# Atmosphere Photochemistry

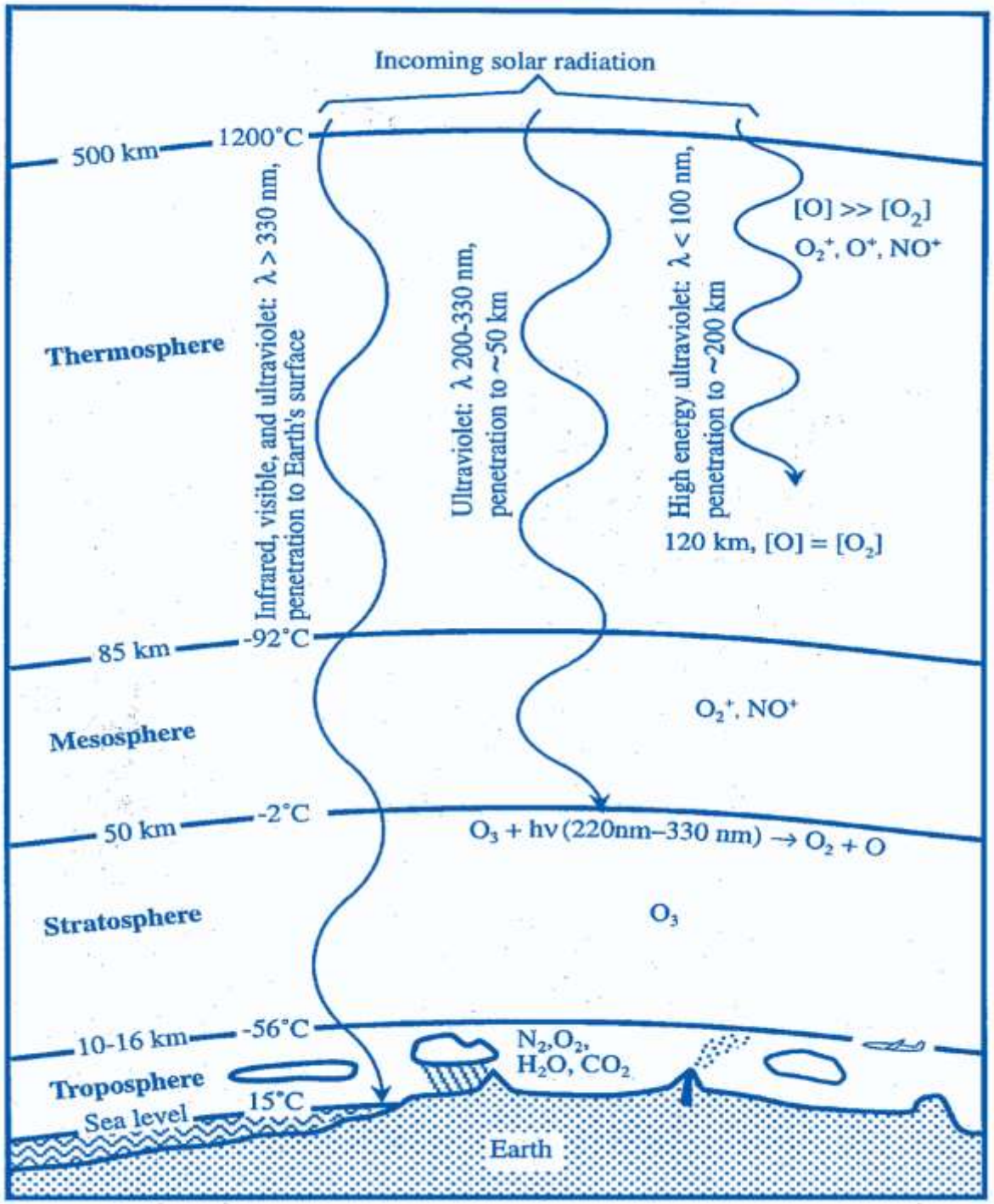
**Dr. R. Babu Rajendran**

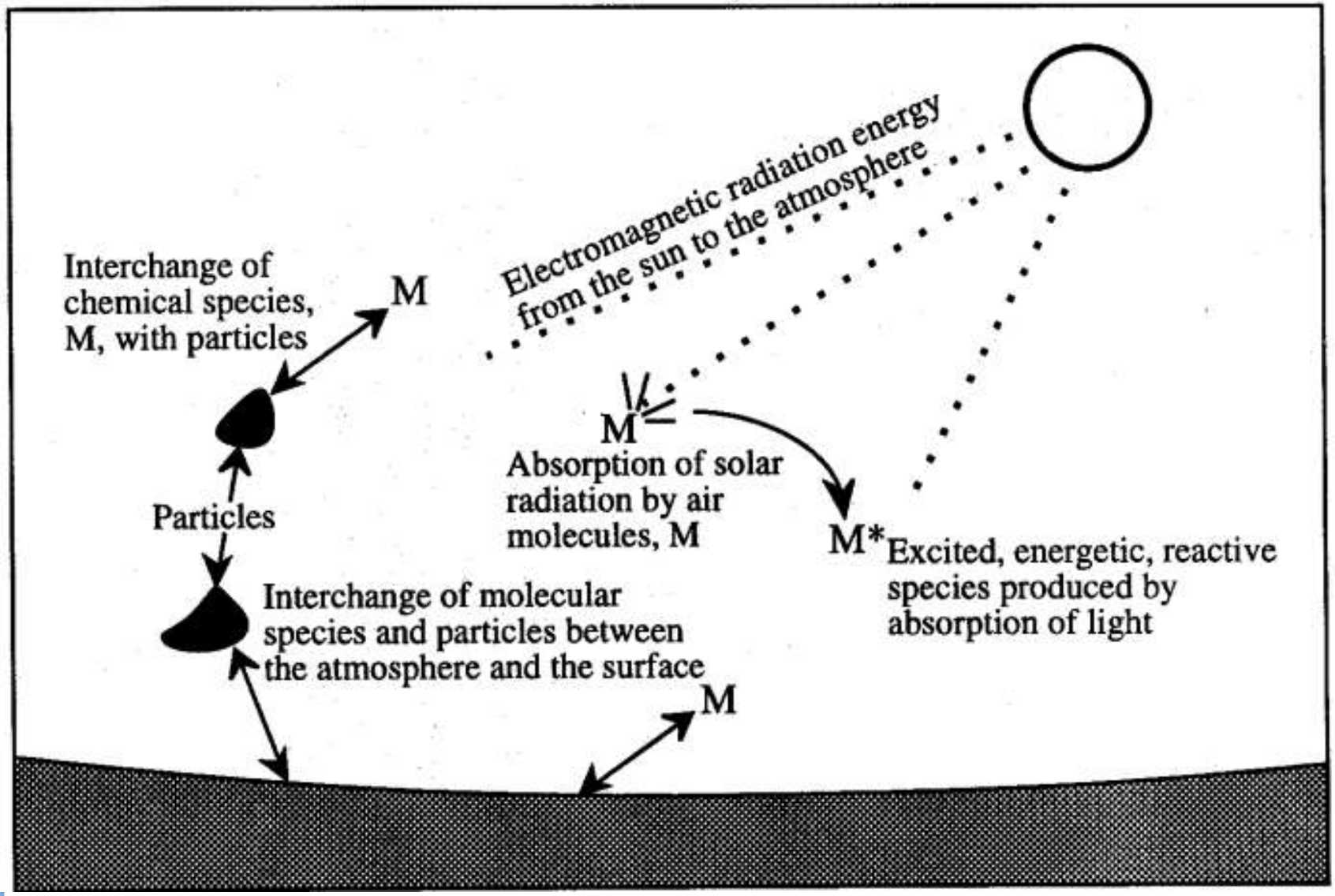
**Professor**

**Dept. of Environmental Biotechnology**

**Bharathidasan University**

# ENERGY TRANSFER IN THE ATMOSPHERE





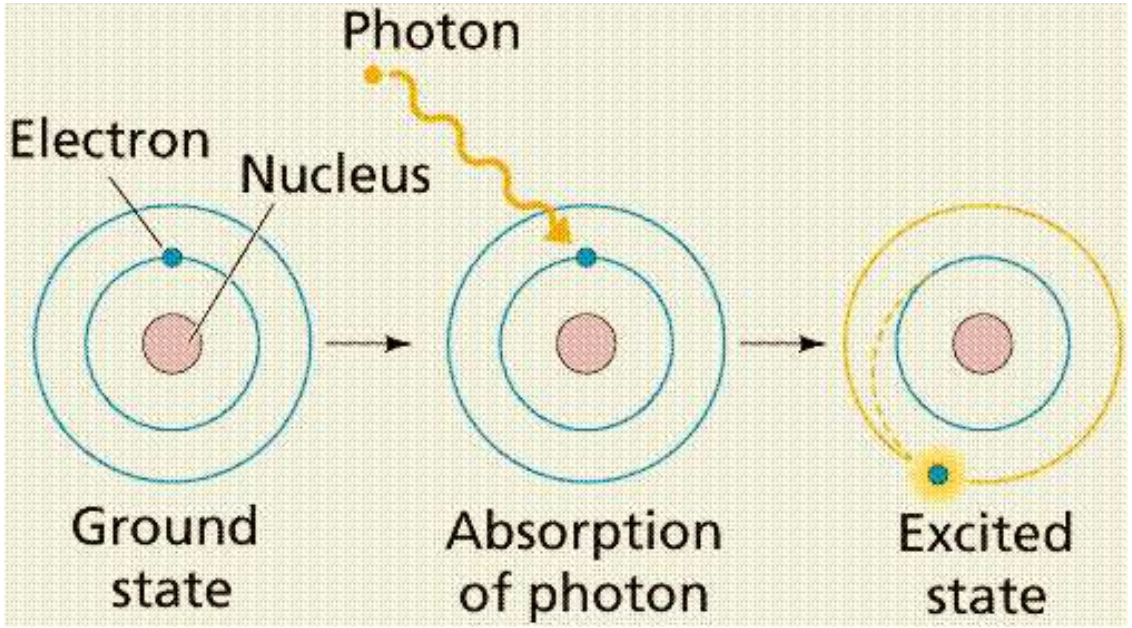

Representation of general atmospheric chemical processes

# Photochemical Reactions

- Photochemical reaction, a chemical reaction initiated by the absorption of energy in the form of light.
- The consequence of molecules' absorbing light is the creation of transient excited states whose chemical and physical properties differ greatly from the original molecules.

- Nitrogen dioxide, $NO_2$, is one of the most photo chemically active species found in a polluted atmosphere and is an essential participant in the smog formation process.

$$NO_2 + h\nu \rightarrow NO_2^*$$



- Photodissociation of $NO_2$ yields atomic oxygen which can subsequently lead to the formation of ozone.

- $NO_2 + hv \rightarrow NO + O^*$
- $O^* + O_2 \rightarrow O_3$

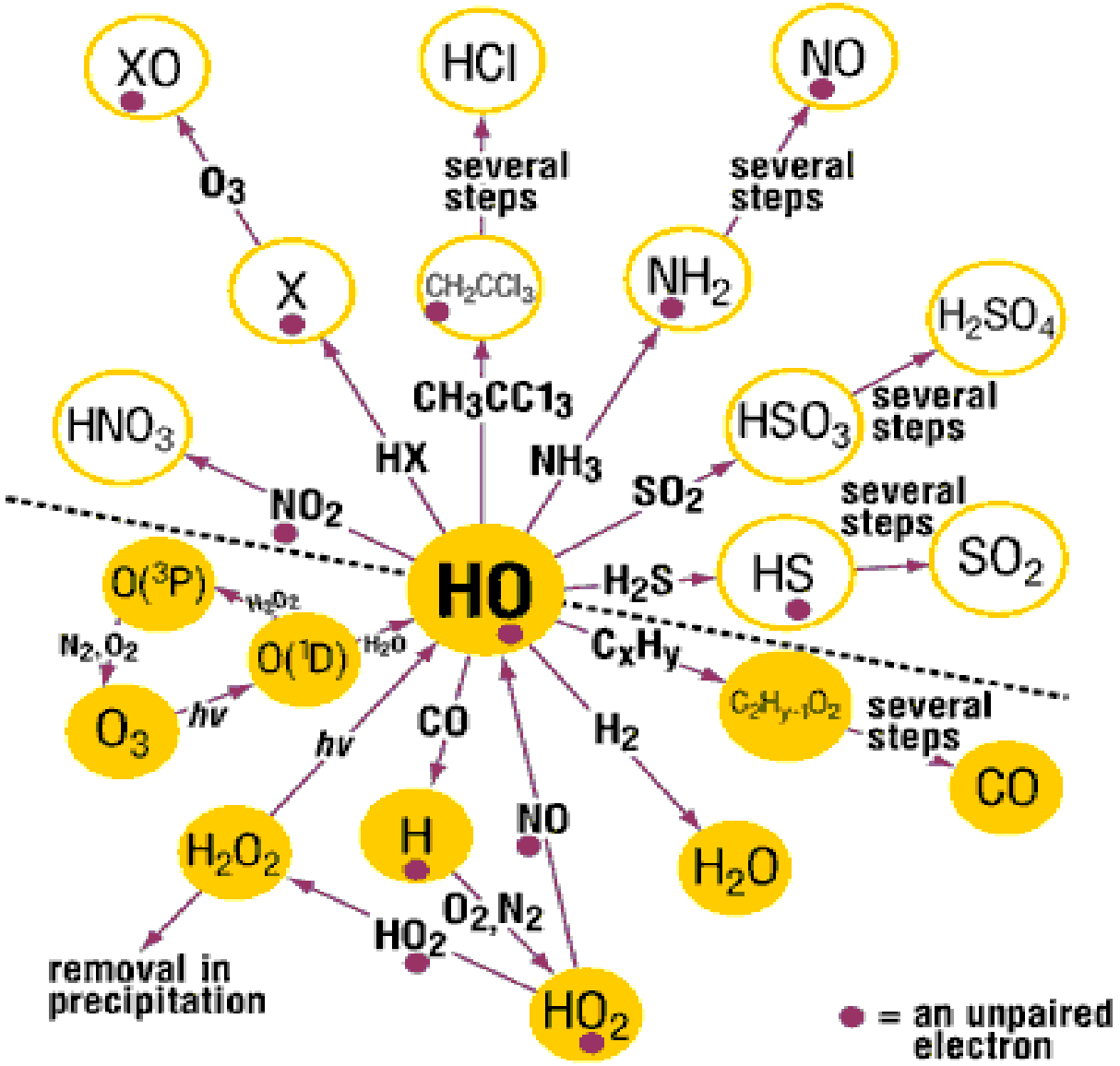
- The ozone is photodissociated as
- $O_3 + hv \rightarrow O^* + O_2$

- The excited oxygen atom may react with water molecule providing a source of hydroxyl radical ($OH^*$).
- $O^* + H_2O \rightarrow 2OH^*$

# Detergent of the atmosphere

- Hydroxyl radical ($OH^*$) produced by reaction of excited oxygen atom (formed by photodissociation of atmospheric ozone) with water is probably the most important radical in the chemistry of troposphere.
- Nobel Prize winner Paul Crutzen coined the phrase "detergent of the atmosphere" to describe this important cleansing role of $OH^*$.
- Most of the trace gases found in the troposphere are oxidised by $OH^*$ into water-soluble products that are washed out by rain and snow.

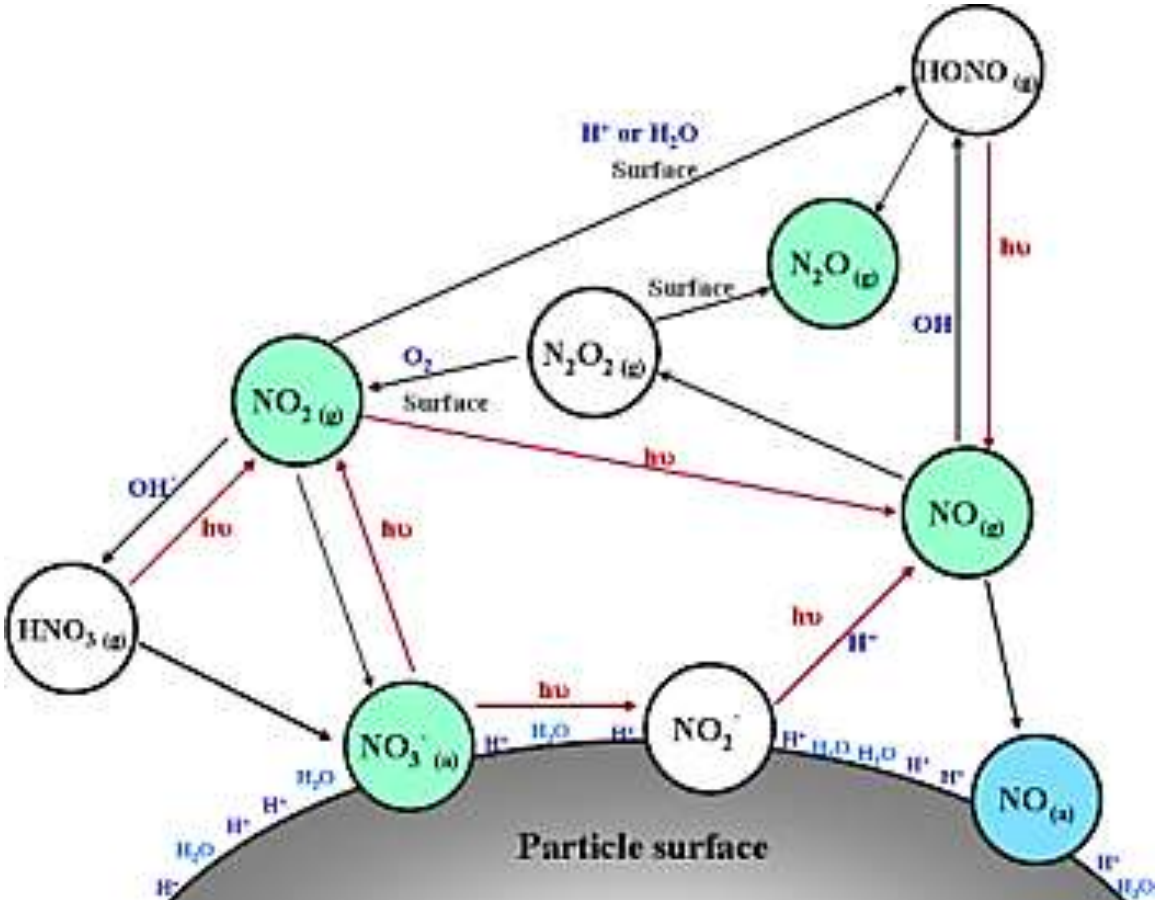
# Atmospheric reactions involving the hydroxyl radical



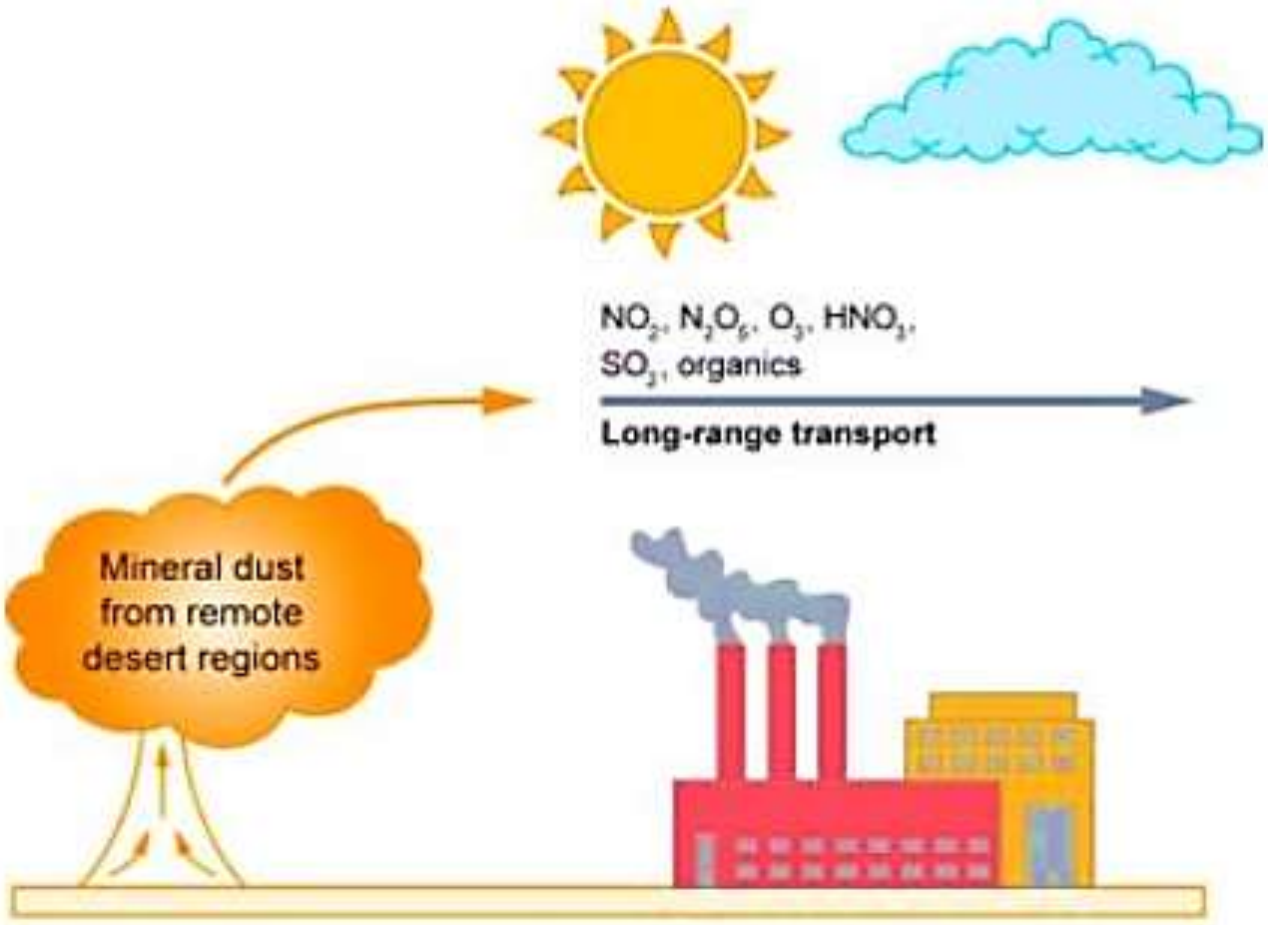
# Photochemistry of Mineral Dust

- Particles in the atmosphere provide reactive surfaces for adsorption as well as for important chemical and photochemical reactions.
- Among all the particulate matter, mineral dust aerosol which is mainly emitted in to the atmosphere from arid desert regions comprises a significantly large mass fraction.
- These dust particles can react with trace atmospheric gases such as $NO_2$, $HNO_3$, $SO_2$, $O_3$, HCl and organics and further undergo photochemical reactions during long range transport from the source region to remote locations due to wind currents.

- Additionally, heterogeneous reactions on mineral dust and its components may provide missing link for some reaction schemes that cannot be explained solely with gas phase reactions.



# Long Range Transport of Mineral Dust



# Acid-Base Reactions in the Atmosphere

$$CO_2(g) \xrightarrow{\text{water}} CO_2(aq)$$

$$CO_2(aq) + H_2O \rightarrow H^+ + HCO_3^-$$

Carbonic acid Formation

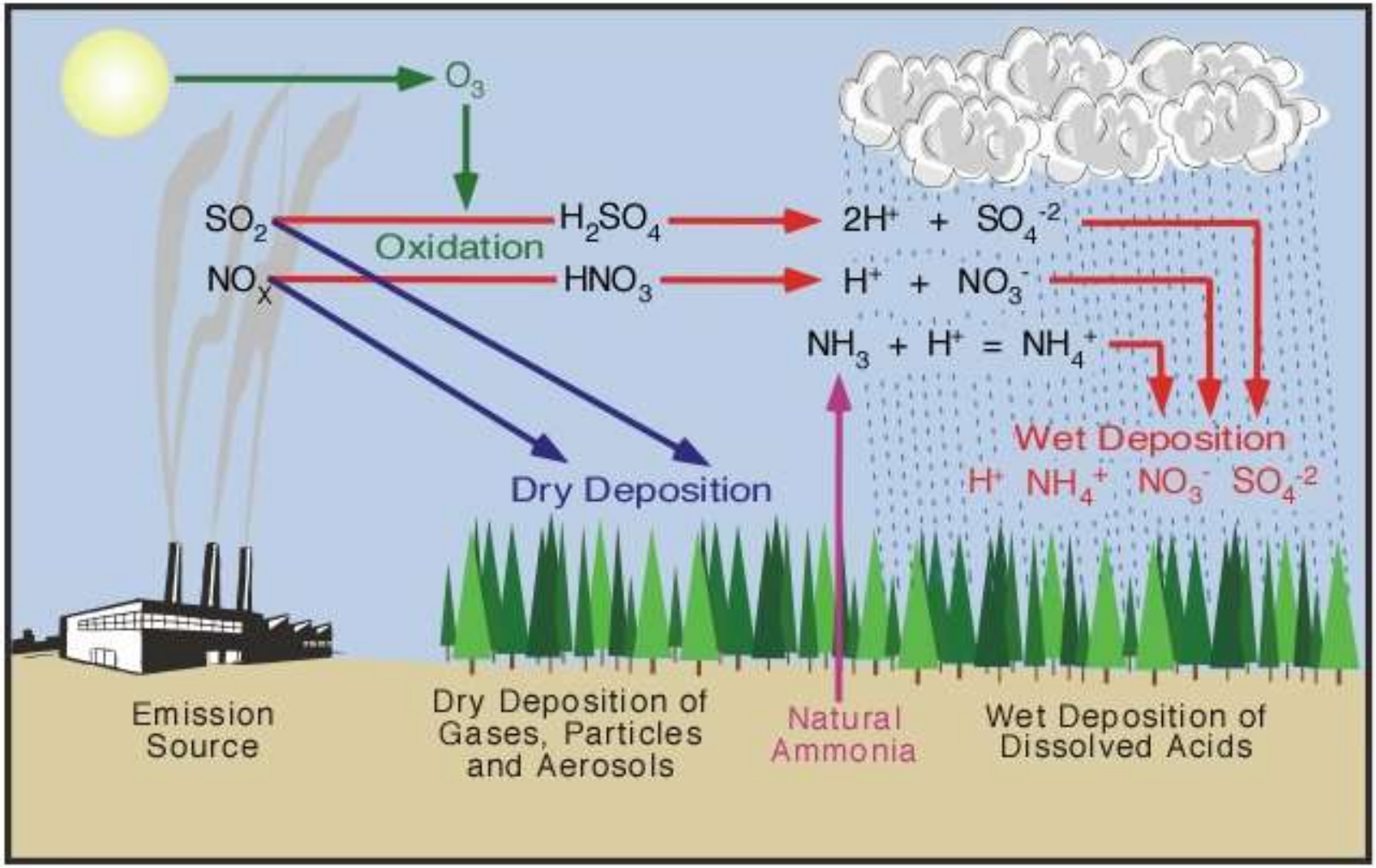
$$SO_2(g) + H_2O \rightarrow H^+ + HSO_3^-$$

Sulfuric acid Formation

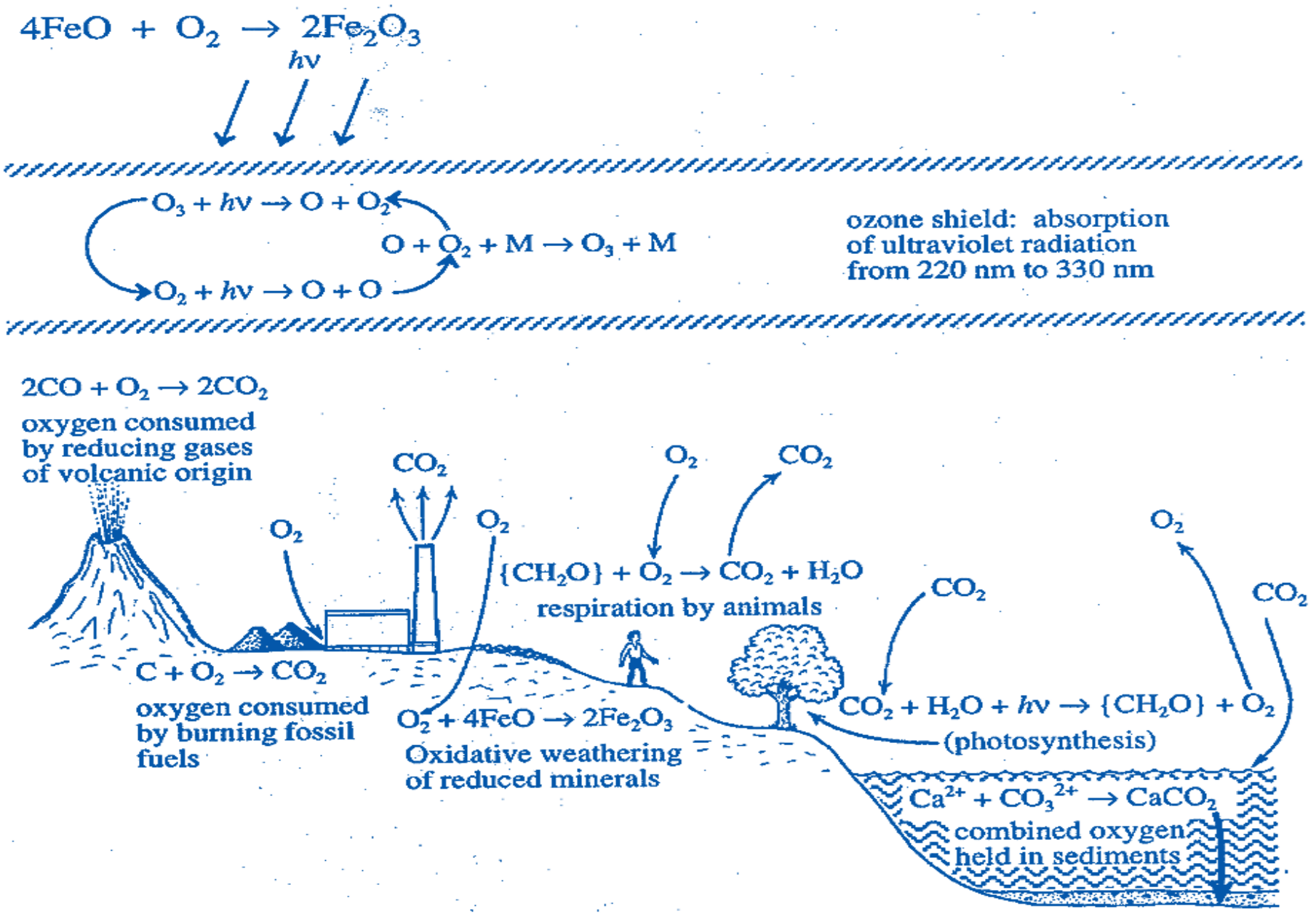
$$NO_2 + OH^\bullet \rightarrow HNO_3$$

Nitric acid Formation

# Reactions of S & N in atmosphere



# Reactions of Atmospheric Oxygen



# Thank You……