

Department of Geography (PG Department), Patna University

MA Semester II (2019-20)

Paper – CC6 (Environment & Disaster Management)

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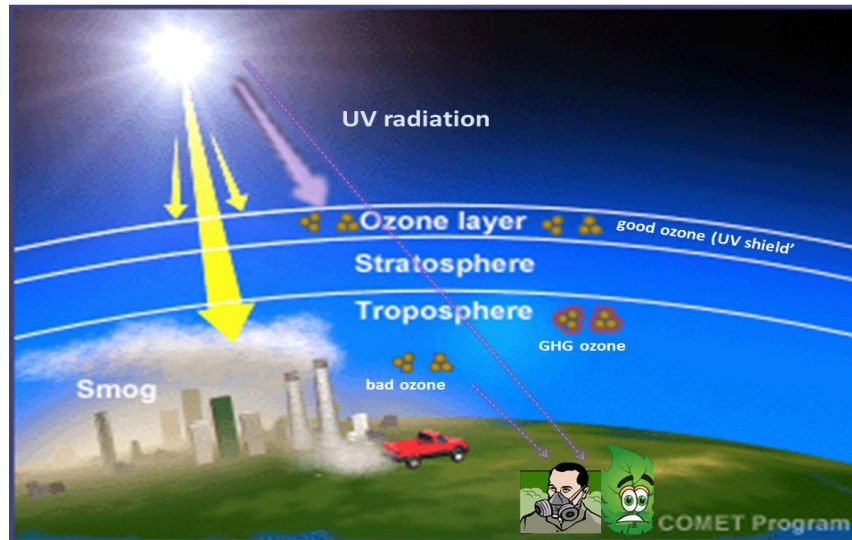
OZONE LAYER AND ITS DEPLETION

Ozone – It is an allotrope of oxygen, having 3 atoms of oxygen. Ozone is found in two layers of the atmosphere i.e.

- 1) Troposphere (bad ozone because it acts as pollutants & irritants)
- 2) Stratosphere (good ozone)

Now, ozone in the stratosphere-

- The ozone layer is the phenomena of the Earth's stratosphere. The ozone layer in the stratosphere protects the earth from the harmful UV rays of the sun.
- It contains high concentration of O₃ (chemical formula of ozone) in comparison to other atmospheric layers.
- The ozone layer is very important for the existence of life on earth. Its configuration and chemical properties are such that it easily absorbs UV light.
- Charles Fabry and Henri Buisson in 1913 discovered the ozone layer.
- Spectrophotometer (the Dobsonmeter) used to measure stratospheric ozone from the ground. It was developed by the GMB Dobson.



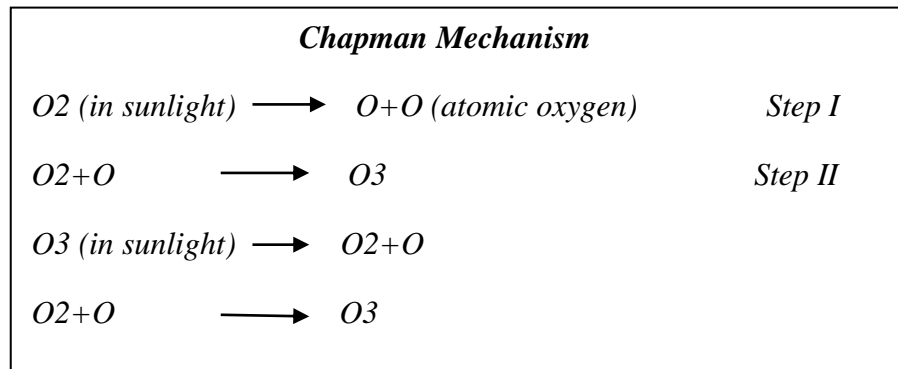
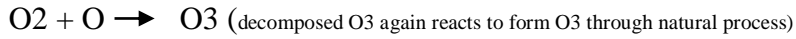
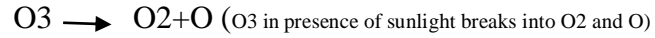
FUNCTIONING OF OZONE LAYER

The ozone layer absorbs 97-99% of Sun's medium frequency UV light (from about 200nm to 315nm wavelength). 16th September is known as the International Day for the preservation of the Ozone Layer.

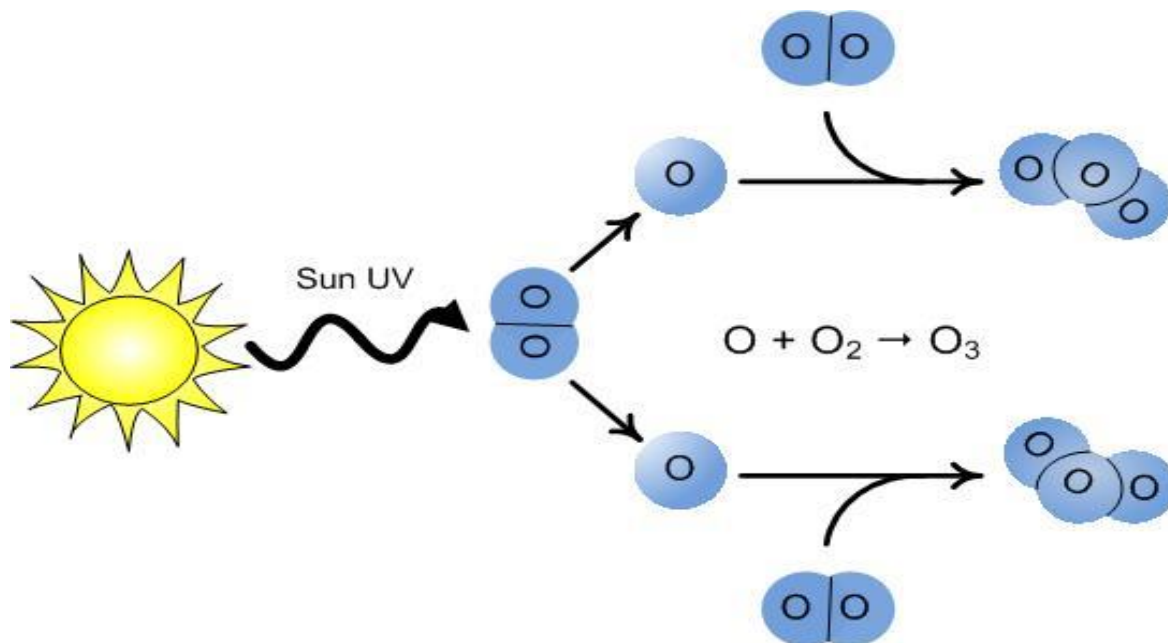
Depletion of Ozone Layer

The molecules of ozone are unstable. So when the Sun's rays hit ozone it splits into a molecule of O₂ and individual oxygen atom. This process is called as decomposition of

ozone layer. But again through natural process it reacts to form ozone (O_3). This continuing process is called Ozone Oxygen Cycle.



This photochemical mechanism was discovered by the British Physicist Sydney Chapman in 1930. Hence, this mechanism is also called as Chapman Mechanism.

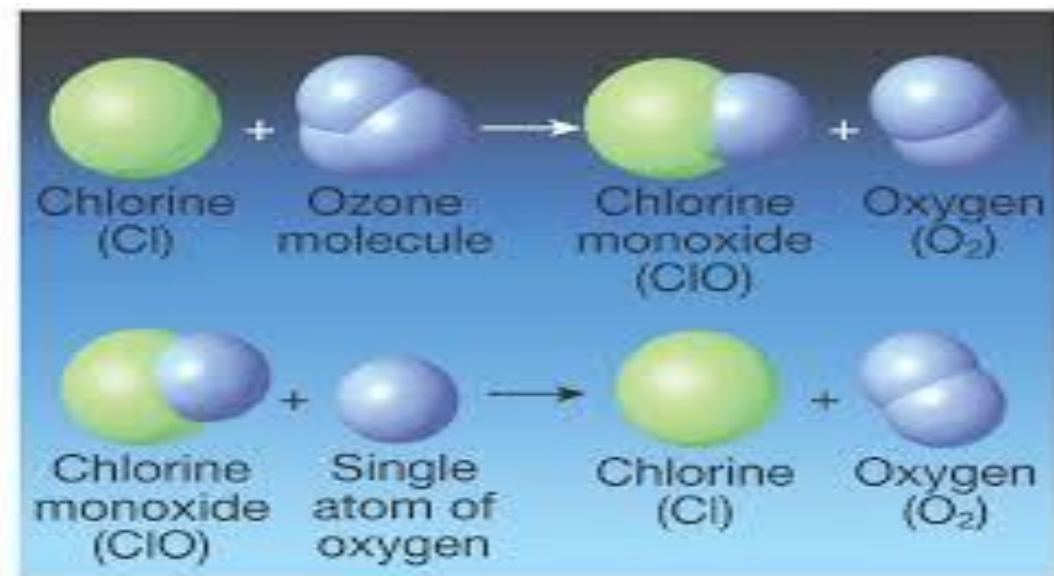


Change in dynamic equilibrium and reasons for the change in dynamic equilibrium

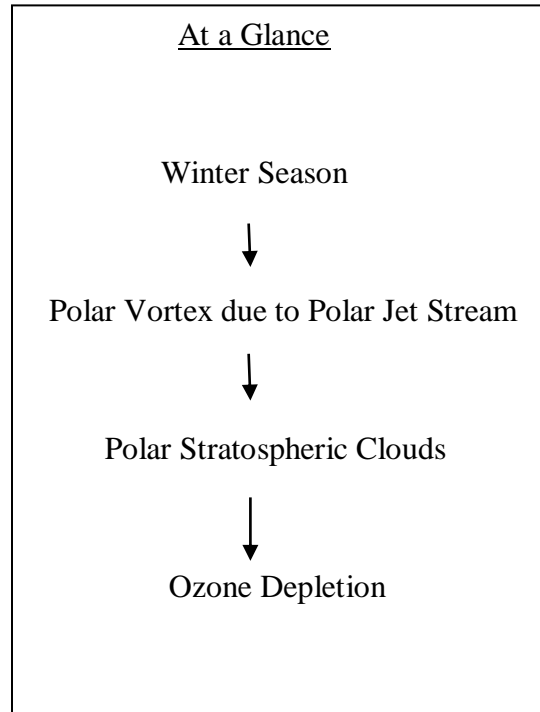
- The change in equilibrium indicates that the rate at which ozone is being destroyed.
- Thus, the decrease in the concentration of ozone in a particular region of the atmosphere is called ozone depletion.
- The disturbance in the natural process has been occurred due to the influx of several unwanted substances. Ex – chlorofluorocarbon, hydrochlorofluorocarbon, etc (uses of CFC are refrigerants, solvents for cleaning and metallic components, air conditioners, fire extinguishing agents, etc). The CFCs enter into the atmosphere by the gradual evaporation from their source. In stratosphere they are exposed to UV radiation and in the troposphere they can survive because they are thermally stable.

How Chlorofluorocarbon Molecules React with Ozone and cause Ozone Depletion

In stratosphere, the CFC molecules get exposed to UV radiation and the molecules breaks down, freeing chlorine atom. The free chlorine atom reacts with an ozone (O_3) molecule to form chlorine monoxide (ClO). This chlorine monoxide further reacts with an atom of oxygen. This process gives the oxygen molecule (O_2) and reformation of the free chlorine atom (Cl).



Antarctic Ozone Depletion

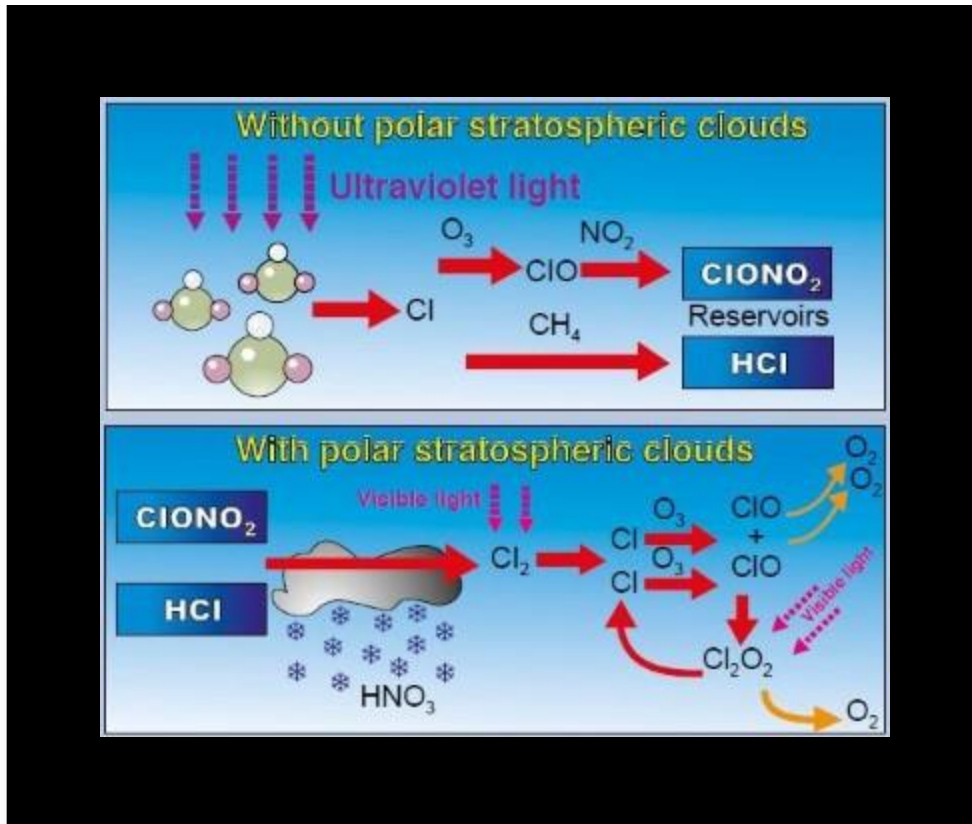


Polar Vortex – Polar vortex is a large packet of very air, which sits over the polar region during the winter season.

- Cold, upper tropospheric (sometimes extending till the lower levels of stratosphere).
- Closely associated with the jet streams. Vortex is formed mainly in winter and gets weaker in summer.

Polar Stratospheric Clouds (PSCs) – By the name it known that they are found in the stratosphere. These are nacreous clouds, also called “*Mother-of -Pearl Clouds*” (because they glow like iridescence-a phenomenon to change colour) and are rare clouds. They are mostly visible within 2-3 hours before and after sunrise and sunset respectively. PCSs are mainly formed during the event of polar vortex in winter, which is more intense at the South Pole. Polar stratospheric clouds contain water, nitric acid or sulfuric acid.

The Cl-catalyzed the ozone depletion is dramatically enhanced in the presence of polar stratospheric clouds.



The free atoms of chlorine in the stratosphere are very active and react with ozone, which ultimately results in the ozone layer depletion. But some of the chlorine atoms which do not react with ozone and these left chlorine atoms reacts with other molecules in the atmosphere and become inactive in nature.

Like in the above picture Chlorine Monoxide (ClO) reacts with Nitrogen Dioxide (NO₂) to form Chlorine Nitrate (ClONO₂). Chlorine nitrate act as inactive and remains as reservoirs in atmosphere and are not harmful. But in the presence of PSCs these inactive compounds (ClONO₂) reacts with Nitric Acid (HNO₃ present in the PSCs). And this nitric acid acts as a catalyst (which intensifies any reaction) which turns the inactive compounds into active compounds. Thus, in this way the PSCs are destroying the ozone layer at the Poles.

Effects of Ozone Depletion

On the basis of energy ultraviolet rays are divided into three categories:

- UV-A : minimal biological effects (low in energy)
- UV-B : higher form and the most damaging one, leads to ozone layer depletion
- UV-C : absorbed by the oxygen in the atmosphere and never reaches us

Effects-

- 1) Effect on skin – cancer, skin diseases
- 2) Effect on eyes – cornea damage
- 3) Effect on the immune system.
- 4) Environmental damages – excessive of UV-B inhibits the growth process of almost all green plants : Role of green plants are:
 - Food shortage in near future
 - Producer (first in the terrestrial food chain)
 - Soil erosion
 - Exhale oxygen and inhale carbon dioxide

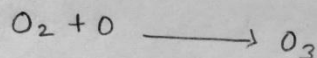
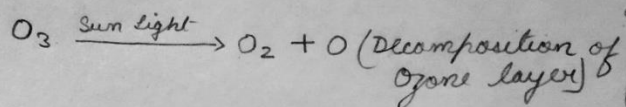
Conventions on the Ozone Layer Protection

Vienna Convention (1985)

Montreal Protocol (on the substances that deplete the ozone layer, 1987)

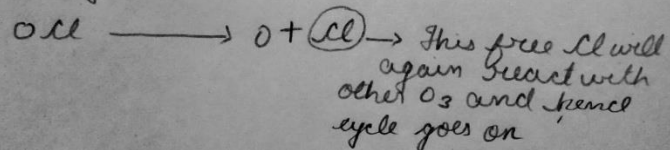
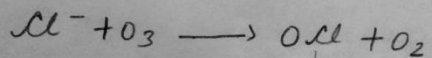
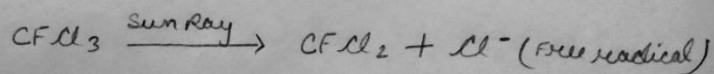
Kigali Amendment to Montreal Protocol (2016)

Natural Process



Dynamic equilibrium form i.e. balance

Role of Cl present in CFCs



Just to make all of you understand in the simple way

(This topic is provided because the last few portions were not covered in the classroom due to the lockdown)