

# METEOROLOGY

The atmosphere, the Sun, radiation, cloud formations, air masses & fronts, global weather patterns & forces, severe weather, optical phenomena, and more

## THE ATMOSPHERE

### Gas Composition

- The atmosphere is composed mainly of nitrogen, an odorless, colorless gas
- Oxygen is the next most abundant element, with other gases represented only in trace amounts
- The atmosphere is a fluid; it has no set shape and moves easily when acted upon by external forces

### Description of Composition

- There are two ways to describe the composition of the atmosphere:
  - By the weight of the constituents
  - By their volume

Principal Gases in Dry Air	
Constituent	Percent by Volume
Nitrogen	78.084
Oxygen	20.946
Argon	.934
Carbon dioxide	.034
Ozone	.000004
Water vapor	~4.0*

\*Water vapor is a variable gas, whereas the others are more permanent

### Possible Originations

- The Earth has what is known as a **secondary atmosphere**, or an atmosphere created after the formation of the planet
- The large gas planets (Jupiter, Saturn, Uranus, and Neptune) are entirely made of gas; Jupiter has a **primary atmosphere**, or an atmosphere that originated with the formation of the planet
- There are two hypotheses for the formation of the Earth's atmosphere:
  - Outgassing:**
    - When the Earth formed, it was a giant spinning ball of molten lava
    - As it cooled, gases trapped in the lava were "belched" up by large volcanoes
    - The combination of these outgassed vapors and the biological transformation of the chemistry of the atmosphere by hundreds of millions of years of plant growth gave us our contemporary atmosphere
  - This hypothesis is more widely accepted

### Comet Impacts:

- A comet is a giant clump of frozen water and gases
- If many large comets struck the Earth several billion years ago, they could have left a residue of water, carbon dioxide, oxygen, and other gases that eventually collected into the atmosphere

### Levels of the Atmosphere



- Because the density of the atmosphere decreases exponentially with altitude, 99% of the atmosphere is within the first 20 miles of the Earth's surface

### Troposphere

- The lowest level of the atmosphere
- Named in 1908 by Léon Teisserenc de Bort, it means "the region where air turns over"
- The layer in which most of the clouds and weather phenomena occur
- Has two layers:
  - The layer that touches the Earth is called the **boundary layer** and is about 5-10 miles high at the equator
  - The troposphere's upper limit is called the **tropopause** and varies in height with both season and location
- In the troposphere, temperatures decrease with altitude; this is called a **lapse rate:**
  - This rate averages out to be  $-6.5^{\circ}\text{C}$  for every kilometer
  - In the tropopause, the temperature does not change with height

### Stratosphere

- The layer of the atmosphere that exists between 12-31 miles above the Earth's surface
- The temperature in the stratosphere increases with height because the **ozone layer** is located here; when temperatures increase with height, it is called an **inversion:**
  - The ozone layer absorbs ultraviolet radiation from the Sun (see **Heat Transfer & the Greenhouse Effect**, p. 2, and **Ozone**, p. 6)
  - There has been a decrease in the ozone layer due to chlorofluorocarbons (CFCs) and other man-made and natural chemical processes
  - Scientists have found that ice crystals, due to the extremely low temperatures of this region, can also deplete ozone, but research is ongoing in this area

### Mesosphere

- The layer of the atmosphere above the stratosphere
- The temperature in the mesosphere begins to fall, often reaching the **coldest temperatures** of any part of the atmosphere:
  - This cold region extends from 31-56 miles above the Earth's surface, and its temperature can reach  $-100^{\circ}\text{C}$

### Thermosphere

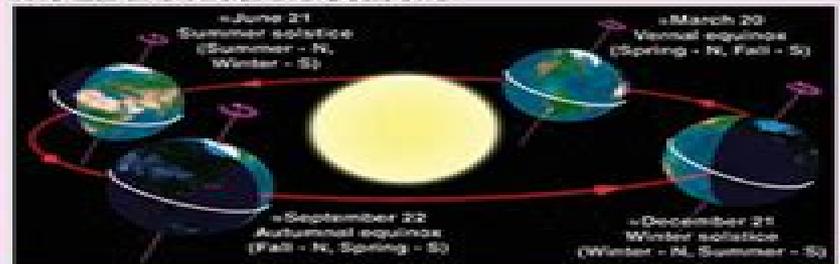
- The layer of the atmosphere above the mesosphere
- It starts about 56 miles above the Earth's surface
- Here, again, the temperature begins to rise with altitude:
  - This is because the atmosphere in this region, while very thin, allows particles to move at extremely high speeds
  - Temperature is the average kinetic energy of the particles; since the particles are moving so fast, the temperature is very high in this layer

### Ionosphere

- The layer within both the thermosphere and mesosphere in which there are enough ionized particles to affect the transmission of radio signals:
  - Radio signals bounce off the ionosphere to extend their range past the horizon
  - This effect is stronger at night when the Sun's radiation does not affect the ionosphere
- Ionized particles are atoms or molecules that have more electrons than protons, making them negatively charged, or more protons than electrons, making them positively charged
- Begins about 37 miles above the Earth's surface and extends upward
- Reflects long-wavelength, low-energy radio signals (like AM radio) back to Earth but allows short-wavelength, high-energy radio signals (like FM radio) to pass through into space

## THE SUN, HEAT, TEMPERATURE & RADIATION

### The Earth's Tilt & the Seasons



- As it orbits around the Sun, the Earth spins on its axis, which is tilted with respect to the Earth-Sun orbital plane, not perpendicular to it:
  - The North Pole does not point directly up and down as the Earth spins but rather is inclined at  $23.5^{\circ}$  with respect to the orbital plane
- As the Earth orbits the Sun, in a near-circular path called an ellipse, it remains at the same angle and pointing in the same direction; this tilt means that during a certain time of the year, the **Northern Hemisphere** is pointed toward the Sun more than the **Southern Hemisphere:**
  - During this period, the Northern Hemisphere receives more direct sunlight than the Southern Hemisphere and therefore becomes warmer; this is summer in the Northern Hemisphere and winter in the Southern Hemisphere; the first day of summer for the Northern Hemisphere is called the **summer solstice**, which has the most day-light hours of the year:
    - On or around June 21, the Sun's most direct perpendicular rays are hitting the Earth at  $23.5^{\circ}$  N latitude, the Tropic of Cancer; this is the farthest north the perpendicular rays will be

# Meteorology Study Guide

**Shasha Hu**



## **Meteorology Study Guide:**

## Unveiling the Magic of Words: A Review of "**Meteorology Study Guide**"

In a world defined by information and interconnectivity, the enchanting power of words has acquired unparalleled significance. Their power to kindle emotions, provoke contemplation, and ignite transformative change is actually awe-inspiring. Enter the realm of "**Meteorology Study Guide**," a mesmerizing literary masterpiece penned by way of a distinguished author, guiding readers on a profound journey to unravel the secrets and potential hidden within every word. In this critique, we shall delve in to the book is central themes, examine its distinctive writing style, and assess its profound effect on the souls of its readers.

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