Department of Mathematics and Natural Science
CHE 101: Introduction to Chemistry

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Content: **Environmental Pollution Part-02**

Atmospheric Chemistry, Aerosols, influence of CFC gases, creation of ozone hole, green house effects

WHAT IS THE ATMOSPHERE?

The atmosphere seen from space

- **Gaesous envelope surrounding the Earth**

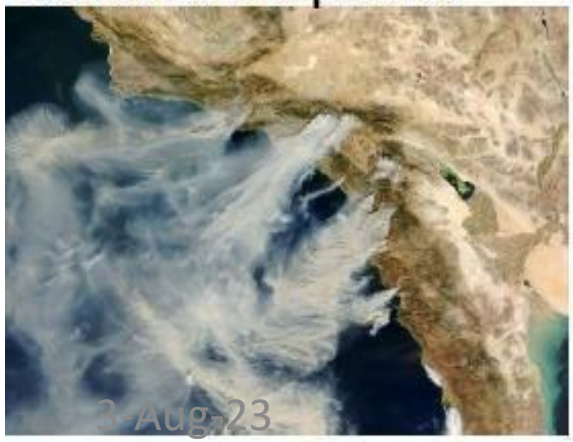
- **Mixture of gases, also contains suspended solid and liquid particles (*aerosols*)**

Aerosol = dispersed condensed phase suspended in a gas

Or, some solid particle or liquid droplets which are suspended in atmosphere are collectively called aerosol

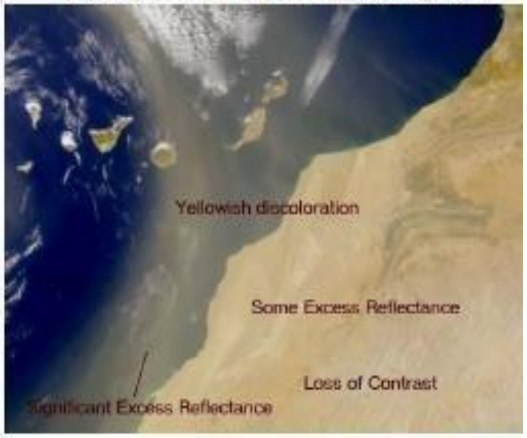
Aerosols are the "visible" components of the atmosphere

California fire plumes



Pollution off U.S. east coast

Dust off West Africa



Types of Air Pollution

Outdoor Air Pollution

- Smog
- Particulates
- Acid rain
- Greenhouse Gases

Indoor Air Pollution

Causes

- Natural Sources

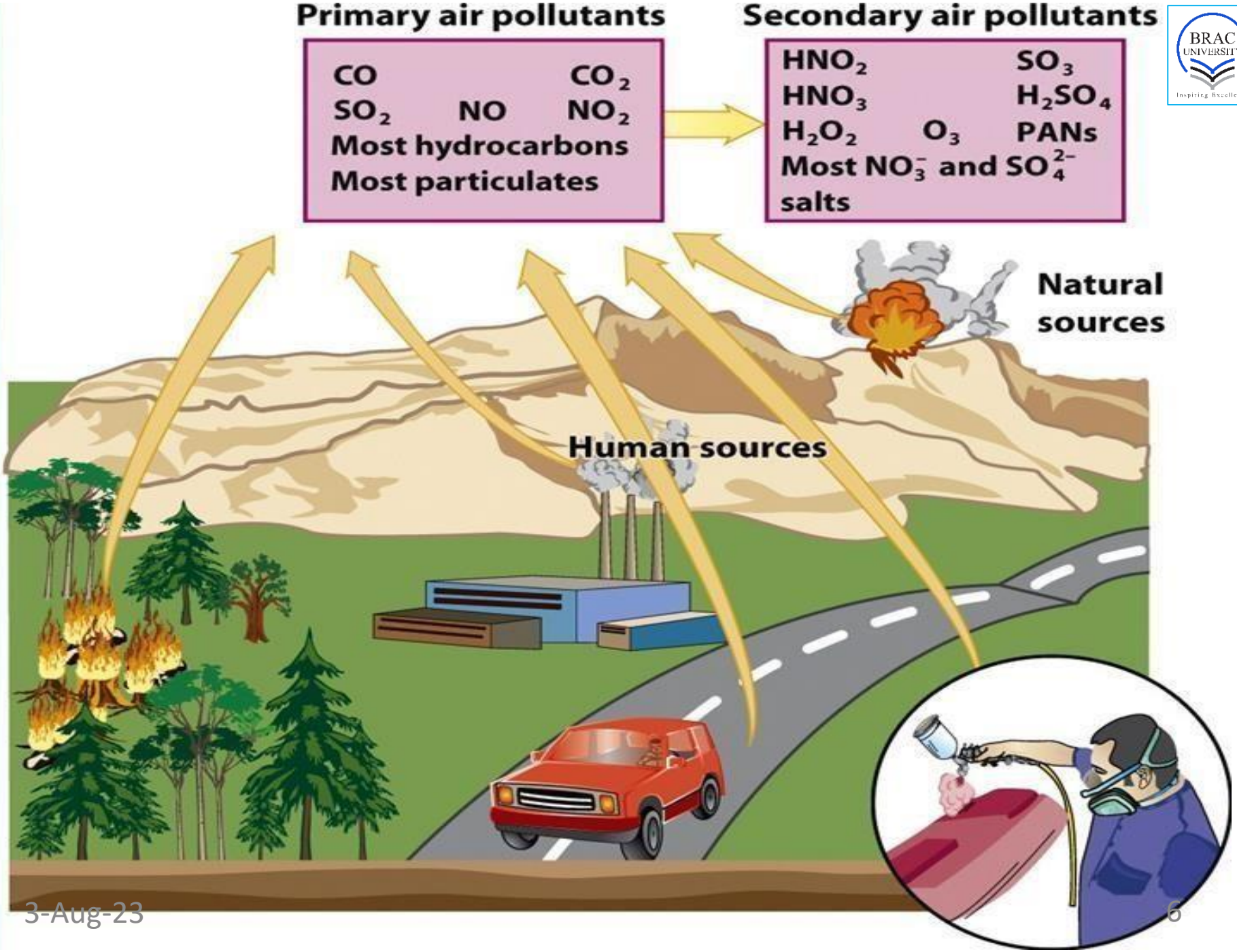
- smoke that comes from wildfire, volcanoes, methane, dust

- Human dust

- power plants and automobile fumes, burning wood, stoves, fireplaces and furnaces

Six major air pollutants

- Carbon monoxide (CO)
- Ozone (O_3)
- Nitrogen dioxide (NO_2)
- Sulfur oxides (SO_x)
- Carbon dioxide (CO_2)
- Lead (Pb)


Primary air pollutants
CO
CO_2
SO_2
NO
NO_2
Most hydrocarbons
Most particulates
Secondary air pollutants
HNO_2
SO_3
HNO_3
H_2SO_4
H_2O_2
O_3
PANs
Most NO_3^- and SO_4^{2-} salts
Natural sources
Human sources

Effects

- Human Effects

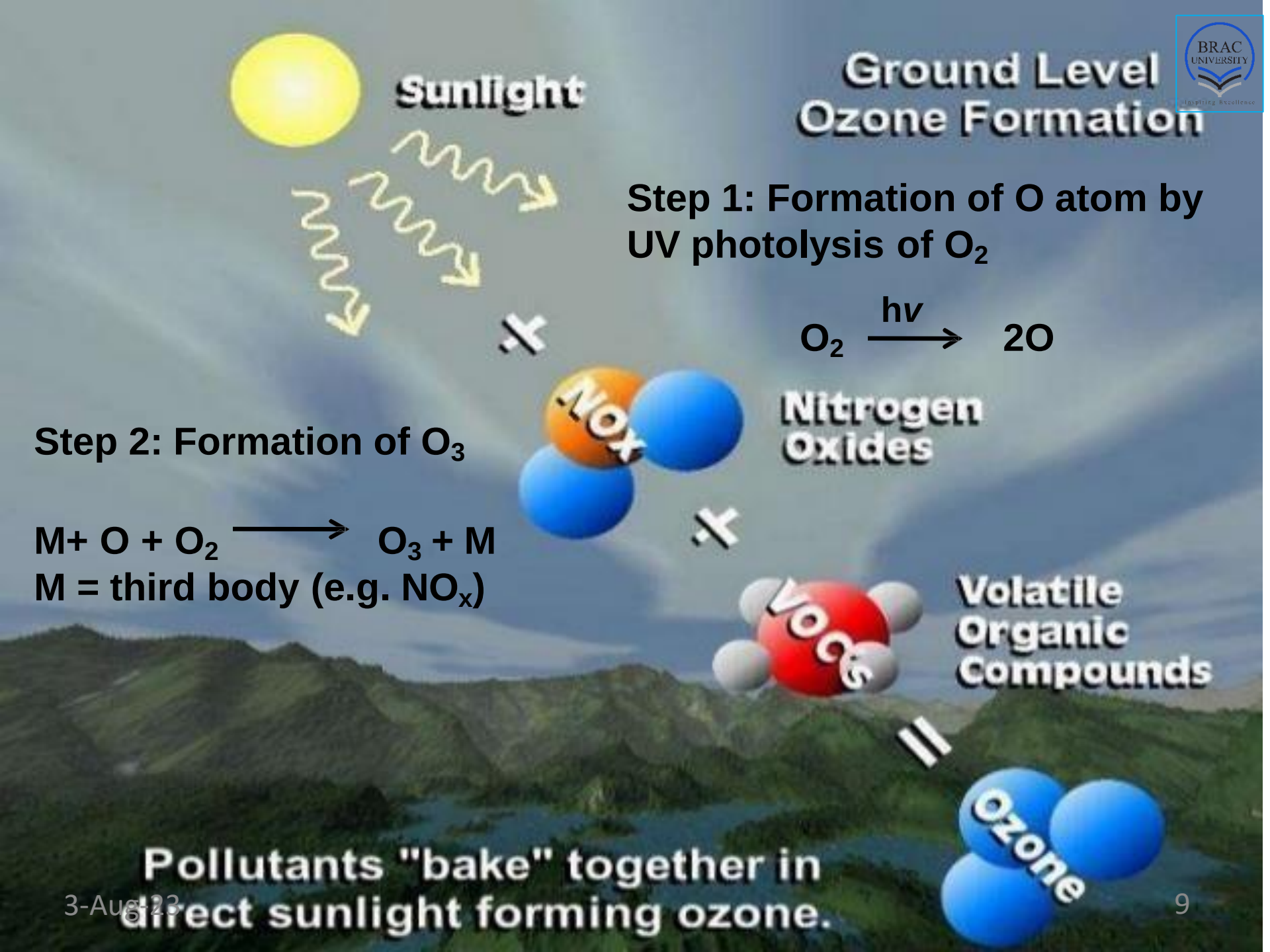
  e.g. diseases

- Environmental Effects

  - Acid rain
  - Eutrophication
  - Haze
  - Wildlife
  - Ozone depletion
  - Crop and forest damage
  - Global Climate change

Health Effects of Air Pollution

- Sulfur Dioxide and Particulate material
  - Irritate respiratory tract and impair ability of lungs to exchange gases
- Nitrogen Dioxides
  - Causes airway restriction
- Carbon monoxide
  - Binds with iron in blood hemoglobin
  - Causes headache, fatigue, drowsiness, death
- Ozone
  - Causes burning eyes, coughing, and chest discomfort

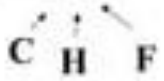

Ground Level
Ozone Formation
Sunlight
Step 1: Formation of O atom by
UV photolysis of O_2
$O_2 \xrightarrow{h\nu} 2O$
NOx
Nitrogen
Oxides
Step 2: Formation of O_3
$M + O + O_2 \longrightarrow O_3 + M$
M = third body (e.g. NO_x)
VOCs
Volatile
Organic
Compounds
Ozone
Pollutants "bake" together in
direct sunlight forming ozone.

Naming of CFC's

(90 Rule)

CFC's name is related to its Formula.

CFC 123 123 + 90 = 213



The remaining bonds are allocated to Cl or Br

C = 2 , H =1 , F = 3 , Cl = (8 - 6) = 2

CFC 123 is CF_3CHCl_2

Letters with the number indicate an isomer.

Formula	C–1	H+1	F	Name
$CFCl_3$	1–1=0	0+1=1	1	Freon–11
CF_2Cl_2	1–1=0	0+1=1	2	Freon–12
$C_2F_2Cl_4$	2–1=1	0+1=1	2	Freon–112
$C_2F_3Cl_3$	2–1=1	0+1=1	3	Freon-113

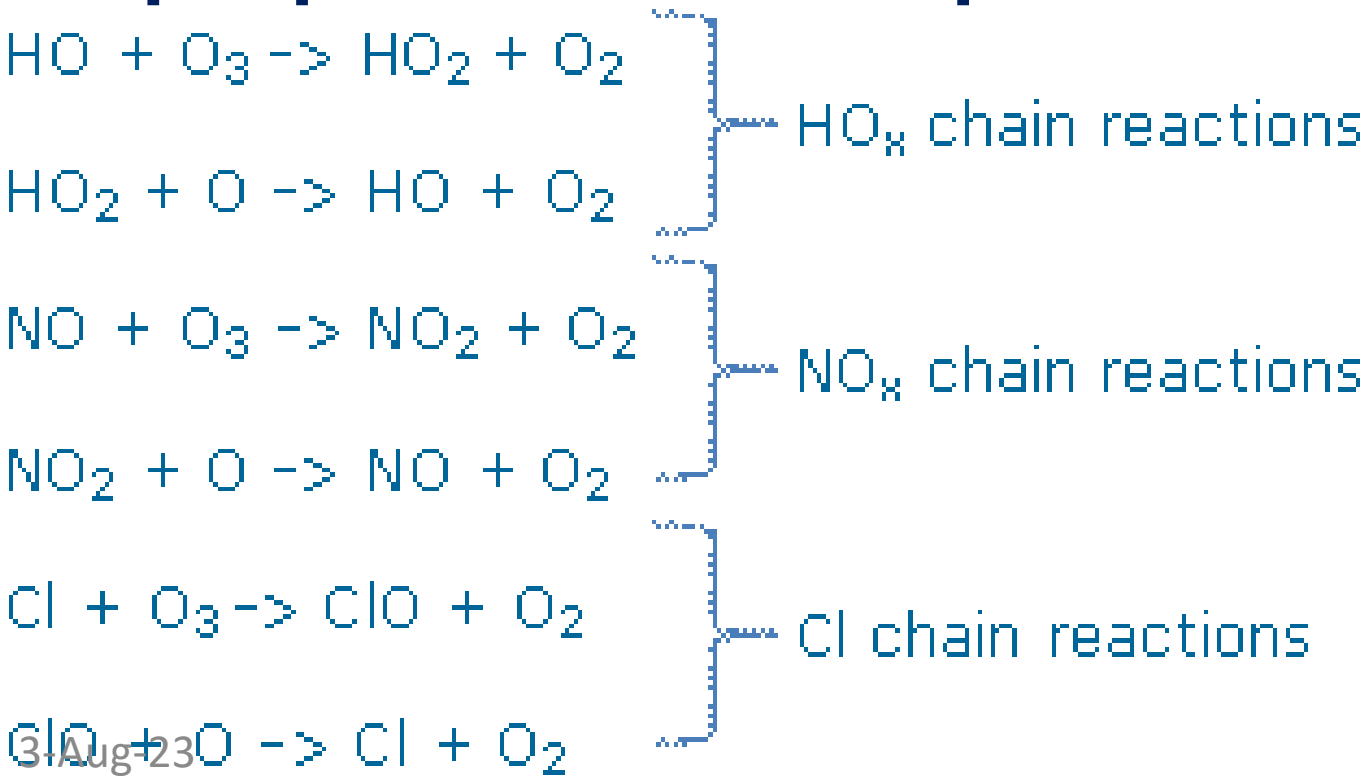
Lifetime of CFC's

Compound	Ozone Depleting Potential	Lifetime(yrs)
CFC- 11	1.0	65 -75
CFC-12	1.0	100 - 140
CFC-113	0.8	100 - 134
CFC-115	0.6	500
CCl4	1.2	50 - 69
Halon 1301	10	110

Ozone depletion

Due to anthropogenic activity human produce some gas which react with ozone in stratosphere and thereby the concentration of ozone in the stratosphere decreases, which is known as ozone depletion.

Tropospheric Ozone Depletion



Stratospheric Ozone Depletion

Chapman cycle

1) $O_2 + h\nu \rightarrow 2O^{\bullet}$

2) $O^{\bullet} + O_2 + M \rightarrow O_3 + M$

3) $O_3 + h\nu \rightarrow O_2 + O^{\bullet}$

Net: $O_2 + 2h\nu \rightarrow 2O^{\bullet}$

CFCs Catalytic Cycle I

$CCl_2F_2 + h\nu \rightarrow CClF_2 + Cl^{\bullet}$

4) $Cl^{\bullet} + O_3 \rightarrow ClO^{\bullet} + O_2$

5) $ClO^{\bullet} + O^{\bullet} \rightarrow Cl^{\bullet} + O_2$

Cl. - Catalytic Cycle II

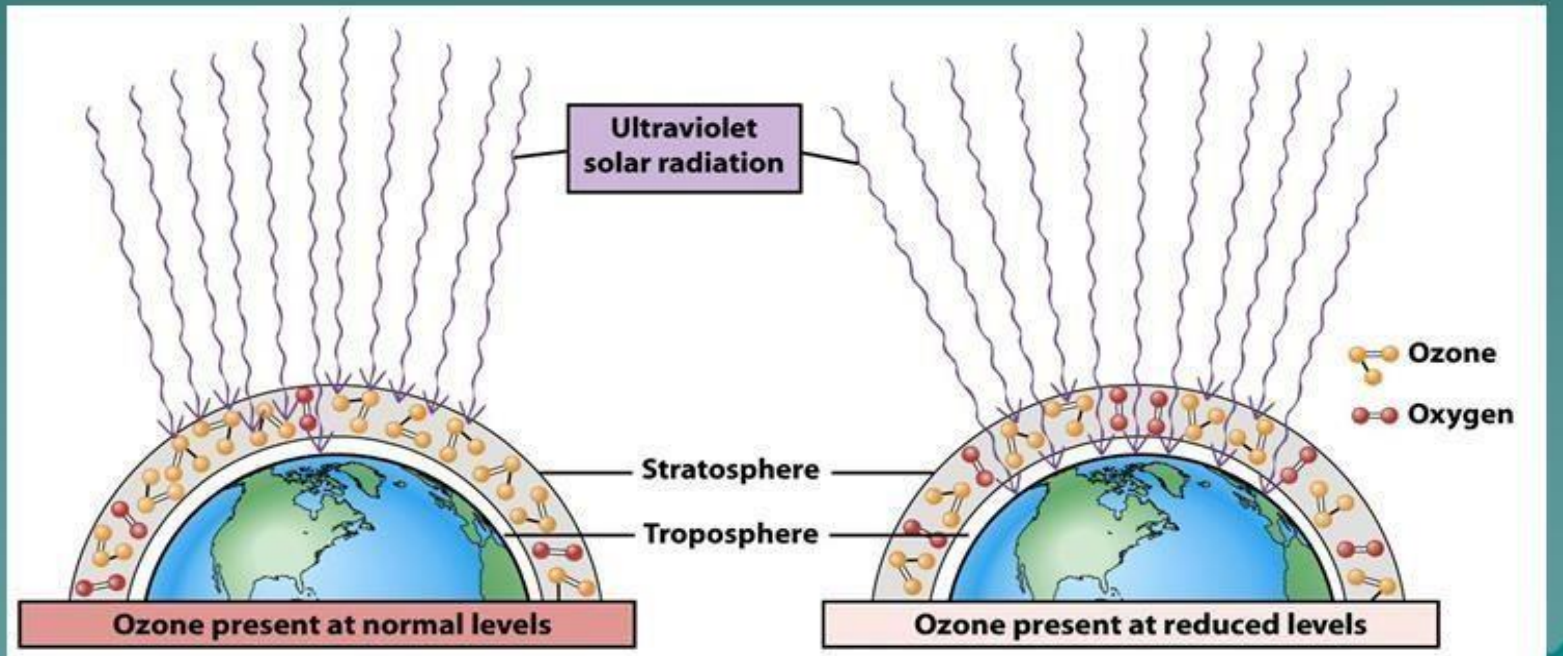
6) $ClO^{\bullet} + ClO^{\bullet} + M \rightarrow (ClO)_2 + M$

7) $(ClO)_2 + h\nu \rightarrow Cl^{\bullet} + ClOO$

8) $ClOO + M \rightarrow Cl^{\bullet} + O_2 + M$

Ozone Depletion in Stratosphere

- Ozone Protects earth from UV radiation
  - Part of the electromagnetic spectrum with wavelengths just shorter than visible light



(a) Stratospheric ozone absorbs about 99% of incoming solar ultraviolet (UV) radiation, effectively shielding the surface.

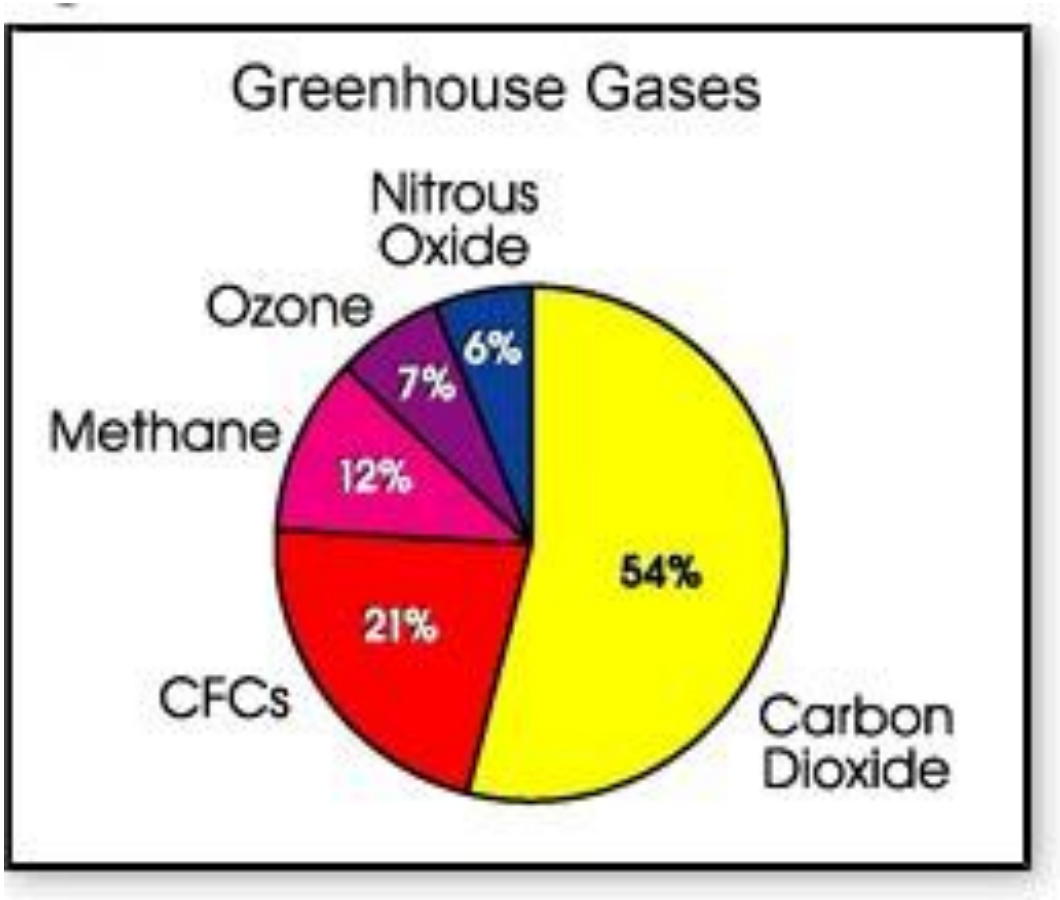
(b) When stratospheric ozone is present at reduced levels, more high-energy UV radiation penetrates the atmosphere to the surface, where its presence harms organisms.

Effects of Ozone Depletion

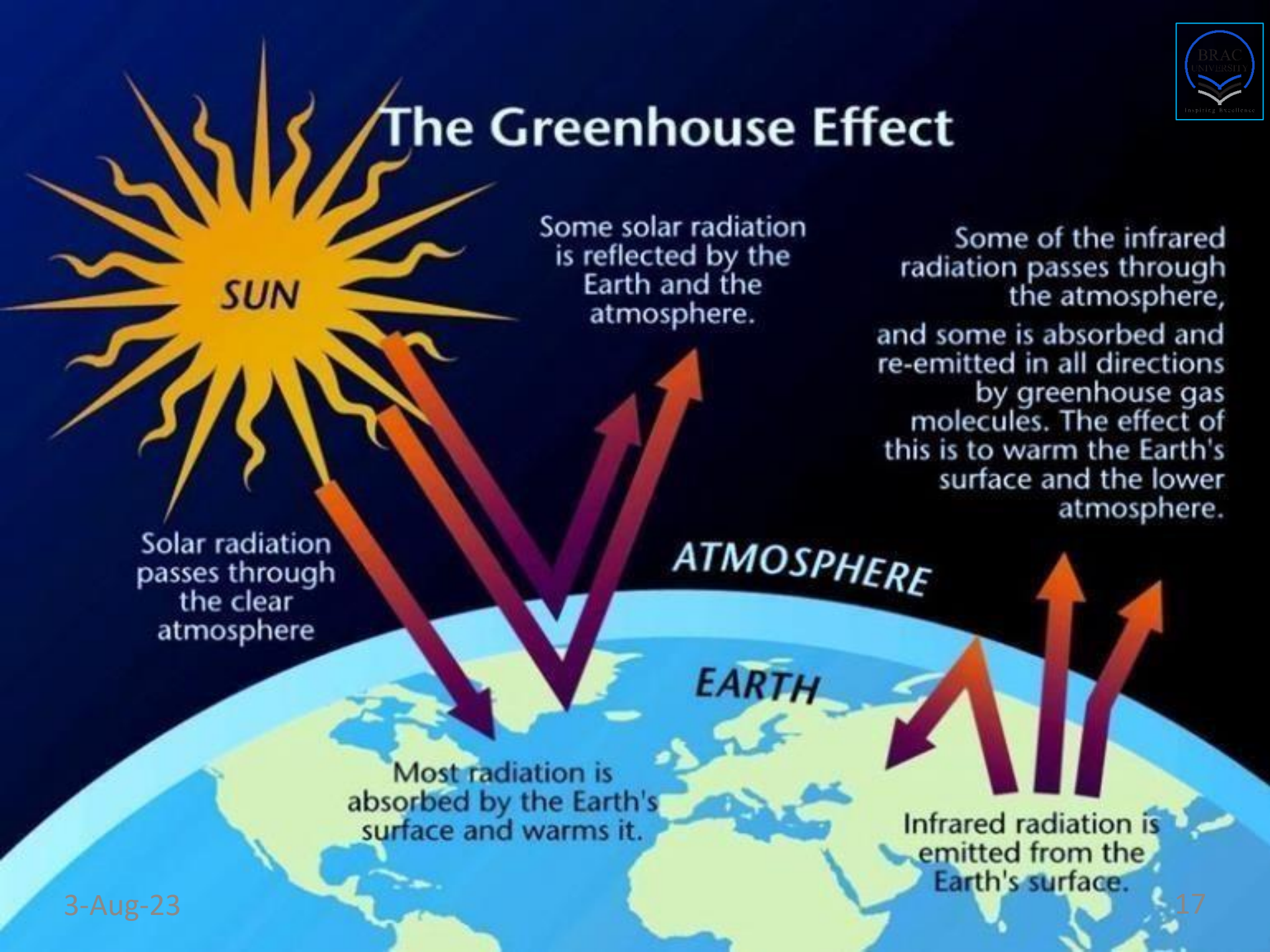
- Higher levels of UV-radiation hitting the earth
  - Eye cataracts
  - Skin cancer (right)
  - Weakened immunity
- May disrupt ecosystems
- May damage crops and forests

Greenhouse Effect

The *greenhouse effect* is the process by which radiation from a planet's atmosphere warms the planet's surface to a temperature above what it would be without its atmosphere.



- Carbon dioxide (CO_2) and other *greenhouse* gases act like a blanket, absorbing IR radiation and preventing it from escaping into outer space. The net *effect* is the gradual heating of Earth's atmosphere and surface, a process known as global warming.


The Greenhouse Effect
SUN
Some solar radiation is reflected by the Earth and the atmosphere.
Some of the infrared radiation passes through the atmosphere,
and some is absorbed and re-emitted in all directions by greenhouse gas molecules. The effect of this is to warm the Earth's surface and the lower atmosphere.
Solar radiation passes through the clear atmosphere
ATMOSPHERE
EARTH
Most radiation is absorbed by the Earth's surface and warms it.
Infrared radiation is emitted from the Earth's surface.

Thank You All