Important Dates:

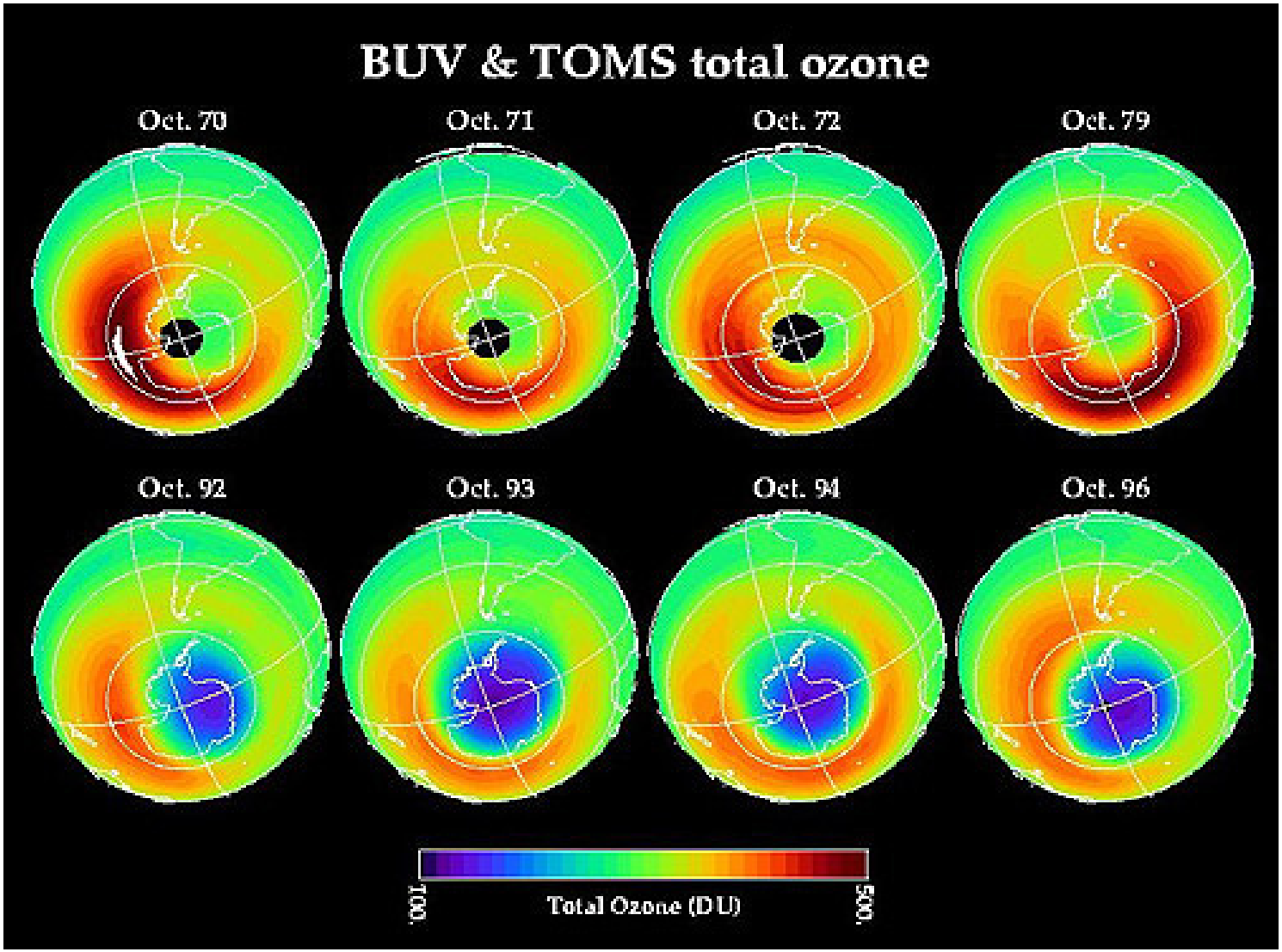
HW 2 due today

HW 3 due next Thursday

Quiz 3 today

EXAM 1 NEXT THURSDAY

Polar Ozone Depletion – The “Ozone Hole”



Atomic Structure and Periodicity

Table 2.3 Isotopes of Hydrogen

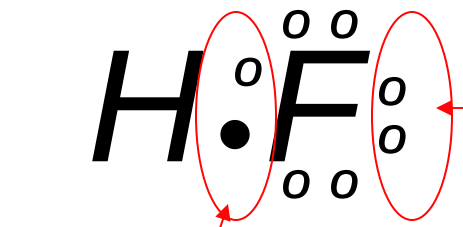
Isotope	Isotopic Symbol	Number of Protons	Number of Neutrons	Sum of Protons and Neutrons
hydrogen, H-1	${}_{1}^{1}H$	1	0	1
deuterium, H-2	${}_{1}^{2}H$	1	1	2
tritium, H-3	${}_{1}^{3}H$	1	2	3

Molecules and Models

$S = N - A$

- Example: hydrogen fluoride, HF
  - Needed (N): hydrogen needs $2e^-$ and fluorine needs $8e^-$.
    - N = 2 + 8 = 10
  - Available (A): hydrogen has $1e^-$ and fluorine has $7e^-$.
    - A = 1 + 7 = 8
  - Shared (S) = N – A = 10 – 8 = 2
  - So $2e^-$ shared between H and F, a single covalent bond

Molecules and Models



Lone Pairs

Shared Electrons

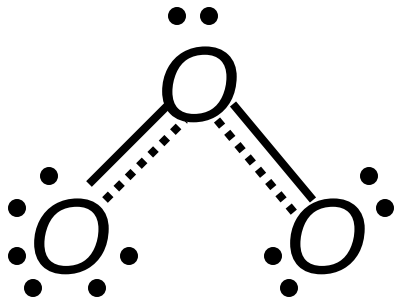
H-F

Lone Pairs are "understood"

Single Covalent Bond

Molecules and Models

- Resonance Forms
  - Structures that are hypothetical extremes of electron arrangements that do not exist exactly as represented by any one Lewis structure.
- Ozone's structure is 'in-between' the two resonance structures.



“Free Radicals”

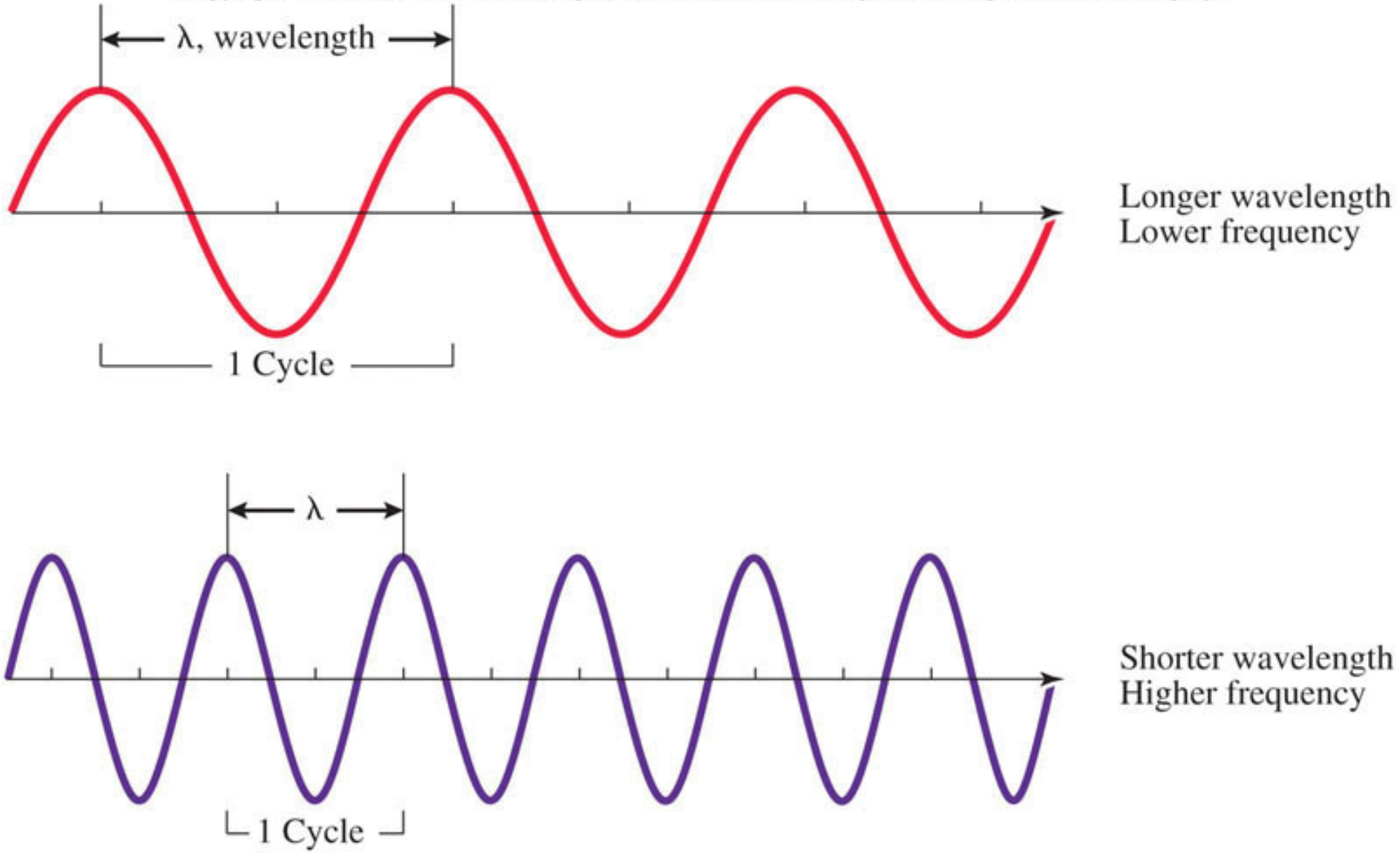
Species with an odd number of electrons – or “unpaired” electrons – are referred to as Free Radicals, or Radicals

Radicals are extremely reactive, because that single unpaired electron will do just about anything to make a pair

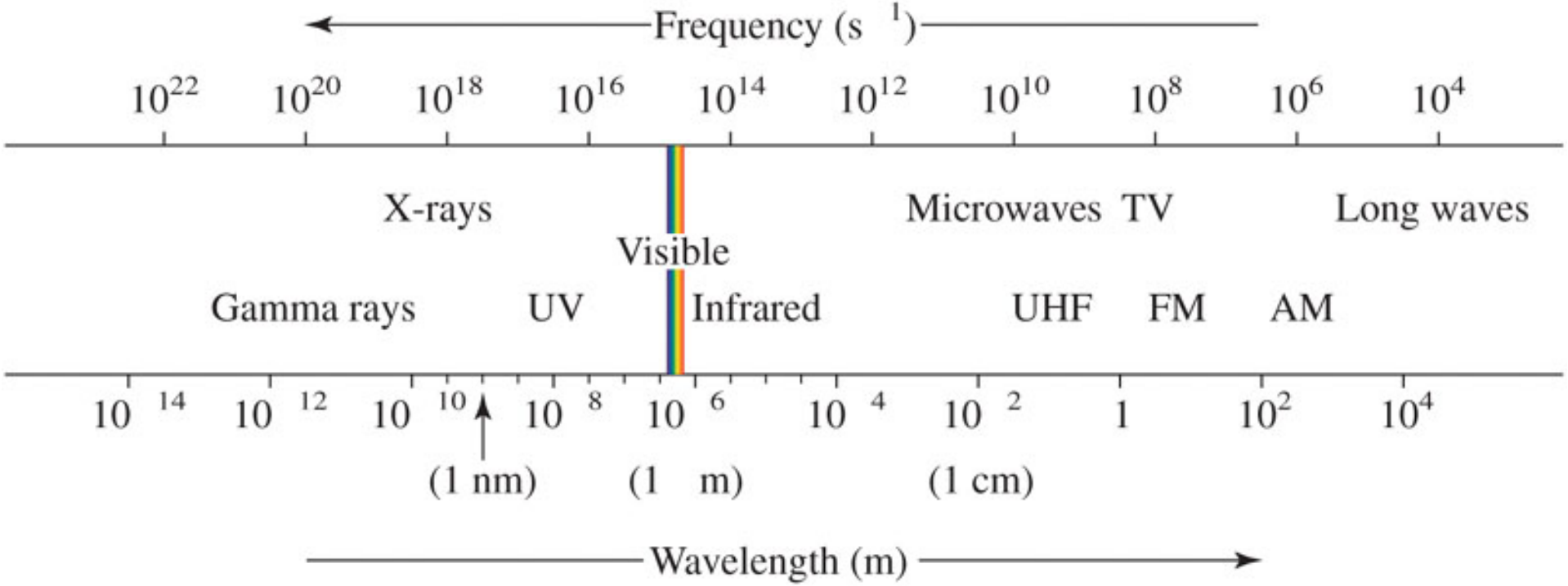
Often (but not always), we indicate that a species is a radical by representing the unpaired electron with a single dot: •

NO•, NO_2•, Cl•, Br•, OH• , ...

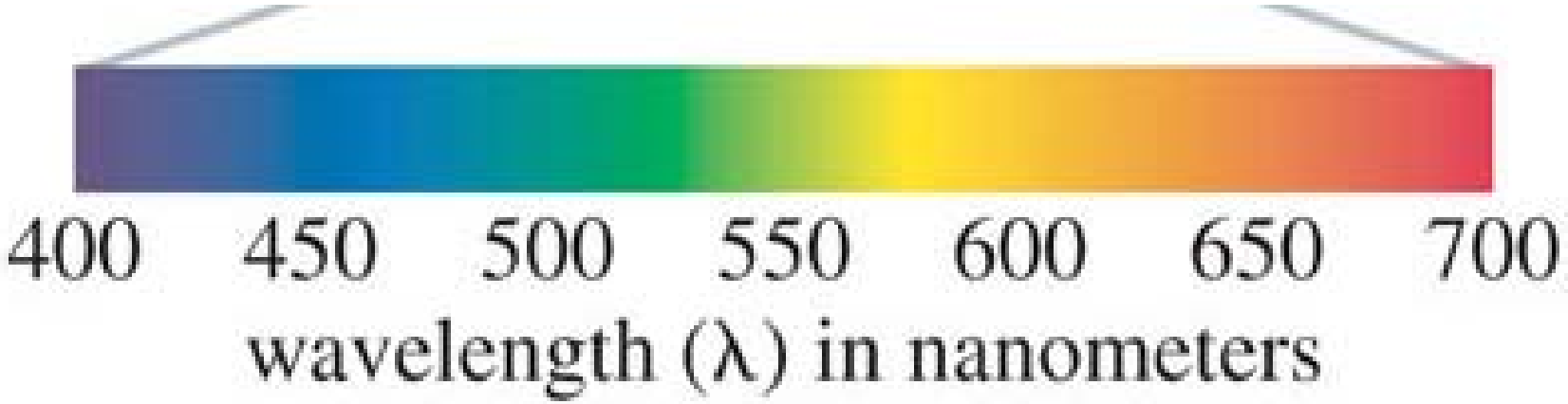
Waves of Light



Waves of Light



Waves of Light



Visible Light

Waves of Light

$$\nu = \frac{c}{\lambda} \qquad c = 3.00 \times 10^{8} \frac{m}{s}$$

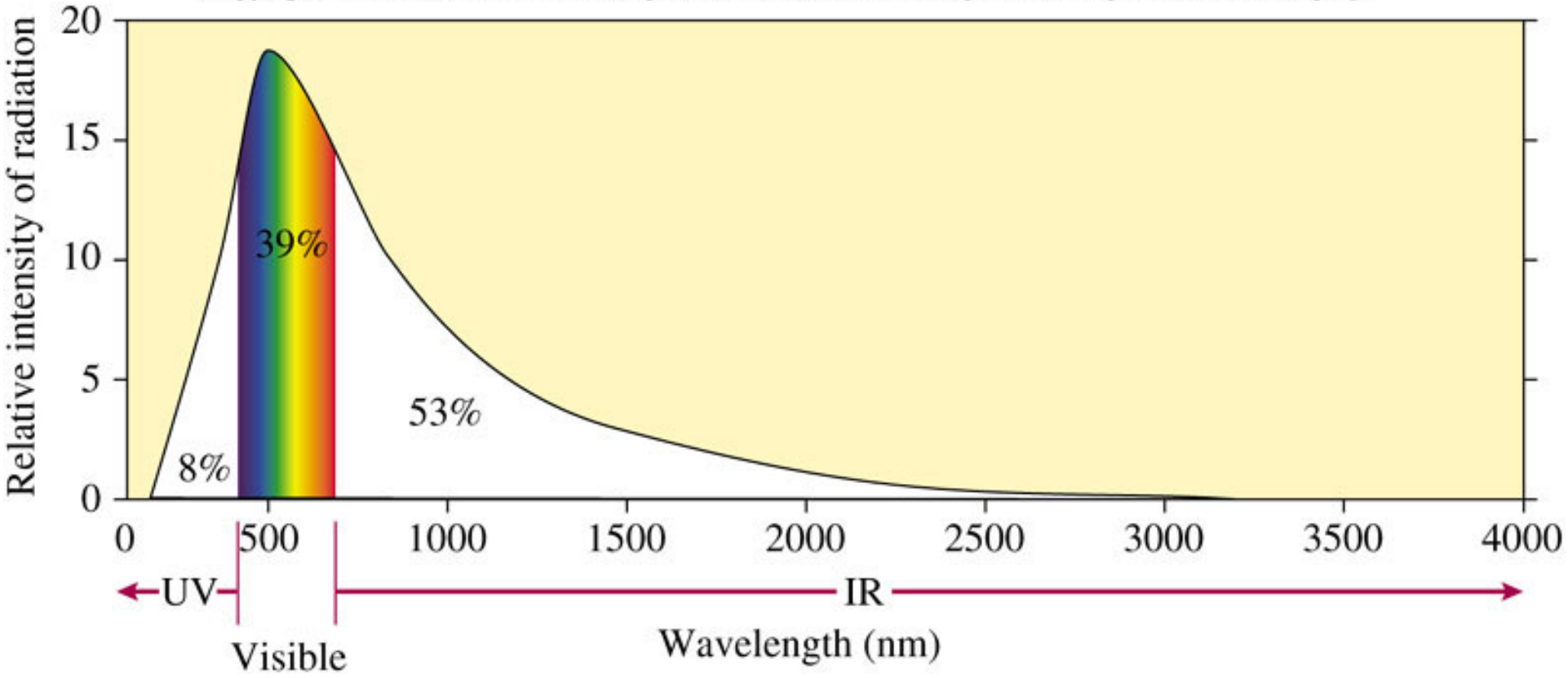
green light has $\lambda = 550\,nm$

$10^{9}\,nm = 1\,m$ or $1\,nm = 10^{-9}\,m$

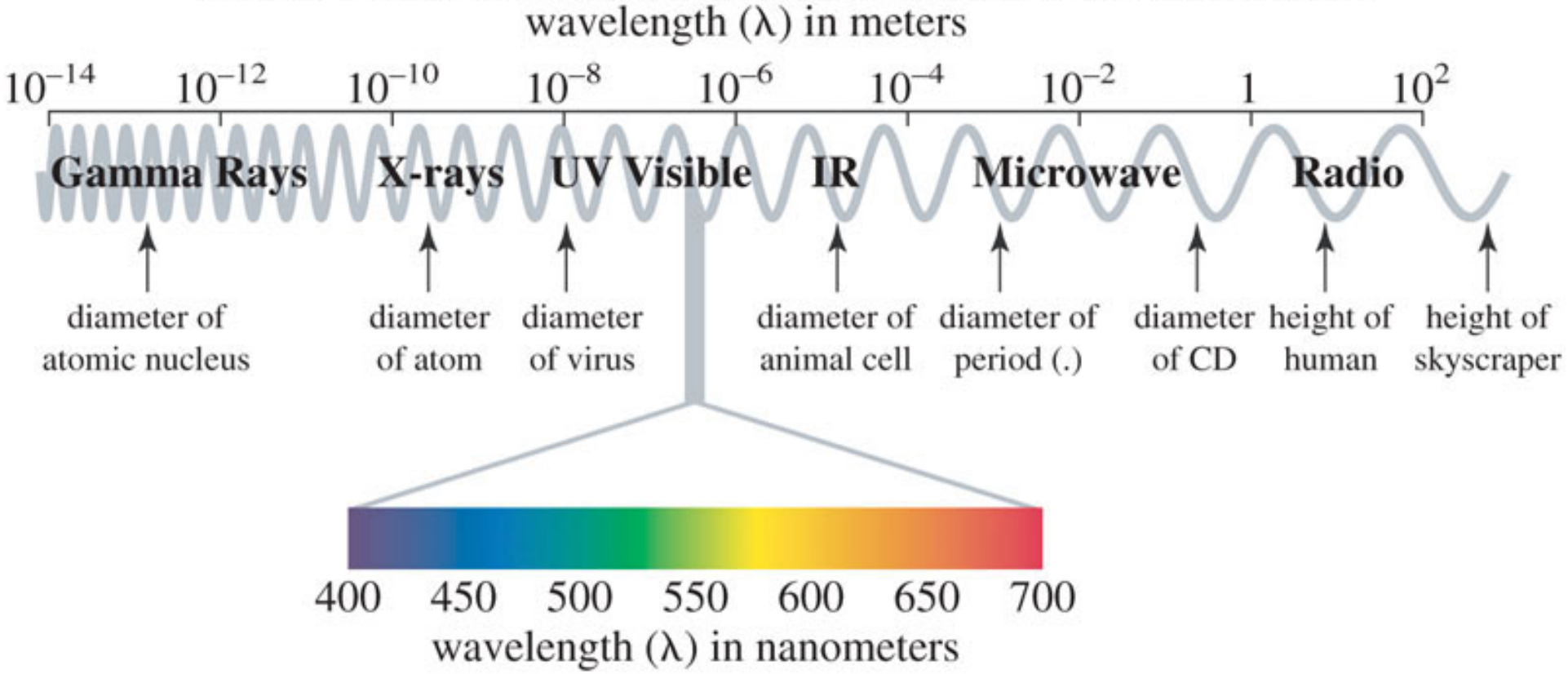
$$\lambda = 550\,nm = 550 \times 10^{-9}\,m = 5.50 \times 10^{-7}\,m$$

$$\nu = \frac{c}{\lambda} = \frac{3.00 \times 10^{8} \frac{m}{s}}{5.50 \times 10^{-7}\,m} = 5.45 \times 10^{14} / s = 5.45 \times 10^{14}\,s^{-1}$$

Waves of Light



Waves of Light



Waves of Light – Particles of Light?

- In the early 1900s, physical science was turned upside down by the development of Quantum Mechanics (as opposed to Classical Mechanics)
- Quantum Mechanics is *required* in order to apply physics to the world on the scale of atoms and molecules
- One of the most shocking postulates of Quantum Mechanics was that light simultaneously possesses properties of a wave **and** of a particle
  - "Wave/particle duality"
- A "particle" of light is called a **photon**, and while it definitely possesses the frequency and wavelength of waves, it also carries a specific amount of energy *per photon*

Energy of Photons

$$E = h\nu = \frac{hc}{\lambda}$$

$$h = 6.63 \times 10^{-34}\ J \cdot s$$

For green light with $\nu = 5.45 \times 10^{14}\ s^{-1}$

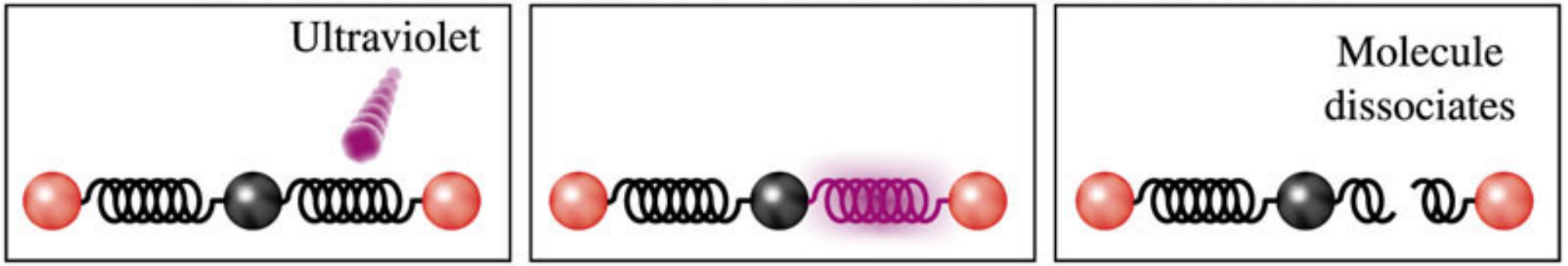
$$E = \left(6.63 \times 10^{-34}\ J \cdot s\right)\left(5.45 \times 10^{14}\ s^{-1}\right)$$

$$E = 3.61 \times 10^{-19}\ J$$

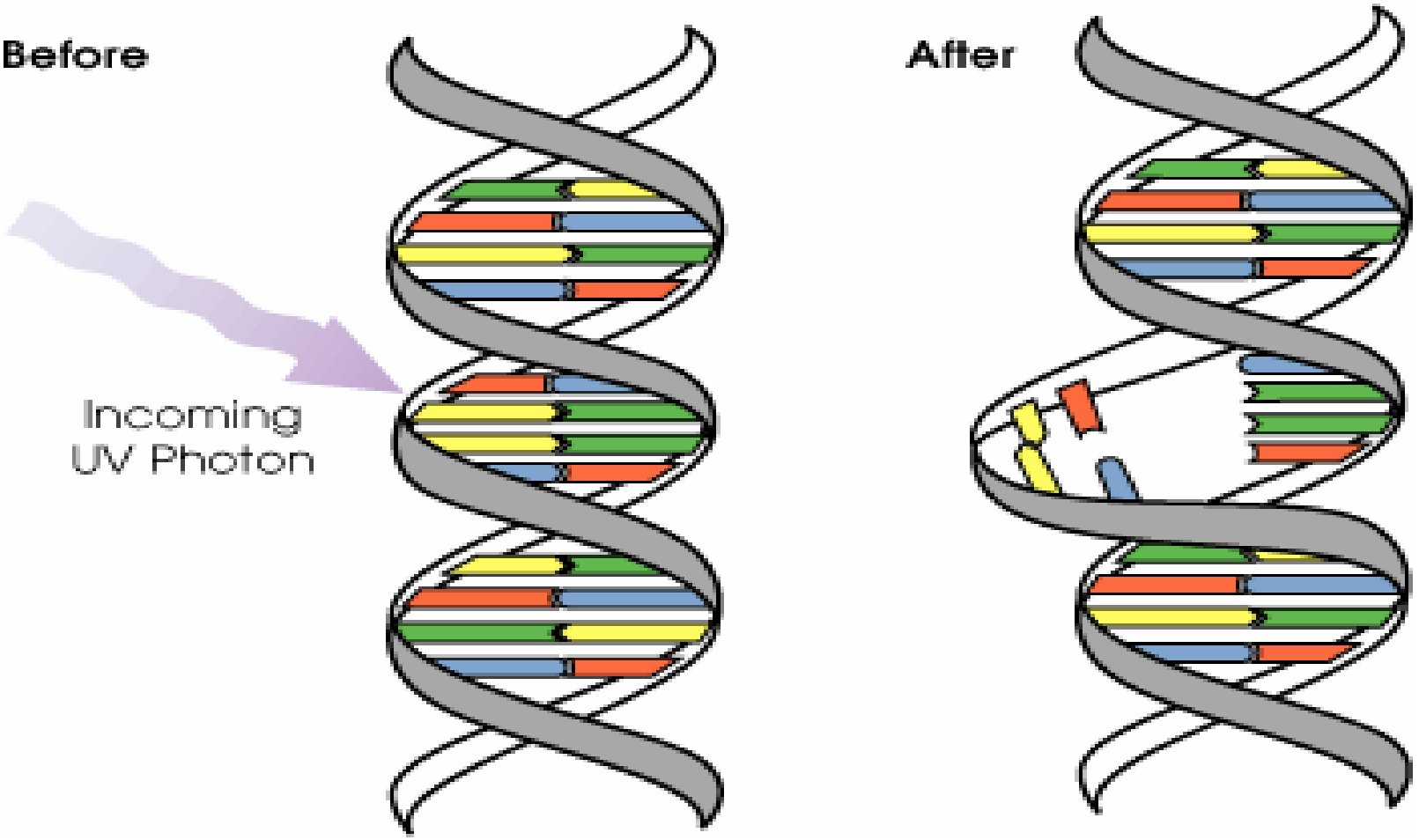
The Interaction of Light with Molecules

•It turns out that the energy in one photon of ultraviolet light has approximately the same energy as a molecular bond!

•If a molecule is struck by a photon of the right energy – that is, of the right frequency! – the molecular bonds will break

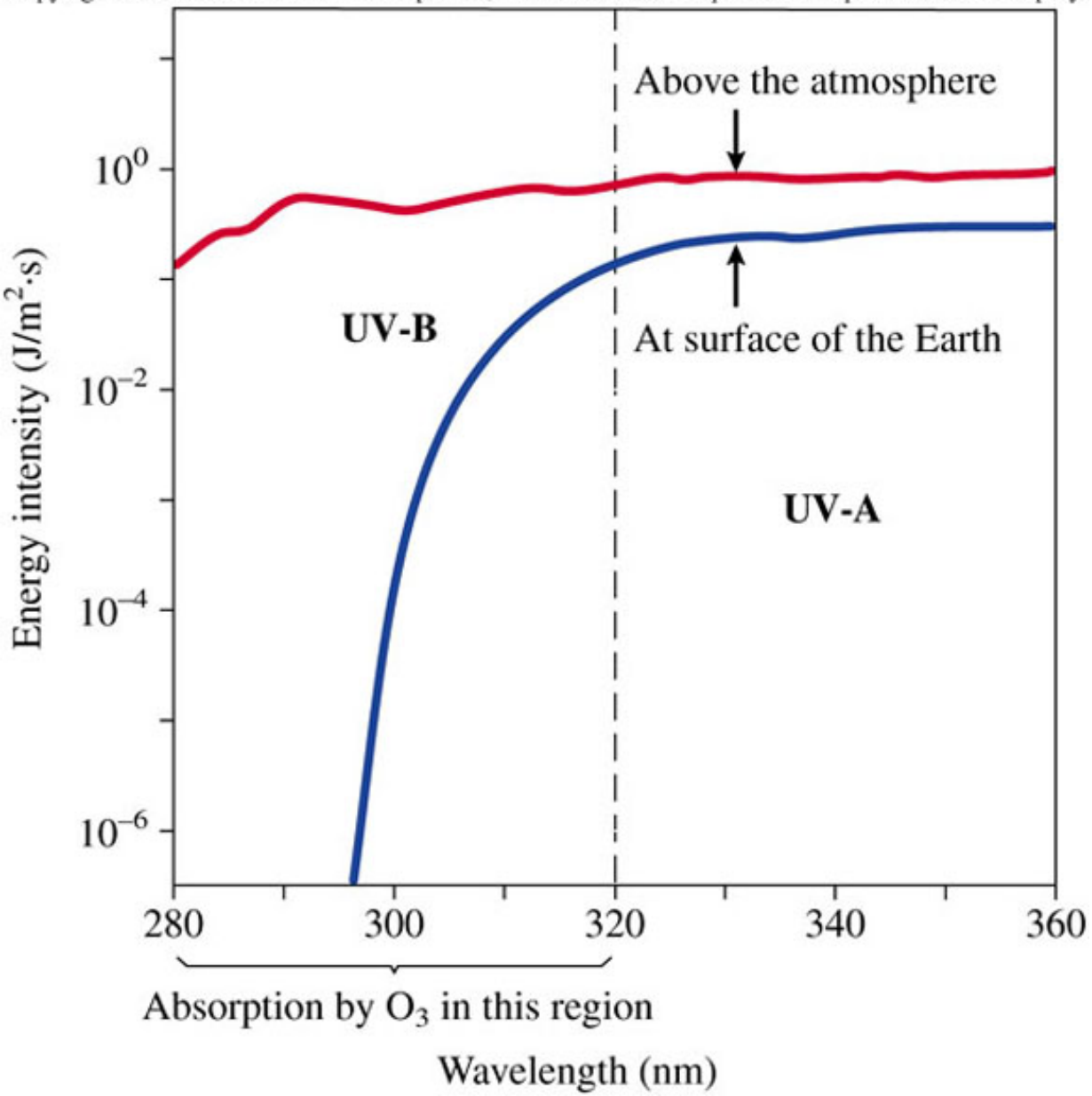


The Interaction of UV Light with DNA

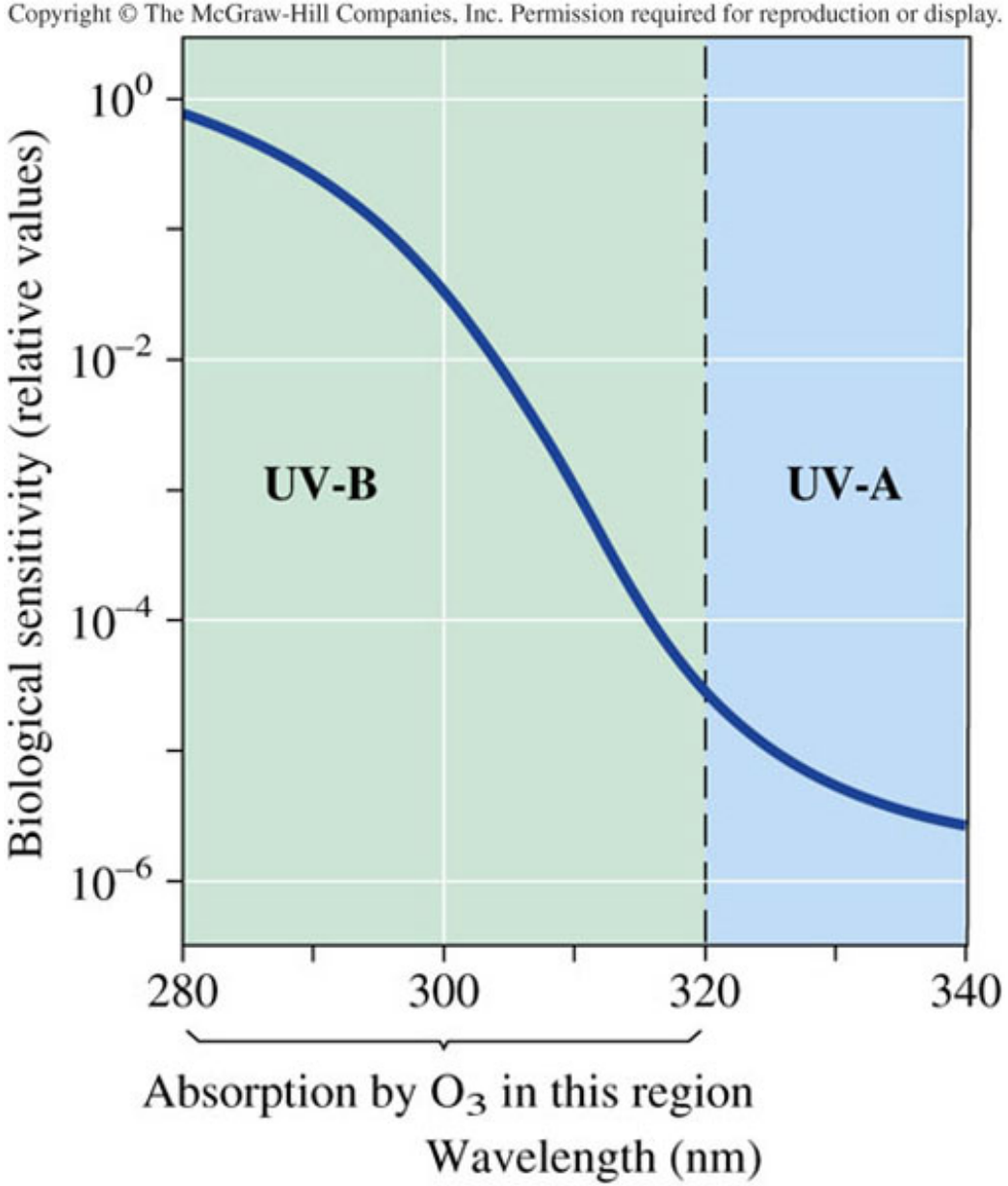


http://earthobservatory.nasa.gov/Library/UVB

Ultraviolet Radiation From The Sun



Biological Effects of Ultraviolet Radiation



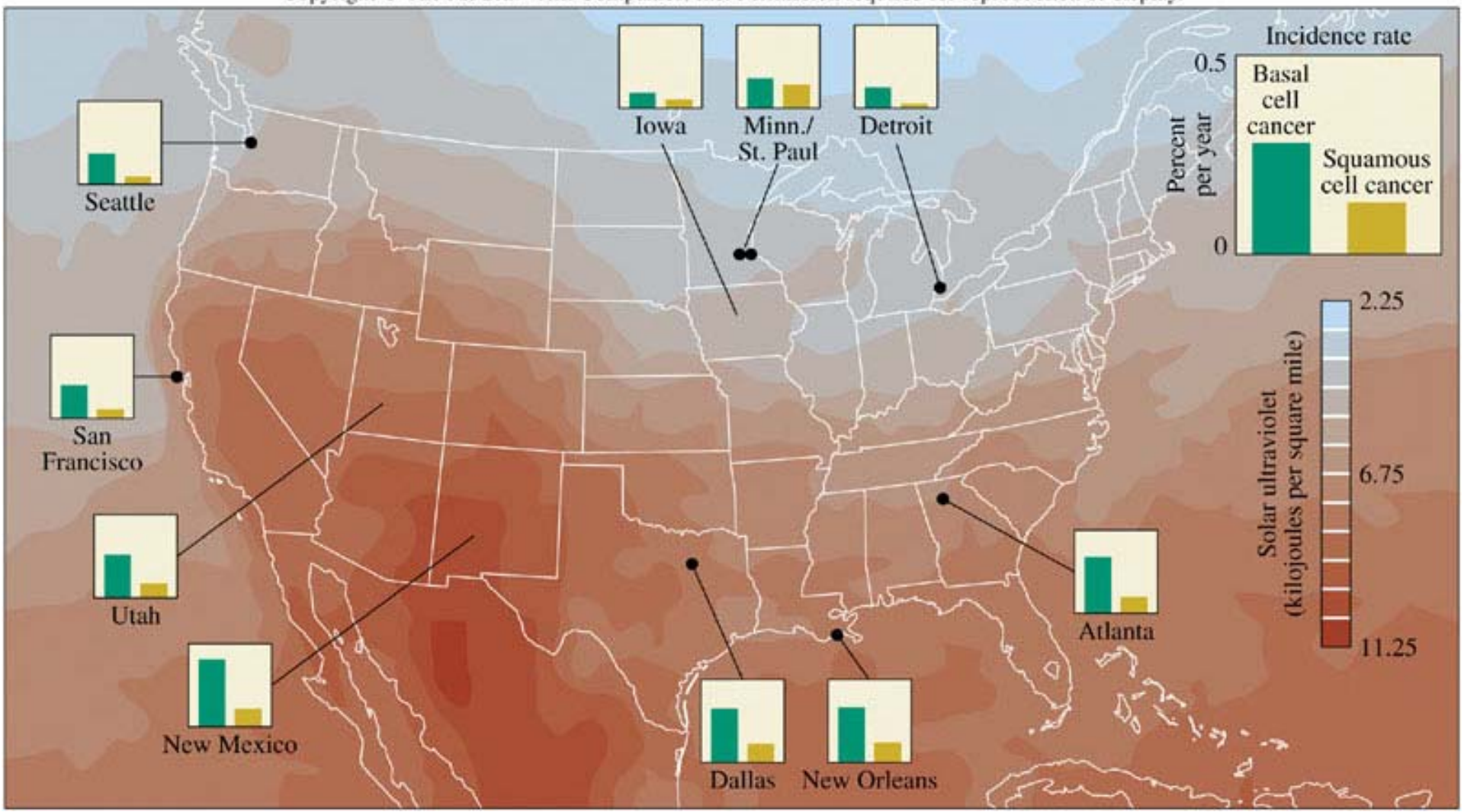
Melanin production

Sunburn

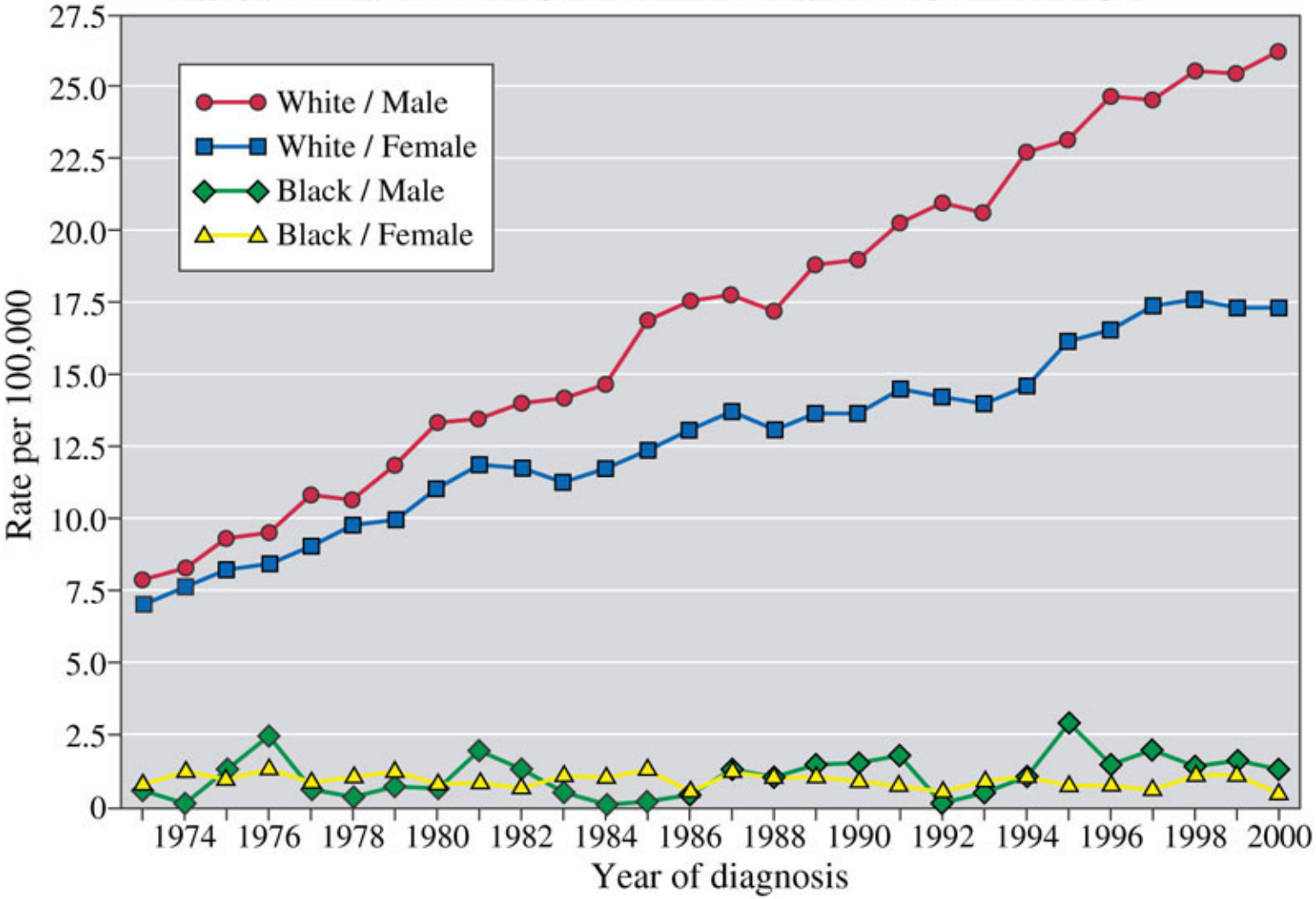
Premature skin aging

Skin cancer

Biological Effects of Ultraviolet Radiation

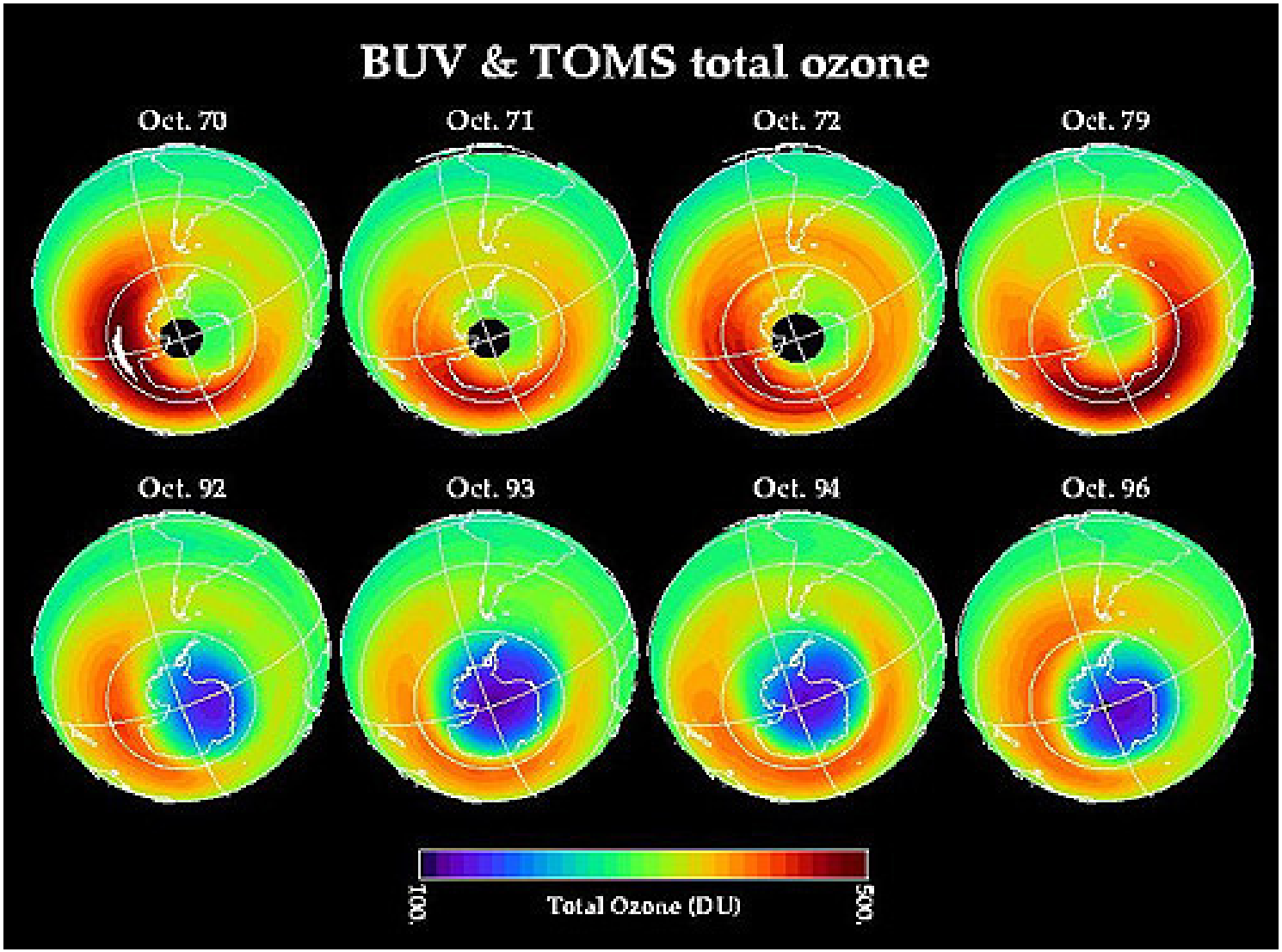


Biological Effects of Ultraviolet Radiation

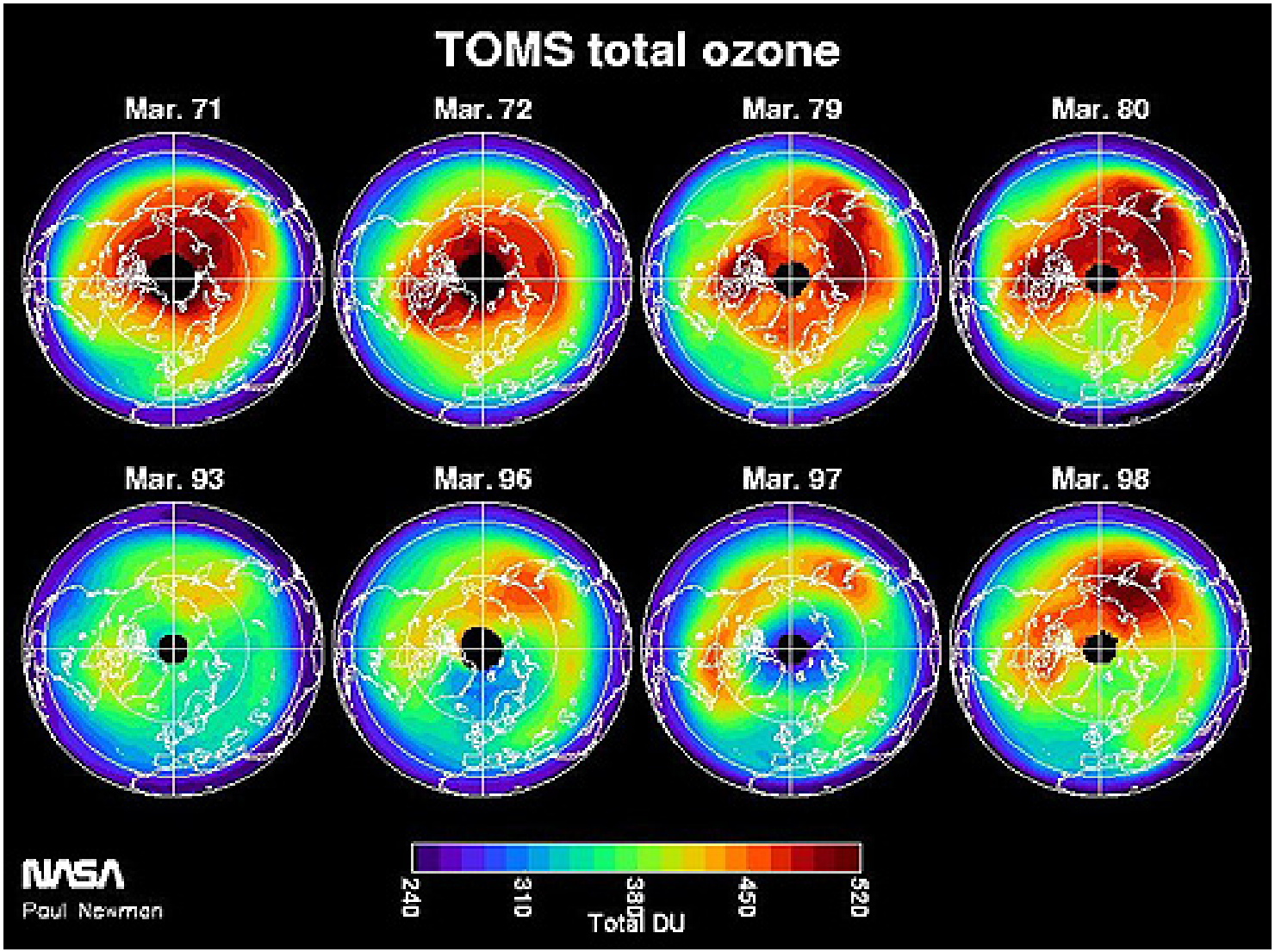


Scientists have determined that a given % reduction in O_3 concentration will produce twice that % increase in skin cancer

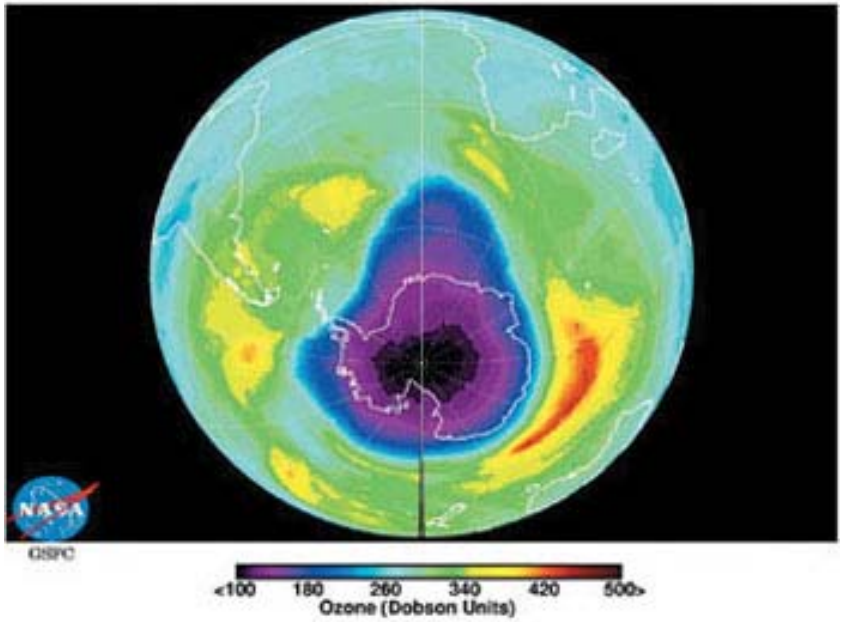
Polar Ozone Depletion – The “Ozone Hole”



Polar Ozone Depletion – The “Ozone Hole”

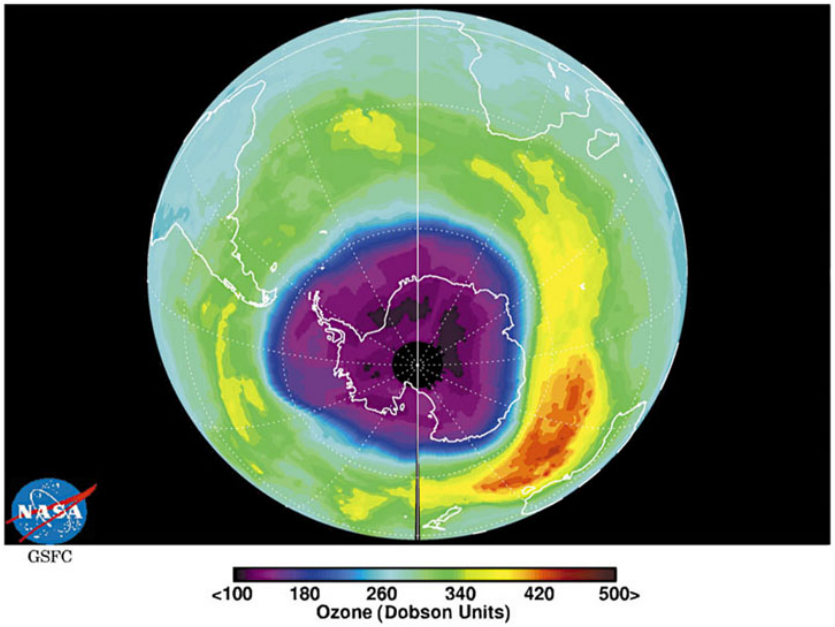


Earth Probe TOMS Total Ozone September 26, 2001
Area = 9.8 million miles² Minimum = 99 Dobson Units



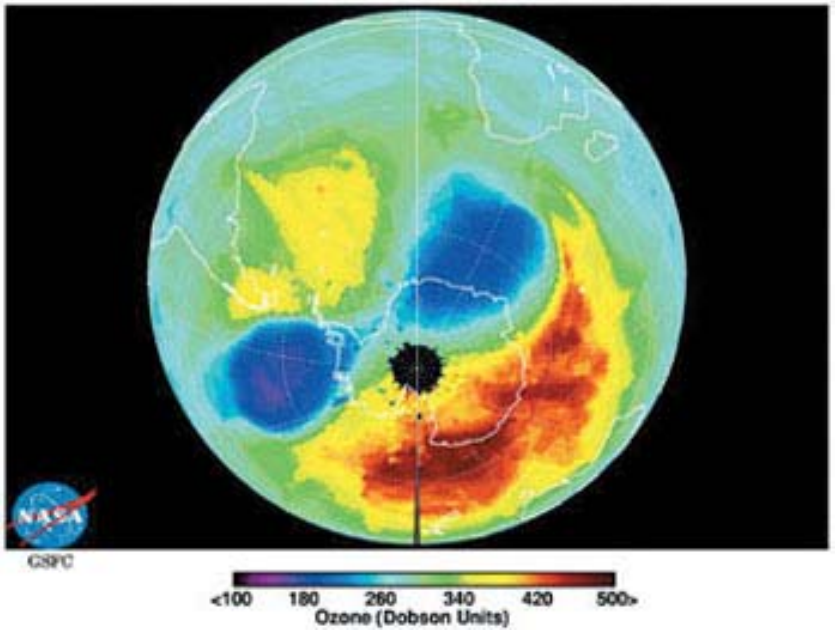
Sept. 2001

Earth Probe TOMS Total Ozone September 24, 2003
Area = 11.1 million miles² Minimum = 111 Dobson Units



Sept. 2003

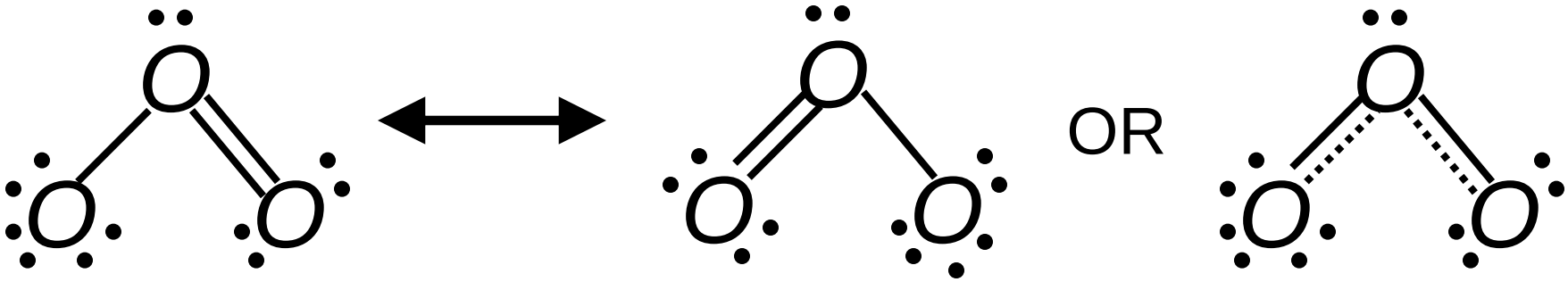
Earth Probe TOMS Total Ozone September 24, 2002
Area = 8.1 million miles² Minimum = 159 Dobson Units



Sept. 2002

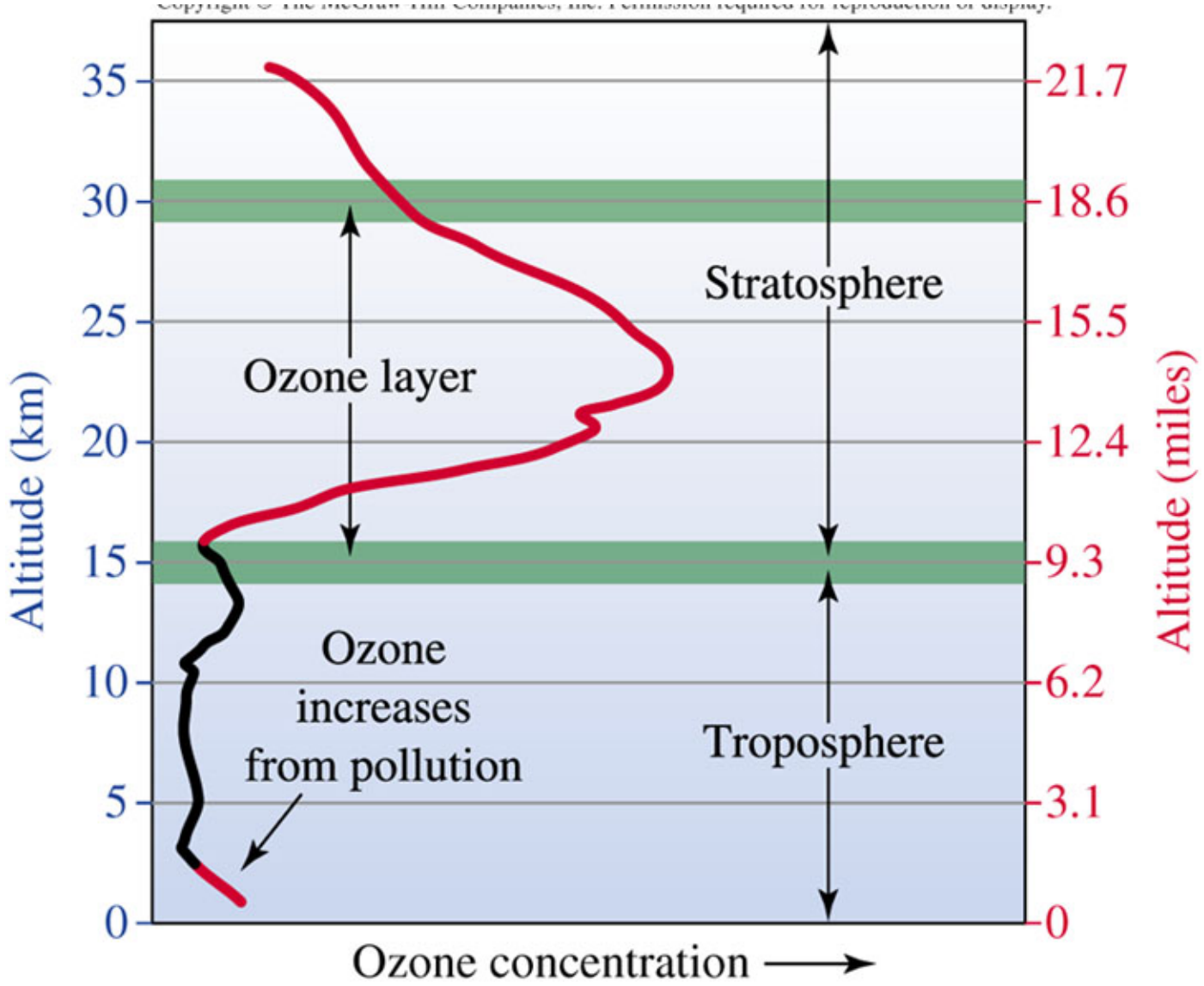
Ozone: What and Where Is It?

- Ozone, O_3, an allotrope of oxygen



Energy + 3 O_2 → 2 O_3

Ozone: What and Where Is It?



Ozone: What and Where Is It?

Table 2.4 Categories and Characteristics of UV Radiation

Radiation	Wavelength Range	Relative Energy	Comments
UV-A	320–400 nm	Least energetic of these three UV categories	Least damaging, reaches Earth's surface in greatest amount
UV-B	280–320 nm	More energetic than UV-A, less energetic than UV-C	More damaging than UV-A, less damaging than UV-C, most absorbed by ozone in the stratosphere
UV-C	200–280 nm	Most energetic of these three categories	Most damaging of these three, but not a problem because totally absorbed by oxygen and ozone in stratosphere

The Oxygen/Ozone Screen

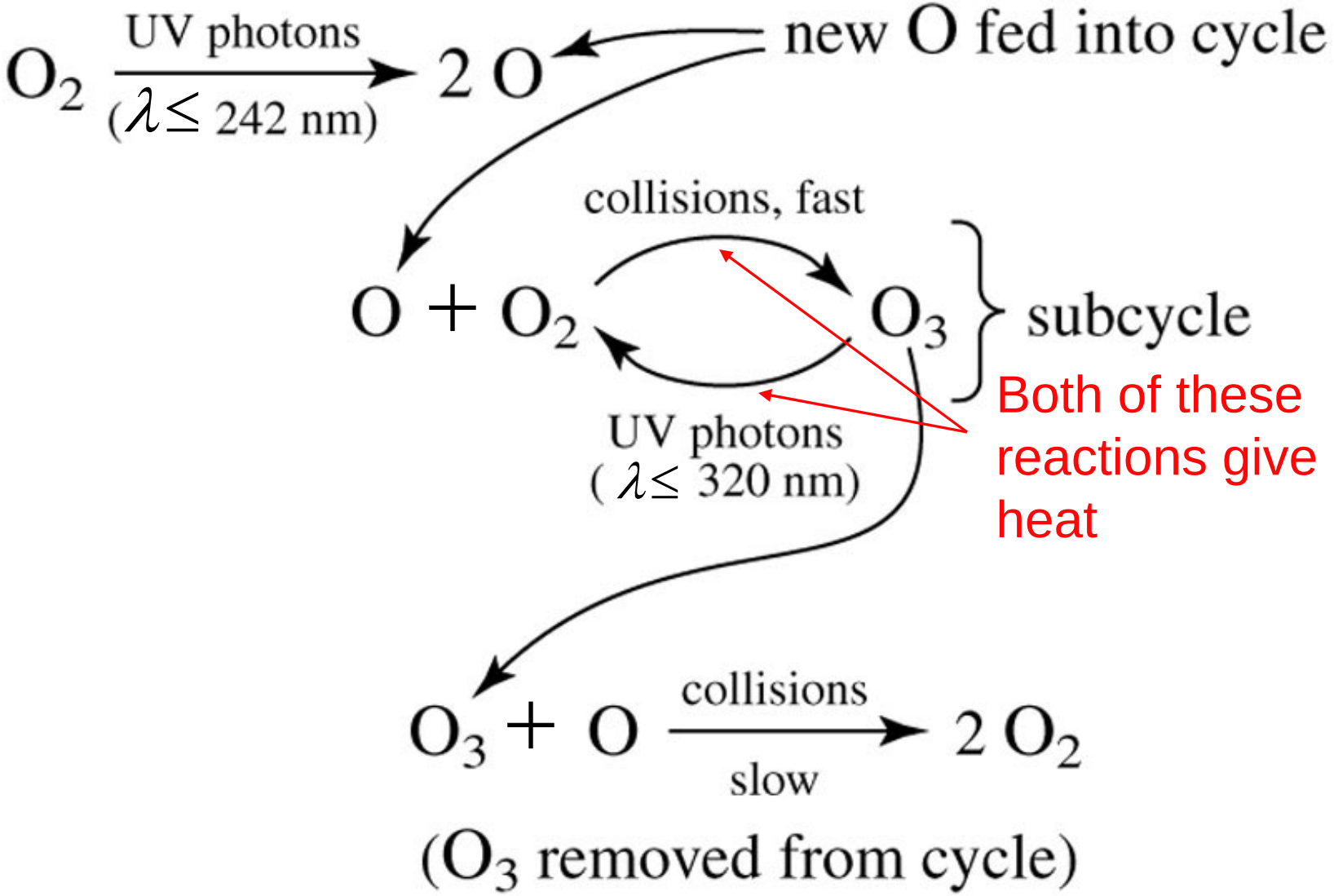
$$O_2 \xrightarrow{\lambda \leq 242\,nm} 2O$$

$$O_3 \xrightarrow{\lambda \leq 320\,nm} O_2 + O$$

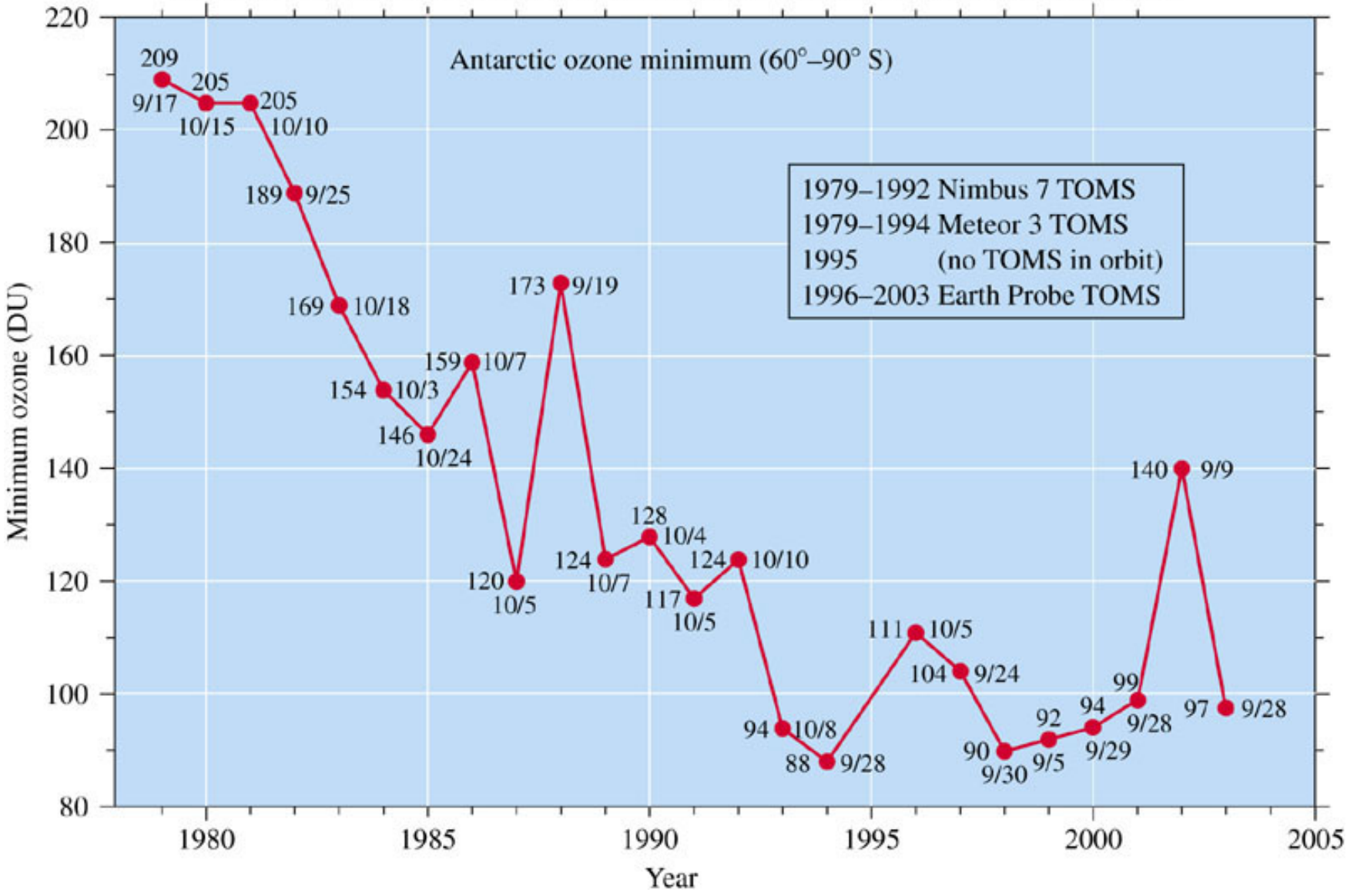
The Oxygen/Ozone Screen

- These two reactions occurring in the stratosphere effectively filter the most dangerous wavelengths of UV radiation.
- Ozone in the stratosphere is continuously being created and destroyed
- Steady State
  - A condition in which a dynamic system is in balance so that there is no net change in concentration of the major species involved.
- Chapman cycle

The Chapman Cycle



Stratospheric Ozone Destruction – A Polar Phenomenon



Stratospheric Ozone Destruction – Also A Global Phenomenon