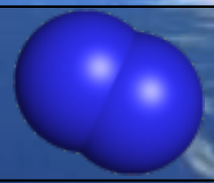
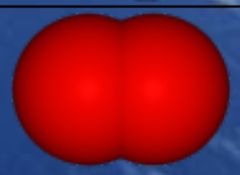
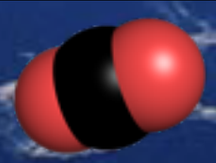
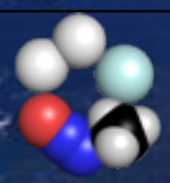
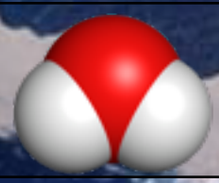
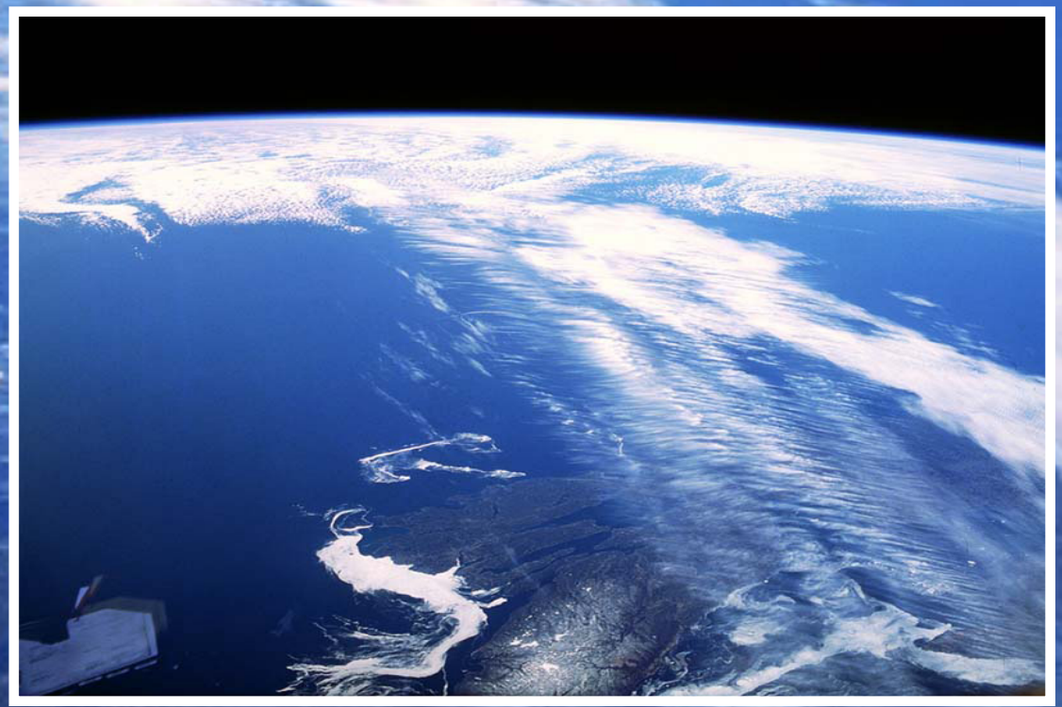
5.6.1 Outline the overall structure and composition of the atmosphere.

Composition of the Earth's atmosphere

- Earth's atmosphere contains roughly:

78% nitrogen	
20.95% oxygen	
0.93% argon	
0.038% carbon dioxide	
Other gases	
1% water vapour	



The **Earth's atmosphere** (where pressure becomes negligible) is over 140 km thick. Compared to the bulk of the planet, this is an extremely thin barrier between the hospitable and the inhospitable.

All images: NASA

The Atmosphere

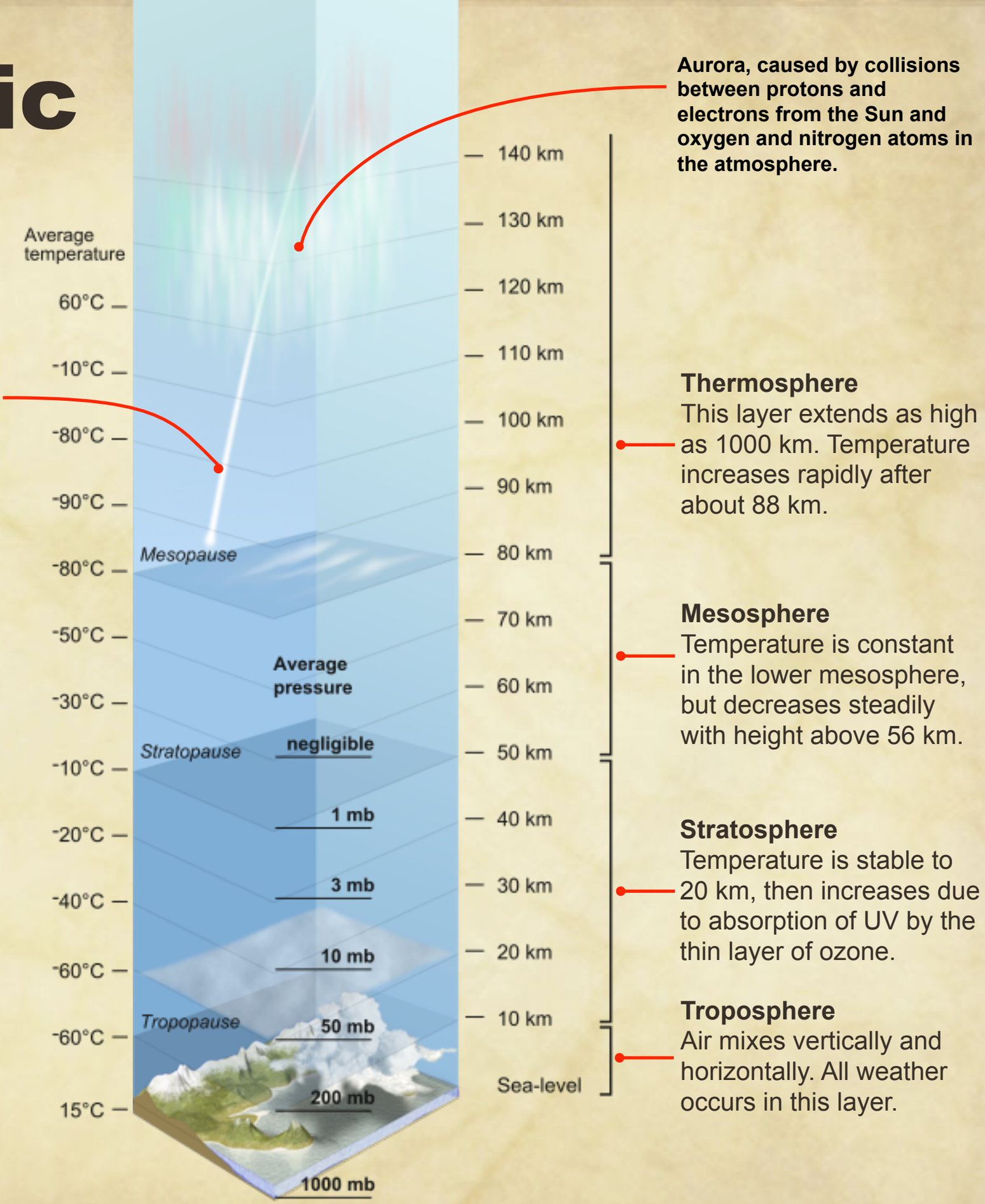
- The mixture of gases forming layers which surround the Earth and protects life.
- The atmosphere is not static. Interactions involving the amount of sunlight, the spin of the planet and tilt of the Earth's axis cause ever changing atmospheric conditions.

Weather occurs in the **troposphere**. Gaseous water molecules held together by intermolecular forces cause the formation of clouds.

The **auroras** occur in the thermosphere and are caused by interactions between the Earth's atmosphere and charged particles streaming from the Sun.

Atmospheric Layers

- The **atmosphere** consists of gas **layers** that surround the Earth, each one defined by the way temperature changes within its limits.
- The layer boundaries are:
  - **Tropopause**
  - **Stratopause**
  - **Mesopause**
- The outermost, the **thermosphere**, thins slowly, fading into space with no boundary.



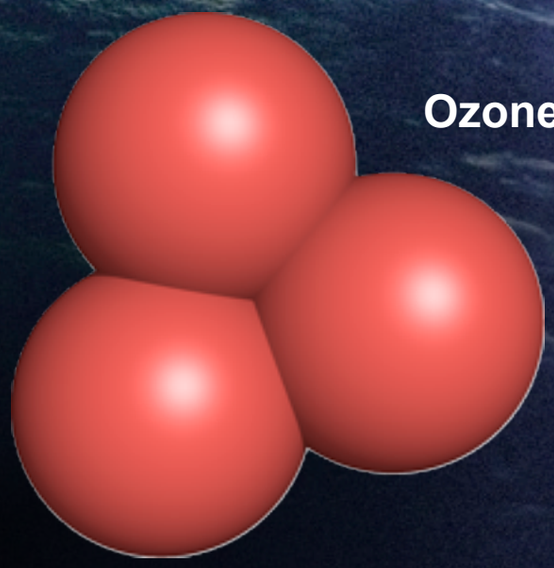
5.6.2 Describe the role of ozone in the absorption of ultraviolet radiation

Memorization of chemical equations not required

Course Companion p. 288+

Stratospheric Ozone

- A thin layer of renewable **ozone** gas exists in the lower **stratosphere**, above the troposphere.
- Stratospheric ozone absorbs about 99% of the harmful incoming **ultra violet (UV) radiation** from the sun and prevents it from directly reaching and damaging our biosphere.
- This is why we call it ‘good’ ozone



Ozone (O_3)

Ozone Depleting Substances (ODS)

- The ozone depleting substances (below) drift into the stratosphere, where UV causes the release of highly reactive free chlorine.

  - **Chlorofluorocarbons** (**CFCs**) are found in:
    - Coolants (refrigerants) in fridges and air-conditioners
    - propellants for aerosol cans
    - Styrofoam/polystyrene insulation and packaging
    - medical sterilizers
  - **Halons are** used in many fire extinguishers
  - **Methyl bromide is** used as a fumigant

Discarded refrigerators leak coolant

Many aerosols use CFC propellants

Ozone Depletion

Oxygen molecule

Ozone

Uv light hits a CFC molecule and releases a chlorine atom

Chlorine reacts with ozone

Free chlorine

Chlorine oxide molecule

Cholofluorocarbon (CFC)

Free chlorine

The following mechanism for ozone depletion is shown in detail on the following slides

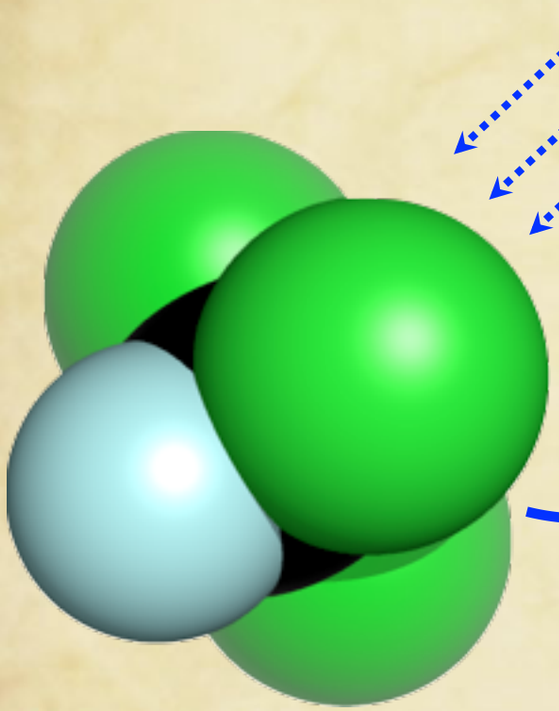
Chlorine oxide reacts with ozone

2 oxygen molecules

Ozone

Ozone Depletion

Uv light hits a CFC molecule and releases a chlorine atom



CCl_3F

Cholofluorocarbon (CFC)

Free chlorine

Cl

Ozone

O_3

Oxygen molecule

O_2

Chlorine reacts with ozone

Chlorine oxide molecule

ClO

Chlorine oxide reacts with ozone

$2O_2$

2 oxygen molecules

O_3

Ozone

Effects of UV Radiation

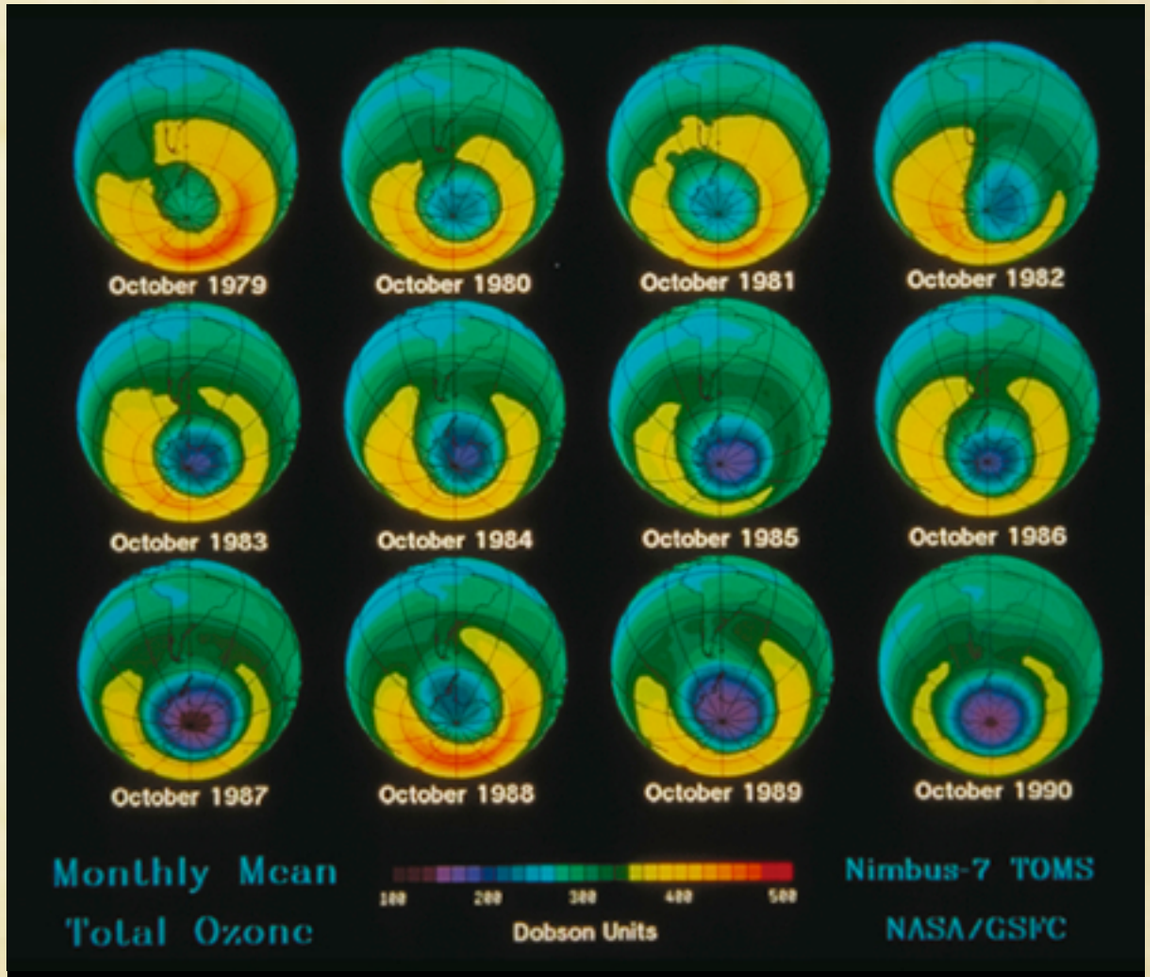
- As well as all the well known health problems associated with ultraviolet radiation, e.g. sunburn and cancers, **UV-B radiation** is likely to cause:
  - decrease in the productivity of forests and surface dwelling plankton
  - immune system suppression in animals
  - lower crop yields
  - increase in smog
  - change in the global climate

Photo: NCI

Melanoma skin cancer

Dobson Units (DU)

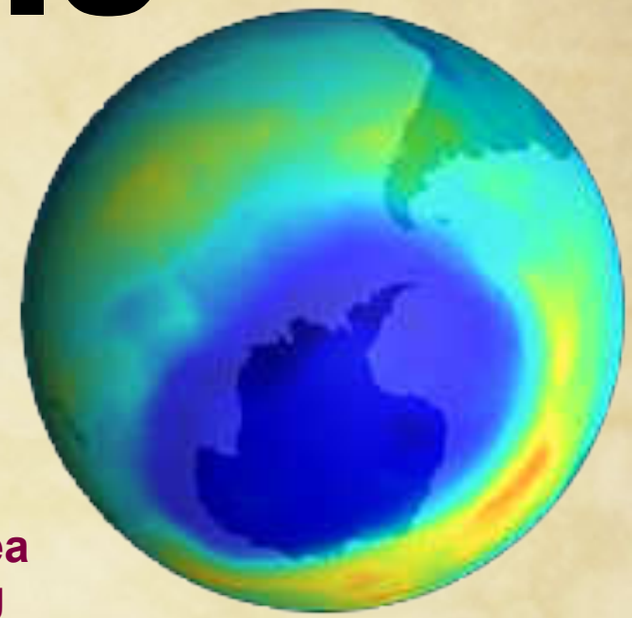
- The **Dobson Unit** (**DU**) is a measurement of column ozone levels (the ozone between the Earth's surface and outer space).
- The size and intensity of the ozone hole is growing each year, as can be seen in the satellite photos below. In recent years, a similar hole has developed over the Arctic.
  - In the **tropics**, ozone levels are typically between 250-300 DU year-round.
  - In **temperate regions**, seasonal variations can produce large swings in the ozone levels and they can occur even in the absence of ozone depletion.



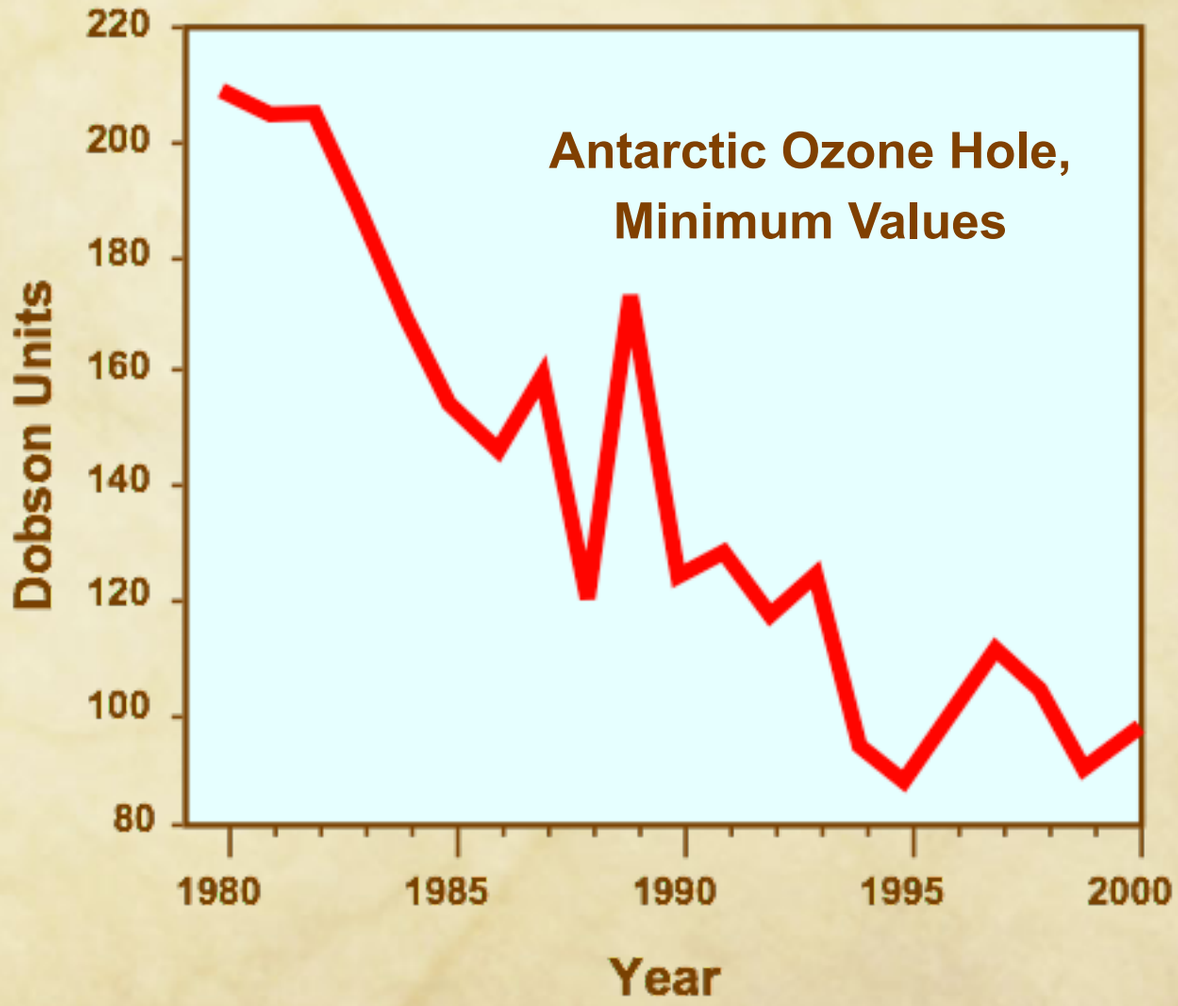
Monthly mean ozone, from the Southern Hemisphere

The Ozone ‘Hole’

- In 2000, the extent of the **ozone hole** over Antarctica was the largest ever.
  - The ozone ‘hole’ is defined as a region with lower than 220 Dobson units.
  - The readings were taken between the South Pole (90 degrees south) and 40 degrees latitude.
  - Data were collected in the Southern Hemisphere spring each year (between 7 September and 13 October.



The dark blue area indicates <200DU



Ozone Recovery

- The problem of **ozone depletion** was first detected in 1984 when researchers discovered the region of thinner ozone over Antarctica.
  - Since 1987, nations have cut their consumption of ozone-depleting substances by 70%.
- Free chlorine in the stratosphere peaked around 1999 and is projected to decline for more than a century.
- Ozone loss is projected to diminish gradually until around 2050 when the polar ozone levels will return to 1975 levels.
- It will take another 100-200 years for full recovery (to pre-1950 levels).

- Other serious problems affecting the biosphere include excess UV radiation and the presence of CFCs (chlorofluorocarbons).
- CFCs released from propellants in aerosol sprays and refrigerants, and have been recognized as a cause of depletion of the ozone layer since 1985.
- CFCs destroy ozone molecules. The destruction of the ozone layer in the stratosphere allows more damaging UV radiation to reach the earth.
- Excess UV radiation causes damage to living tissues (e.g. skin cancer, mutation of DNA, sunburn and cataracts). Excess UV radiation also causes reduced biological productivity. Floating microscopic plants are especially susceptible.