

# Weather Summary

- The weather starts with energy from the sun
- Energy is transferred in three ways
  - Radiation - light energy
  - Conduction - energy transfer by contact
  - Convection - energy circulation patterns

# Energy Transitions

- Radiant or light energy causes water to evaporate (the start of the water cycle) and causes the warming of the air.
- Contact (conduction) of air with warm or cold surfaces enhances the radiant energy.
- Warm air rising and cold air falling cause the circulation (convection) patterns of weather.

# The Atmosphere

The Earth's atmosphere is about 300 miles (480 km) thick.

The atmosphere is made up of layers defined by temperature changes.

Each layer has distinct characteristics and uses.

# Troposphere

- Extends from the earth's surface to about 17 km (about 11 miles).
- The layer where weather occurs and all life is supported.
- Accounts for about 75% of the atmosphere by mass.
- The temperature gradually decreases with altitude in the troposphere from an average of 14°C to -52°C

# Stratosphere

- The stratosphere starts with a slight increase in temperature from  $-52^{\circ}\text{C}$  to  $-3^{\circ}\text{C}$ .
- The stratosphere extends from about 17 to 50 km (11 to 31 miles) above the earth.
- The stratosphere contains the ozone layer that is normally between 2.5 and 3.5 mm thick.
- The ozone layer absorbs ultraviolet light from the sun, protecting us from severe sunburn and skin cancer.

# Mesosphere

- Meso means middle - the mesosphere is the middle layer of the atmosphere
- Temperatures quickly decrease in the mesosphere from about 0°C to -100°C.
- The mesosphere is about 50 to 80 km (31 to 50 miles) above the surface of the earth.

# Thermosphere

- Thermo means heat - the thermosphere is hot. Temperatures rise to as much as 1700°C
- The thermosphere is from 85 km to about 640 km above the earth.
- The aurora borealis or northern lights appear in the thermosphere.

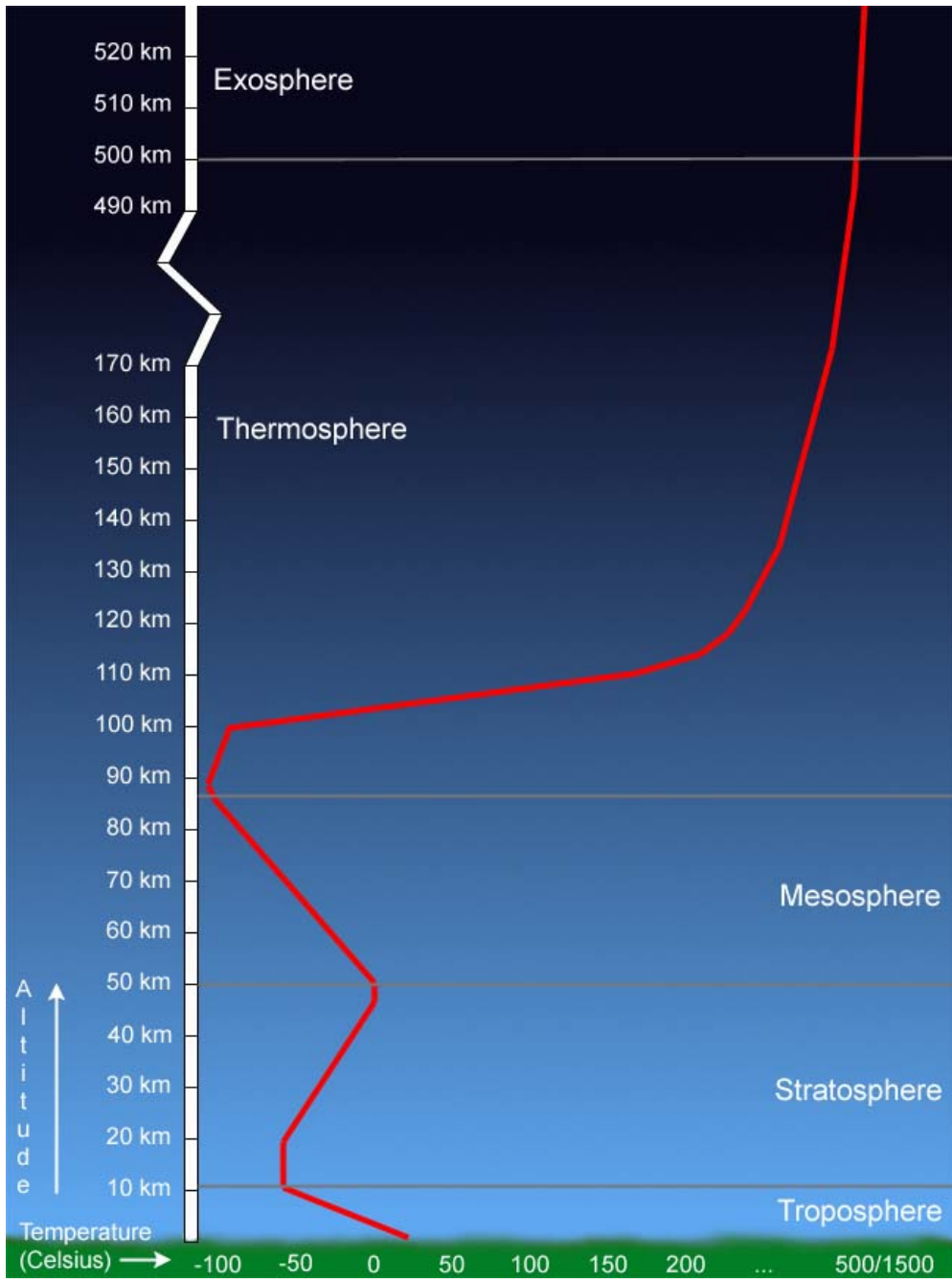
# Exosphere

- Exo means to exit or go out. The exosphere is the exit between the atmosphere and outer space.
- The exosphere starts at about 600 km above the surface of the earth.



# The Ionosphere

- The ionosphere is a combination of the exosphere, the thermosphere and parts of the mesosphere.
- It contains many free ions - charged particles caused when sunlight collides with atoms.
- These ions are useful in reflecting radio waves.



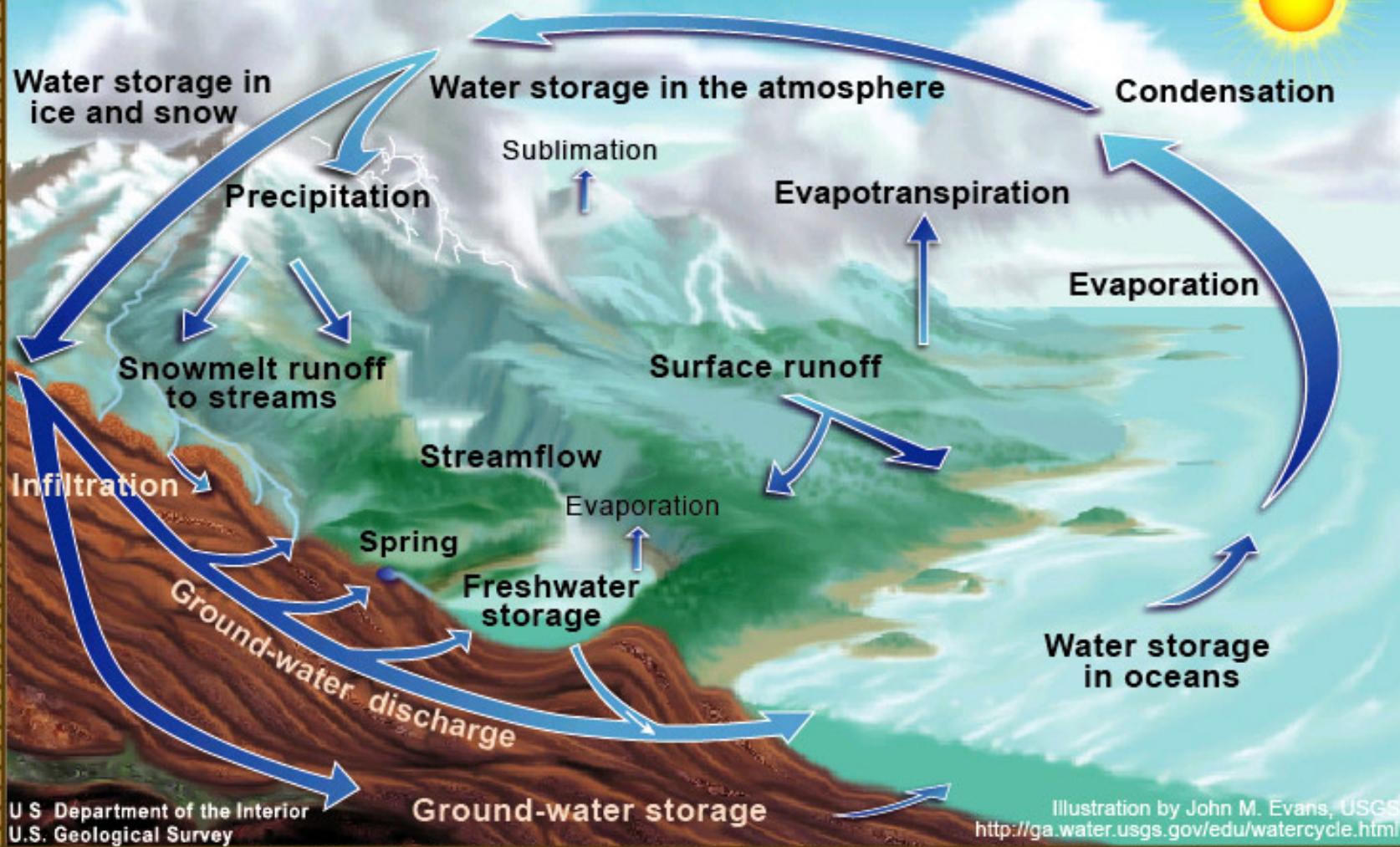
# The Water Cycle

- The water cycle starts with energy of the sun causing water to evaporate.
- The warm moist air will start to rise because it is less dense than cool air.
- As the air rises it cools, causing the water vapor to condense.

# The Water Cycle

- When the moist air cools enough precipitation occurs.
- The precipitation becomes the rivers that replenish the water that was evaporated.
- A complete water cycle takes about 10 days. About 36 cycles occur each year.

# The Water Cycle



# Air Masses

Air masses are named for the area of the earth where they were formed.

Abbreviations are used to indicate the properties of the air mass.

c - continental - formed over land

m- maritime - formed over water

T - tropical - formed near the equator

P - polar - formed near the north or south pole

# Air Masses

The symbols are combined to describe the individual situations

cT continental tropical - warm and dry air

cP continental polar - cold and dry air

mT maritime tropical - warm and moist air

mP maritime polar - cold and moist air

# Air Mass Movement

- Air masses generally move from west to east in the United States (and other northern temperate climates)
- The air masses that typically affect Minnesota are cP starting near Alberta, Canada; and mT starting over the Gulf of Mexico



# Pressure

- Pressure is measured with an instrument called a barometer.
- High pressure is a result of cold (more dense) air falling and generally produces dry conditions with clear skies.
- Low pressure is a result of warm (less dense) air rising and often produces clouds and precipitation.

# Wind

- Wind is air in motion
- Air will move from areas of high pressure to areas of low pressure.
- The larger the difference in pressure, the greater the wind speed.
- Pressure areas are determined by drawing isobars on weather maps.

# Minnesota Weather

- To get significant precipitation in Minnesota there must be a low pressure area over or at least near Minnesota and a high pressure area over the Gulf of Mexico.
- This pressure difference will cause warm moist air from the Gulf to move north, cool causing condensation and precipitation.
- The moist air will usually circulate in a counterclockwise pattern ( a comma shape) causing precipitation both in ahead and behind the front.

# Precipitation Amounts

- The amount of precipitation depends on the amount of moisture in the air:

The amount of moisture is measured with either relative humidity or dew point.

- And on the temperature change:

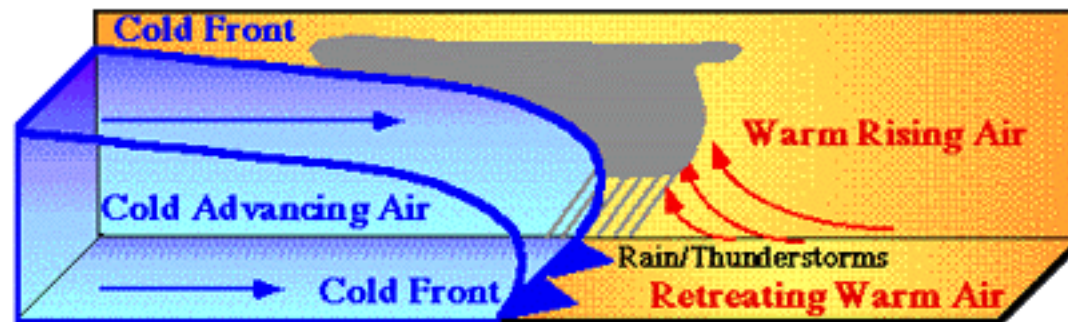
Cooler temperatures will cause more of the moisture to condense.

- More moisture in the air and larger temperature changes mean more precipitation.

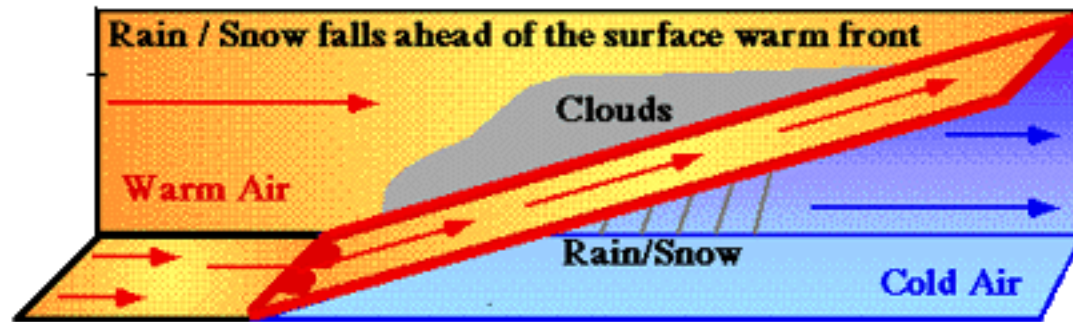
# Fronts & Precipitation

- Fronts

# Fronts & Precipitation



# Fronts & Precipitation



# Cloud Types

- Cloud Types and Development