Volcanic Influence on Earth’s Atmosphere

- Creation of early Earth atmosphere
- Global cooling or global warming
- Mass extinctions
Magma contains many dissolved gases that are released during venting and eruption.

- Water vapor (H$_2$O)—most abundant
- Carbon Dioxide (CO$_2$)
- Sulfur Dioxide (SO$_2$)
- Hydrogen Fluoride (HF)
- Hydrogen Chloride (HCl)
• Earth’s Early Atmosphere
  • Created by volcanic outgassing (release of gas from volcanoes)
  • Lots of water vapor, carbon dioxide, sulfur dioxide, chlorine gas, ammonia, some methane.
  • Atmosphere primarily composed of clouds of water vapor and carbon dioxide.
  • Little to no oxygen until photosynthetic organisms develop
**Current atmosphere**

- 78% nitrogen, 21% oxygen, 1% other gas
- Four layers:
  - **Troposphere**: layer closest to Earth, contains water vapor (clouds) and all the weather.
  - **Stratosphere**: layer above troposphere; contains the ozone layer
    - Ozone layer: thin layer of $O_3$ (3 oxygen bonded together); protects Earth from Ultraviolet radiation
  - **Mesosphere**: layer above stratosphere; coldest layer of the atmosphere
  - **Thermosphere**: outermost layer of the atmosphere; hottest layer due to intense solar radiation
Volcanoes affect the troposphere and stratosphere.

- Large pyroclastic eruptions eject gas, dust, and ash into the upper troposphere, circulating the globe and blocking sunlight leading to nuclear winter.
How Volcanoes Cause Extinctions

Eruptions

SO\textsubscript{2} emissions
- Short-term cooling
  - Glaciation
  - Sea-level drop

Cl. F emissions
- Acid Rain
  - Fungal proliferation
- Increased continental weathering
  - Increased oceanic Sr/Sr ratios
  - Extinction on Land

CO\textsubscript{2} emissions
- Long-term warming
  - Oceanic stagnation and marine anoxia
  - Marine Extinction
• **Sulfur Dioxide** (SO$_2$) emissions:
  
  • **Cooling of earth**: causes glaciation/ice ages, drop in sea level, death of marine life
  
  • **Acid rain**: destroys plant life, which causes animals to starve—death of land creatures.
• Carbon Dioxide (CO$_2$)
  • Volcanoes release 130 million tons of CO$_2$ per year.
  • Excessive CO$_2$ emissions cause long-term warming, which can cause marine extinctions (ocean stagnation, excess algae)
Hydrogen Fluoride and Hydrogen Chloride

- Both fluorine and chlorine are VERY toxic!
- Can cause acid rain
- Can cause ozone depletion (usually short-term, unless eruption is extensive/long-lasting)
- Poisons land, water, vegetation, and animals
Mass Extinctions

- **Mass extinction**—rapid destruction of multiple species in a short period of time
  - Typically widespread throughout Earth—a significant portion of life on Earth is affected
  - Examples: Permian extinction (250 million years ago; 90% of life; volcano); Triassic (210 mya; 65% of life); Cretaceous (65 mya; 85% of life, including dinosaurs; large asteroid)