

Ozone and Ultraviolet (UV) Radiation

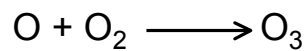
Monash University 2002

Lecture Outline

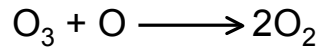
- Introductory Comments
 - Historical background
- What is ozone?
- What determines the distribution of ozone?
- What is UV radiation and why is it important?
- How does ozone affect UV radiation?

What is ozone?

- Ozone is the tri-atomic form of the oxygen molecule, O_3
- It is formed when oxygen absorbs high energy (short wavelength) solar radiation



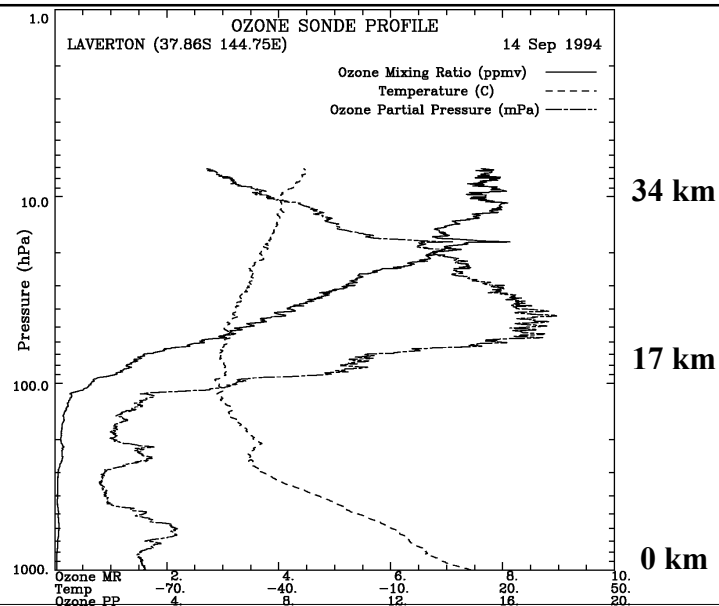
- It is highly reactive



- It absorbs UV radiation

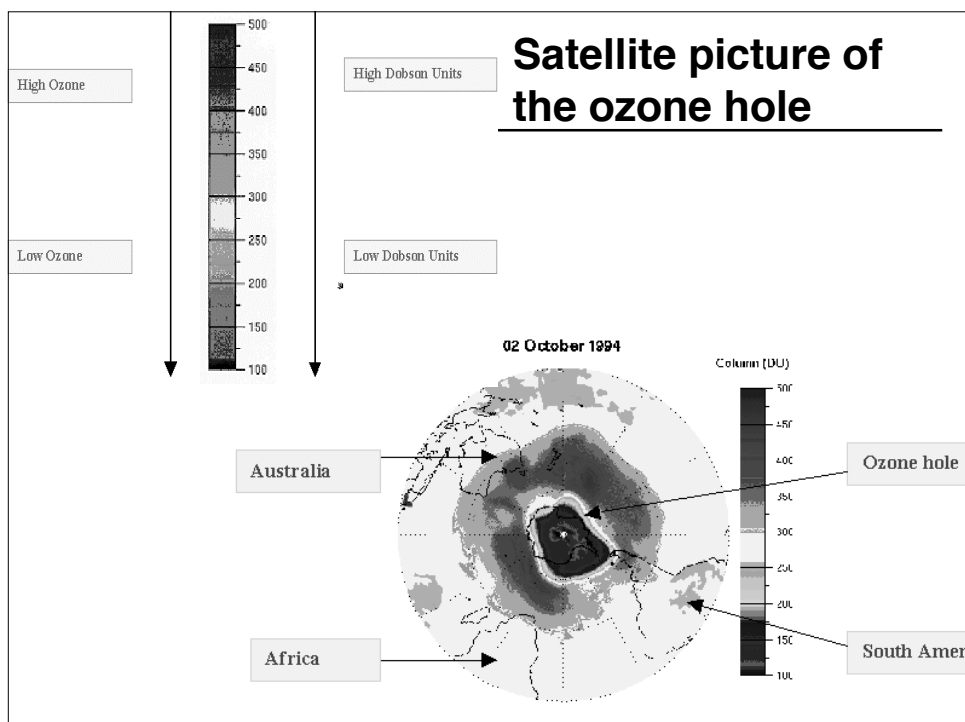


Vertical distribution of ozone on a single day



How do we measure ozone?

- Ozone mixing ratio:
The number of ozone molecules relative to the total number of air molecules, usually in ppm.
Increases with height to a maximum around 40km
- Ozone partial pressure:
The contribution of ozone to air pressure, in mPa.
Maximum around 20km, then decreases with height as pressure decreases.
Often has a second maximum near the surface.
- Total column ozone:
Amount of ozone above a point, measured in Dobson Units (DU) or milliAtmosphere cm

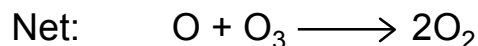
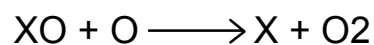
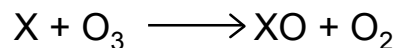


What determines the ozone distribution?

- Balance between production, transport and destruction
- Ozone is formed mainly in the upper stratosphere in the tropics
- It is transported by the large scale circulation (winds) in the stratosphere, from the tropics to higher latitudes, and from west to east.

What determines the ozone distribution?

- Ozone is destroyed by photochemical reactions



where the catalyst X is one of the stratospheric chemicals OH, NO, Cl, Br.

- This catalytic destruction of ozone is faster than the reaction just involving an oxygen atom

What is Ultraviolet (UV) radiation?

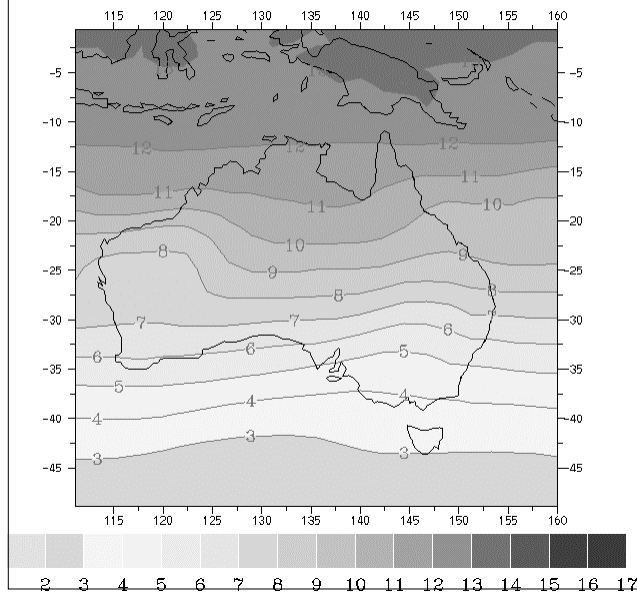
- UV radiation is emitted by the sun, with wavelengths from 200 - 400 nm
- It is broken into three ranges
 - UVC, 200 - 290 nm,
 - UVB, 290 - 320 nm,
 - UVA, 320 - 400 nm,
- UV radiation causes sunburn, skin cancer and eye disease, as well as other health problems

What affects the amount of UV radiation?

- Absorption by oxygen and ozone
 - No UVC reaches the surface
 - UVB is partly absorbed by ozone
- Scattering by air molecules and dust
 - UVA amount is determined by scattering
- Path length of radiation through atmosphere
 - Sun overhead or high elevation, shorter path, less scattering and absorption, more UV
 - Sun low in sky, longer path, less UV
- Water droplets in clouds cause much scattering

UV Index forecasts

FORECAST CLEAR SKY UV INDEX FOR LOCAL NOON TUE 10 SEP 02



From Bureau of
Meteorology,
UV Index
1 UVI=25 mW/m²

UV INDEX	DANGER CATEGORY
Below 3	Moderate
3 to 6	High
7 to 9	Very High
10 and above	Extreme

UV radiation and skin cancer

- UV radiation over Australia is high because of its location in low latitudes
- Ozone depletion over Australia is relatively small, and has led to small increases in UV radiation
- Increased skin cancer in Australia has been mainly due to changes in behaviour, leading to increased UV exposure

Lecture Summary

- What is ozone?
 - O₃, mainly in stratosphere, absorbs UV, but is also a greenhouse gas.
- What determines the distribution of ozone?
 - Balance between production, transport and loss
- What is UV radiation?
 - High energy, short wavelength radiation from the sun
- How does ozone affect UV radiation?
 - UVB is partly absorbed by ozone, UVA is scattered by air and dust, more UV if sun is overhead