

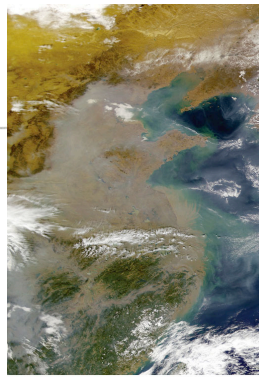
CHAPTER 18: AIR POLLUTION

APES 2013

1

SOUTH ASIA

- ASIAN BROWN CLOUD - TWO MILES THICK AND IS ABOUT THE SIZE OF THE CONTINENTAL UNITED STATES
- COMPOSED OF
 - 1/3 = DUST, SMOKE, AND ASH
 - 2/3 = ACIDIC COMPOUNDS, SOOT, TOXIC METALS (EX. MERCURY & LEAD), ORGANIC COMPOUNDS

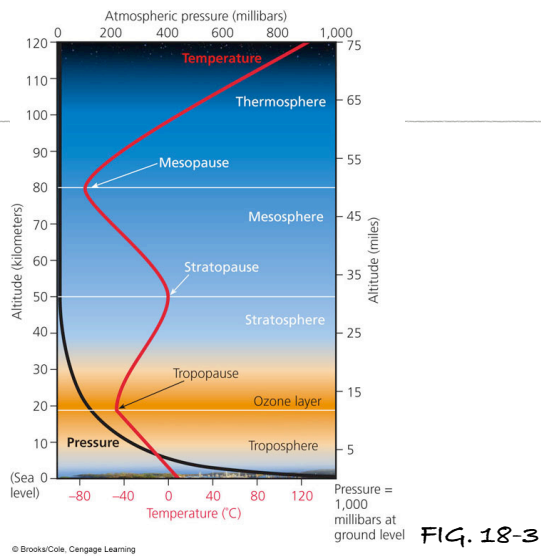


2

THE ATMOSPHERE

- TROPOSPHERE - CLOSEST TO THE EARTH'S SURFACE, MAINLY COMPOSED OF NITROGEN (78%) AND OXYGEN (21%)
- STRATOSPHERE - SIMILAR TO THE TROPOSPHERE WITH LESS WATER VAPOR AND MORE OZONE
 - OZONE LAYER - FOUND IN STRATOSPHERE AND ACTS AS A UV LIGHT FILTER ($3O_2 + UV \rightleftharpoons 2O_3$)

3



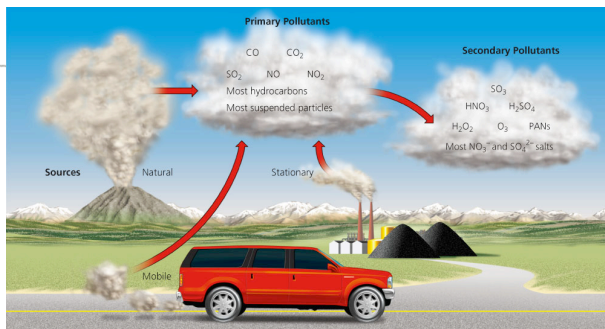
4

OUTDOOR AIR POLLUTANTS

- AIR POLLUTION - PRESENCE OF CHEMICALS IN THE ATMOSPHERE
 - CAN COME FROM NATURAL OR HUMAN SOURCES
 - POLLUTION IS NOT NEW
 - 1700S WORSE WITH AMOUNT OF COAL BURNED
 - 1800S LONDON WAS ENGULFED IN SMOG
 - 1956 BRITISH CLEAN AIR ACT

5

SUPER-POLLUTANTS



- PRIMARY POLLUTANTS - HARMFUL CHEMICALS EMITTED DIRECTLY INTO THE AIR
- SECONDARY POLLUTANTS - PRIMARY POLLUTANTS REACT WITH ONE ANOTHER AND WITH COMPONENTS OF THE AIR TO FORM NEW CHEMICALS

6

MAJOR POLLUTANTS: CARBON OXIDES

Pollutant	Characteristics	Sources	Effects
Carbon Monoxide (CO)	colorless, odorless, forms during incomplete combustion of carbon-containing compounds	vehicle exhaust, burning of forests and grasslands, tobacco smoke	reacts w/ hemoglobin in red blood cells, trigger heart attacks, headaches, nausea, drowsiness, mental impairments
Carbon Dioxide (CO ₂)	colorless, odorless, forms during combustion of carbon-containing compounds	any combustion of organic material	climate change

7

MAJOR POLLUTANTS: NITROGEN BASED

Pollutant	Characteristics	Sources	Effects
Nitrogen Oxides (NO, NO _x)	colorless, forms when nitrogen and oxygen react at high temps (ex. automobile engine, coal power plant, lightning)	vehicle exhaust, coal power plants, lightning strikes, nitrogen fixing bacteria	irritates eyes, nose, and throat; respiratory aggravation, suppress plant growth
Nitric Acid (HNO ₃)	COMPONENTS: Nitrogen oxides (see above) and water	nitrogen oxides react with water vapor	acid deposition; formation of smog; irritates eyes, nose, and throat; respiratory aggravation, suppress plant growth

8

MAJOR POLLUTANTS: SULFUR BASED

Pollutant	Characteristics	Sources	Effects
Sulfur Dioxide (SO ₂)	colorless gas with strong odor	One third from natural sources (sulfur cycle) Majority from coal power plants, oil refining, smelting ores	Asian Brown Cloud; damage plants, soil, and aquatic life; damage stone, paint, metal
Sulfuric Acid (H ₂ SO ₄)	corrosive	sulfur dioxide reacting with water vapor	damage plants, soil, and aquatic life; damage stone, paint, metal; aggravate breathing problems

9

MAJOR POLLUTANTS: PARTICULATES

Pollutant	Characteristics	Sources	Effects
Suspended Particulate Matter (SPM)	<p>variety of solid particles and liquid droplets</p> <p>Types:</p> <p>Fine particles (diameter less than 10 micrometers),</p> <p>Ultrafine Particles (diameter less than 2.5 micrometers - less than one quarter a human hair)</p>	<p>Natural sources: dust, wild fires, sea salt</p> <p>Human sources: coal power plants, vehicles, smoke</p>	<p>In general: irritate nose and throat, damage lungs, aggravate asthma</p> <p>Toxics (lead, cadmium, and PCBs): cause mutations, reproductive problems, cancer</p>

10

MAJOR POLLUTANTS: OZONE

Pollutant	Characteristics	Sources	Effects
Ozone (O ₃)	colorless, highly-reactive gas, main component of smog	reaction between sunlight and air containing hydrocarbons and nitrogen oxides	coughing and breathing problems; aggravate heart and lung disease; irritate eyes, nose, and throat; damages plants, rubber, fabric, and paint

11

MAJOR POLLUTANTS: VOCs

Pollutant	Characteristics	Sources	Effects
Volatile Organic Compounds	organic compounds that exist as gasses in the atmosphere: isoprenes and terpenes (emitted by plants), methane	<p>Natural sources: plants, wetlands</p> <p>Human sources: rice paddies, landfills, oil and natural gas wells, cows, tobacco smoke, plastics, rubber, dry cleaning fluid, paint</p>	<p>Short term exposure: dizziness, unconsciousness, death</p> <p>Long term exposure: leukemia, blood disorders, immune system damage</p>

12

LEAD

- LEAD DOES NOT BREAK DOWN IN THE ENVIRONMENT
- NEUROTOXIN - HARMS NERVOUS SYSTEM
- EACH YEAR 12,000-16,000 AMERICAN CHILDREN UNDER 9 ARE TREATED FOR ACUTE LEAD POISONING (ABOUT 200 DIE AND 30% OF SURVIVORS SUFFER FROM PARALYSIS, BLINDNESS AND MENTAL RETARDATION)
- SIGNIFICANT REDUCTIONS IN LEAD POISONING SINCE 1976 WHEN LEADED GASOLINE WAS BANNED
- CURRENTLY PRODUCTS FROM OVERSEAS HAVE BEEN RECALLED BECAUSE OF LEAD LEVELS

13

INDUSTRIAL SMOG

- INDUSTRIAL SMOG - CONSISTS OF SULFUR DIOXIDE, SULFURIC ACID, AND VARIOUS OTHER SPM
- WHEN COAL AND OIL ARE BURNED, CARBON IS CONVERTED INTO CO_2 AND CO; SOME SMALLER PARTICLES ALSO MAKE THEIR WAY INTO THE ATMOSPHERE
- THE OTHER COMPOUNDS IN THE COAL ARE ALSO RELEASED (SULFUR AND NITROGEN COMPOUNDS)

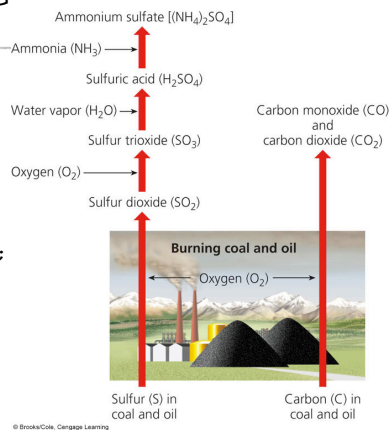


FIG. 18-8

14

PHOTOCHEMICAL SMOG

- PHOTOCHEMICAL SMOG - REACTION ACTIVATED BY LIGHT; MIXTURE OF PRIMARY AND SECONDARY POLLUTANTS UNDER INFLUENCE OF UV RADIATION
- OZONE ACTION DAYS

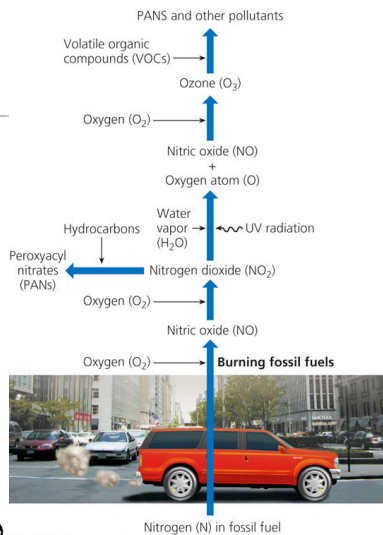


FIG. 18-9

15

NATURAL FACTORS THAT REDUCE AIR POLLUTION

- HEAVY PARTICLES SETTLE OUT BECAUSE OF GRAVITY
- RAIN AND SNOW PULL PARTICLES OUT OF THE AIR
- SALTY SPRAY WASHES OUT PARTICLES OUT OF AIR BY SEA
- WIND BLOWS AND MIXES POLLUTED AND CLEAN AIR
- CHEMICAL REACTIONS CAN REMOVE

16

FACTORS THAT INCREASE AIR POLLUTION

- URBAN BUILDINGS SLOW WIND SPEED AND REDUCE DILUTION
- HILLS AND MOUNTAINS REDUCE THE FLOW OF AIR IN VALLEYS BELOW THEM
- HIGH TEMPERATURES PROMOTE REACTIONS THAT FORM SMOG
- VOLATILE ORGANIC COMPOUNDS
- GRASSHOPPER EFFECT - POLLUTANTS TRANSPORTED BY EVAPORATION AND WINDS FROM TROPICAL AND TEMPERATE AREAS TO THE POLAR AREAS
- TEMPERATURE INVERSIONS - POLLUTION BUILD UP IN COOLER GROUND-LEVEL AIR BECAUSE AIR DOES NOT MIX

17

TEMPERATURE INVERSION

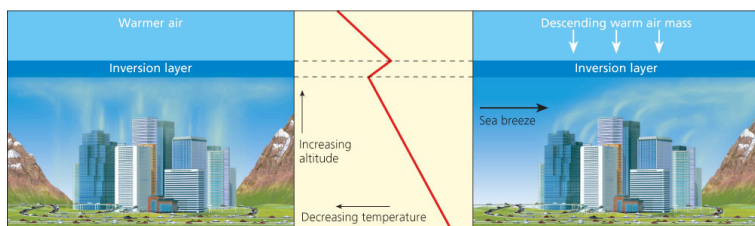


FIG. 18-11

18

ACID DEPOSITION

- SMOKESTACKS
 - EMIT SULFUR DIOXIDE, SPM, AND NITROGEN OXIDES HIGH INTO THE ATMOSPHERE SO THE WIND CAN DILUTE AND DISPERSE
 - REDUCE LOCAL AIR POLLUTION; INCREASE REGIONAL AIR POLLUTION
 - SUBSTANCES CAN STAY IN THE AIR FOR 2-14 DAYS
- ACID DEPOSITION (POLLUTION FALLS TO THE GROUND AS)
 - WET DEPOSITION - ACIDIC RAIN, SNOW, OR FOG (PH < 5.6)
 - DRY DEPOSITION - ACIDIC PARTICLES

19

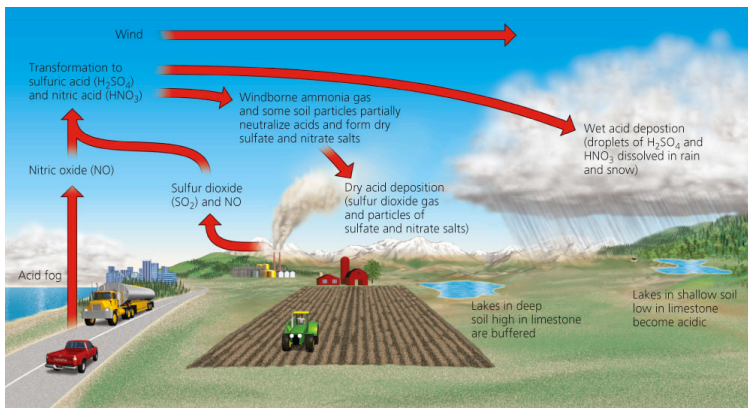


FIG. 18-12

20

ACID DEPOSITION PROBLEMS

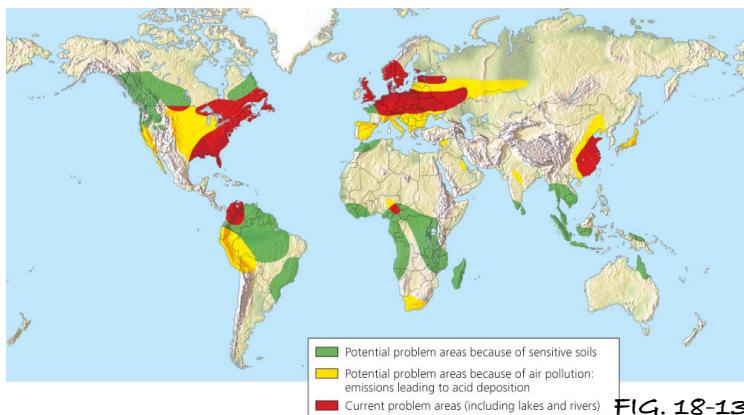


FIG. 18-13

21

EFFECTS OF ACID DEPOSITION

- CONTRIBUTES TO RESPIRATORY DISEASES
- BUILDINGS, DAMAGES STATUES, MONUMENTS
- METALS AND CAR FINISHES
- LEACHES TOXIC METALS (EX. LEAD AND MERCURY) INTO DRINKING WATER
 - CHEMICALS ACCUMULATE IN FISH
 - BIOACCUMULATION

22

EFFECTS OF ACID DEPOSITION

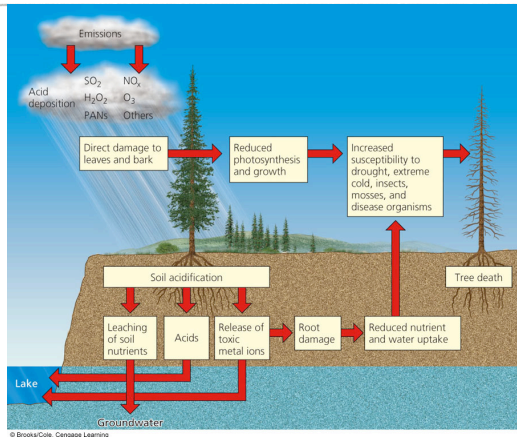


FIG.
18-14

23

REDUCING ACID DEPOSITION

- PREVENTION APPROACHES
 - LOW SULFUR COAL
 - REMOVING SULFUR FROM COAL BEFORE BURNING
 - ALTERNATIVE ENERGY SOURCES
- TREATMENT
 - LIMESTONE USED TO NEUTRALIZE ACIDIFIED LAKES AND SOIL

24

INDOOR AIR POLLUTION

- BIG PROBLEM IN DEVELOPED COUNTRIES
- POLLUTANT LEVELS CAN BE 2 TO 5 TIMES HIGHER THAN OUTSIDE
- POLLUTANT LEVELS IN CARS IN URBAN AREAS CAN BE 18 TIMES HIGHER
- HEALTH RISKS ARE HIGHER BECAUSE 70-98% OF TIME INDOORS

25

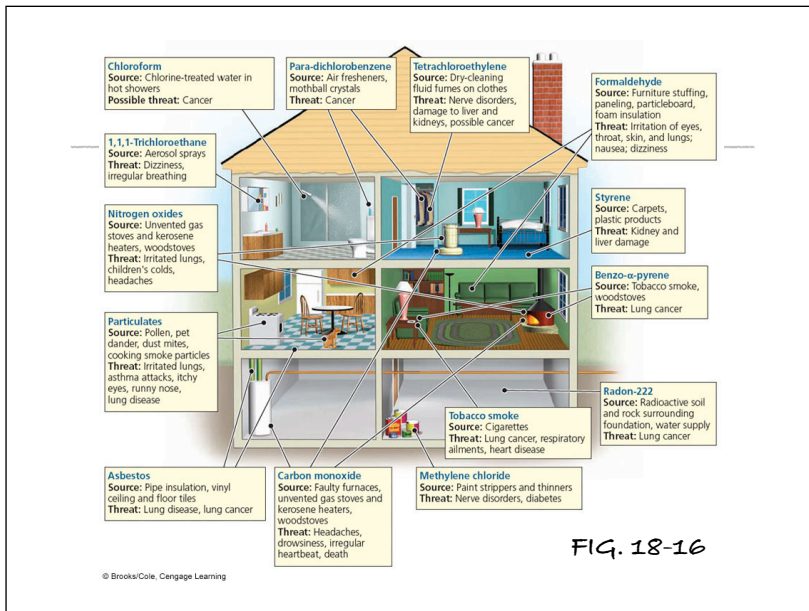


FIG. 18-16

26

RADON GAS

- RADON-222 IS COLORLESS, ODORLESS, RADIOACTIVE GAS
- PRODUCED BY DECAY OF URANIUM-238
- DAMAGES LUNG TISSUE, LUNG CANCER

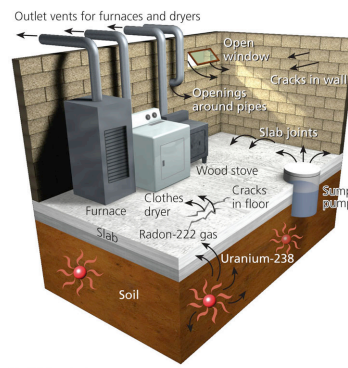


FIG. 18-18

27

BODY DEFENSES

- MUCUS AND CILIA IN RESPIRATORY TRACT
- EMPHYSEMA CAN RESULT FROM CONTINUED EXPOSURE TO POLLUTANTS AND SMOKING

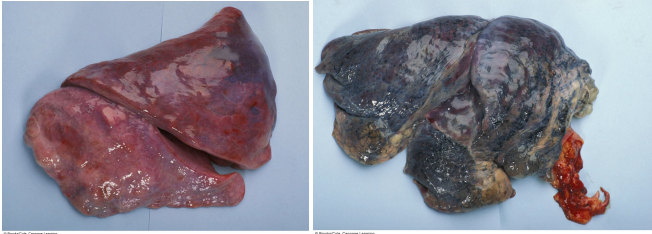
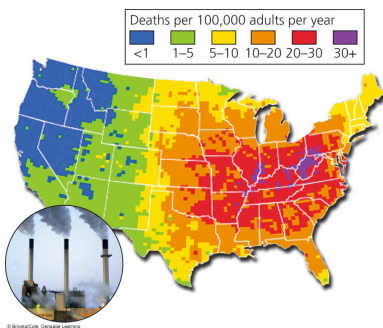


FIG. 18-20

28

AIR POLLUTION DEATHS



- ACCORDING TO THE WHO (WORLD HEALTH ORGANIZATION) 3 MILLION PEOPLE A YEAR DIE FROM EFFECTS OF AIR POLLUTION (2.2 MILLION FROM EFFECTS OF INDOOR AIR POLLUTION)

FIG. 18-21

29

LAWS AND REGULATIONS

- CLEAN AIR ACTS IN 1970, 1977, AND 1990
- EPA DEVELOPED NAAQS (NATIONAL AMBIENT AIR QUALITY STANDARDS) FOR SIX POLLUTANTS: CARBON MONOXIDE, NITROGEN OXIDES, SULFUR DIOXIDES, SPM, OZONE, AND LEAD
- EPA EMISSION STANDARDS FOR 188 HAPS (HAZARDOUS AIR POLLUTANTS)
 - TRI (TOXIC RELEASE INVENTORY) - REQUIRES INDUSTRIES TO REPORT THEIR RELEASES AND WASTE MANAGEMENT FOR 667 DIFFERENT CHEMICALS
 - THIS WAS WEAKENED IN 2005
- THESE POLICIES HAVE BEEN VERY SUCCESSFUL

30

WHY US SUCCEDES

- CITIZENS DEMANDED REGULATIONS
- COUNTRY IS RICH ENOUGH TO FUND CHANGES

31

WEAKNESSES OF AIR POLLUTION LAWS

- LAWS RELY ON CLEAN-UP MORE THAN PREVENTION
- HAVE NOT INCREASED FUEL EFFICIENCY STANDARDS
- INADEQUATE EMISSIONS CONTROLS FOR MOTORCYCLES AND TWO-CYCLE ENGINES
- LACKS REGULATION FOR SHIPS IN AMERICAN PORTS
- AIRPORTS ARE EXEMPT
- NO REGULATION OF GREENHOUSE GAS CO₂
- ULTRAFINE PARTICLES NOT REGULATED
- URBAN OZONE LEVELS STILL TOO HIGH
- LAWS DO NOT DEAL WITH INDOOR AIR POLLUTION
- REGULATIONS OF CLEAN AIR ACT NOT ALWAYS ENFORCED

32

USING CAPITALISM TO REDUCE AIR POLLUTION

- CLEAN AIR ACT OF 1990 AUTHORIZES EMISSIONS TRADING OR CAP-AND-TRADE PROGRAMS
 - ALLOWS POLLUTERS TO BUY AND SELL POLLUTION RIGHTS
 - EACH POLLUTER GETS CREDITS AND CAN SELL THEM TO ANOTHER PLANT
 - THIS WILL HELP REDUCE POLLUTION IF THE AMOUNT OF CREDITS GIVEN OUT CONTINUES TO DECREASE

33