Section 10.2.
Energy Transfer in the Atmosphere.

Textbook pages 436 to 459.

Before You Read.

What do you think causes wind?

What is Earth's atmosphere like?

Many planets have **atmospheres**, layers of gases that extend above a planet's surface. Earth's atmosphere is made up of five layers: from lowest to highest, they are the troposphere, stratosphere, mesosphere, thermosphere, and exosphere. These layers differ in chemical composition, average temperature, and density.

The troposphere is the layer nearest the surface of the Earth. Almost all water vapour and dust in the atmosphere is found here. The average temperature near Earth is fifteen degrees Celsius but at the top of the troposphere is negative fifty five degrees Celsius. Ninety nine percent of the gases in the troposphere are nitrogen and oxygen.

The stratosphere has dry air and an average temperature of about negative fifty five degrees Celsius at the bottom and zero degrees Celsius at the top. The ozone layer, which absorbs much of the ultraviolet radiation from the Sun, is in the stratosphere.

Temperatures in the mesosphere can reach as low as negative one hundred degrees Celsius. Every day, small pieces of dust and meteors rush through the mesosphere.

Temperatures in the thermosphere can reach one thousand five hundred degrees Celsius to three thousand degrees Celsius. The northern lights, or aurora borealis, are a result of charged particles colliding in the thermosphere. The boundaries of the exosphere are not well defined, and this layer merges with outer space.

The atmosphere is constantly changing, due to many factors, including the Sun's rotation and the effects of day and night.

How is the atmosphere warmed?

Solar radiation transfers heat to Earth. The amount of solar radiation that reaches a certain area is called **insolation**.

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Higher latitudes receive less insolation due to a greater **angle of incidence**. The angle of incidence is the angle that occurs between a ray reaching a surface and a line

perpendicular to that surface. It increases with latitude.

Very little solar radiation heats the atmosphere directly. Solar radiation arrives in short wavelengths, some of which pass through the atmosphere to Earth's surface, where they are absorbed. Earth's surface reradiates some of this energy as longer, infrared waves. The atmosphere absorbs this infrared radiation and convection transfers the thermal energy throughout the atmosphere.

Earth has a **radiation budget** that keeps incoming and outgoing energy in balance. Incoming short-wave solar radiation is reflected and absorbed to various degrees. **Albedo** describes the amount of radiation reflected by a surface. Forested regions and other dark areas (low albedo), for example, will absorb more radiation than areas covered in ice and snow (high albedo).

What is atmospheric pressure?

Atmospheric pressure is the pressure exerted by the mass of air above any point on Earth's surface. Atmospheric pressure is measured with a **barometer** in **Kilopascals**. As the atmospheric pressure changes, a capsule of flexible metal in an aneroid barometer expands or contracts. Kilopascals measure the force per one square metre. Changes in atmospheric pressure occur as a result of the following:

1. Altitude: As altitude increases, atmospheric pressure decreases.
2. Temperature: Warm air is less dense than cold air, resulting in lower atmospheric pressure.
3. Humidity: **Humidity** is a measurement that describes the amount of water vapour in air. The greater the humidity, the lower the atmospheric pressure.

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High pressure system.

- air cools and becomes more dense.
- air mass contracts, draws in surrounding air, and sinks.
- due to weight of extra air, atmospheric pressure increases; high pressure air moves outward toward areas of low pressure, creating wind.
- wind flows clockwise in the northern hemisphere.
- air becomes warmer and drier as it sinks, bringing clear skies.

Low pressure system.

- air warms and becomes less dense.
- air mass expands and rises.
- air pressure at Earth's surface decreases and draws in air from areas of high pressure, creating wind.
- wind flows counterclockwise in the northern hemisphere.

- water vapour condenses as air cools, bringing wet weather.

What is an air mass?

An **air mass** is a parcel of air with similar temperature and humidity throughout. Conditions in an air mass become like Earth's surface below it. When an air mass cools over a cold region, a high pressure system forms. Air masses that travel over warm regions may develop into low pressure systems. The boundary between two air masses is called a **front**. An approaching front means a change in the weather. The extent of the change depends on the amount of difference between conditions in the two air masses.

What is weather?

Weather is the condition of the atmosphere in a specific place and at a specific time. Weather describes all aspects of the atmosphere, including temperature, atmospheric pressure, humidity, and wind speed and direction. Weather is closely connected to heat transfer in the atmosphere. As heat is transferred, convection moves air and thermal energy throughout the troposphere, causing various kinds of weather.

Several types of extreme weather occur on Earth, including thunderstorms, tornados, and tropical cyclones.

A tornado is a violent funnel-shaped column of air. It is found when high altitude winds meet large thunderstorms. Surface winds caused by tornadoes can reach four hundred kilometers per hour. Tropical cyclones, or hurricanes, result from the exchange of thermal energy in the tropics. Warm moist air is lifted high into the atmosphere. As rain is produced, thermal energy is released. Warm air rushes to replace the rising air, and the Coriolis effect forces the air to rotate. The result is a massive, spinning storm.

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How is wind generated on Earth?

Wind is the movement of air from an area of higher pressure to an area of lower pressure. Geographic features such as mountains, oceans, and lakes greatly affect the characteristics of **local winds**. **Prevailing winds** are winds that are typical for a certain region. Over long distances, wind is also affected by Earth's rotation. The **Coriolis effect** is a change in the direction of moving air, water, or objects due to Earth's rotation. The Coriolis effect and convection currents (rising warm air and sinking cool air) result in three major global wind systems: the trade winds, the prevailing westerlies, and the polar easterlies.

Jet streams form in the upper troposphere due to convection currents and become bands of fast-moving air in the stratosphere. They are so strong that airline pilots try to fly with them.