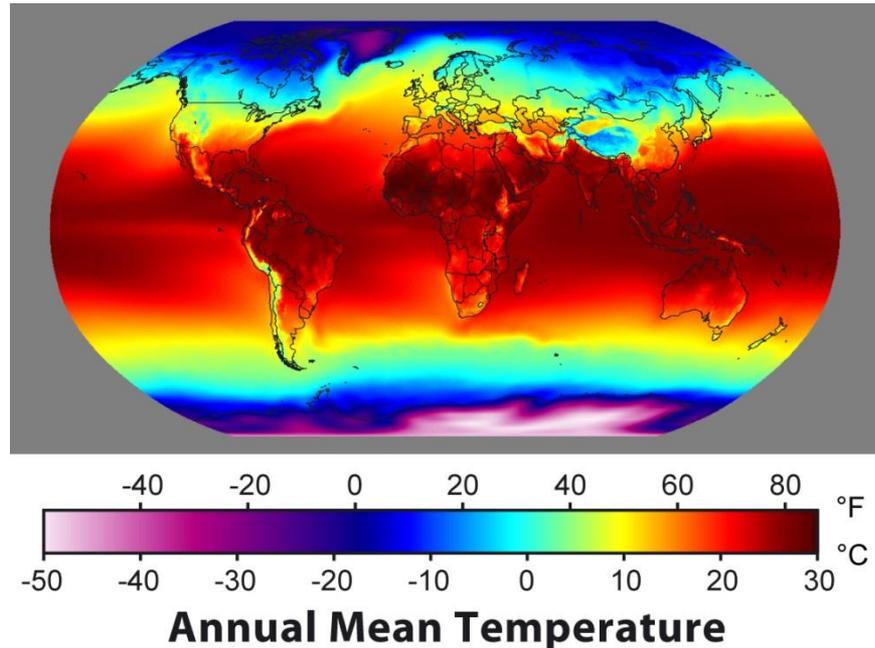


Chapter 14 Climate



What is Climate?

- Understanding and predicting climatic changes are the basic goals of climatology.
- **Climatology** is the study of Earth's climate and the factors that affect past, present, and future climatic changes.



Climate: More Than Just Average Weather

- **Climate** describes the long-term weather patterns of an area.
- Climate describes annual variations of temperature, precipitation, wind, and other weather variables.

Weather ≠ Climate



Now



Over Time

Climate: More Than Just Average Weather

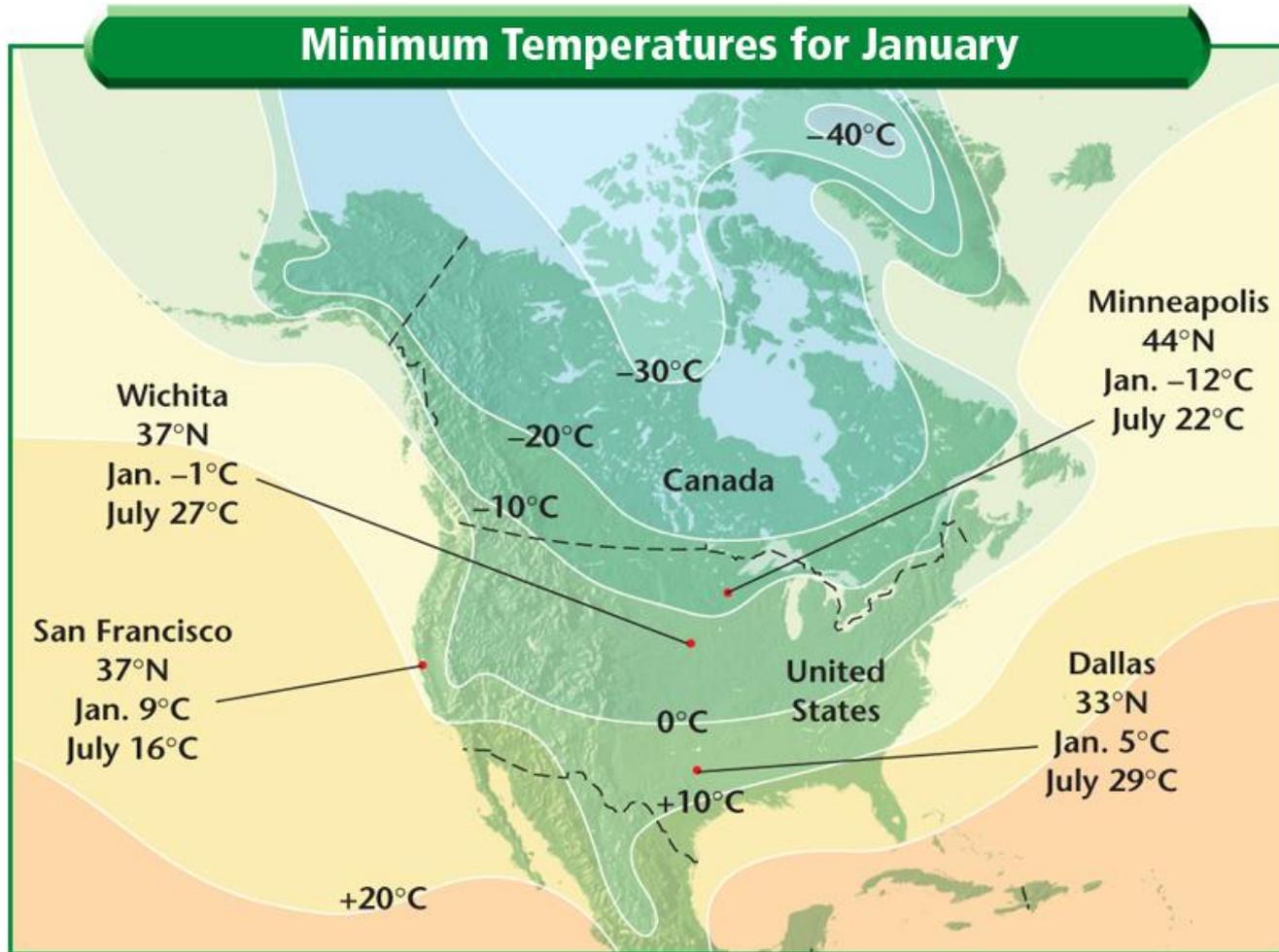
Normals

- The data used to describe an area's climate include daily high and low temperatures, amounts of rainfall, wind speed and direction, humidity, and air pressure.
- The **normals**, or standard values, for a location are the average values on a monthly or annual basis for a period of at least 30 years.
- Weather conditions on any given day might differ widely from normals.
- Normals apply only to the specific place where the meteorological data were collected, not to regions.

What Causes Climates?

- Climates around the country vary greatly due to latitude, topography, closeness of lakes and oceans, availability of moisture, global wind patterns, ocean currents, and air masses.
- 3 Causes:
 - 1) Latitude
 - 2) Topographic effects
 - 3) Air Masses

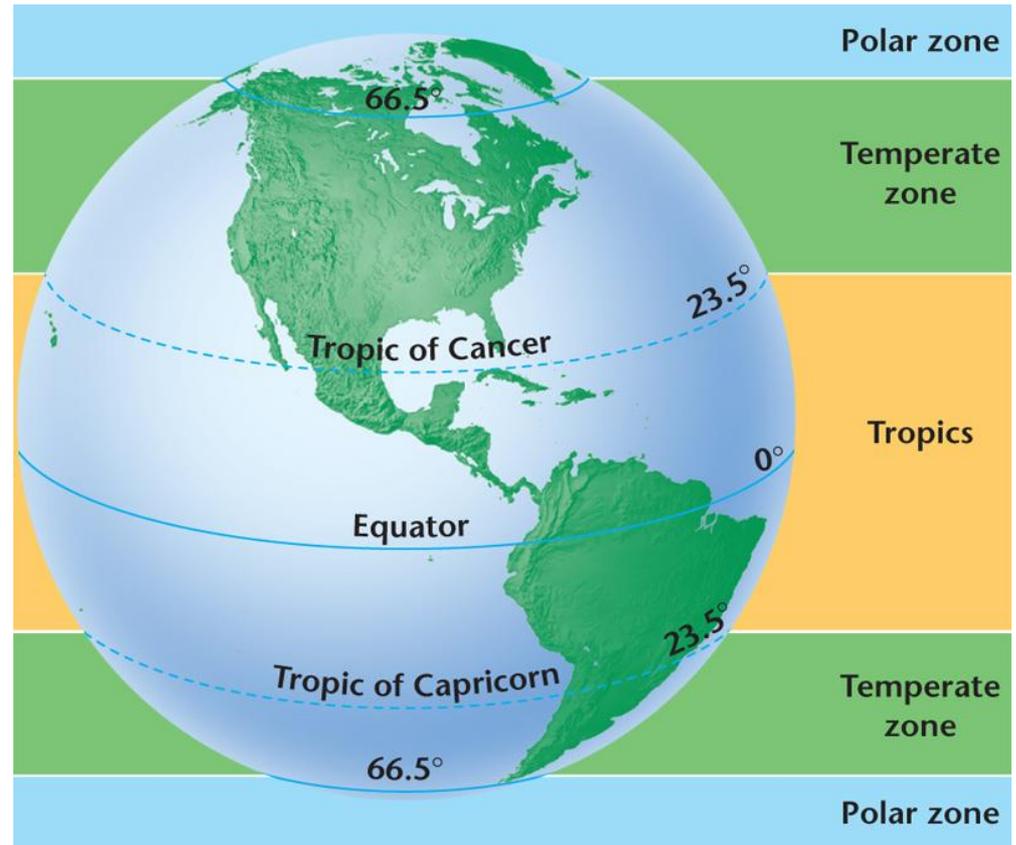
What Causes Climates?



What Causes Climates?

1. Latitude

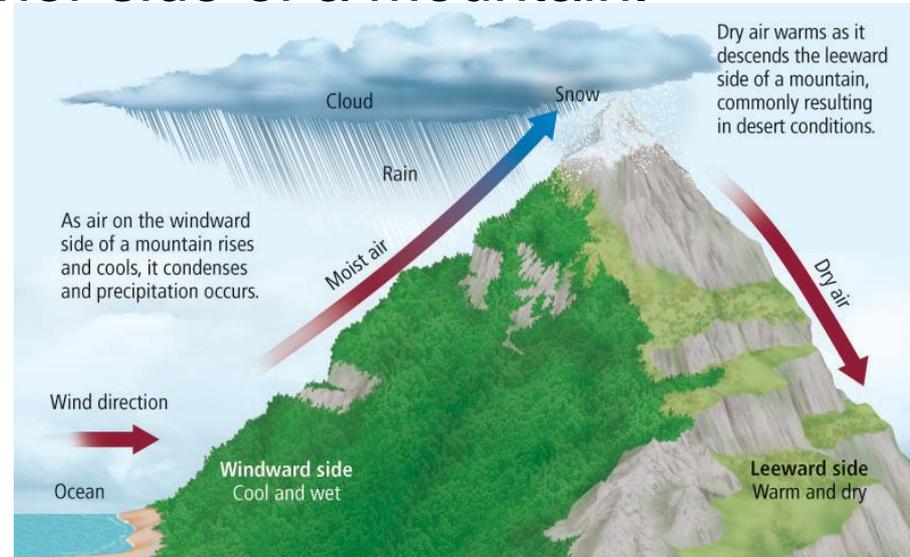
- The amount of solar radiation received by any one place varies because Earth is tilted on its axis, and this affects how the Sun's rays strike Earth's surface.



What Causes Climates?

2. Topographic Effects

- Large bodies of water affect the climates of coastal areas because water heats up and cools down more slowly than land.
- Mountain climates are usually cooler than those at sea level because temperatures in the lower atmosphere generally decrease with altitude.
- Climates often differ on either side of a mountain.



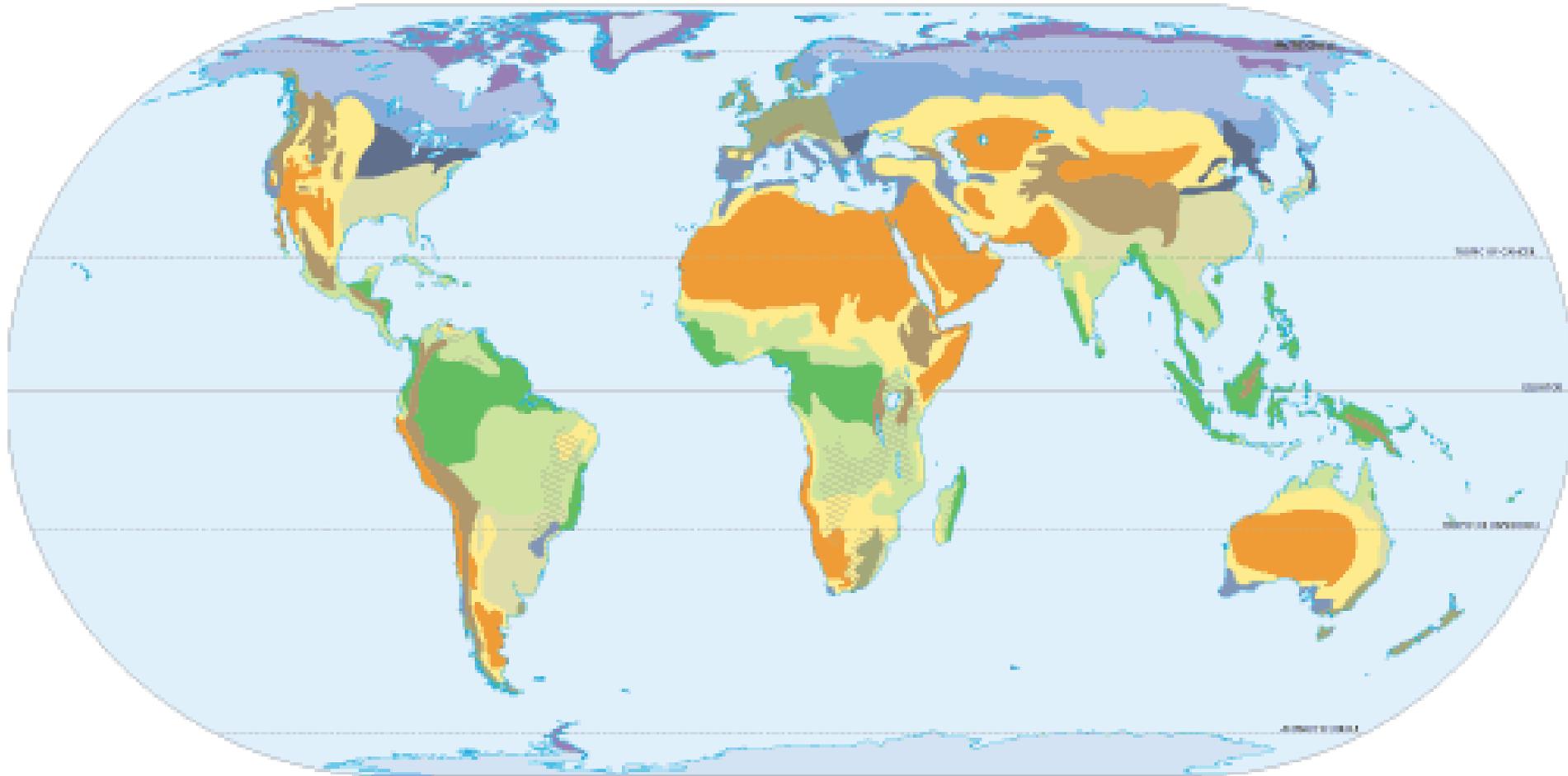
Causes of Climate

3. Air masses

Air masses affect regional climates by transporting the temperature and humidity of their source regions.



14.2 Climate Classification



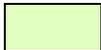
Climate Classification

- The **Koepfen classification system** is a climate classification system
- Takes into account:
 1. Temperature
 2. Precipitation
 3. Distinct vegetation

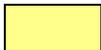
Koepfen Climate Zones

Tropical

 Tropical wet

 Tropical Dry

Dry

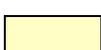
 Semi arid

 Arid

Mild

 Marine west coast

 Mediterranean

 Humid Subtropical

Continental

 Warm Summer

 Cool Summer

 Subartic

Polar

 Tundra

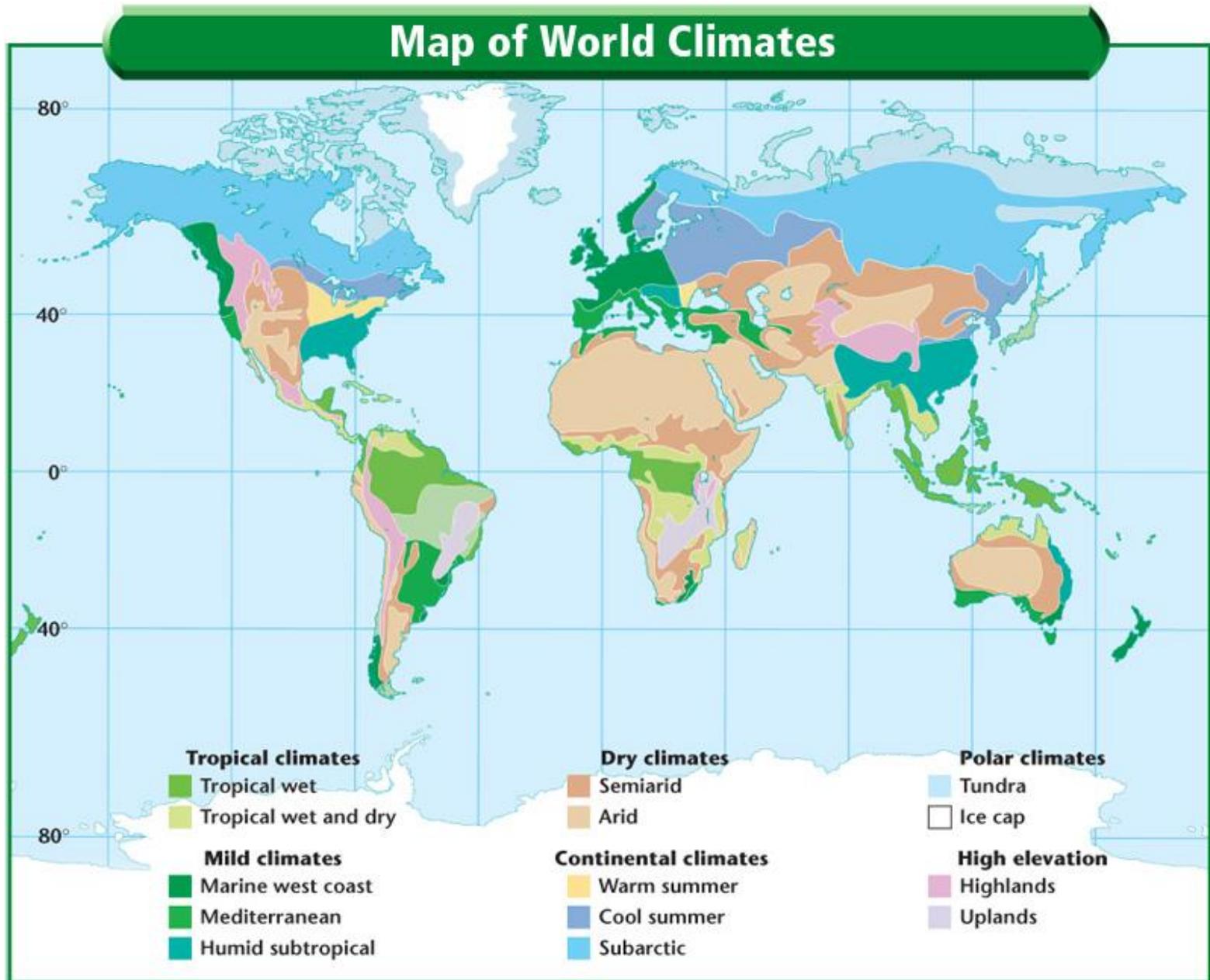
 Ice

High Elevations

 Highlands

 Uplands

Koeppen Classification System



Koepfen Classification System

Tropical Climates

- Constant high temperatures characterize tropical climates.

Dry Climates

- Cover about 30 percent of Earth's land area, make up the largest climatic zone.

Mild Climates (3 Types)

- Humid subtropical
- Marine west coast
- Mediterranean

Continental Climates

- Continental climates classified into three subtypes:
 - warm summer climates**
 - cool summer climates**
 - subarctic climates.**

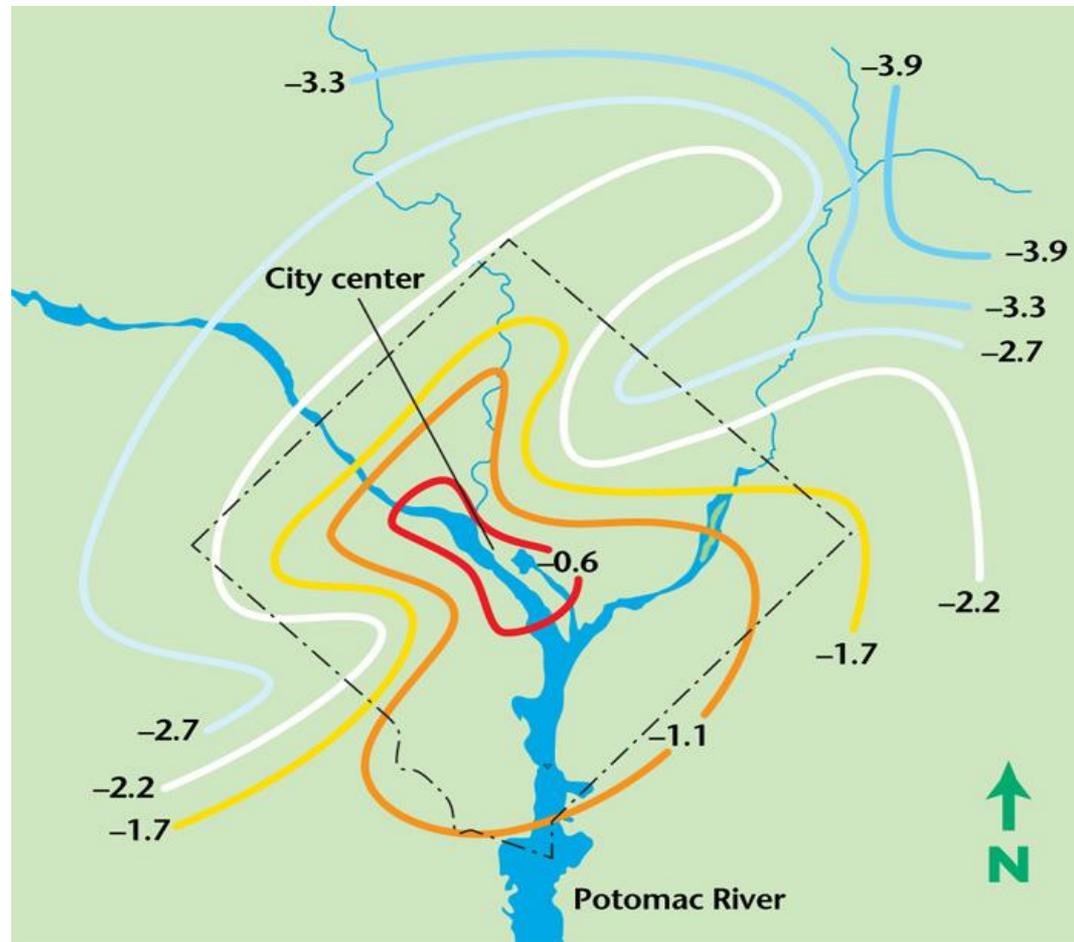
Polar Climates

- Ice the coldest regions on Earth. Avg temp less than 10°C in the warmest month.

Microclimates

- A **microclimate** is a localized climate that differs from the main regional climate.

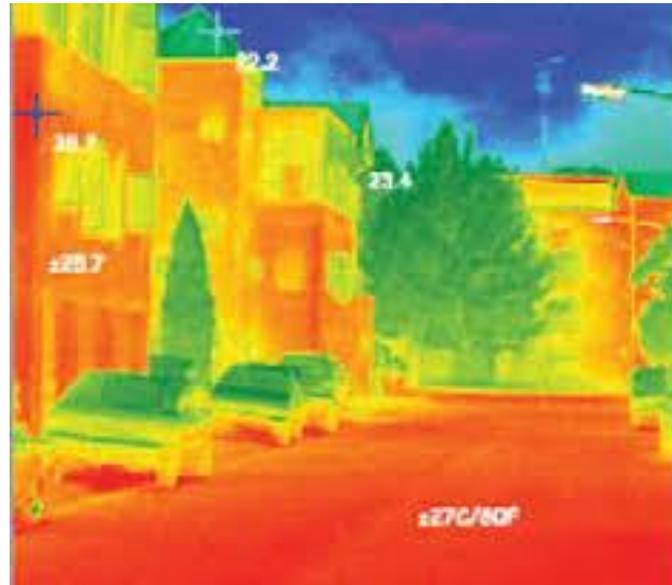
In the example to the right, which shows winter temperatures in Washington, D.C., the buildings and paved surfaces of the city create a microclimate. The temperature in the center of the city is -0.6°C , nearly 3°C warmer than temperatures in some parts of the surrounding area.



Microclimates

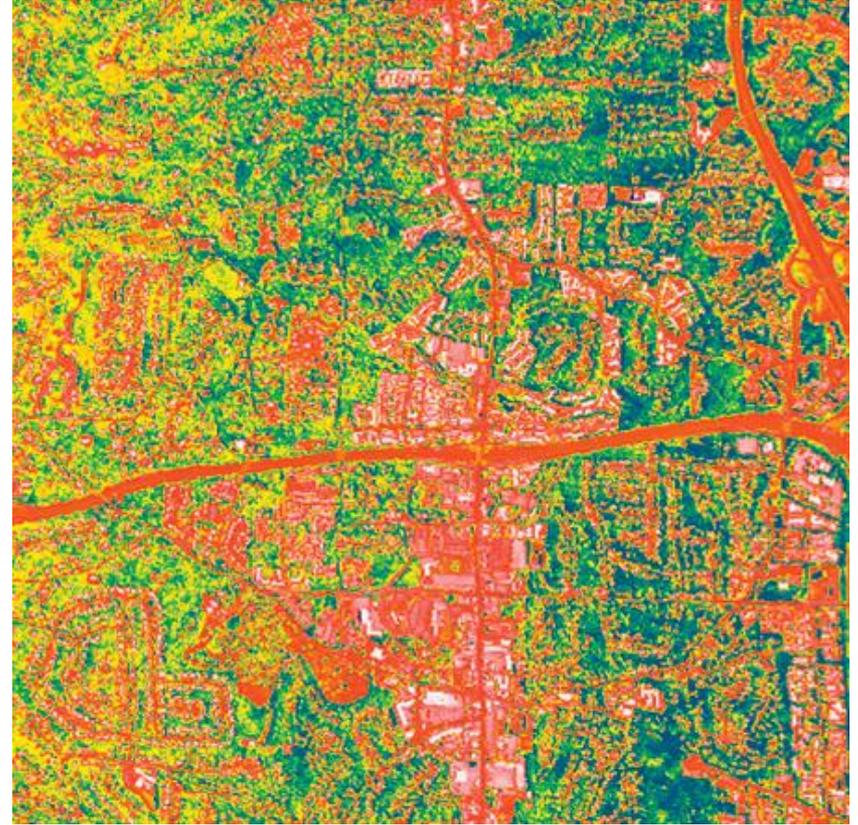
Heat Islands

- **Heat islands**, wherein the climate is warmer than in surrounding rural areas, are caused by the presence of many concrete buildings and large expanses of asphalt.
- Heat islands are examples of climatic change on a small scale.



Microclimates

Heat Islands



These images show differences in daytime temperatures between an urban area (left) and a suburban area (right). The coolest temperatures are represented by blue; the warmest temperatures are represented by red.

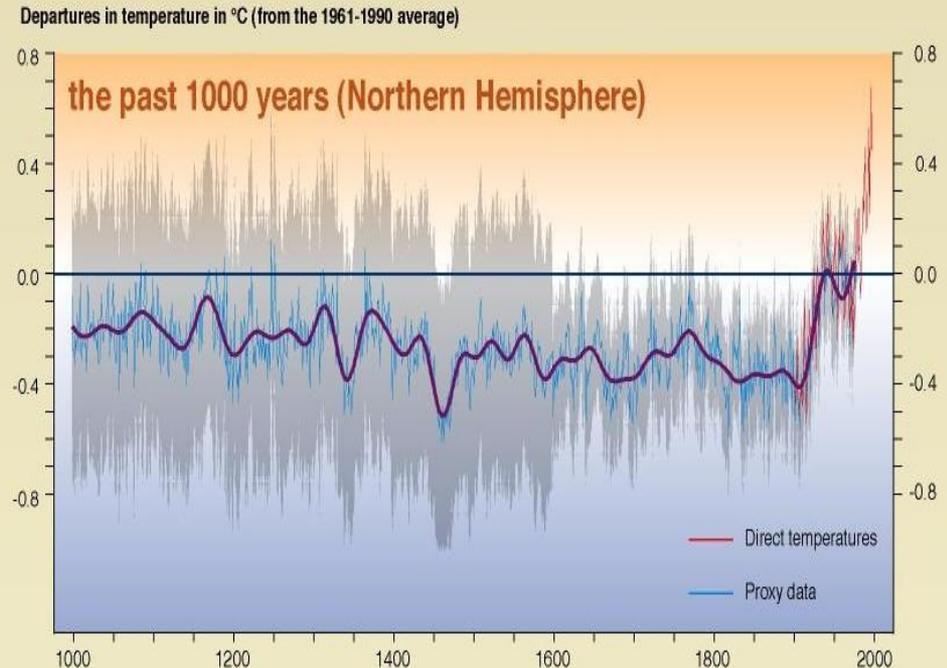
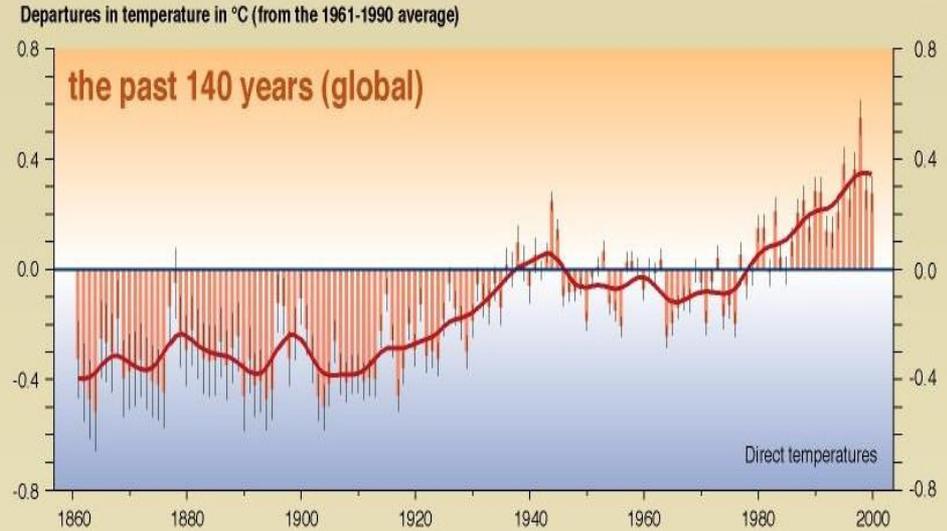
14.3 Climatic Changes



During the average human lifetime (80-100 years), climates do not appear to change significantly.

- Climatic change is constantly ongoing and usually takes place over extremely long time periods.

Variations of the Earth's surface temperature for...



Ice Ages

- **Ice ages** - periods where the average global temperatures decreased by about 5°C and a lot of glacial coverage.



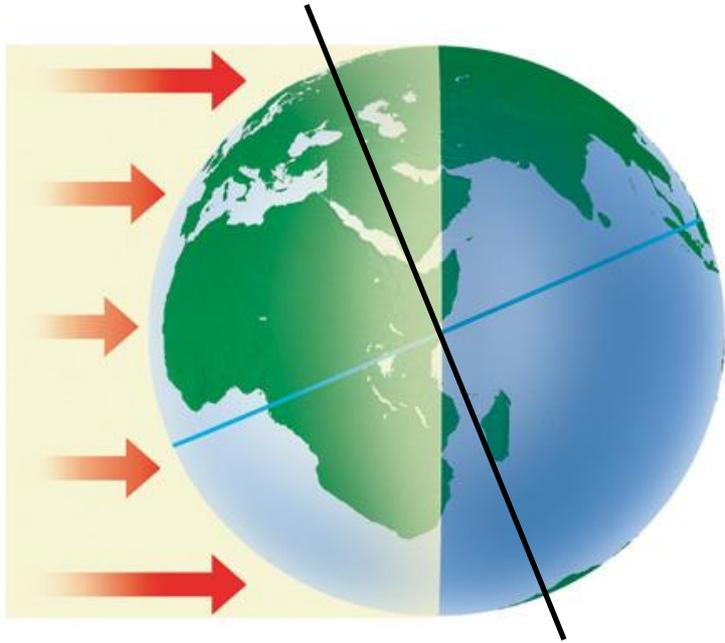
- Ice ages alternate with warm periods called interglacial intervals.
- The most recent ice age ended only about 10 000 years ago.

Short-Term Climatic Changes

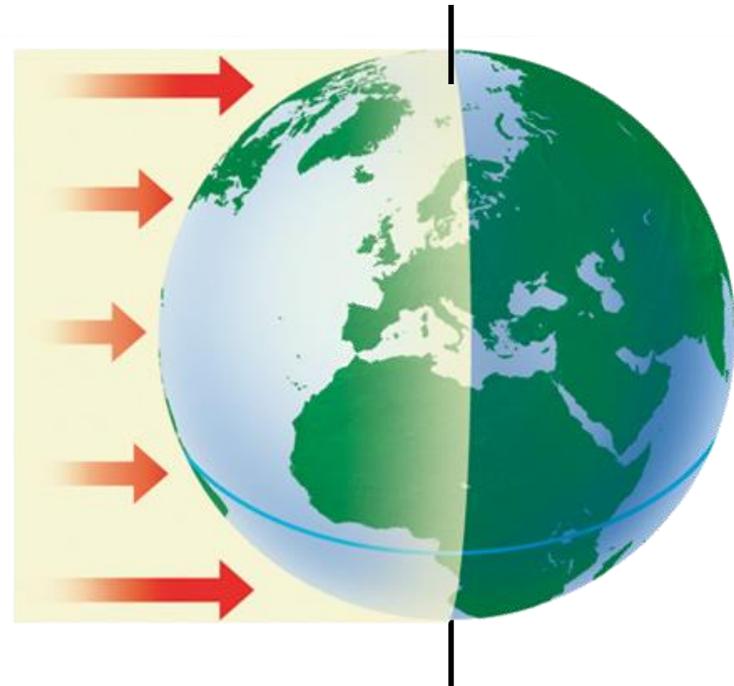
- **Seasons** - short-term periods of climatic change caused by regular variations in daylight, temperature, and weather patterns.
- Summer
- Fall (Autumn)
- Winter
- Spring
- These variations are the result of changes in the amount of solar radiation an area receives.



Short-Term Climatic Changes



When the north pole is pointed toward the sun, the northern hemisphere experiences summer and the southern hemisphere experiences winter.



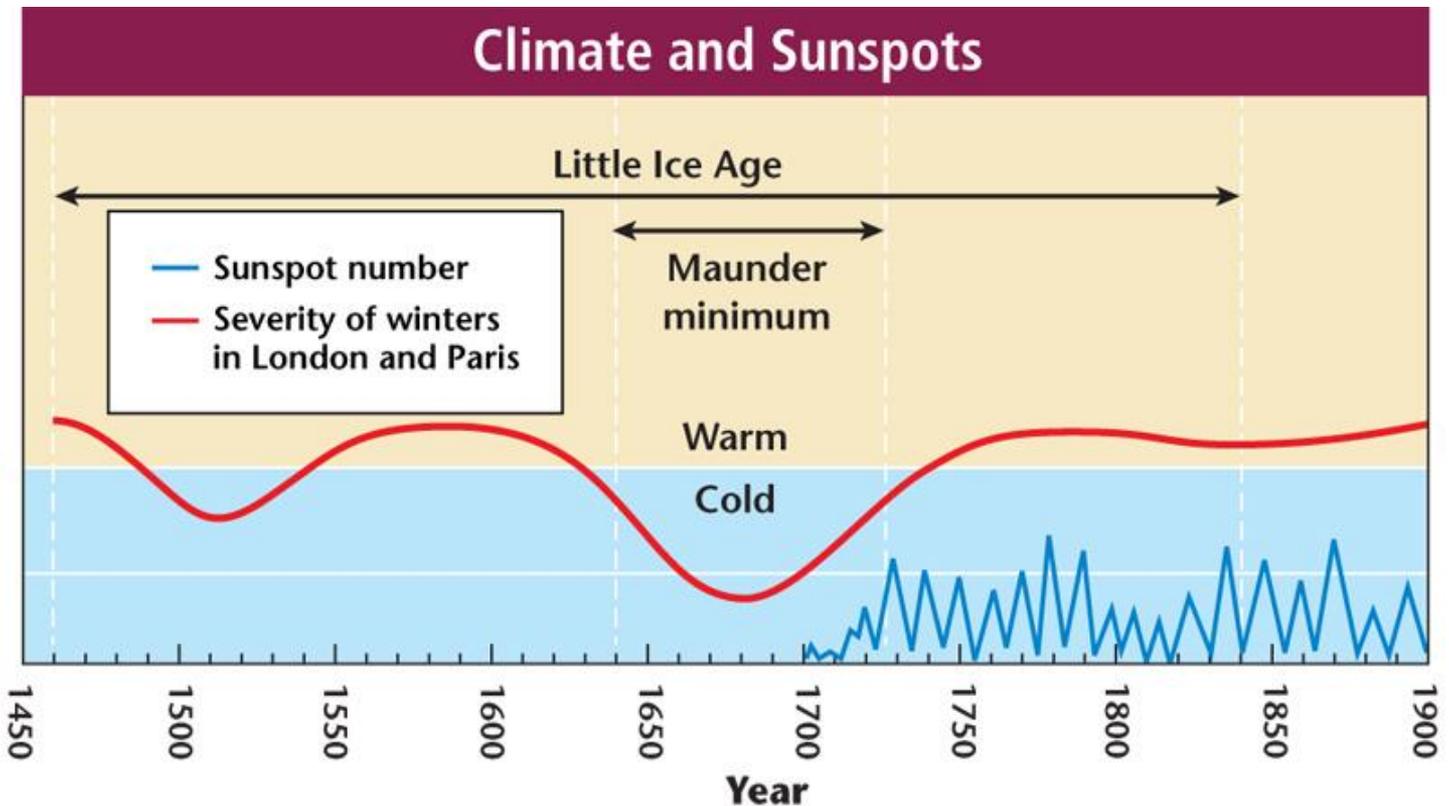
During spring and fall, neither pole points toward the sun.

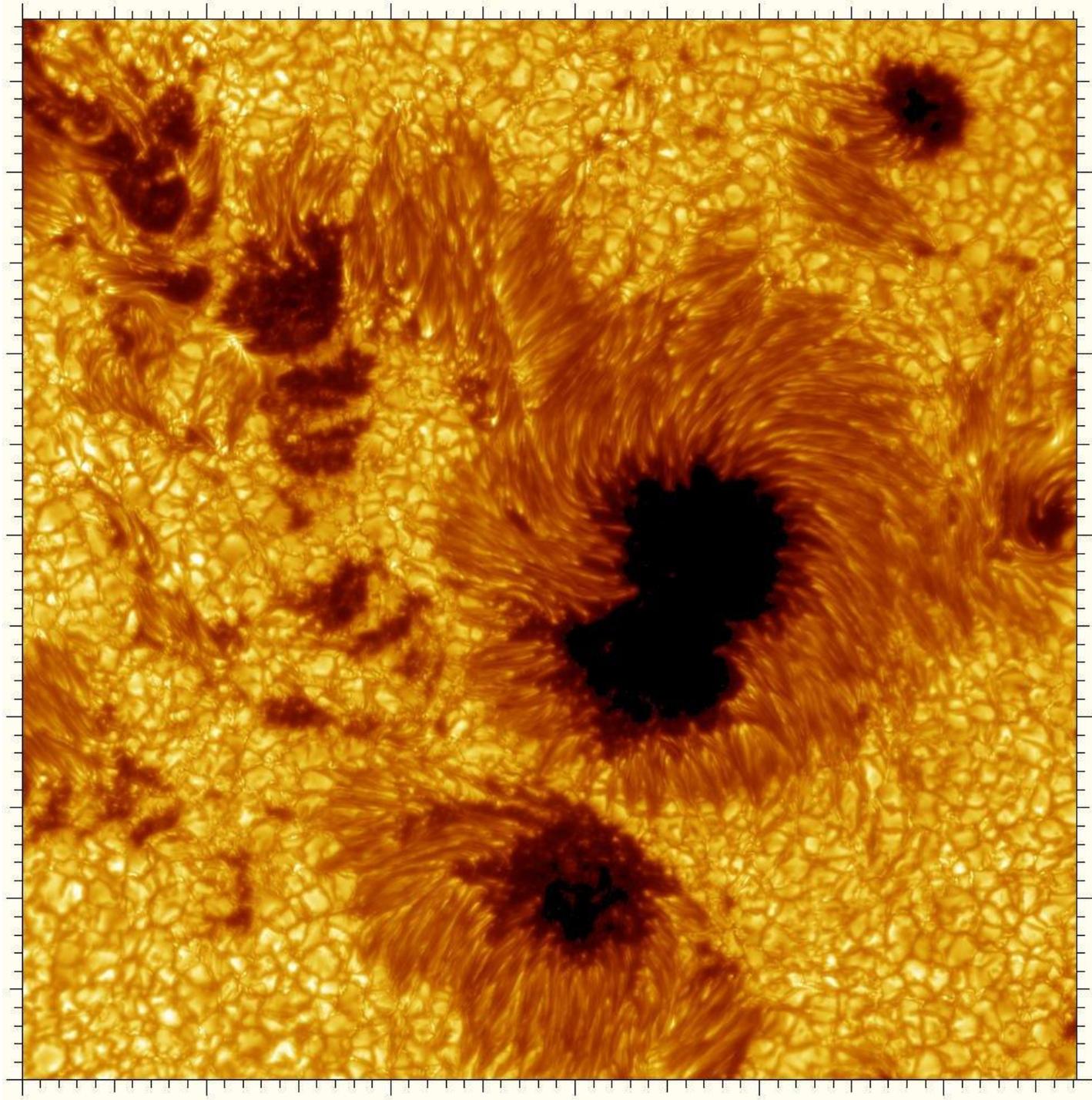
Change Can Be Natural

- Climatic changes occurred long before humans came on the scene.
- Studies of tree rings, ice-core samples, fossils, and radiocarbon samples provide evidence of past climatic changes.
- These changes in Earth's climate were caused by natural events such as variations in solar activity, changes in Earth's tilt and orbit, and volcanic eruptions.

Solar Activity

- The existence of sunspot cycles lasting approximately 11 years had been recognized since the days of Galileo.
- The **Maunder minimum** was a period of very low sunspot activity from 1645 to 1716 that closely corresponds to an **unusually cold climatic episode** called the “Little Ice Age.”

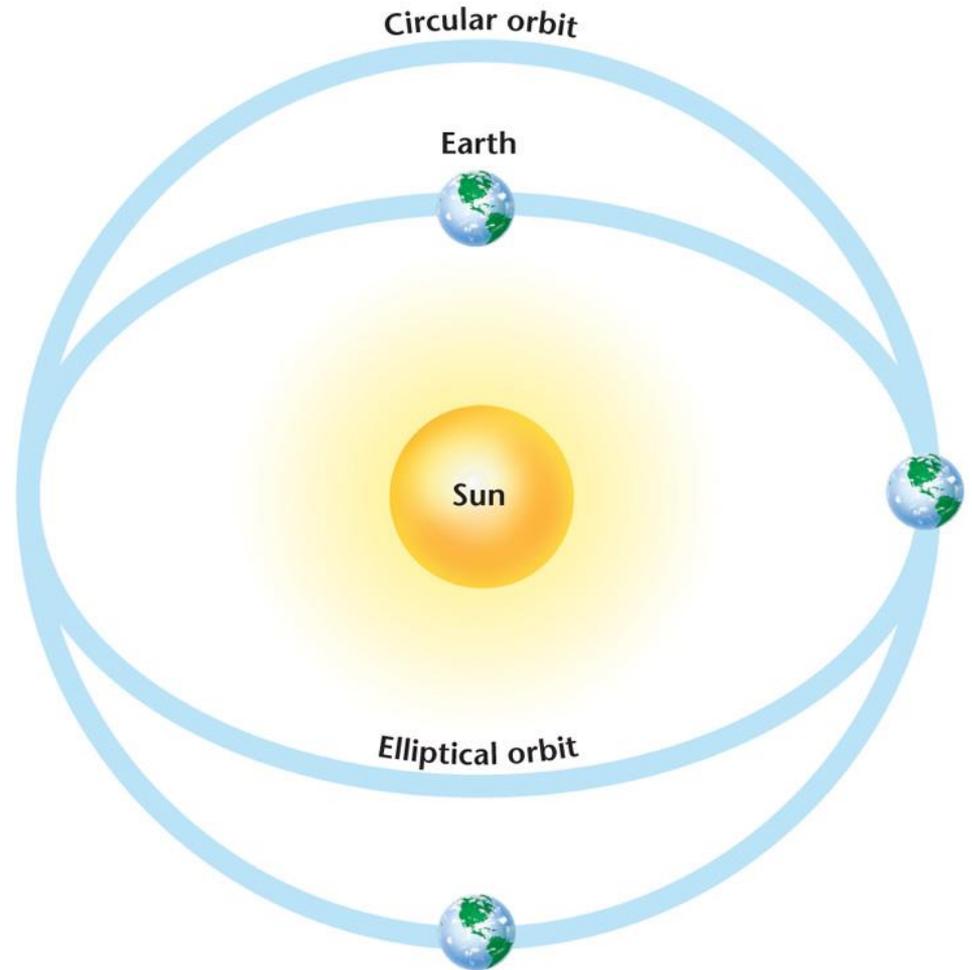




Change Can Be Natural

Earth's Orbit

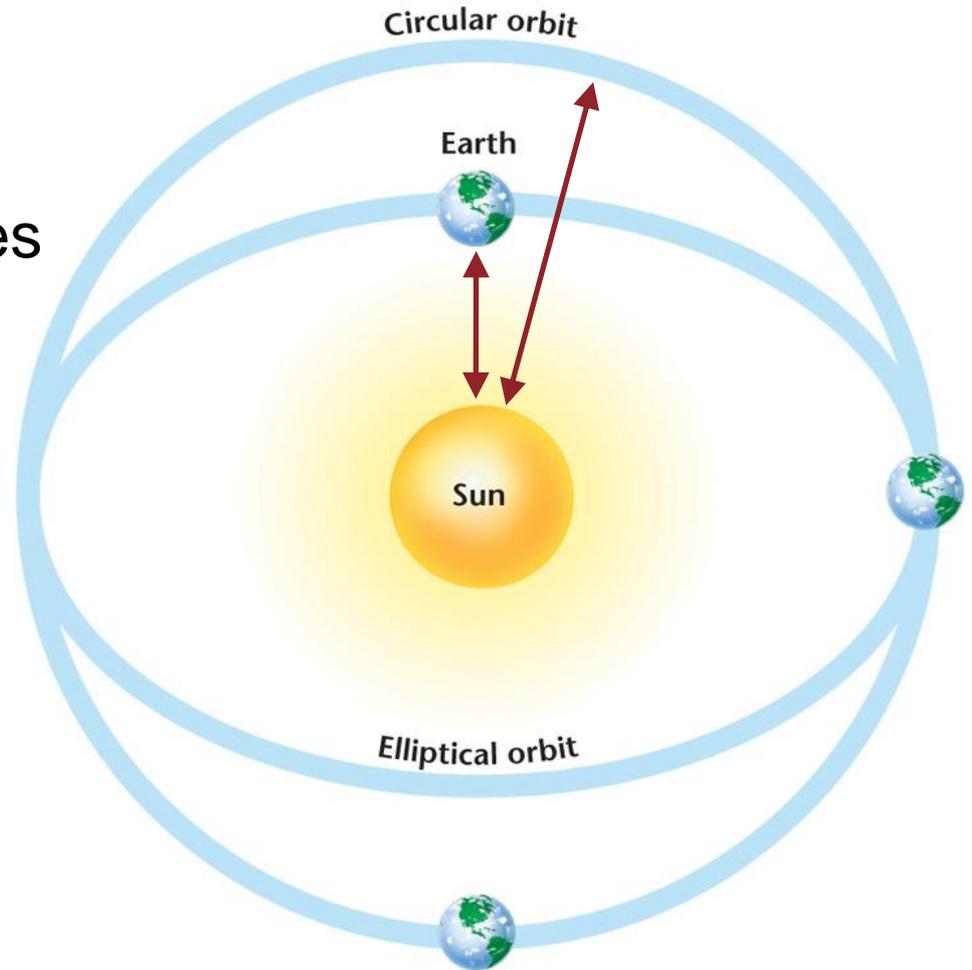
- Climatic changes may also be triggered by changes in Earth's axis and orbit.
- The shape of Earth's elliptical orbit appears to change, becoming more elliptical, then more circular, over the course of a 100 000-year cycle.



Change Can Be Natural

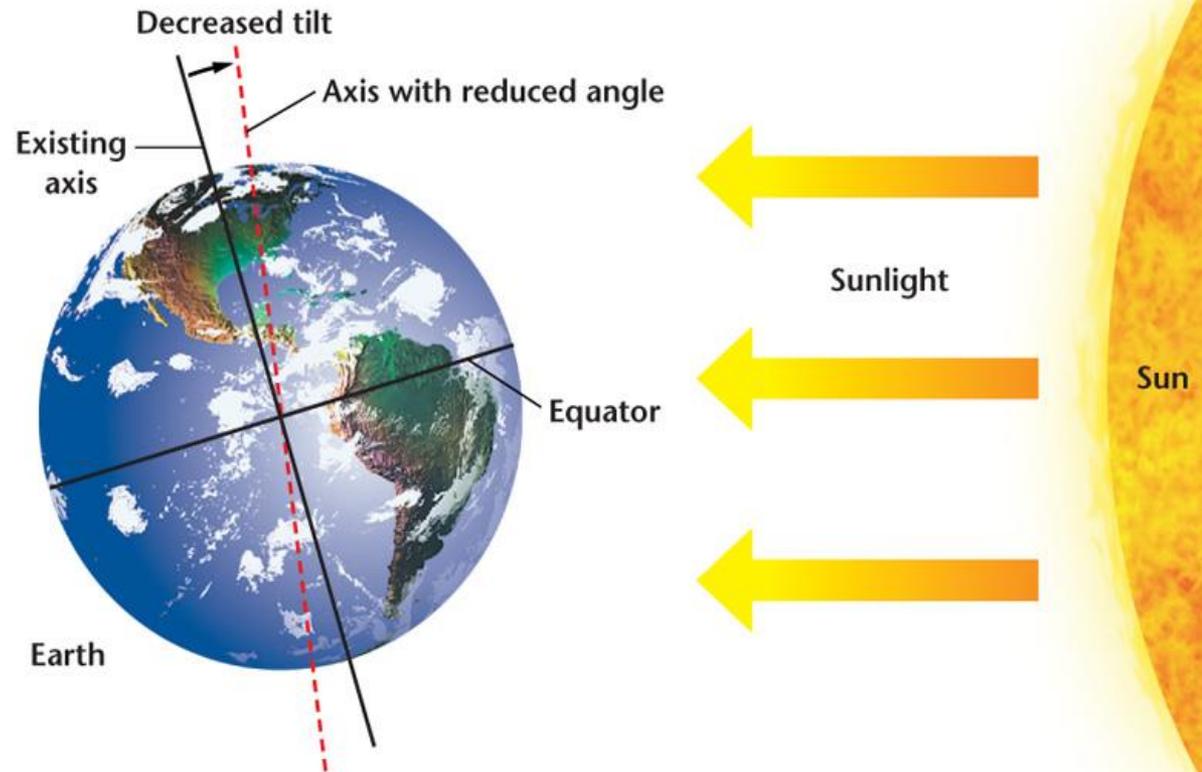
Earth's Orbit

- When the orbit elongates, Earth passes closer to the Sun, and temperatures become warmer than normal.
- When the orbit is more circular, Earth is farther from the Sun and temperatures dip below average.



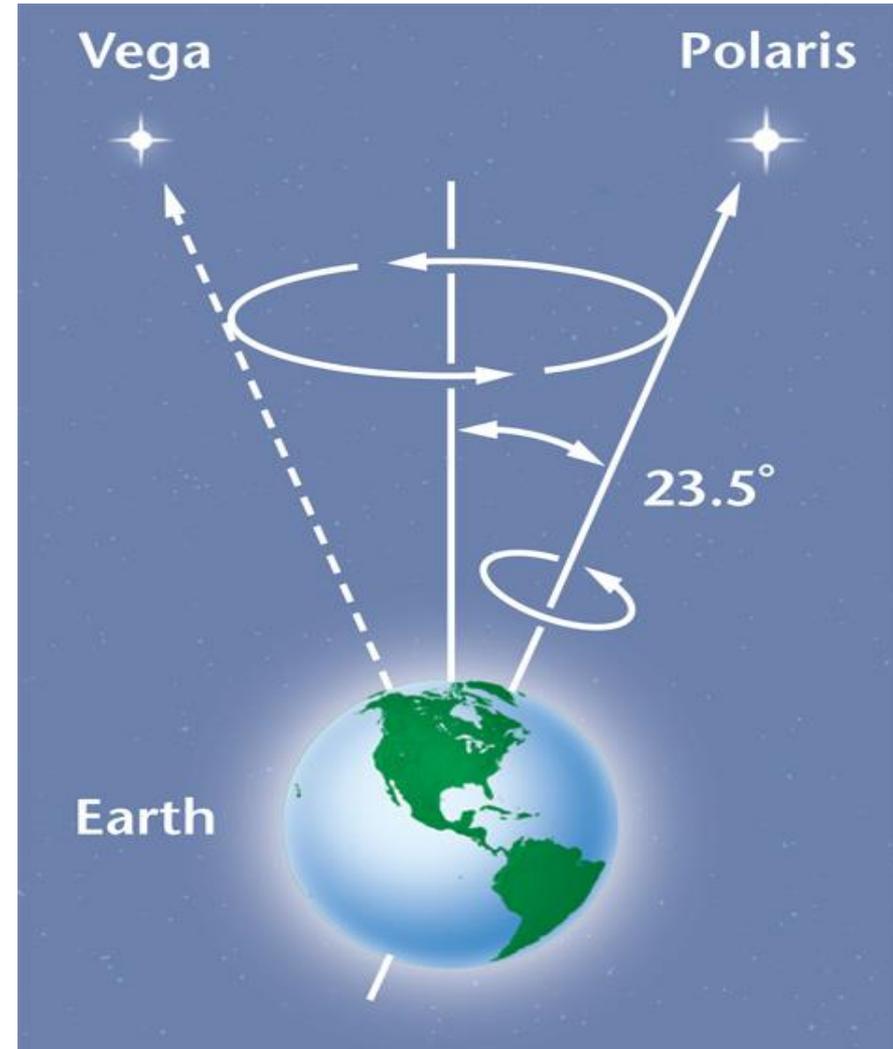
Earth's Orbit

- The angle of Earth's tilt varies from a minimum of 22.1° to a maximum of 24.5° every 41 000 years.
- Scientists theorize that these changes in angle cause seasons to become more severe and may cause ice ages.



Earth's Wobble

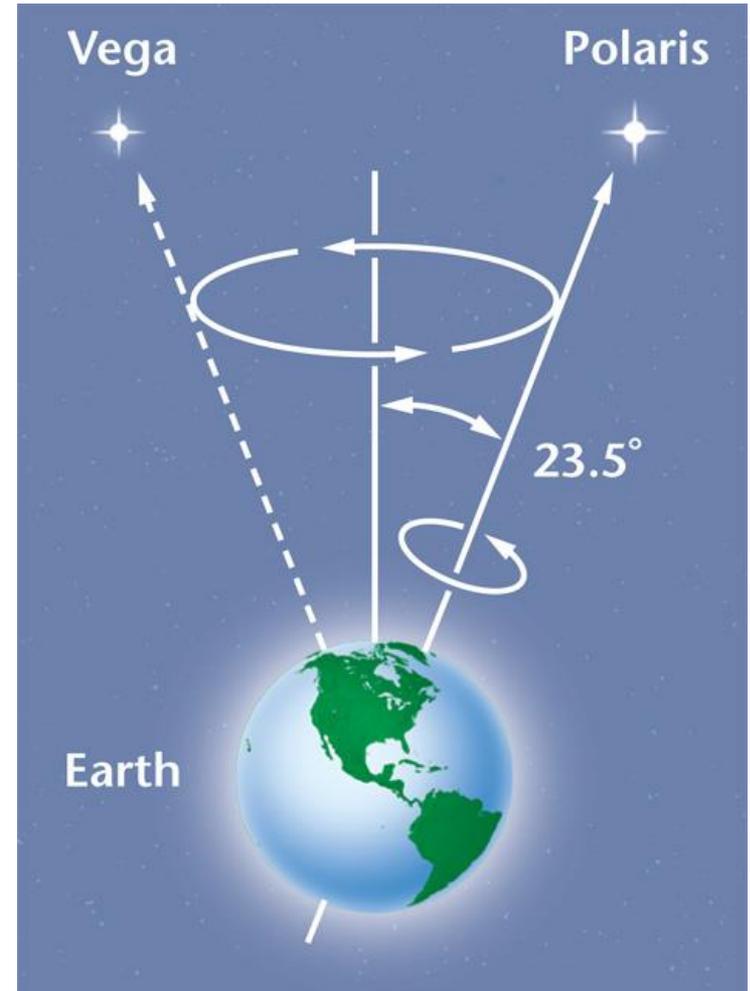
- Over a period of about 26 000 years, Earth wobbles as it spins on its axis.
- Currently, the axis points toward the North Star, Polaris.
- Because of Earth's wobbling, however, the axis will tilt toward another star, Vega, by about the year 14 000.



Change Can Be Natural

Earth's Wobble

- Winter currently occurs in the northern hemisphere when Earth is closest to the Sun.
- This will cause warmer summers and colder winters than those that we now experience.



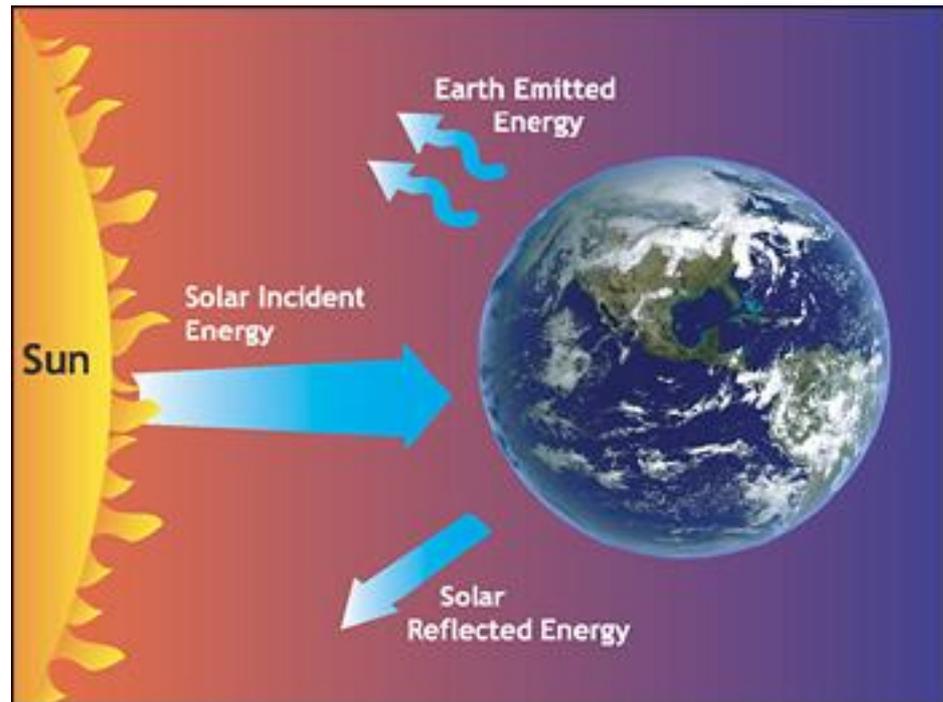
Volcanic Activity

- Volcanic dust can remain suspended in the atmosphere for several years, blocking incoming solar radiation and thus lowering global temperatures.
- Some scientists theorize that periods of high volcanic activity cause **cool climatic periods**.



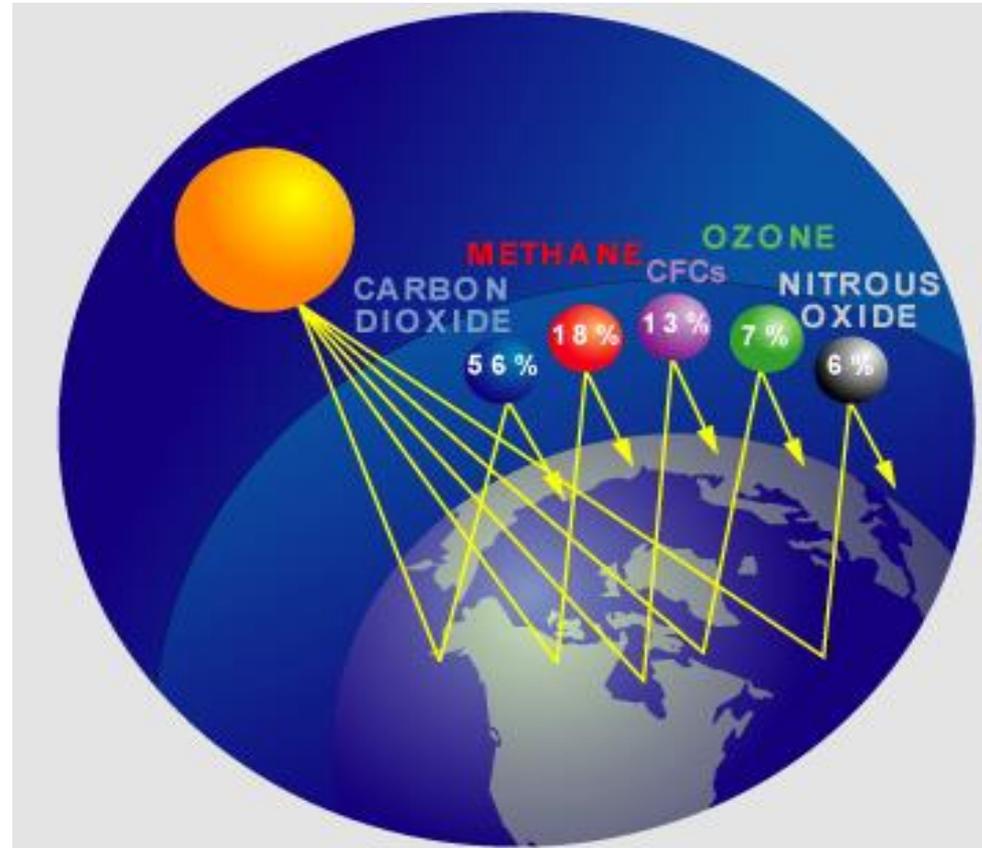
14.4 The Human Factor

- Solar radiation is absorbed by Earth's surface and released as long-wavelength radiation.
- This radiation is absorbed by atmospheric gases such as water vapor, methane, and carbon dioxide.

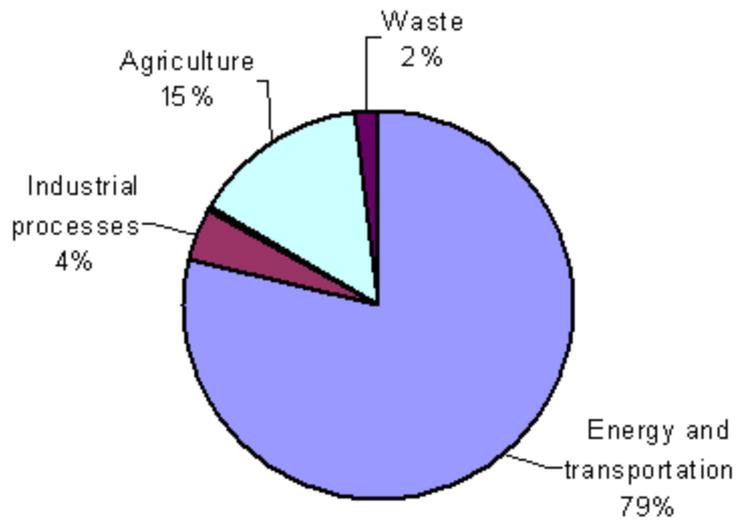


Greenhouse Gasses

- Methane
- Nitrous Oxide NO_2
- Carbon Dioxide CO_2



The Greenhouse Effect



- The **greenhouse effect** is the natural heating of Earth's surface caused by the retention of heat by certain atmospheric gases called greenhouse gases.

- Without the greenhouse effect our planet would be cold.
- A marked increase in the greenhouse effect might cause our planet to be hot.

The Greenhouse Effect

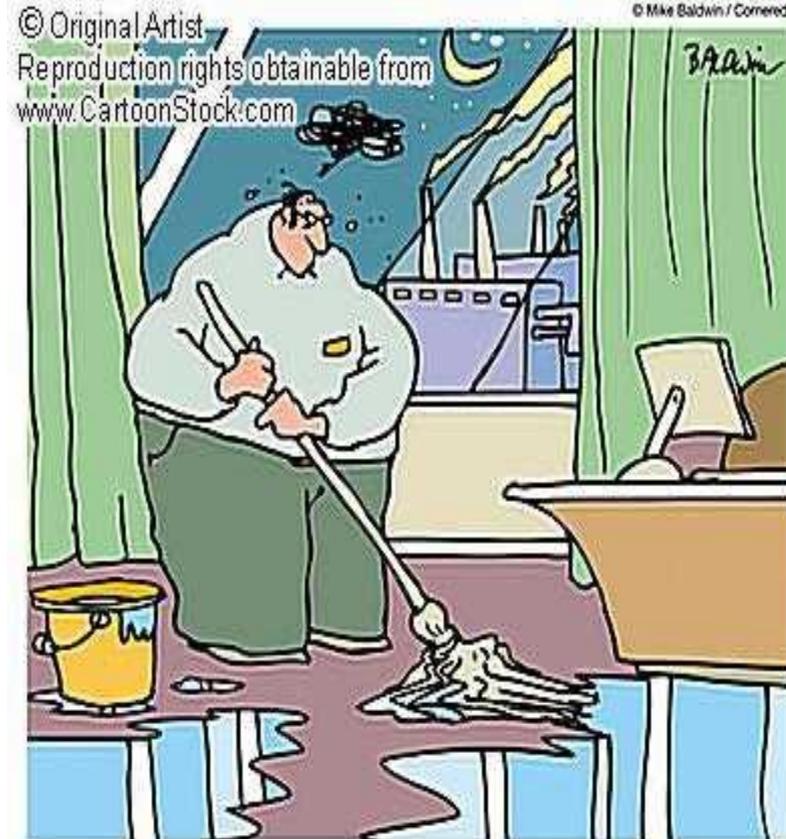
Solar radiation reaches Earth's surface and is reradiated as long-wavelength radiation. This radiation cannot escape through the atmosphere and is absorbed and re-released by atmospheric gases. This process is called the greenhouse effect because it is similar to the way that heat is trapped and released in a greenhouse.





- Theory = any increase in greenhouse gases, particularly carbon dioxide (CO_2) results in the increased absorption of radiation.

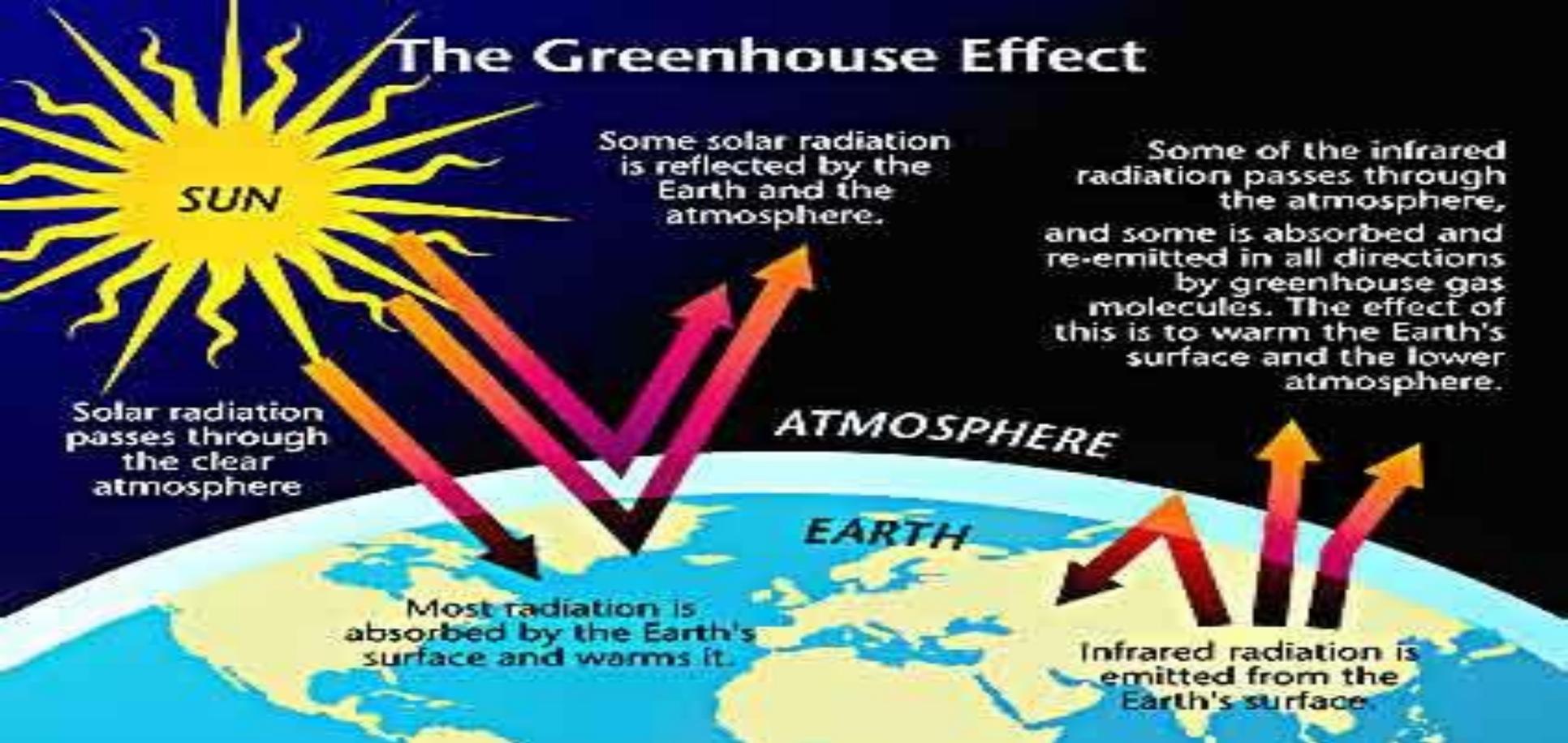
Global warming is a rise in global temperatures that could result from the increased absorption of radiation due to higher levels of greenhouse gases.



The ice caps were melting and no one seemed to care. Except the guy who had to clean it up.

Because of Global Warming...

- Rising Ocean levels
- Ice caps will melt
- Storms will be increased
- Fertile areas will become deserts



– 2 controversial View Points

1. **natural changes** in Earth's atmosphere explain the increased temperatures.
2. Because of human activity the warming trend is a result of **increases in atmospheric carbon dioxide**.

- During photosynthesis, vegetation removes carbon dioxide from the atmosphere.
- When trees are cut down through **deforestation**, rates of photosynthesis are reduced and more carbon dioxide remains in the atmosphere.



EQUATOR

EQUATOR

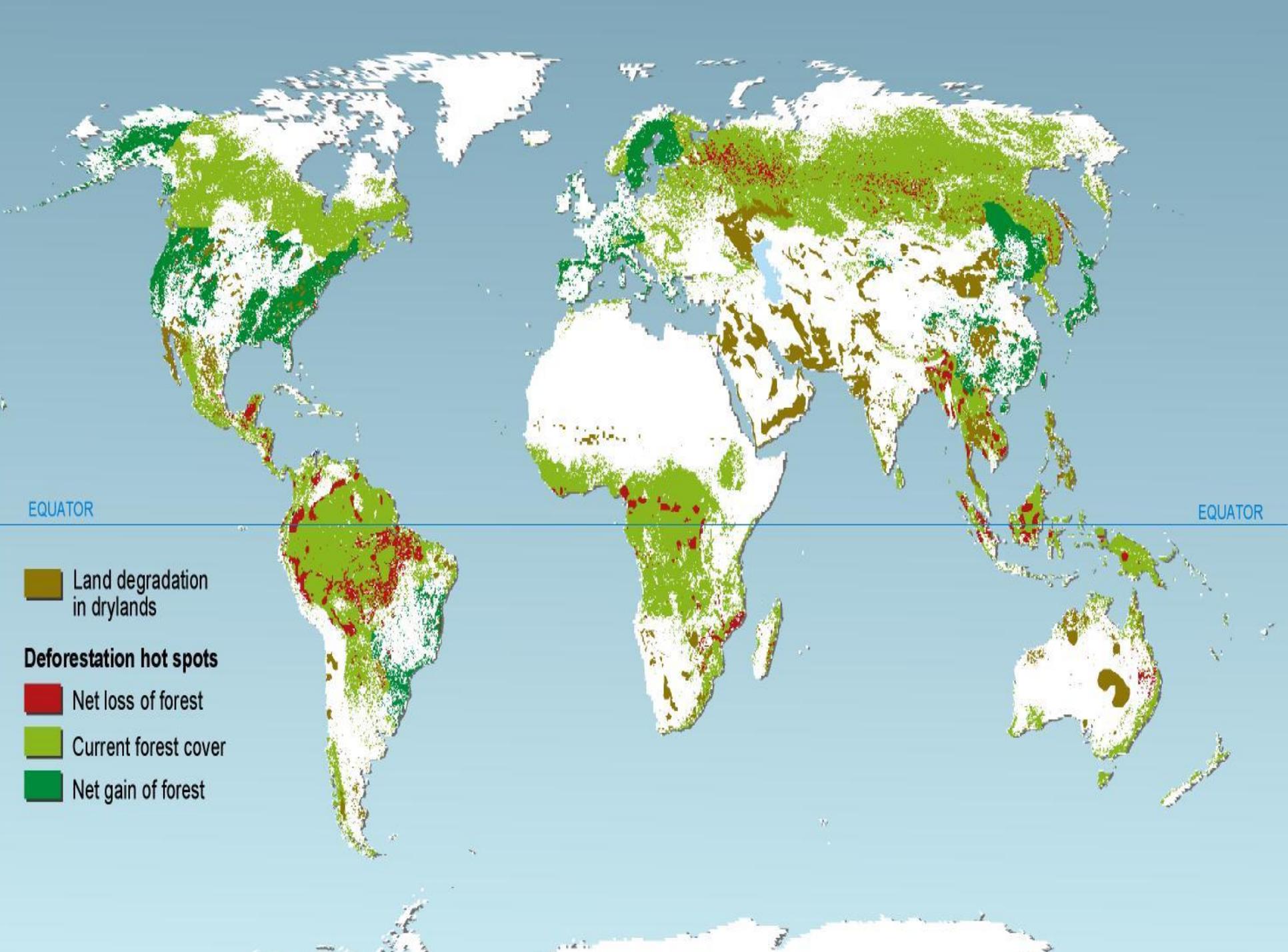
 Land degradation
in drylands

Deforestation hot spots

 Net loss of forest

 Current forest cover

 Net gain of forest



Global warming: Causes and effects

Earth's temperature has risen about 1 degree Fahrenheit in the last century. The past 50 years of warming has been attributed to human activity.

Burning fuels such as coal, natural gas and oil produces greenhouse gases in excessive amounts.

Greenhouse gases are emissions that rise into the atmosphere and trap the sun's energy, keeping heat from escaping.

The United States was responsible for 20 percent of the global greenhouse gases emitted in 1997.

Most of the world's emissions are attributed to the United States' large-scale use of fuels in vehicles and factories.

During the past 100 years global sea levels have risen 4 to 8 inches.

Some predictions for local changes include increasingly hot summers and intense thunderstorms.



Damaging storms, droughts and related weather phenomena cause an increase in economic and health problems. Warmer weather provides breeding grounds for insects such as malaria-carrying mosquitoes.

Environmental Efforts

- We must closely examine activities that cause pollution and deforestation and work to reduce their environmental impact by...
- 1. Planting more trees
- 2. Recycle
- 3. Conserve energy
- 4. Use less electricity
- 5. Burn less fossil fuels