Energy and Environment Engineering

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ENVIRONMENT AND ECOSYSTEMS

Introduction: Concept of an ecosystem- structure and functions of ecosystem. Components of ecosystem - producers, consumers, decomposers, Food chains, food webs, ecological pyramids, Energy flow in ecosystem. Bio-geo- chemical cycles, Hydrologic cycle Components of Environment and their relationship, Impact of technology on environment, Environmental degradation. Environmental planning of urban network services such as water supply, sewerage, solid waste management.

ENVIRONMENTAL POLLUTION

Water, air, soil, noise, thermal and radioactive, marine pollution: sources, effects and engineering control strategies. Drinking water quality and standards, Ambient air and noise quality standards

GLOBAL ENVIRONMENTAL ISSUES AND ITS MANAGEMENT

Engineering aspects of climate change. Acid rain, depletion of ozone layer. Concept of carbon credit. Concepts of Environmental impact assessment and Environmental audit. Environmental life cycle assessment

Ambient Air and Noise Quality Standard

"Ambient air" refers to the surrounding air, specifically the air in its natural, uncontaminated state, which typically consists of 78% nitrogen and 21% oxygen, with trace amounts of other gases.

Noise Pollution. ... **Sound** that which is unwanted and distrupts one's quality of life, is known as **NOISE**.

Salient features of noise pollution:

- ✓Unwanted **sound** (**noise**) can damage physiological health.
- ✓**Noise pollution** is associated with several health conditions, including cardiovascular disorders, hypertension, high stress levels, tinnitus, hearing loss, sleep disturbances, and other harmful and disturbing effects.

Sources of noise:

Domestic gadgets like the mixer-grinders, pressure cookers, desert coolers, air- conditioners, exhaust fans, vacuum cleaners, sewing and washing machines are all indoor **sources of noise** pollution.

Ambient Air Quality Standards in Respect to Noise

ZONE CODE	ZONE	LIMITS IN dB(A)	
		DAY TIME 6 AM TO 9 PM)	NIGHT TIME 9 PM TO 6 AM)
(A)	Industrial	75	70
(B)	Commercial	65	55
(C)	Residential	55	45
(D)	Silence	50	40

Source: Noise Pollution (regulation and Control) 2000

Ambient air quality standard

NOTE:

1. National Ambient Air Quality Standard: The levels of air quality with an adequate margin of safety, to protect the public health, vegetation and property.

2. Whenever and wherever two consecutive values exceeds the limit specified above for the respective category, it would be considered adequate reason to institute regular/ continuous monitoring and further investigation. S.O. 384(E), Air (Prevention & Control of Pollution) Act, 1981, dated April 11, 1994][EPA Notification: GSR 176(E), April 02, 1996].

1. Include vide Notification SO.955(E), Air (Prevention & Control of Pollution) Act, 1981, dated October 14, 1998]

National Ambient Air Quality Standards

Pollutants	Time weighted average	Concentration in ambient air		
		Industrial Area	Residential, Rural & other Areas	Sensitive Area
1	2	3	4	5
Sulphur Dioxide(SO2)	Annual Average*	80 µg/m3	60 µg/m3	15 µg/m3
	24 hours****	120 µg/m3	80 µg/m3	30 µg/m3
Oxides of Nitrogen as NO2	Annual Average*	80 µg/m3	60 µg/m3	15 µg/m3
	24 hours****	120 µg/m3	80 µg/m3	30 µg/m3
Suspended Particulate Matter (SPM)	Annual Average*	360 µg/m3	140 µg/m3	70 µg/m3
	24 hours****	500 µg/m3	200 µg/m3	100 µg/m3
Respirable Particulate Matter (RPM) (size less than 10	Annual Average*	120 µg/m3	60 µg/m3	50 µg/m3
	24 hours****	150 µg/m3	100 µg/m3	75 µg/m3

micrograms per cubic meter (µg/m³)

National Ambient Air Quality Standards

Pollutants	Time weighted average	Concentration in ambient air		
		Industrial Area	Residential, Rural & other Areas	Sensitive Area
1	2	3	4	5
Lead	Annual Average*	1.0 µg/m3	0.75 µg/m3	0.50 µg/m3
	24 hours****	1.5 µg/m3	1.0 µg/m3	0.75 µg/m3
Ammonia1	Annual Average*	0.1 mg/m3	0.1 mg/m3	0.1 mg/m3
	24 hours****	0.4 mg/m3	0.4 mg/m3	0.4mg/m3
Carbon Monoxides	8 hours**	5.0 mg/m3	2.0 mg/m3	1.0 mg/m3
	1 hours	10.0 mg/m3	4.0 mg/m3	2.0 mg/m3
*	Annual Arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform interval.			
**	24 hourly/ 8 hourly values should be met 98% of the time in a year. However, 2% of the time, it may exceed but not on two consecutive days.Annual Arithmetic mean of minimum 104 measurements in a year taken twice a week at uniform interval.			

Acid Rain

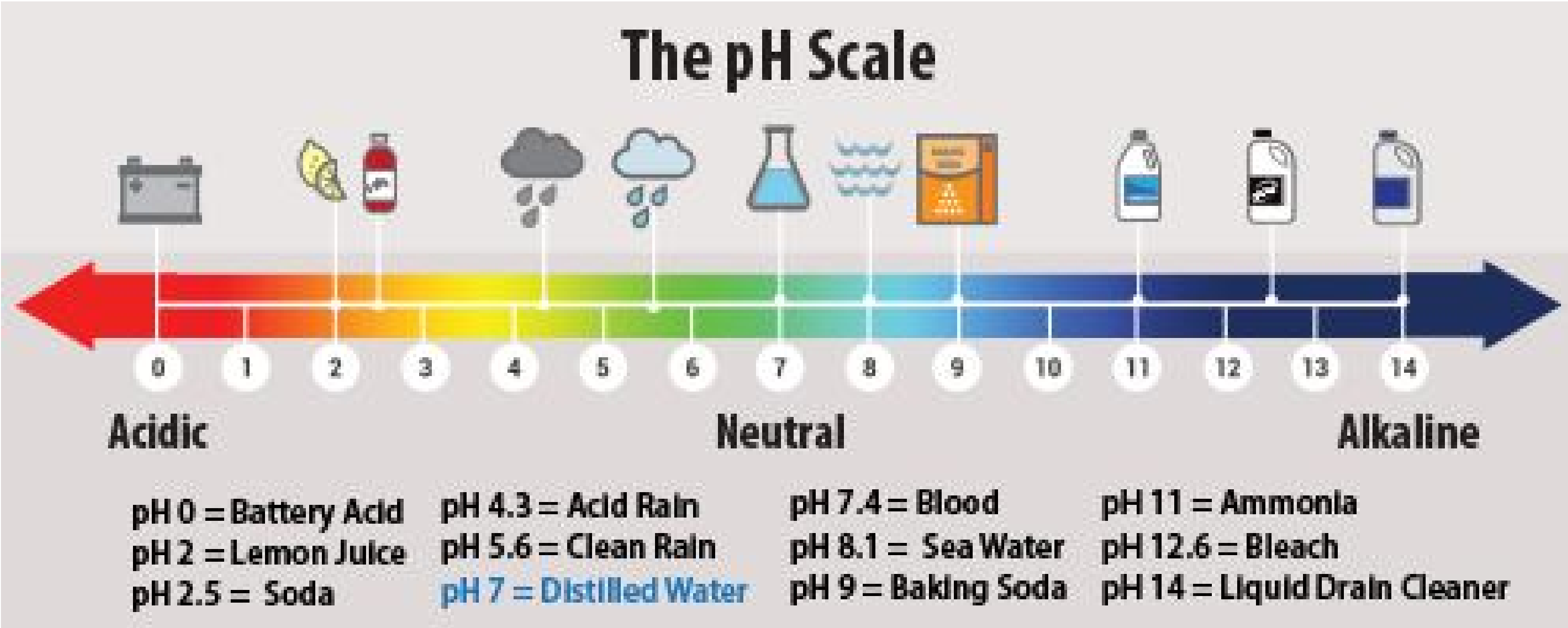
Acid rain, or **acid deposition**, is a broad term that includes any form of precipitation with **acidic** components, such as sulfuric or nitric **acid** that fall to the ground from the atmosphere.

This can include rain, snow, fog, that is **acidic**

It can have harmful effects on Man, Material and Environment (ex.plants, aquatic animals and infrastructure).

Acid rain is caused by emissions of sulfur dioxide and nitrogen oxide, which react with the water molecules in the atmosphere to produce acids.

- Acid rain results when sulfur dioxide (SO_2) and nitrogen oxides (NO_X) are emitted into the atmosphere and transported by wind and air currents.
- The SO_2 and NO_X react with water, oxygen and other chemicals to form sulfuric and nitric acids. These then mix with water and other materials before falling to the ground.
- While a small portion of the SO_2 and NO_X that cause acid rain is from natural sources such as volcanoes, most of it comes from the burning of fossil fuels.
- The major sources of SO_2 and NO_X in the atmosphere are:
  - Burning of fossil fuels to generate electricity. Two thirds of SO_2 and one fourth of NO_X in the atmosphere come from electric power generators.
  - Vehicles and heavy equipment.
  - Manufacturing, oil refineries and other industries.



Acidity and alkalinity are measured using a pH scale for which 7.0 is neutral. The lower a substance's pH (less than 7), the more acidic it is; the higher a substance's pH (greater than 7), the more alkaline it is.

Normal rain has a pH of about 5.6; it is slightly acidic because carbon dioxide (CO_2) dissolves into it forming weak carbonic acid. Acid rain usually has a pH between 4.2 and 4.4.

Forms of Acid Deposition

Wet Deposition

Wet deposition is what we most commonly think of as ***acid rain***. The sulfuric and nitric acids formed in the atmosphere fall to the ground mixed with rain, snow, fog, or hail.

Dry Deposition

- ❖Acidic particles and gases can also deposit from the atmosphere in the absence of moisture as ***dry deposition***. The acidic particles and gases may deposit to surfaces (water bodies, vegetation, buildings) quickly or may react during atmospheric transport to form larger particles that can be harmful to human health. When the accumulated acids are washed off a surface by the next rain, this acidic water flows over and through the ground, and can harm plants and wildlife, such as insects and fish.
- ❖The amount of acidity in the atmosphere that deposits to earth through dry deposition depends on the amount of rainfall an area receives. For example, in desert areas the ratio of dry to wet deposition is higher than an area that receives several inches of rain each year.

Chemical Processes Involved In acid rain

Formation Of Sulphuric Acid

$$S + O_2 \longrightarrow SO_2$$

$$SO_2 + 1/2O_2 + H_2O \longrightarrow H_2SO_4$$

Reaction Involving Formation Of Nitric Acid

$$NO + O_3 \longrightarrow NO_2 + O_2$$

$$NO_2 + O_3 \longrightarrow NO_3 + O_2$$

$$NO_3 + NO_2 \longrightarrow N_2O_5$$

$$N_2O_5 + H_2O \longrightarrow 2HNO_3$$

Chemical processes

Combustion of fuels produces sulfur dioxide and nitric oxides. They are converted into sulfuric acid and nitric acid.[43]

Gas phase chemistry

In the gas phase sulfur dioxide is oxidized by reaction with the hydroxyl radical via an intermolecular reaction:[5]

$$SO_2 + OH\cdot \rightarrow HOSO_2\cdot$$

which is followed by:

$$HOSO_2\cdot + O_2 \rightarrow HO_2\cdot + SO_3$$

In the presence of water, sulfur trioxide (SO_3) is converted rapidly to sulfuric acid:

$$SO_3\ (g) + H_2O\ (l) \rightarrow H_2SO_4\ (aq)$$

Nitrogen dioxide reacts with OH to form nitric acid:

$$NO_2 + OH\cdot \rightarrow HNO_3$$

Chemistry in cloud droplets

When clouds are present, the loss rate of SO_2 is faster than can be explained by gas phase chemistry alone. This is due to reactions in the liquid water droplets.

Hydrolysis

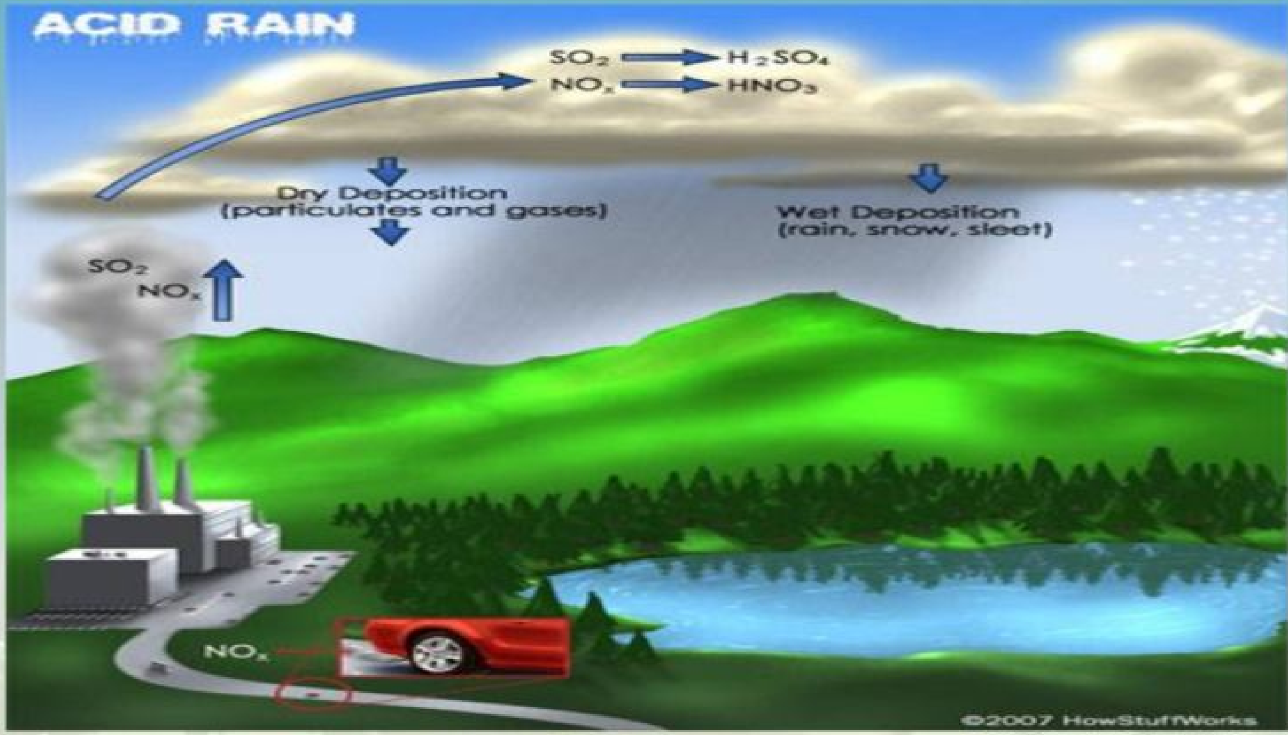
Sulfur dioxide dissolves in water and then, like carbon dioxide, hydrolyses in a series of equilibrium reactions:

$$SO_2\ (g) + H_2O \rightleftharpoons SO_2\cdot H_2O$$
$$SO_2\cdot H_2O \rightleftharpoons H^+ + HSO_3^-$$
$$HSO_3^- \rightleftharpoons H^+ + SO_3^{2-}$$

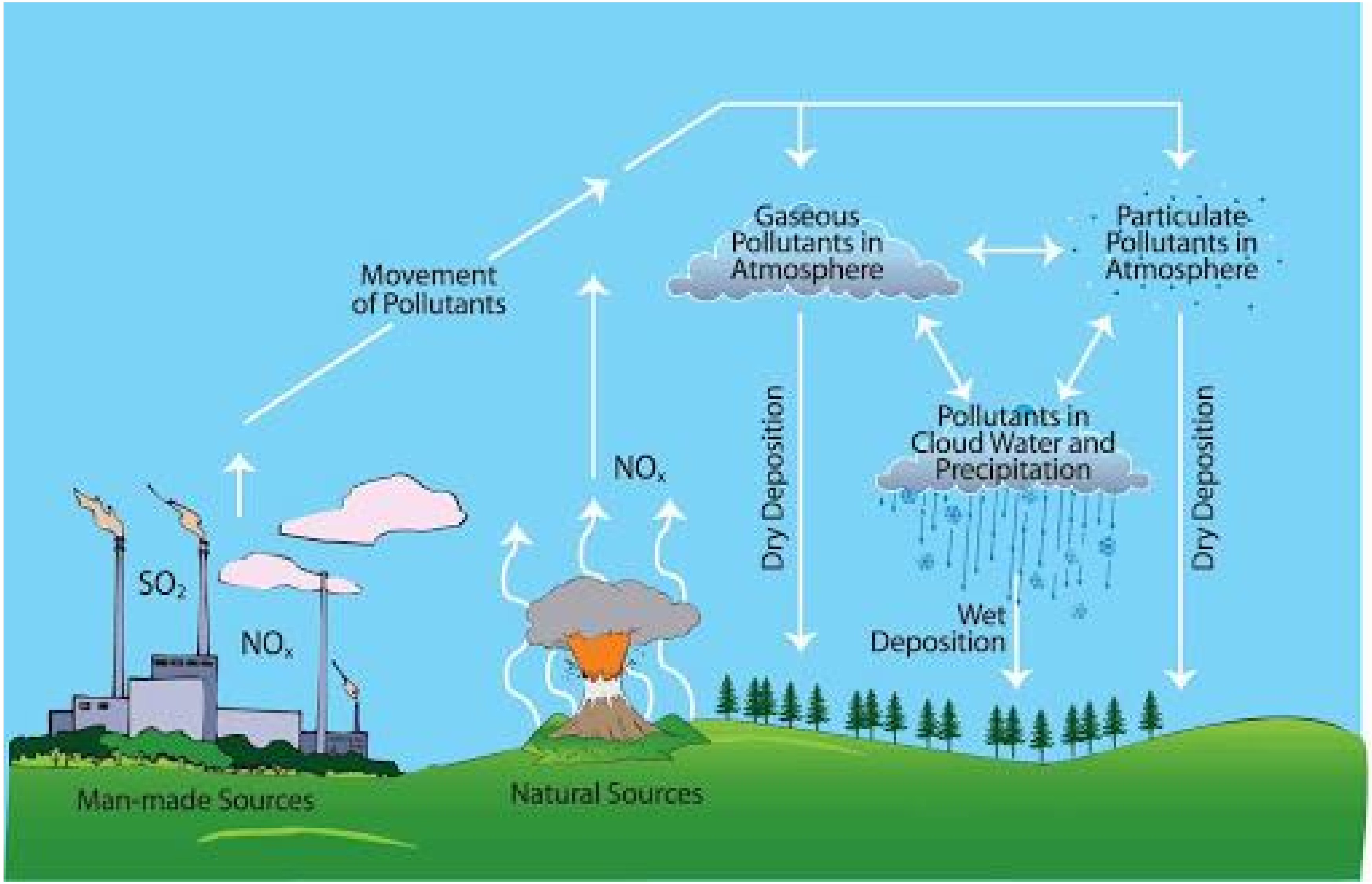
Oxidation

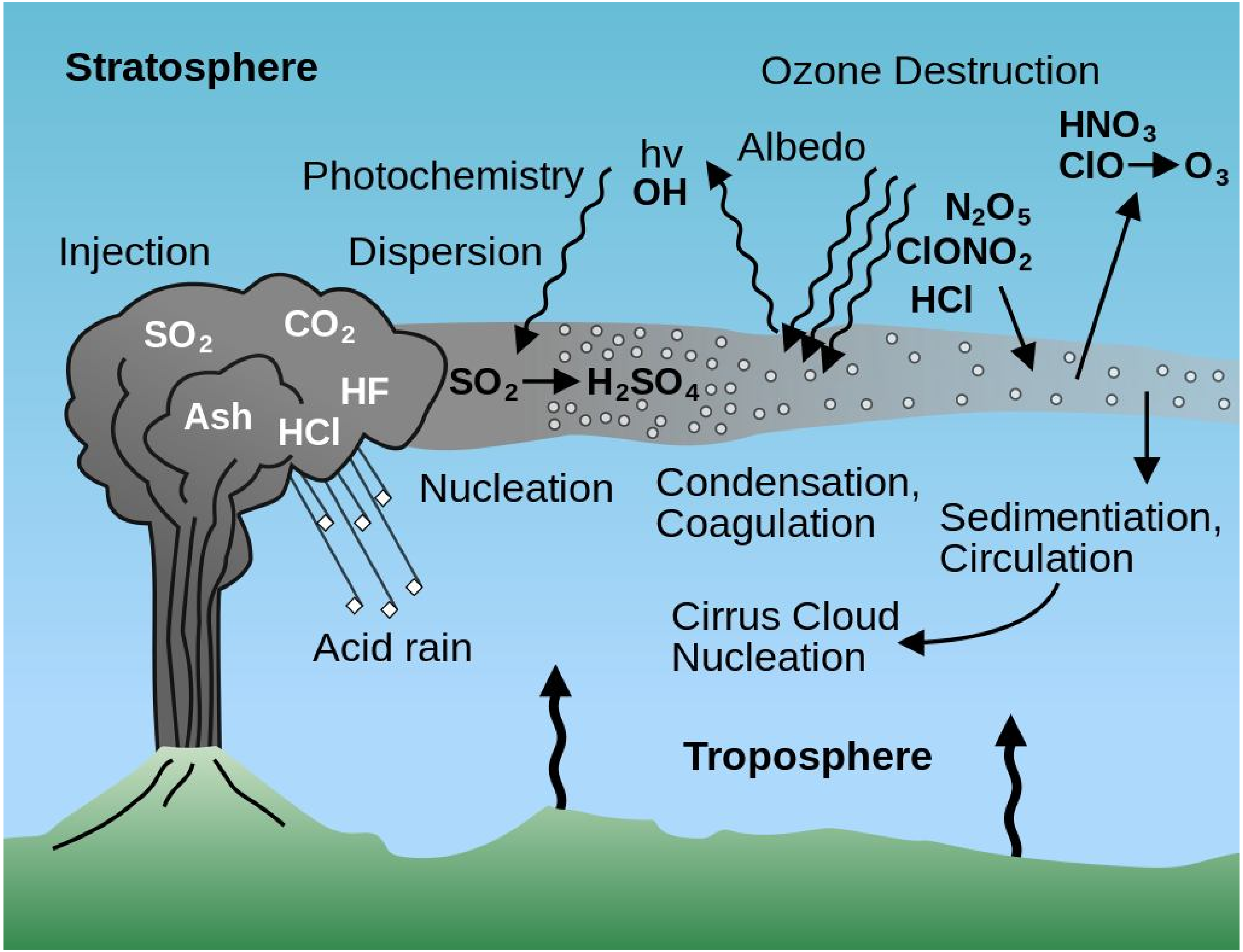
There are a large number of aqueous reactions that oxidize sulfur from S(IV) to S(VI), leading to the formation of sulfuric acid. The most important oxidation reactions are with ozone, hydroger
with oxygen are catalyzed by iron and manganese in the cloud droplets).[5]

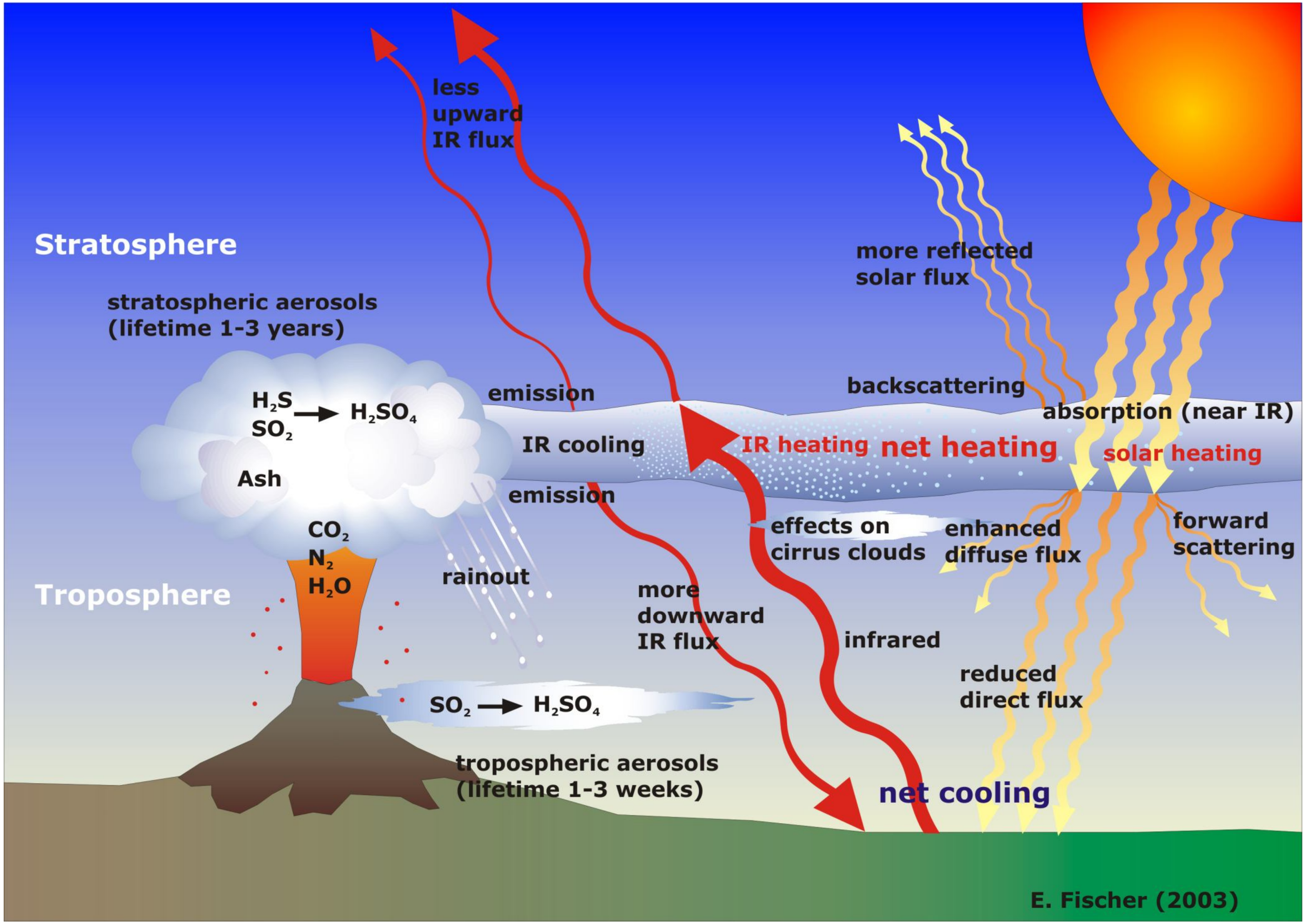
Acid Rain Formation

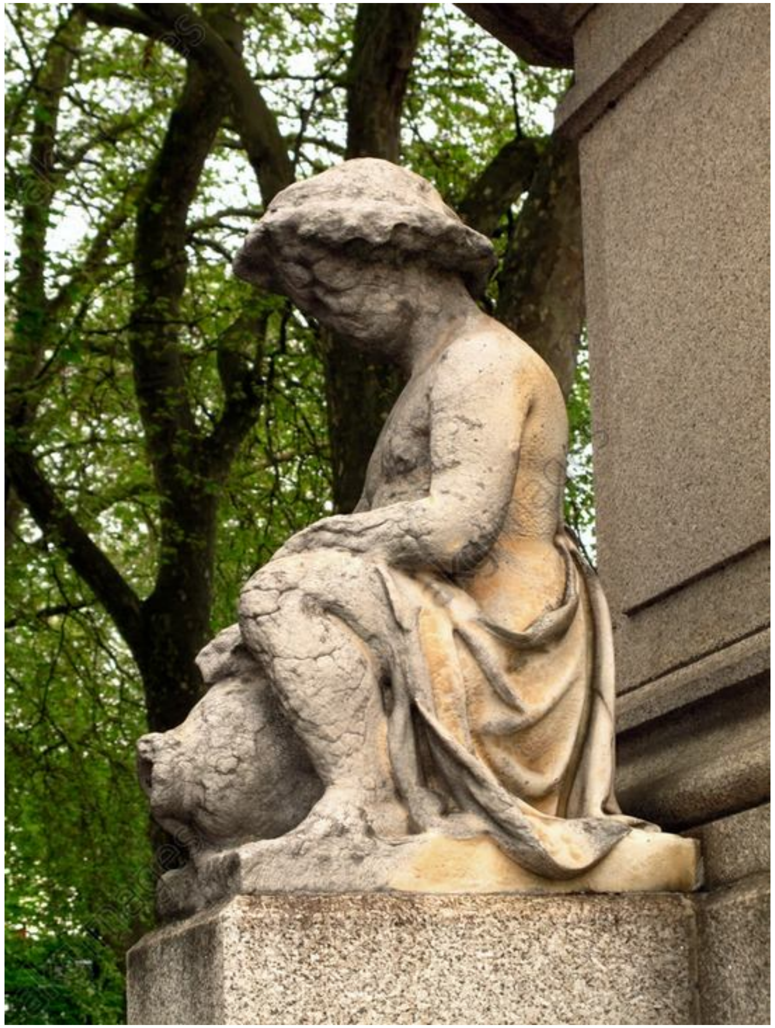


Emissions of sulfur dioxide and nitrogen oxides react with water vapor in the atmosphere to create sulfuric and nitric acids.


Movement
of Pollutants
Gaseous
Pollutants in
Atmosphere
Particulate
Pollutants in
Atmosphere
Dry Deposition
Pollutants in
Cloud Water and
Precipitation
Dry Deposition
NOx
SO2
NOx
Wet
Deposition
Man-made Sources
Natural Sources


Stratosphere
Ozone Destruction
Photochemistry
hv
OH
Albedo
HNO_3
$ClO \rightarrow O_3$
N_2O_5
$ClONO_2$
HCl
Injection
Dispersion
SO_2
CO_2
HF
Ash
HCl
$SO_2 \rightarrow H_2SO_4$
Nucleation
Condensation,
Coagulation
Sedimentiation,
Circulation
Acid rain
Cirrus Cloud
Nucleation
Troposphere


less
upward
IR flux
Stratosphere
stratospheric aerosols
(lifetime 1-3 years)
more reflected
solar flux
backscattering
absorption (near IR)
emission
H_2S
SO_2 → H_2SO_4
IR cooling
IR heating
net heating
solar heating
Ash
emission
CO_2
N_2
H_2O
effects on
cirrus clouds
enhanced
diffuse flux
forward
scattering
Troposphere
rainout
more
downward
IR flux
infrared
reduced
direct flux
SO_2 → H_2SO_4
tropospheric aerosols
(lifetime 1-3 weeks)
net cooling
E. Fischer (2003)




a
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Thanks