Earth’s Modern Atmosphere

Physical Geography Lecture - GEOG B1

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You're breathing it...

Air is a mixture of gases that is blended so thoroughly that it behaves as if it were a single gas. It is naturally odorless, colorless, tasteless, and formless.
Generally we think of the top of the atmosphere to be around 480 km, or 300 miles above Earth's surface. This is where the thermopause exists.
Beyond that is the **exosphere** ("outer sphere") - where the atmosphere barely exists in a near-vacuum. A few hydrogen and helium atoms are loosely held by gravity.

Atmospheric Profile

The atmosphere must be studied in layers - each with unique properties and processes.

Scientists use 3 atmospheric criteria to define the layers for analytical purposes:

>>composition - what gasses are where

>>temperature

(See Fig. 3.1)

>>function - what the gasses do in each layer

Air pressure changes throughout the atmospheric profile (Fig. 3.2).

Air molecules create **air pressure** through their motion, size, and number, exerting a force on all surfaces they come in contact with.

At sea level, the atmosphere exerts an average force of 1 kg/cm^2 (14.7 lb/in^2)

Atmospheric Composition

Chemical composition -- Two broad regions -- Fig. 3.1
Heterosphere: outer atmosphere from about 80 km (50 mi) outward
>gasses not evenly mixed - occur in layers according to atomic weight of gasses (hydrogen & helium are lightest / oxygen & nitrogen are heaviest)
Homosphere: inner atmosphere from about 80 km down to Earth's surface
>gasses blended uniformly throughout (except "ozone layer" 19-50 km above sea level) - See Table 3.1

>>>Nitrogen - inert gas, key to life - integrates into bodies through food we eat >>>Oxygen - essential for life (by-product of photosynthesis) - one-fifth of atmos >>>Carbon Dioxide (CO_2) - natural by-product of life processes - increasing amounts affect global temperatures (CO_2 traps heat)

Atmospheric Temperature - Part I

Thermosphere: 80-480 km (50-300 mi) - upper limit is **thermopause**
> Fig. 3.3**a** - temperature rises sharply with altitude (up to 1200℃ and higher) - temp rise is due to **kinetic energy**, the energy of motion, as solar radiation excites molecules to high levels of vibration

Mesosphere: 50-80 km (30-50 mi) - outer boundary is *mesopause*
>Fig. 3.3**a** - coldest part of atmos at mesopause, -90℃ (-130℉), due to extremely low pressure

Stratosphere: 18-50 km (11-31 mi) - outer boundary is the *stratopause*
>Fig. 3.3a - temp increases with altitude, -57℃ (-70℉) to 0℃ (32℉)
--location of the ozone layer

Atmospheric Temperature - Part II

Troposphere: this layer supports all life, most weather activity, most of water vapor, holds 90% of atmosphere's mass, and air pollution

Tropopause: outer boundary of Troposphere - defined by temp: -57℃ (-70℉) >varies in altitude depending on season, latitude, surface temperatures and pressures (higher at equator, lower at poles) - Fig. 3.3**b**
Temperatures decreases rapidly with increasing altitude - Fig 3.3**a**

Atmospheric Function - Part I

Two zones which together remove most of the harmful wavelengths of insolation.
Ionosphere: extends throughout thermosphere and into the mesosphere

>Fig 3.4 - absorbs cosmic rays, gamma rays, X-rays, and shorter wavelengths of UV radiation

>changes atoms to positively charged ions

>where the auroral lights occur

>distinct layers within are important for broadcast and GPS signals - reflect certain radio wavelengths, especially at night - solar flares, solar storms, and geomagnetic storms can trigger radio blackouts or GPS position errors

Atmospheric Function - Part II

Ozonosphere / Ozone layer: found in the stratosphere where there is an increased level of ozone (O_3) - a highly reactive oxygen molecule

>Fig. 3.4 - absorbs shorter wavelengths of UV radiation (UVC and UVB rays)

UVA rays not absorbed - makes up 95% of UV radiation that reaches surface

>penetrate skin more deeply - causes damage to basal level of epidermis

UV Index / UVI: included in many weather reports to alert public of need to use sun protection - uses scale of 1 to 11+ (higher number=greater danger). See Table 3.2

Ozone loss due to chlorofluorocarbons (CFCs) - synthetic chemicals with chlorine atoms that decompose ozone. Pages 68-69 - Focus Study 3.1

Pollutants in the Atmosphere

Pollutants: natural and human-caused gases, particles, and other substances that are harmful to organisms or cause environmental damage.
Air pollution is NOT a new problem.
Natural sources produce greater amounts of air pollutants than do sources attributable to humans (Table 3.3).
>Pollutants: nitrogen oxides, carbon monoxide, hydrocarbons, carbon dioxide
>Sources: volcanoes, forest fires (Fig. 3.5), plants, decaying plants, soil, ocean
Aerosols: particulates produced by natural sources that include liquid droplets and suspended solids

Anthropogenic Pollution

Anthropogenic - “human-caused”
Most prevalent in urbanized regions. Table 3.4
Motor vehicle transportation still the largest source of air pollution in US & Canada
Stationary pollutions sources - power plants and industrial plants that use fossil fuels - contribute the most sulfur oxides and particulates
>>Focused in Northern Hemisphere - esp over eastern China and northern India
See p. 77, 3.3-Air Pollution: A Global Problem

Anthropogenic “Smog”

Photochemical smog: results from the interaction of sunlight and the combustible products of automobile exhaust (primarily nitrogen oxides and VOCs) Despite the connection between photochemical smog with and auto exhaust, mass transit continues to decline, while more humans drive more cars.
Industrial smog: air pollution associated with coal-burning industries and steel manufacturing - has high concentrations of $C0_2$, particulates, and sulfur oxides.
>>Sulfur oxides mix with water vapor to form sulfuric acid - dangerous to health, corrosive to metal, and it accelerates the deterioration of stone building materials.
Particulate matter: or aerosols - fine particles, both liquid and solid, that pollute the air and affect human health - can get into lungs and bloodstream (ie: “soot”)
See pp. 76-77, Geosystems in Action 3 (3.1 and 3.2)

Natural Factors that Affect Pollutants

Winds gather and move pollutants across oceans and all over the world.

>Dust can be traced back to it's source (Fig. 3.7)

Winds make the atmosphere's condition an international issue - dust and pollutants do NOt recognize political borders.

Landscapes: Hawaii / Iceland - volcanoes=sulfur dioxide, Bakersfield, Mexico City, Los Angeles

Temperature inversions: occurs when temperature (usually decreases with altitude) reverses trend and begins to increase - can happen at any altitude - air can not vertically mix and pollution gets trapped (Fig. 3.8)

See p. 79 - The Human Denominator