


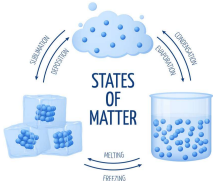
Chapter 1 Atmosphere and Composition of the Atmosphere

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States of matter

All matter is made from atoms. Every substance (oxygen, lead, silver, neon ...) has a unique number of protons, neutrons, and electrons. Oxygen, for example, has 8 protons, 8 neutrons, and 8 electrons. Hydrogen has 1 proton and 1 electron. Individual atoms can combine with other atoms to form molecules. Water molecules contain two atoms of hydrogen H and one atom of oxygen O and is chemically called H₂O. Oxygen and nitrogen are the major components of air and occur in nature as diatomic (two atom) molecules. Regardless of the type of molecule, matter normally exists as either a solid, a liquid, or a gas. We call this property of matter the phase of the matter. The three normal phases of matter have unique characteristics which are listed on the slide.



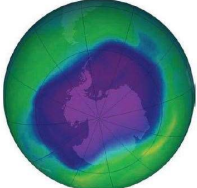
Solid
 In the solid phase the molecules are closely bound to one another by molecular forces. A solid holds its shape and the volume of a solid is fixed by the shape of the solid.

Liquid
 In the liquid phase the molecular forces are weaker than in a solid. A liquid will take the shape of its container with a free surface in a gravitational field. In microgravity, a liquid forms a ball inside a free surface. Regardless of gravity, a liquid has a fixed volume.

Gas
 In the gas phase the molecular forces are very weak. A gas fills its container, taking both the shape and the volume of the container.

Atmosphere

- One of the main components of Earth's interdependent physical systems is the atmosphere. An atmosphere is made of the layers of gases surrounding a planet or other celestial body. Earth's atmosphere is composed of about 78% nitrogen, 21% oxygen, and one percent other gases.
- The atmosphere of Earth is composed of nitrogen (78%), oxygen (21%), argon (0.9%), carbon dioxide (0.04%) and trace gases.
- Most organisms use oxygen for respiration; lightning and bacteria perform nitrogen fixation to produce ammonia that is used to make nucleotides and amino acids; plants, algae, and cyanobacteria use carbon dioxide for photosynthesis. The layered composition of the atmosphere minimizes the harmful effects of sunlight, ultraviolet radiation, solar wind, and cosmic rays to protect organisms from genetic damage. The current composition of the atmosphere of the Earth is the product of billions of years of biochemical modification of the paleoatmosphere by living organisms.



The ozone layer or ozone shield is a region of Earth's stratosphere that absorbs most of the Sun's ultraviolet radiation.

Weather and Climate

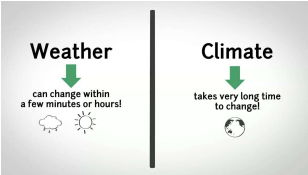
Weather is basically the way the atmosphere is behaving, mainly with respect to its effects upon life and human activities. The difference between weather and climate is that weather consists of the short-term (minutes to months) changes in the atmosphere. Most people think of weather in terms of temperature, humidity, precipitation, cloudiness, brightness, visibility, wind, and atmospheric pressure, as in high and low pressure.

In short, **climate** is the description of the long-term pattern of weather in a particular area.

Some scientists define climate as the average weather for a particular region and time period, usually taken over 30-years. It's really an average pattern of weather for a particular region.

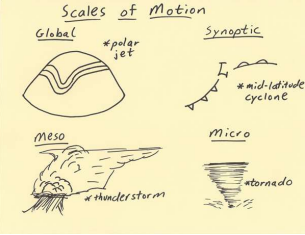
When scientists talk about climate, they're looking at averages of precipitation, temperature, humidity, sunshine, wind velocity, phenomena such as fog, frost, and hail storms, and other measures of the weather that occur over a long period in a particular place.

For example, after looking at rain gauge data, lake and reservoir levels, and satellite data, scientists can tell if during a summer, an area was drier than average. If it continues to be drier than normal over the course of many summers, than it would likely indicate a change in the climate.



Dynamics Process of Atmosphere

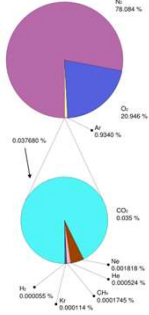
Microscale
 Mesoscale
 Synoptic Scale
 Global Scale



<http://www.theweatherprediction.com/habyhints3/733/>

Composition of the Atmosphere

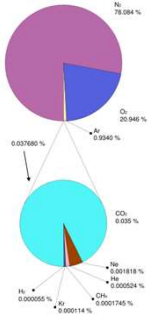
- Permanent Gases
- Variable Gases



Composition of the Atmosphere

Permanent Gases

Nitrogen
Oxygen



Sunlight (UV) + Water (H₂O) + Carbon dioxide (CO₂) = Carbohydrates (sugar and starch) (C₆H₁₂O₆) + Oxygen GAS (O₂)

Composition of the Atmosphere

Permanent Gases

Argon, Neon, Helium, Krypton และ Hydrogen

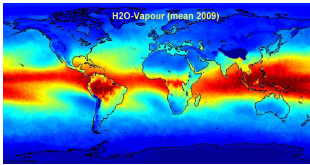
	Percent of Volume of Dry Air	Concentration in Parts per Million Parts of Air
Permanent gases		
Nitrogen (N ₂)	78.084	
Oxygen (O ₂)	20.946	
Argon (Ar)	0.934	
Neon (Ne)	0.00182	18.2
Helium (He)	0.00052	5.2
Krypton (Kr)	0.00011	1.1
Hydrogen (H ₂)	0.00005	0.5

Composition of the Atmosphere

Variable Gases

Water Vapor

Water vapor is Earth's most abundant greenhouse gas. It's responsible for about half of Earth's greenhouse effect — the process that occurs when gases in Earth's atmosphere trap the Sun's heat. Greenhouse gases keep our planet livable. Without them, Earth's surface temperature would be about 59 degrees Fahrenheit (33 degrees Celsius) colder. Water vapor is also a key part of Earth's water cycle: the path that all water follows as it moves around Earth's atmosphere, land, and ocean as liquid water, solid ice, and gaseous water vapor.

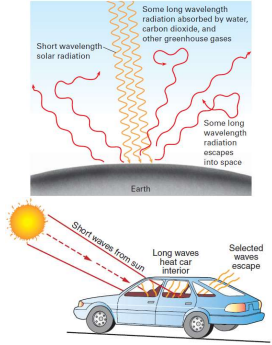


Composition of the Atmosphere

Variable Gases

Carbon dioxide

- Carbon dioxide (CO₂) is an important heat-trapping gas, or greenhouse gas, that comes from the extraction and burning of fossil fuels (such as coal, oil, and natural gas), from wildfires, and from natural processes like volcanic eruptions. The first graph shows atmospheric CO₂ levels measured at Mauna Loa Observatory, Hawaii, in recent years, with natural, seasonal changes removed. The second graph shows CO₂ levels during Earth's last three glacial cycles, as captured by air bubbles trapped in ice sheets and glaciers.

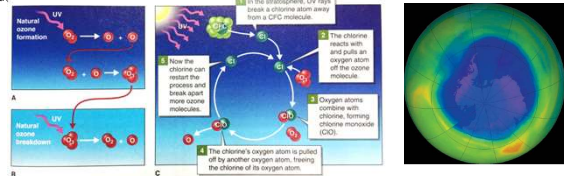


Composition of the Atmosphere

Variable Gases

Ozone

- Ozone (O₃) is a highly reactive gas composed of three oxygen atoms. It is both a natural and a man-made product that occurs in the Earth's upper atmosphere. Ozone molecule (the stratosphere) and lower atmosphere (the troposphere). Depending on where it is in the atmosphere, ozone affects life on Earth in either good or bad ways.
- Stratospheric ozone is formed naturally through the interaction of solar ultraviolet (UV) radiation with molecular oxygen (O₂). The "ozone layer," approximately 6 through 30 miles above the Earth's surface, reduces the amount of harmful UV radiation reaching the Earth.




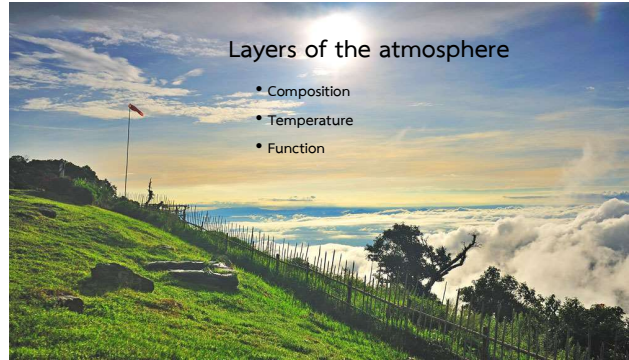
Composition of the Atmosphere

Variable Gases

Aerosol

- Aerosol is defined as a suspension system of solid or liquid particles in a gas. An aerosol includes both the particles and the suspending gas, which is usually air. Meteorologists usually refer them as particle matter - PM_{2.5} or PM₁₀, depending on their size.





Layers of the atmosphere

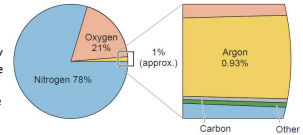
- Composition
- Temperature
- Function

Layers of the atmosphere

Composition

Homosphere
the lower segment of the two-part division of atmosphere and further consists of three regions namely troposphere, stratosphere and mesosphere. All the three regions have the same composition of air. However, the concentration of air keeps decreasing significantly as the altitude increases.

Heterosphere
the layer of an atmosphere where the gases are separated out by molecular diffusion with increasing altitude such that lighter species become more abundant relative to heavier species.

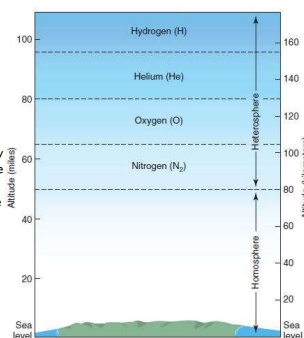


Layers of the atmosphere

Composition

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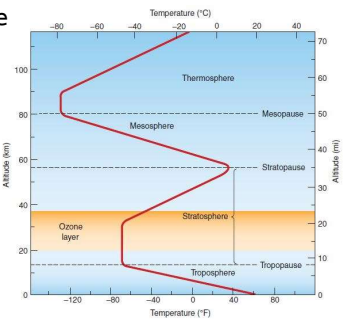
Heterosphere
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Layers of the atmosphere

Temperature

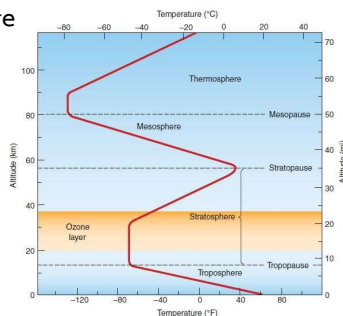
- Troposphere
- Stratosphere
- Mesosphere
- Thermosphere



Layers of the atmosphere

Troposphere

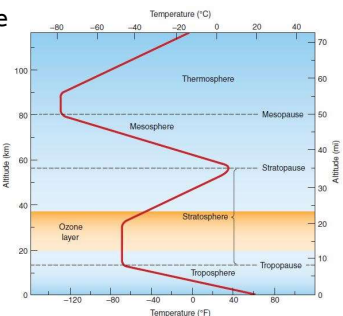
- The troposphere is the lowest layer of our atmosphere. Starting at ground level, it extends upward to about 10 km (6.2 miles or about 33,000 feet) above sea level. We humans live in the troposphere, and nearly all weather occurs in this lowest layer. Most clouds appear here, mainly because 99% of the water vapor in the atmosphere is found in the troposphere. Air pressure drops, and temperatures get colder, as you climb higher in the troposphere.



Layers of the atmosphere

Stratosphere

- The next layer up is called the stratosphere. The stratosphere extends from the top of the troposphere to about 50 km (31 miles) above the ground. The infamous ozone layer is found within the stratosphere. Ozone molecules in this layer absorb high-energy ultraviolet (UV) light from the Sun, converting the UV energy into heat. Unlike the troposphere, the stratosphere actually gets warmer the higher you go! That trend of rising temperatures with altitude means that air in the stratosphere lacks the turbulence and updrafts of the troposphere beneath. Commercial passenger jets fly in the lower stratosphere, partly because this less-turbulent layer provides a smoother ride. The jet stream flows near the border between the troposphere and the stratosphere.



Layers of the atmosphere

Mesosphere

- Above the stratosphere is the mesosphere. It extends upward to a height of about 85 km (53 miles) above our planet. Most meteors burn up in the mesosphere. Unlike the stratosphere, temperatures once again grow colder as you rise up through the mesosphere. The coldest temperatures in Earth's atmosphere, about -90° C (-130° F), are found near the top of this layer. The air in the mesosphere is far too thin to breathe (the air pressure at the bottom of the layer is well below 1% of the pressure at sea level and continues dropping as you go higher).

Layers of the atmosphere

Thermosphere

- The layer of very rare air above the mesosphere is called the thermosphere. High-energy X-rays and UV radiation from the Sun are absorbed in the thermosphere, raising its temperature to hundreds or at times thousands of degrees. However, the air in this layer is so thin that it would feel freezing cold to us! In many ways, the thermosphere is more like outer space than a part of the atmosphere. Many satellites actually orbit Earth within the thermosphere! Variations in the amount of energy coming from the Sun exert a powerful influence on both the height of the top of this layer and the temperature within it. Because of this, the top of the thermosphere can be found anywhere between 500 and 1,000 km (311 to 621 miles) above the ground. Temperatures in the upper thermosphere can range from about 500° C (932° F) to 2,000° C (3,632° F) or higher.

Layers of the atmosphere

Function

- Ozonosphere
- Ionosphere

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Ozonosphere

- A region of the atmosphere from about 15 to 60 km (roughly the extent of the stratosphere) that contains large concentrations of ozone.

Ionosphere

- The ionosphere is not a distinct layer like the others mentioned above. Instead, the ionosphere is a series of regions in parts of the mesosphere and thermosphere where high-energy radiation from the Sun has knocked electrons loose from their parent atoms and molecules. The electrically charged atoms and molecules that are formed in this way are called ions, giving the ionosphere its name and endowing this region with some special properties. The aurora, or Northern Lights and Southern Lights, occur in the parts of the thermosphere that correspond to layers of the ionosphere.

Structure for Climatology study

- Solar Radiation
- Temperature
- Pressure and Wind
- Moisture Content

Factor

Latitude and Mean Temperatures in Aug. and Jan.

City	Latitude	August Temperature	January Temperature
Miami, FL	26	83	67
Houston, TX	30	82	60
Mobile, AL	31	82	60
Phoenix, AZ	33	92	43
Dallas, TX	33	85	54
Los Angeles, CA	34	75	58
Memphis, TN	35	81	40
Norfolk, VA	37	77	38
San Francisco, CA	38	64	49
Baltimore, MD	39	76	32
Kansas City, MO	39	76	28
Washington, DC	39	74	31
Pittsburgh, PA	40	71	25
Cleveland, OH	41	70	25
New York, NY	41	76	32
Boston, MA	42	72	28
Syracuse, NY	43	68	22
Minneapolis, MN	45	71	12
Portland, OR	46	69	40
Duluth, MN	47	64	7

Data source: The World Almanac and Book of Facts, 1988, pp. 220, 456. Reprinted by permission.

Factor

- Latitude
- **Altitude**
- Distribution of Land and Water
- General Circulation of the Ocean
- Topographic Barriers

Elevation (ft)	Temperature (°C)
19,800 (6,000 m)	11 (-12)
16,500 (5,000 m)	2 (-28)
13,200 (4,000 m)	7 (-17)
9,900 (3,000 m)	14 (-8)
6,600 (2,000 m)	21 (7)
3,300 (1,000 m)	28 (82)
Sea Level	35 (95)

Factor

- Latitude
- Altitude
- **Distribution of Land and Water**
- General Circulation of the Ocean
- Topographic Barriers

- 1 Radiation penetrates to depth
- 2 Water heats slowly (high specific heat)
- 3 Mixing of warm and cold waters
- 4 More evaporation

- 1 No penetration of radiation
- 2 Land heats quickly (low specific heat)
- 3 No mixing
- 4 Less evaporation

Factor

- Latitude
- Altitude
- Distribution of Land and Water
- **General Circulation of the Ocean**
- Topographic Barriers

Factor

- Latitude
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