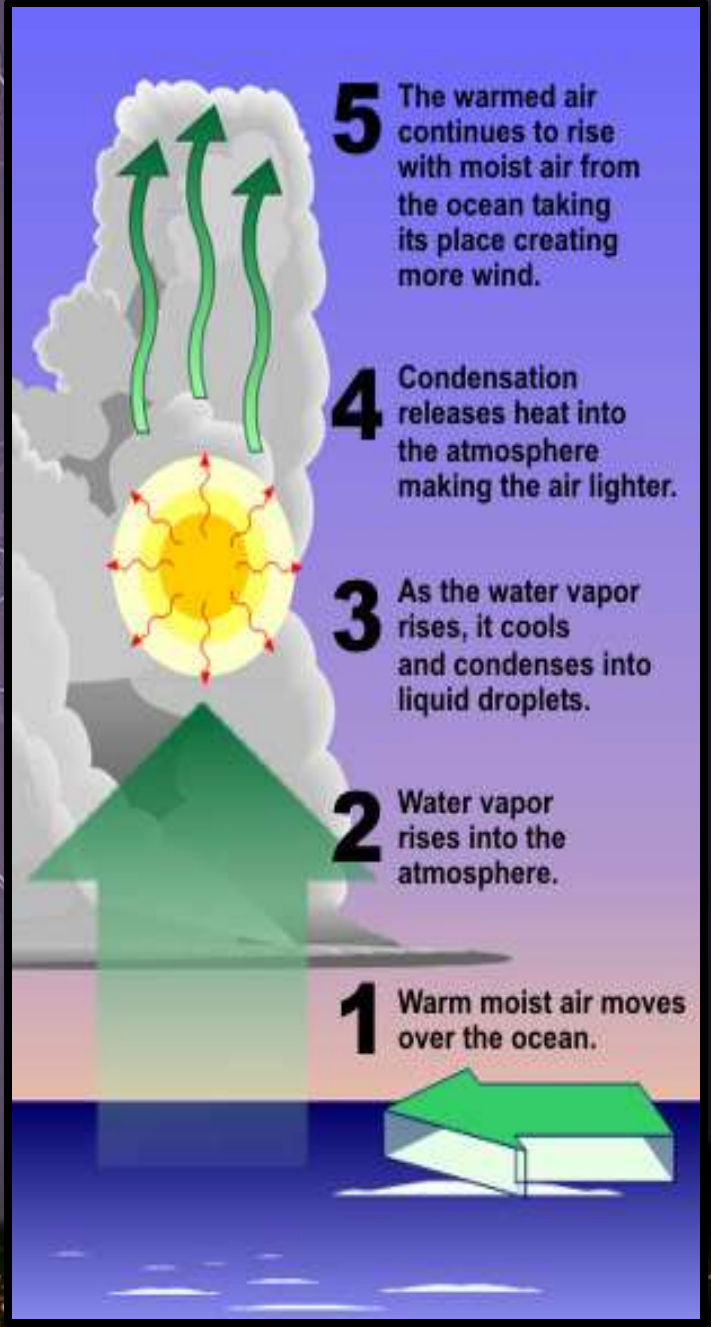
- Hurricanes (western hemisphere) and typhoons (western Pacific in Asia) and cyclone in Indian Ocean

- Develop over warm ocean surfaces between 8° and 15° latitude, migrate westward and curve toward the poles

- Tropical cyclones often create tremendous damage due to high winds, high waves, flooding (storm surges) and heavy rains

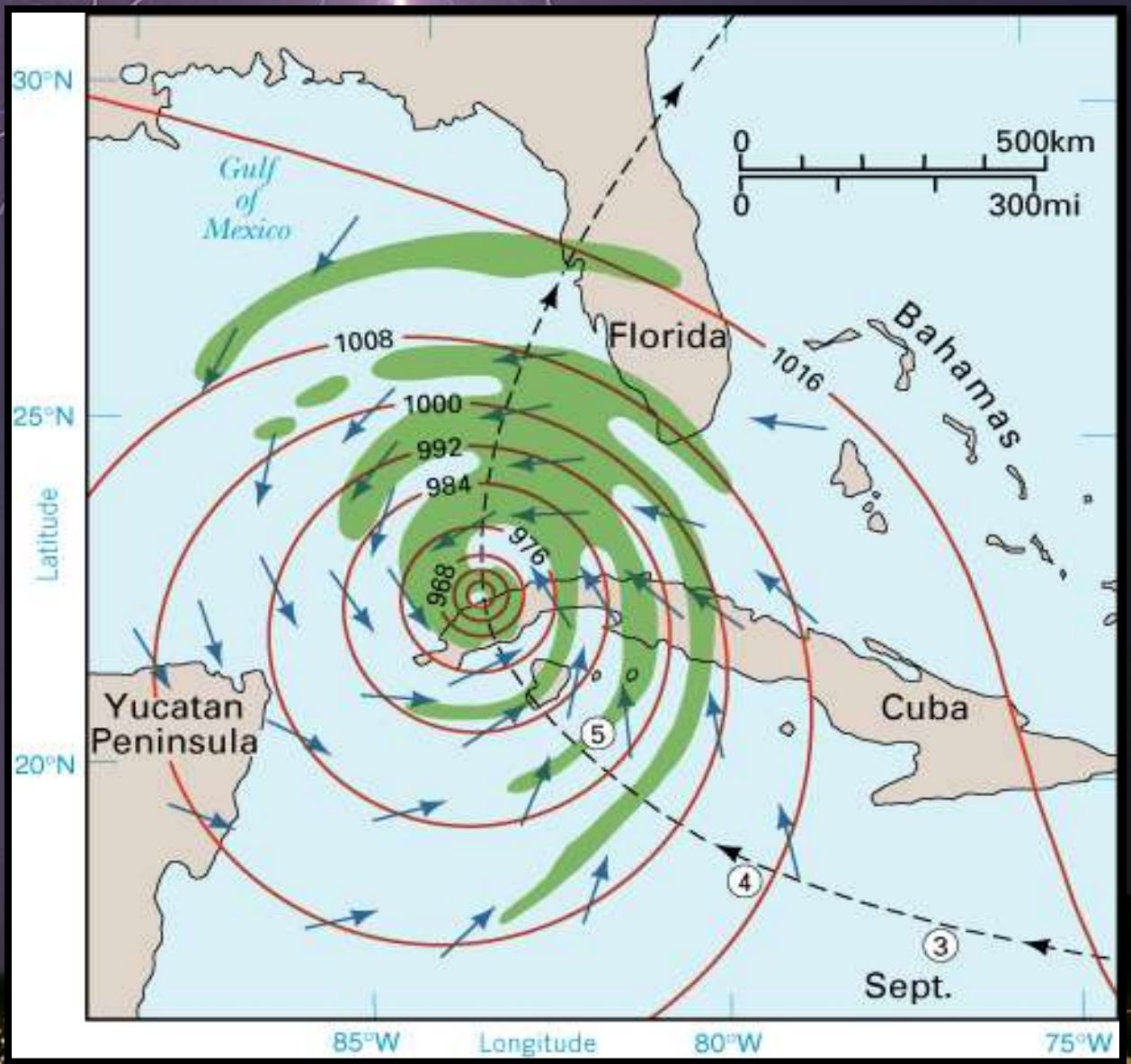


Planet Earth: Storm/Bill Hezlep © 1982 Time-Life Books, Inc.



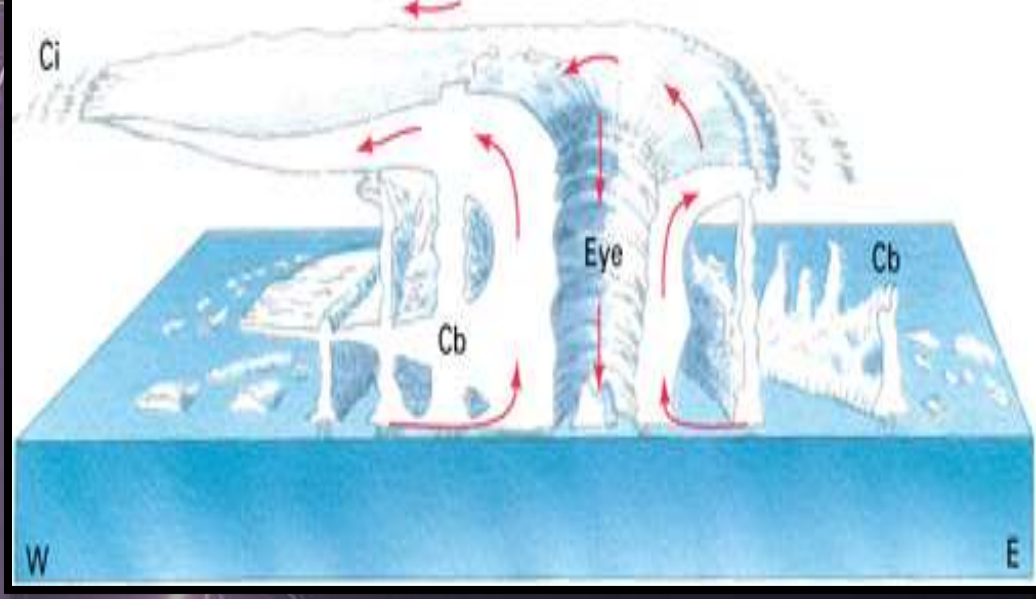
Hurricanes

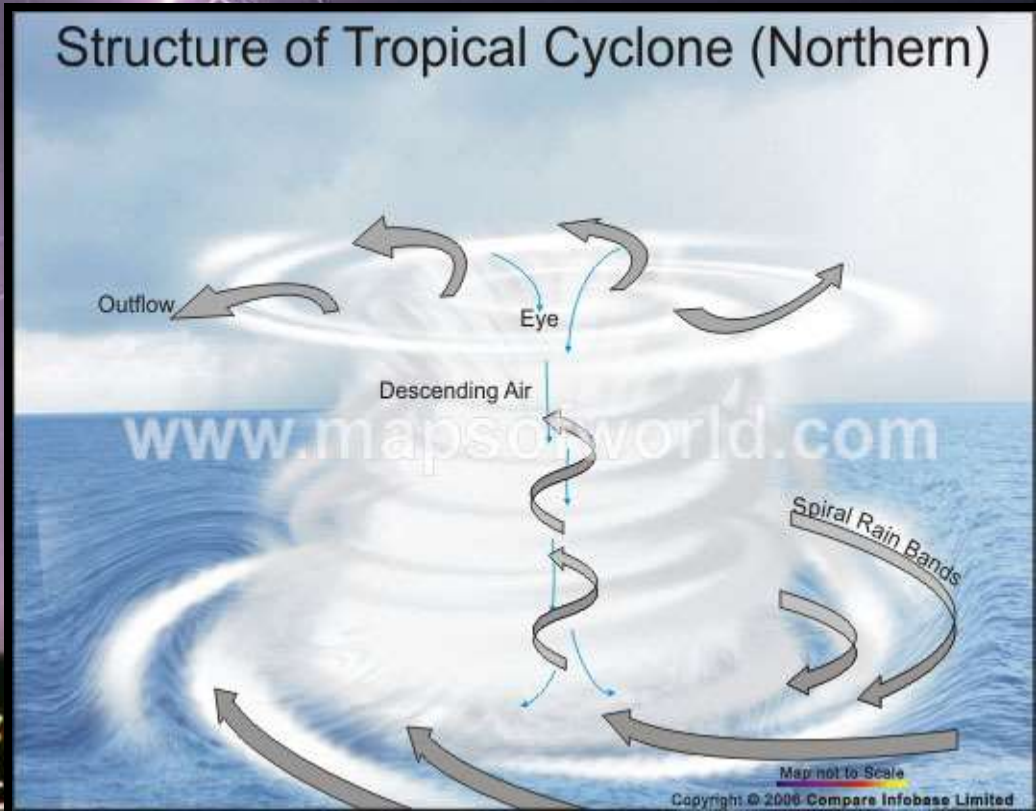
The most powerful and destructive tropical cyclone in the western hemisphere



Hurricanes

- Fueled by the heat released when moist air rises and the water vapor in it condenses
- Rotates around a low pressure core (among the lowest pressures found on the surface of earth)
- Central “eye” (clear skies and calm winds)






NASA


Hurricane John
5 PM EDT Fri Sep 01 2006
Position 22.8 N 109.0 W
Maximum Winds 110 mph
Gusts 130 mph
Movement NNW at 8 mph
Minimum Pressure 958 mb (28.28 inches)
Blue Marble basemap imagery courtesy NA


(c) 2006,Howard Ekman
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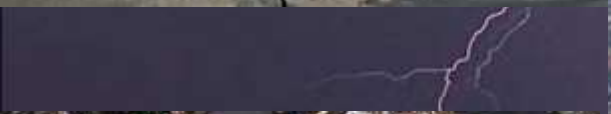
AP/St. Petersburg Times



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Simpson-Saffir Scale of Tropical Cyclone Intensity

Categories 1 to 5 (5 is the most intense and devastating)

Categorized by central pressure, storm surge wave height and mean wind speed

Simpson-Saffir Scale of Tropical Cyclone Intensity

Category	Central Pressure (mb)	Storm Surge (m)	Wind Speed (m/sec)
1. Weak	> 980	1.2-1.7	33-42
2. Moderate	965-979	1.8-2.6	43-49
3. Strong	945-964	2.7-3.8	50-58
4. Very Strong	920-944	3.9-5.6	59-69
5. Devastating	<920	>5.6	>69

But….

- They relieve drought conditions
- They transfer heat and energy allowing for the earth to maintain it's energy balance

The atmospheric circulation

Atmospheric circulation transfers heat from equatorial regions toward the polar regions by:

- The Hadley cell circulation,
- Air mass movement
- Rossby waves
- Tropical cyclones
- Ocean Currents