

## 1 Air Pollution

Ch 17

## 2 Atmosphere Layers

- Each layer characterized by distinct temperature differentiation ,
- Troposphere: most mass, where weather occurs, largely N<sub>2</sub> and O<sub>2</sub>, 17 km
- Stratosphere: less molecules, roughly same proportions as troposphere, more O<sub>3</sub> and less H<sub>2</sub>O, reflects UVA and UVB
- Mesosphere: -100C, ice clouds, layer where meteor burns up – shooting stars
- Thermosphere: 1,727C; fast chemical reactions, considered upper atmosphere
- Exosphere- ionosphere, magnetosphere

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## 5 Outdoor Air Pollution

- Air pollution: presence of one or more chemicals in the atmosphere in sufficient quantities and duration that cause harm to life or alter climate
- CO<sub>x</sub>, NO<sub>x</sub>, SO<sub>x</sub>
- Volatile organic cmpds, (VOCs)
- Suspended particulate matter SPM
- Photochemical oxidants
- Radioactive substances
- Hazardous air pollutants (HAPS)

## 6 Primary and Secondary Pollutants

- Primary: harmful when released directly into the atmosphere
- Secondary: form after released as a result of chemical reactions in atmosphere producing harmful products

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## 8 Indoor Air Pollution

- Infiltration of outside pollution
- Chemicals used inside buildings
- Organisms that grow inside buildings (spores, for example)

## 9 Photochemical Smog

- Primary and secondary air pollutants
- Rx facilitated by sunlight
- >100 compounds, of which O<sub>3</sub> is worst problem
- N<sub>2</sub>+O<sub>2</sub>→ 2NO yellowish, choking odor
- 2NO+O<sub>2</sub>→2NO<sub>2</sub> brown color
- 3NO<sub>2</sub> + H<sub>2</sub>O→ 2HNO<sub>3</sub> + NO
- NO<sub>2</sub> + UV → NO + O

- $O + O_2 \rightarrow O_3$
- Photochemical reactions and oxidants

10  **Photochemical Oxidants**

- NO<sub>2</sub>, O<sub>3</sub>, PANs
- React with and oxidize certain compounds in the atmosphere that are not usually oxidized
- Traces of photochemical oxidants or aldehydes in the atmosphere can irritate respiratory tracts and kill trees
- Spotted leaves in Raleigh, NC

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12  Daily Pattern of Changes of Conc → PhotochemicalSmog

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14  **Industrial Smog**

- Grey air smog
- Sulfuric acid
- Sulfur dioxide
- Particulates
- Aerosols (suspended droplets)
- $C + O_2 \rightarrow CO_2$
- $2C + O_2 \rightarrow 2CO$
- $S + O_2 \rightarrow SO_2$  (coal and smelting of PbS)
- $2SO_2 + O_2 \rightarrow 2SO_3$
- $SO_3 + H_2O \rightarrow H_2SO_4$
- $2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$  salt

15  **Factors Contributing to Smog**

- Local climate
- Topography
- Population density
- Amount of industry
- Fuels used in industry, heating, and transportation
- Reduced by precipitation and wind
- Increased by tall buildings in close proximity, mountains, high temperatures

16  **Temperature Inversions**

- Normally warm air w pollutants rises and mixes with cool air above; resulting turbulence disperses pollution
- If the warm air cannot rise due to cold layer underneath then pollutants concentrate in cooler denser layer near the ground

17  **Temperature Inversions**

- Subsidence inversion
- Mass warm air at high altitude moves over colder air in valley (Raleigh)

- 18  **Temperature Inversion**
- Radiation inversion
  - Air near ground cools (sea breezes) warm air over traps pollutants
  - Sun rises and warms surface, radiation inversion disappears by noon and disperses night pool of pollution
- 19  **Acid Deposition**
- Secondary pollutants form nitric acid and sulfuric acid in addition to sulfates and nitrate salts
  - Retention time 2-14 days
  - Back to surface as wet deposition (rain, snow, fog) or acid anhydrides
  - Acid anhydrides fall first and closer to site of pollution
  - Fall downwind of pollution source-sometimes long distances across oceans and continents
- 20  **Acid deposition**
- 21  **Soil pH measurements**
- 22  **Soil type ameliorates or exacerbates acid deposition**
- Yorktown formations – large deposits of  $\text{CaCO}_3$  act as a buffer (however, they are dissolving and form sinkholes-Grafton sinkholes)
  - Thin acid soils are most affected by acid deposition (over granite that has no buffering capacity)
- 23  **Wind Effects**
- Moves acidic emissions (acid anhydrides) from Ohio River valley to SE Canada
  - Smelters in SE Canada affect eastern seaboard
  - Emissions from China pollute Japan/Korea
  - China w big coal emissions pollutes area over Indian Ocean equivalent to size of US
- 24  **Global Wind Circulation**
- 25  Regions where acid deposition is a problem
- 26  Haze caused by burning fossil fuels in China
- 27  **Effects of Acid Rain on Human Health and Economy**
- Respiratory diseases
  - Acid rain in water leaches toxic metals (Pb & Cu) into drinking water
  - Property damage
  - Reduce atmospheric visibility (sulfate particles)
  - Lower productivity of fisheries, forests, farms
  - Local example Sandy Bottom ponds
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30  **Prevention**

- Reduce air pollution by improving energy efficiency
- Reduce coal use
- Increase natural gas use
- Increase use of renewable resources
- Burn low-sulfur coal
- Remove SO<sub>2</sub> particulates, and NO<sub>x</sub> from smokestack gases
- Remove NO<sub>x</sub> from motor vehicles' exhaust
- Tax emissions of SO<sub>2</sub>

31  **CLEAN UP**

- PREVENTION PREVENTION PREVENTION clean up is never totally possible
- Add lime to neutralize acidified lakes \$\$\$\$\$\$
- Add phosphate fertilizer to neutralize acidified lakes
- Soil-kiss it off; \$\$\$\$\$\$ add lime

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33  **Indoor Air Pollution**

- People spend 70+% of time inside, exacerbating problems of air pollution
- High risk members of population are infants, children, elderly, pregnant women, sick people, people w respiratory or heart problems, factory workers, and smokers
- Problems include cancer, headaches, flu like symptoms, chronic fatigue – sick building syndrome
- Problems drive up absenteeism, health care costs, and reduce productivity

34  **3 greatest indoor pollutants**

- Cigarette smoke
- Formaldehyde (outgassed from common household materials) 1 in 5K people will develop cancer
- Radioactive radon-222 gas often associated with coal deposits and uranium-238, phosphate, granite and shale-lung cancer and smokers at much greater risk

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36  **Asbestos**

- This is not as great a problem in US as it once was-illegal to have in buildings as insulation material.
- Led to asbestosis, lung cancer, mesothelioma
- Now a problem in developing countries.

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40  **Respiratory diseases**

- Lung cancer
- Asthma
- Chronic bronchitis
- emphysema

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42  **Clean Air Act**

- Most recent revision 1990; previously 1970 and 1977
- EPA establish national ambient air quality standards NAAQS for 6 criteria pollutants
- Primary standard set to protect human health
- Secondary standard prevent env and property damage
- Compliance a problem

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47  **PREVENTION**

- Reduce personal transportation
- Improve engines
- Restrict driving
- Coat various materials and filter houses to reduce pollutants
- Set stricter standards
- Use less polluting substances

48  **Clean up**

- Dilute
- Dilute
- Dilute
- Circulate, bring in fresh air
- Use exhaust hoods and fans

49  **prevention**

- Alternative energy sources!