Air Pollution

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Introduction

- Currently only two real problematic classes of pollutants
  - Non-point source agricultural pollution
  - Air quality
- Difficult to control because air flows in all directions (air shed)
- Difficult to perform bioassay(生物鉴定)
- Easier to control front end (decrease generation of polluted air) than back end (clean up polluted air)
- Like water pollution, originates in one place, impact another place (unlike soil pollution).
- Most air pollution due to use of E.

Sources & Types of Air Pollution

- Natural Sources: Volcano, Fire, Bacteria, Plant Pollen
- Artificial Sources:
  - Stationary sources: Industry, Boiler
  - Mobile sources: Cars, Trains, Planes

- Three Types:
  - Coal Combustion (reduction): Soot, SO_2
  - Oil Combustion (oxidation): NOx, CHx, SO_2, CO, Pb
  - Both

Some air pollution is not regulated

Wishful thinking →

More unregulated air pollution - burning rice stubble in Poinsett Co., Arkansas

Photo by R. Grippo

Air pollution in India

Photo by R. Grippo

Policeman directing traffic in India

Photo by J. Farris

悉尼于九月底遭到沙尘暴袭击，图为在沙尘笼罩下的悉尼歌剧院。

Toxic Effects of Air Pollution

- Acute Toxicity
  - Geographical & Meteorological change
  - Accidents
- Chronic Toxicity & Disease
  - Irritative Pollutants
  - Nonirritative Pollutants
  - Metals & others
  - In food
- Low Functional Immune Status
- Carcinogenic Action
  - Lung Cancer
  - Others


2010年9月17日15时30分许，浙江金华开发区秋滨街道熟溪路866号一废弃化肥厂的厂区内发生废酸泄漏事件，约8吨浓度超65%的强酸沿破裂的储液罐漏出。
环球网图片
PHOTO.HUANQIU.COM
www.icpress.cn

俄罗斯森林大火
导致的空气污染

Primary & Secondary Air Pollutants

- Primary Pollutants: 由污染源直接排入大气
  - A. Suspended particulates
  - B. Gasses: SO_2, NO_x, CO, O_3, CH_x

- Secondary Pollutants:

  一次污染物在大气中相互作用
  与大气正常组成成分发生反应
  太阳光紫外线引起光化学反应而产生

A. Suspended particulates

Most common, oldest problem addressed

- Trace rock from burning pulverized（压成细粉的）coal (unburnable residues)
- Fly ash from coal (contains Cd, Cu, Pb, Se, As, Hg) has high volume → control by electrostatic（静电的） precipitators（沉降）
- Carbon/ soot（煤烟）from diesel（柴油）
- Natural Sources: volcano（火山）,Forests Fire, Soil particulates

Toxicity of SP

A. 对呼吸道黏膜的刺激和腐蚀作用
B. 对肺细胞的腐蚀和损伤
C. 诱发心血管病
D. 免疫毒性
E. 间接毒性作用
F. 致突变作用
G. 致癌变作用

Factors of Toxicity ↗
- Size ↘
- Concentration ↗
- Component：化学组成；表面吸附的有毒物

Size:
- TSP: Grain Diameter≤100um
- PM_{10}: Grain Diameter≤10um
- $PM_{2.5}$: Grain Diameter≤2.5um

B. Gasses- SO_2

- Respiratory inhibitor（呼吸抑制剂）
- Causes mutation（突变）& Cancerization（癌变）
- Affects enzymatic（酶）action
- Plant leaf injury
- Oxidizes to SO_3 (sulfur trioxide) → H_2SO_4

{ Human health
Hydrobiology（水生生物）
Soil and buildings


Photo courtesy U.S. EPA

B. Gasses-NOx

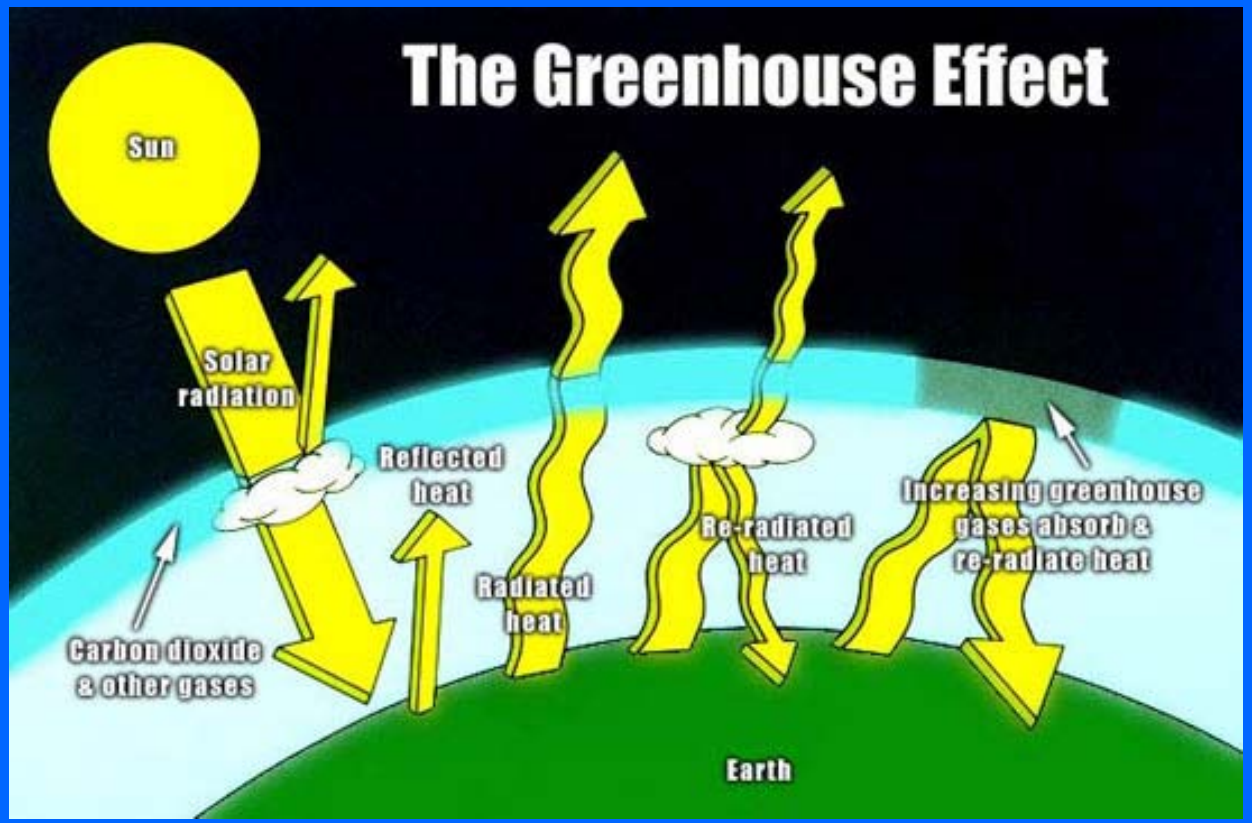
Nitrogen oxides (NOx)

- N_2O nitric acid (ha, ha!)
- NO_2 nitrous oxide
- Respiratory aggravator 呼吸系统恶化
- Decreases soil pH → reduces soil micronutrient availability to plants
- $NO_2 + H_2O = HNO_3$ = azury（浅蓝色的）haze = smog

B. Gasses-CO

Carbon oxides

- CO → competes with O_2 binding on hemoglobin（血红蛋白） (affinity亲和力 is 200 X O_2)
- CO_2 dioxide = greenhouse effect



B. Gasses-O_3

Oxidants (O_3)

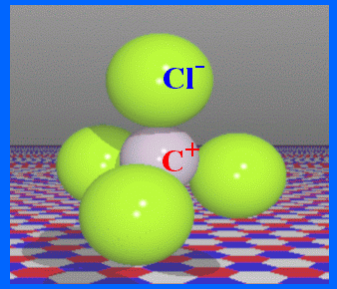
- in atmosphere → not enough
- at ground level → too much → comes from hydrocarbons (gasoline) + O_2 = O_3
- also a respiratory aggravator
  - 加速衰老
  - 减低血液输氧功能
  - 引起甲状腺功能损害
  - 诱发肺部肿瘤和染色体畸变

Minor Gaseous Air Pollutants

Low in direct effects, high in indirect effects

1. CFC's (Freon)
   - Principal refrigerant 冷冻剂 (a/c, refrigerators)

2. Halon 卤代烷
   - Related to CFC
   - Used in fire extinguishers



3. Carbon tetrachloride(CCl_4) and Methychloroform(三氯乙烷)
   - Dry cleaner solvents（溶剂）
   - Manufacturing processes

All above compounds catalyze（催化）the destruction of ozone（臭氧）- Ozone forms protective layer around earth → partially blocks UV

Recall: catalyzers participate in a reaction but are not consumed → hang around a long time and continue to reduce ozone

Therefore, if stopped using now → good effects would take many years to appear

Characteristics of Greenhouse Gasses

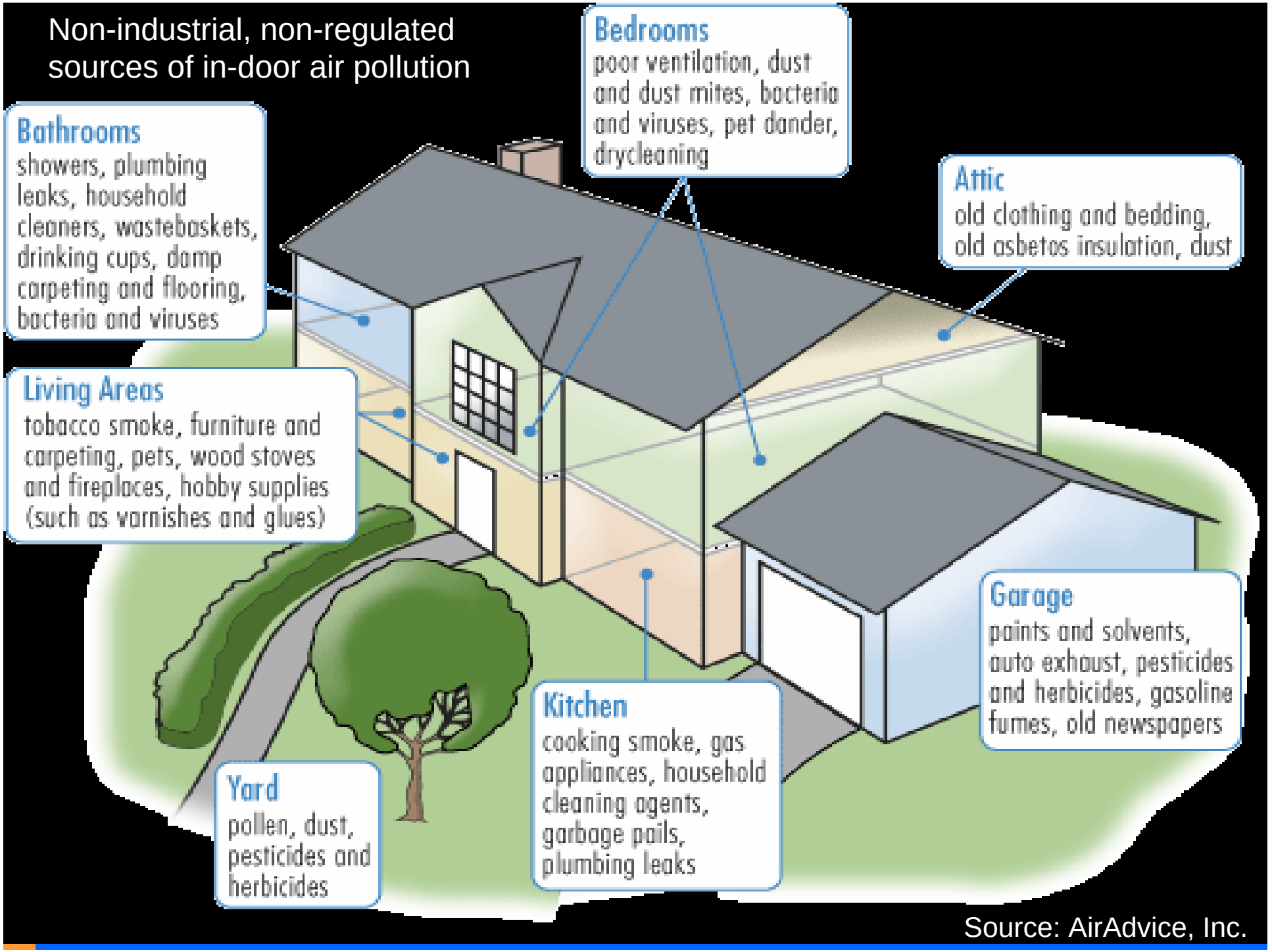
	CO_2	CH_4	N_2O	O_3	CFC-11	CFC-12
Atm contribution	346	1.65	0.31	0.02	0.0002	0.00032
Potential GH effect	1	32	150	2000	14,000	17,000

Note: Up to 1970 → CO_2 dominated → by 1980 dominance decreased → by 2020 → other gasses dominate. Result in predicted increase of 0.5° to 3°C

Indoor Air Pollutants

- Includes SO_2, NOx, CO, CO_2 (coal furnace（炉）, kerosene（煤油）heater）

- Formaldehyde（甲醛，福尔马林）
  - Common constituent of building material
  - Many health effects
    - Respiratory aggravator
    - Potential carcinogen（潜在的致癌物）


Non-industrial, non-regulated sources of in-door air pollution
Bedrooms
poor ventilation, dust and dust mites, bacteria and viruses, pet dander, drycleaning
Bathrooms
showers, plumbing leaks, household cleaners, wastebaskets, drinking cups, damp carpeting and flooring, bacteria and viruses
Attic
old clothing and bedding, old asbetos insulation, dust
Living Areas
tobacco smoke, furniture and carpeting, pets, wood stoves and fireplaces, hobby supplies (such as varnishes and glues)
Garage
paints and solvents, auto exhaust, pesticides and herbicides, gasoline fumes, old newspapers
Kitchen
cooking smoke, gas appliances, household cleaning agents, garbage pails, plumbing leaks
Yard
pollen, dust, pesticides and herbicides
Source: AirAdvice, Inc.

Summary of Major Air Pollutants

- Burning fossil fuels = air pollution
- Coal → sulfur → acid rain
- Cars → NOx -→ "smog", haze

Approximately 10,000,000 premature deaths（猝死）/year world-wide are attributable to stationary and mobile air pollution sources