

**Chapter 13**  
**Atmosphere and Climate Change**  
**Section 1**  
**DAY ONE**

**Climate**

- \_\_\_\_\_ is the average weather conditions in an area over a long period of time.
- Climate is determined by a variety of factors that include:
  - \_\_\_\_\_
  - \_\_\_\_\_
  - \_\_\_\_\_
  - \_\_\_\_\_
  - \_\_\_\_\_
  - \_\_\_\_\_
- The most important of these factors is \_\_\_\_\_ from the equator.

**Latitude**

- \_\_\_\_\_ is the distance north or south from the equator and is expressed in degrees.
  - \_\_\_\_\_ = equator
  - \_\_\_\_\_ = North Pole, most northerly
  - \_\_\_\_\_ = South Pole, most southerly
- Latitude strongly affects climate because the \_\_\_\_\_ of solar energy an area of the Earth receives \_\_\_\_\_ on its latitude.

**Low Latitudes**

- \_\_\_\_\_ solar energy falls on areas near the equator than on areas closer to the poles.
- In regions near the equator, night and day are both about \_\_\_\_\_ long throughout the year.

**High Latitudes**

- In regions closer the poles, the sun is \_\_\_\_\_ in the sky, reducing the amount of energy arriving at the surface.
- In the northern and southern latitudes, sunlight hits the Earth at an \_\_\_\_\_ angle and spreads over a larger surface area than it does at the equator.
- The hours of daylight also vary.
  - At \_\_\_\_\_ latitude, there is as much as 16 hours of daylight each day during the summer and as little as 8 hours of sunlight each day in the winter.

**Atmospheric Circulation**

- Three important properties of air illustrate how air circulation affects climate.
  - Cold air \_\_\_\_\_ because it is denser than warm air. As the air sinks, it compresses and warms.
  - Warm air \_\_\_\_\_. It expands and cools as it rises.

- Solar energy \_\_\_\_\_ the ground, which warms the air above it.
  - This warm air rises, and cooler air moves in to replace it.
- Movement of air within the atmosphere is called \_\_\_\_\_.
- Because the Earth rotates, and because different latitudes receive different amounts of solar energy, a pattern of \_\_\_\_\_ results.
- This circulation pattern determines Earth's \_\_\_\_\_ patterns.
- As a result, areas near the equator receive \_\_\_\_\_ of rain.

### Prevailing Winds

- Winds that blow predominantly in one direction throughout the year are called \_\_\_\_\_.
- \_\_\_\_\_ of prevailing winds are produced in both hemispheres between 30° north and south latitude and the equator.
- These belts of winds are called the \_\_\_\_\_.
- Prevailing winds known as the \_\_\_\_\_ are produced between 30° and 60° north latitude and 30° and 60° south latitude.
- In the Northern Hemisphere, these westerlies are \_\_\_\_\_, and in the Southern Hemisphere, these winds are \_\_\_\_\_.
- The \_\_\_\_\_ blow from the poles to 60° north and south latitude.

### Oceanic Circulation

- \_\_\_\_\_ have a great effect on climate because water holds large amounts of heat.
- The movement of surface ocean currents is caused mostly by \_\_\_\_\_ of the Earth.
- These \_\_\_\_\_ redistribute warm and cool masses of water around the world and in doing so, they affect the climate in many parts of the world.

### El Niño–Southern Oscillation

- \_\_\_\_\_ is the warm phase of the El Niño–Southern Oscillation.
- It is the \_\_\_\_\_ in the eastern Pacific Ocean in which the surface-water temperature becomes unusually warm.
- Rainfall follows this warm water eastward and produces \_\_\_\_\_ rainfall in the southern half on the U.S., but drought in Australia.
- \_\_\_\_\_ is the cool phase of the El Niño–Southern oscillation.
- It is the \_\_\_\_\_ in the eastern Pacific Ocean in which the surface water temperature becomes unusually cool.

### Global Circulation Patterns

- Cool air normally sinks, but cool air over the equator cannot descend because hot air is rising up below it.
  - This cool air is forced away from the equators toward the North and South Poles where it \_\_\_\_\_ at about 30° north latitude and 30° south latitude.

- Some of the air sinks back to the Earth's surface and becomes \_\_\_\_\_ as it descends.

### Pacific Decadal Oscillation

- The \_\_\_\_\_ (PDO) is a long-term, 20 to 30 year change in the location of warm and cold water masses in the Pacific Ocean.
- PDO \_\_\_\_\_ the climate in the northern Pacific Ocean and North America.
- It affects \_\_\_\_\_.

### Topography

- Height above sea level ( \_\_\_\_\_ ) has an important effect on climate. Temperatures fall by about 6°C (about 11°F) for every 1,000 m increase in elevation.
- Mountain ranges also influence the \_\_\_\_\_ of precipitation.
- As the air rises, it cools, causing it to rain on the western side of the mountain. When the air reaches the eastern side of the mountain it is dry.
  - This effect is known as a \_\_\_\_\_.

### Other Influences on Earth's Climate

- Both the \_\_\_\_\_ influence Earth's climate.
- UV radiation produces more \_\_\_\_\_, which warms the stratosphere.
- In large-scale volcanic eruptions, \_\_\_\_\_ gas can reach the upper atmosphere.
- This reaction forms a \_\_\_\_\_ that reflects enough sunlight to cause the global temperature to decrease.

### Seasonal Changes in Climate

- The seasons result from the \_\_\_\_\_, which is about \_\_\_\_\_ relative to the plane of its orbit.
- During summer in the Northern Hemisphere, the Northern Hemisphere tilts toward the sun and receives \_\_\_\_\_.
- The number of hours of daylight is \_\_\_\_\_ in the summer.
  - Therefore, the amount of time available for the sun to heat the Earth becomes greater.
- During summer in the Northern Hemisphere, the Southern Hemisphere tilts away from the sun and receives \_\_\_\_\_.
- But, during the summer in the Southern Hemisphere, the situation is reversed.

**Chapter 13**  
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**Section 1**  
**DAY TWO**

### The Ozone Shield

- The \_\_\_\_\_ is the layer of the atmosphere at an altitude of 15 to 40 km in which ozone absorbs ultraviolet solar radiation.
  - \_\_\_\_\_ is a molecule made of three oxygen atoms.

- \_\_\_\_\_ is harmful to organisms because it can damage the genetic material in living cells.
- By shielding the Earth's surface from most of the sun's UV light, the ozone in the \_\_\_\_\_ acts like a sunscreen for the Earth's inhabitants.

### Chemicals That Cause Ozone Depletion

- \_\_\_\_\_ are hydrocarbons in which some or all of the hydrogen atoms are replaced by chlorine and fluorine.
- Used in:
  - \_\_\_\_\_ for refrigerators and air conditioners
  - \_\_\_\_\_
  - \_\_\_\_\_ of everyday products
    - deodorants, insecticides, and paint.
- Their use is now restricted because they destroy ozone molecules in the stratosphere.
- At the Earth's surface, CFCs are chemically \_\_\_\_\_.
- But, CFC molecules \_\_\_\_\_ high in the stratosphere, where UV radiation is absorbed.

### The Ozone Hole

- In 1985, studies by scientists working in Antarctica revealed that the ozone layer above the South Pole had thinned by 50 to 98 percent.
- The \_\_\_\_\_ is a thinning of stratospheric ozone that occurs over the poles during the spring.
- This was the first news of the hole, and was published in an article in the scientific journal \_\_\_\_\_.
- After the results were published, NASA scientists reviewed data that had been sent to Earth by the *Nimbus 7* weather satellite.
  - Able to see the first signs of ozone thinning in the data from \_\_\_\_\_.
- Although the concentration of ozone fluctuated during the year, the data showed a \_\_\_\_\_.

### How Does the Ozone Hole Form?

- During the dark polar winter, strong circulating winds over Antarctica, called the \_\_\_\_\_, isolate cold air from surrounding warmer air.
  - Air within the vortex is extremely cold.
- \_\_\_\_\_ are clouds that form at altitudes of about 21,000 m during the Arctic and Antarctic winter or early spring, when air temperatures drop below  $-80^{\circ}\text{C}$ .
- On the surfaces of polar stratospheric clouds, the products of CFCs are converted to molecular \_\_\_\_\_.
- When sunlight returns to the South Pole in the spring, molecular chlorine is split into two chlorine atoms by \_\_\_\_\_.
  - The chlorine atoms rapidly \_\_\_\_\_ ozone.

- The destruction of ozone causes a thin spot, or \_\_\_\_\_, which lasts for several months.
- Ozone produced by pollution \_\_\_\_\_ with other substances in the troposphere long before it can reach the stratosphere to replace ozone that is being destroyed.

### Effects of Ozone Thinning on Humans

- As the amount of ozone in the stratosphere \_\_\_\_\_ is able to pass through the atmosphere and reach Earth's surface.
- UV light is dangerous to living things because it \_\_\_\_\_, the genetic material that contains the information that determines inherited characteristics.

### Effects of Ozone Thinning on Animals and Plants

- High levels of UV light can kill single-celled organisms called \_\_\_\_\_ that live near the surface of the ocean.
- In addition, a reduction in the number of phytoplankton would cause an \_\_\_\_\_ in the amount of carbon dioxide in the atmosphere.
- In fact, ecologists often use the health of amphibian populations as an \_\_\_\_\_ of environmental change due to the environmental sensitivity of these creatures.

### Protecting the Ozone Layer

- In 1987, a group of nations made an agreement, called the \_\_\_\_\_, to sharply limit their production of CFCs.
- At a second conference in Copenhagen, Denmark in 1992, developed countries agreed to \_\_\_\_\_ most CFCs by 1995.
- After developed countries banned most uses of CFCs, chemical companies developed \_\_\_\_\_.
- Aerosol cans no longer uses \_\_\_\_\_ as propellants, and air conditioners are becoming CFC free.
- CFC molecules remain active in the stratosphere for \_\_\_\_\_.

**Chapter 13**  
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**Section 3**  
**DAY THREE**

### The Greenhouse Effect

- The Earth is similar to a \_\_\_\_\_. The Earth's atmosphere acts like the glass in a greenhouse.
- The rest of the heat is absorbed by gases in the \_\_\_\_\_ and warms the air.
- This process of heat absorption is called the \_\_\_\_\_.
- A \_\_\_\_\_ is a gas composed of molecules that absorb and radiate infrared radiation from the sun.
- The major greenhouse gases are \_\_\_\_\_.

- Water vapor and carbon dioxide account for most of the absorption of that occurs in the atmosphere.

### Measuring Carbon Dioxide in the Atmosphere

- In 1985, a geochemist named \_\_\_\_\_ installed an instrument at the top of a tall tower on the volcano \_\_\_\_\_ in Hawaii.
- In a forest, carbon dioxide levels rise and fall with the daily rhythms of \_\_\_\_\_.
- Keeling reasoned that at Mauna Loa, the \_\_\_\_\_ carbon dioxide levels for the entire Earth could be measured.
- Keeling's first measurement, in March of 1958, was \_\_\_\_\_, and the levels rose slightly the next month.
- During the summer, growing plants use more carbon dioxide for photosynthesis than they release in respiration, causing the levels to \_\_\_\_\_.
- In the winter, dying grasses and fallen leaves decay and \_\_\_\_\_ the carbon that was stored in them, causing levels to rise.

### Rising Carbon Dioxide Levels

- After a few years of measurement, it was obvious that the levels were undergoing \_\_\_\_\_ other than seasonal fluctuations.
- In 42 years, carbon dioxide has gone from 314 to 386 parts per million, an increase of 54 parts per million.
  - This increase may be due to the \_\_\_\_\_.

### Greenhouse Gases and the Earth's Temperature

- Many scientists think that because greenhouse gases trap heat near the Earth's surface, more greenhouse gases in the atmosphere will result in an \_\_\_\_\_ in global temperature.
- Millions of tons of carbon dioxide are released into the atmosphere each year from \_\_\_\_\_.

### How Certain is Global Warming?

- \_\_\_\_\_ is a gradual increase in the average global temperature that is due to a higher concentration of gases such as carbon dioxide in the atmosphere.
- Some scientists believe that the warming is part of \_\_\_\_\_.

### The Consequences of a Warmer Earth

- These problems range from the disruption of \_\_\_\_\_ to adverse impacts on human health, agriculture, and animal and plant populations.

### Melting Ice and Rising Sea Levels

- If the global temperature increased, the amount of ice and snow at the poles would \_\_\_\_\_, causing sea levels around the world to rise.
- Coastal wetlands and other low-lying areas could be \_\_\_\_\_. People who live near coastlines could lose their homes and sources of income.

- The salinity of bays and estuaries might \_\_\_\_\_, adversely affecting marine fisheries. Also, freshwater aquifers could become too salty to be used as sources of fresh water.

### Global Weather Patterns

- If the Earth warms up significantly, the surface of the oceans will \_\_\_\_\_ more heat, which may make hurricanes and typhoons more common.

### Human Health Problems

- Greater numbers of heat related deaths could occur. Very young and very old people would have the greatest risk of \_\_\_\_\_.
- Concentrations of ground level ozone could \_\_\_\_\_ as air temperatures rise, causing respiratory illnesses, especially in urban areas, to increase.
- Warmer temperatures might enable \_\_\_\_\_, which carry diseases such as malaria and encephalitis, to greatly increase in number.

### Agriculture

- Agriculture would be most severely impacted by global warming if extreme weather events, such as drought, became \_\_\_\_\_.
- Higher temperatures could result in \_\_\_\_\_.

### Effects on Plants

- A warmer climate could cause trees to \_\_\_\_\_ into cooler areas.

### Effects on Animals

- Global warming could cause a \_\_\_\_\_ in the geographical range of some animals. For example, Northern birds may not migrate as far south during the winter.

### Recent Findings

- The IPCC reported that the average global surface temperature increased by \_\_\_\_\_ during the 20th century, snow and ice cover has dropped, and the global sea level has risen.
- The IPCC also reported that concentrations of atmospheric gases have continued to \_\_\_\_\_ as a result of human activities.

### Reducing the Risk

- The \_\_\_\_\_ is an international treaty according to which developed countries that signed the treaty agree to reduce their emissions of carbon dioxide and other gases that may contribute to global warming by the year 2012.
- In March of 2001, the United States decided \_\_\_\_\_ to ratify the Kyoto Protocol. However, most other developed nations are going ahead with the treaty.