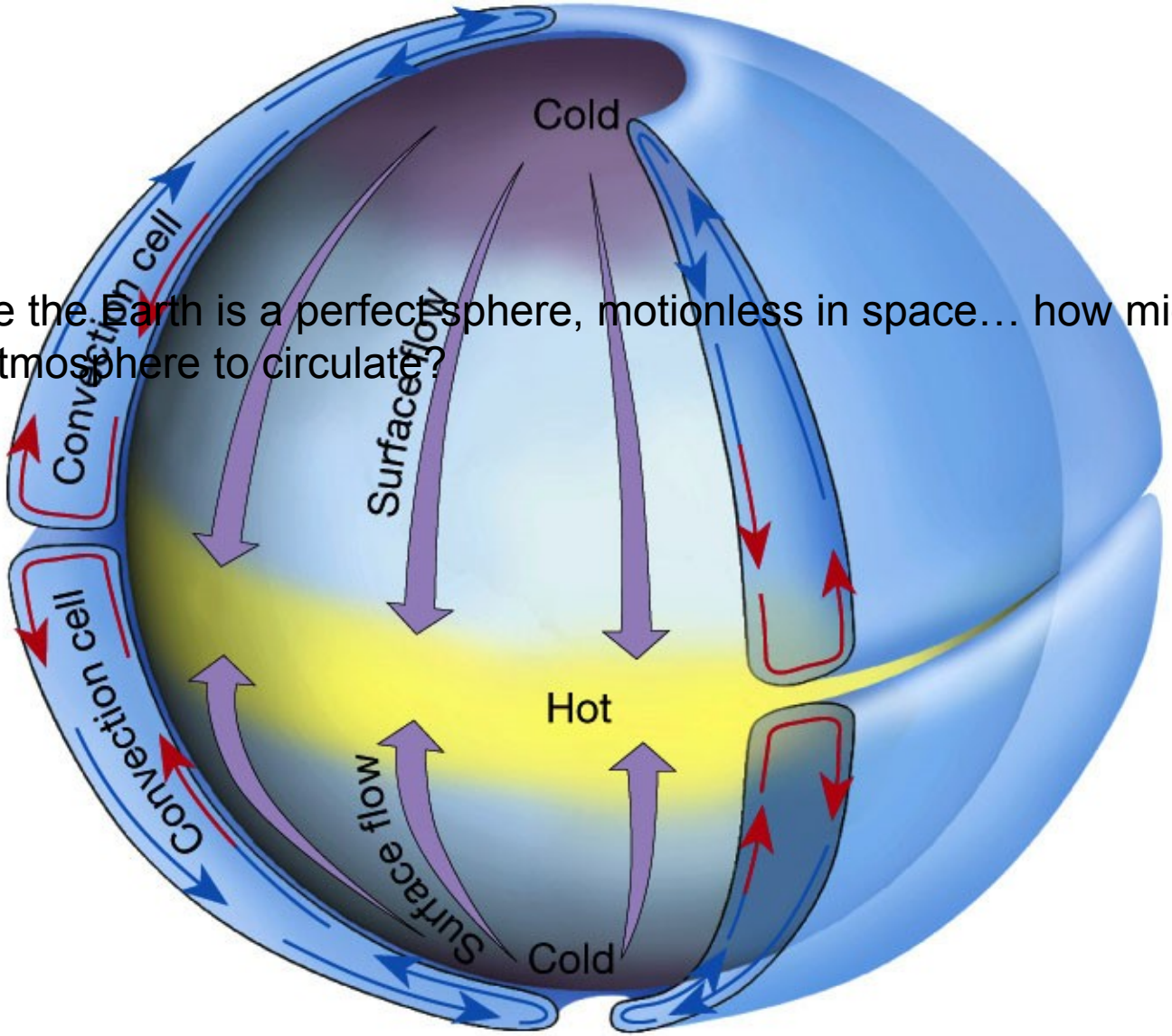
Chemistry 471/671

The Structure of the Earth's Atmosphere

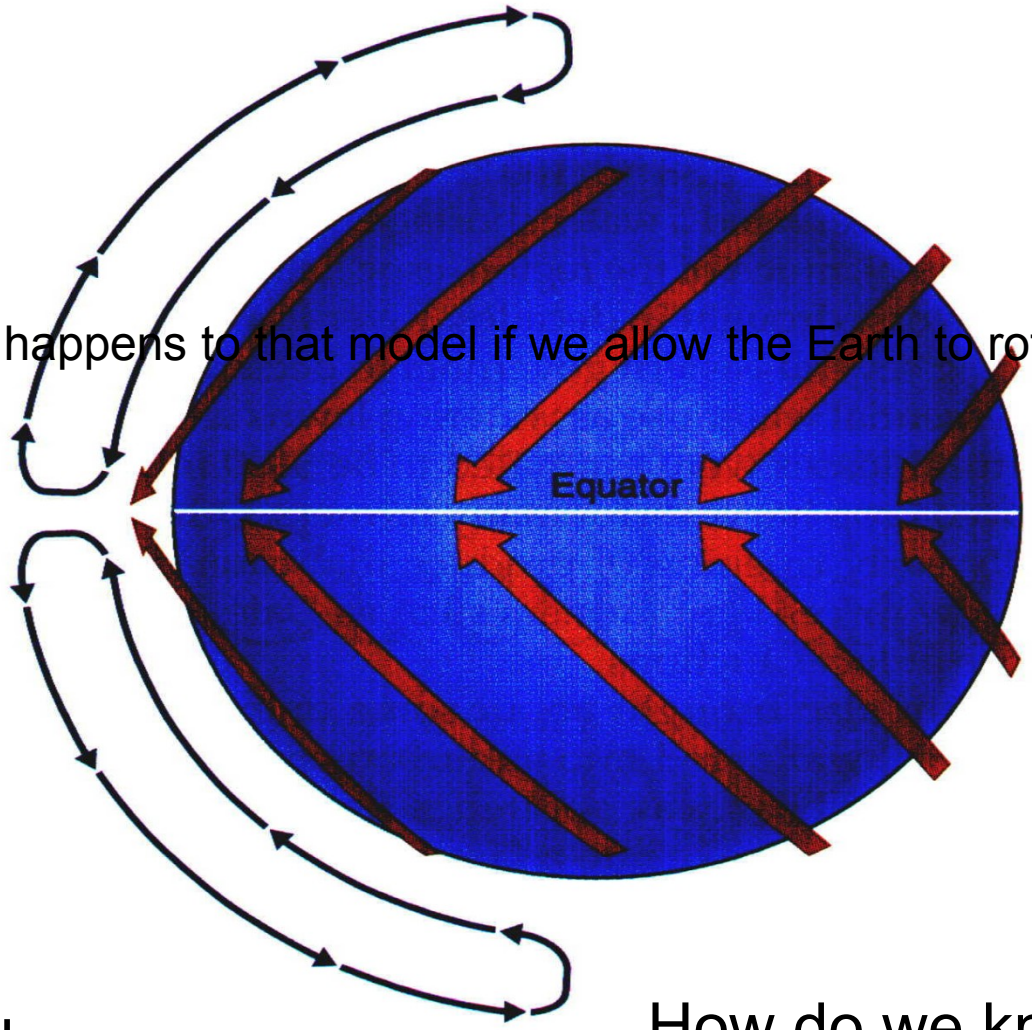
Atmospheric Circulation

If we assume the Earth is a perfect sphere, motionless in space… how might we expect the atmosphere to circulate?



Atmospheric Circulation

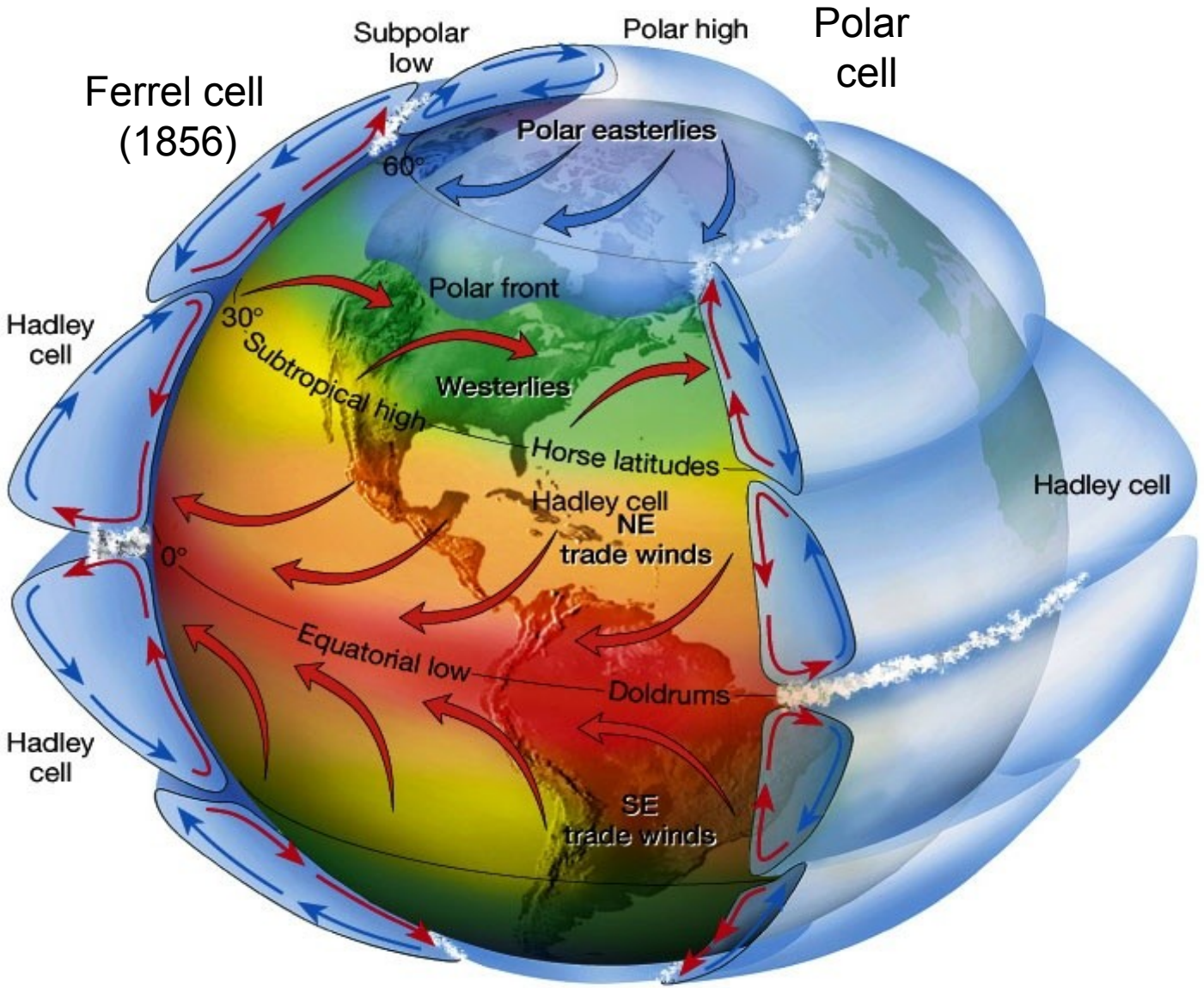
What happens to that model if we allow the Earth to rotate?



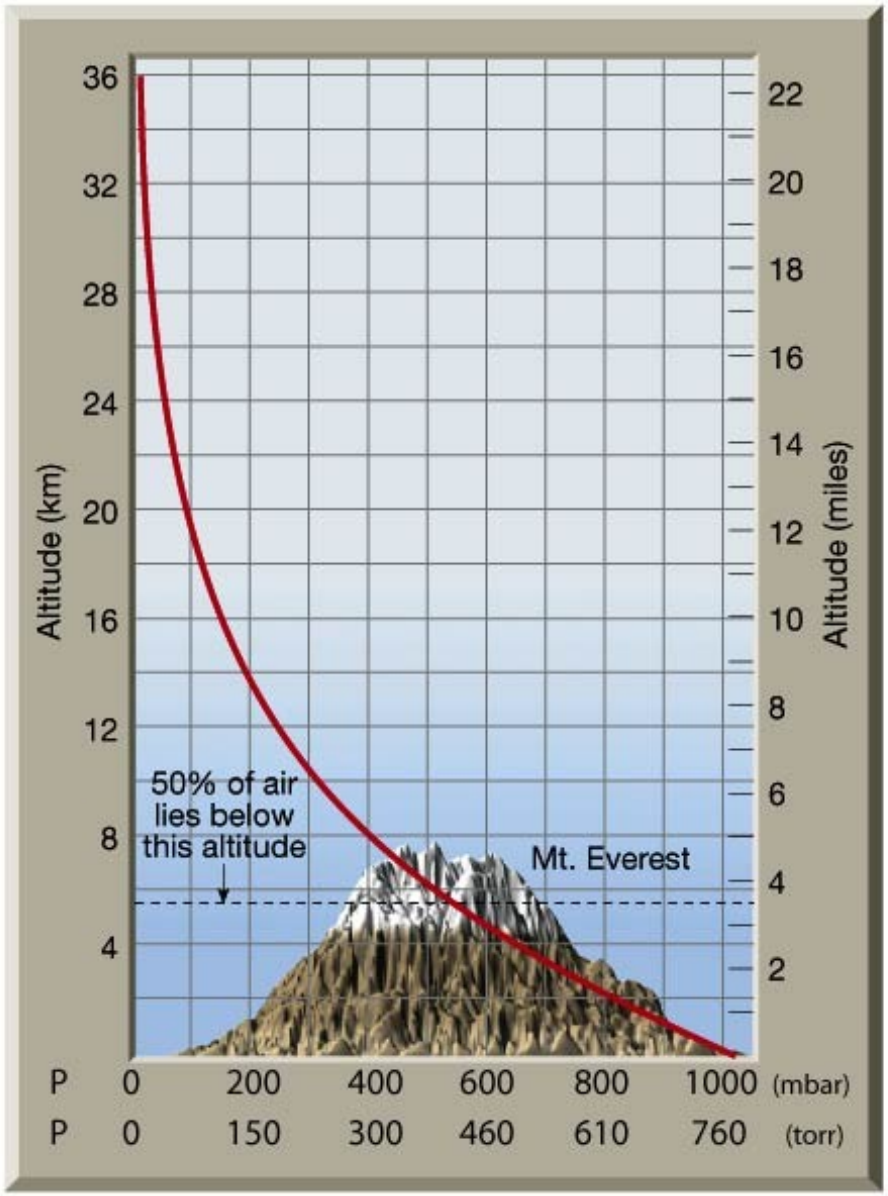
As proposed by
Geoffrey Hadley, 1735

How do we know that this model is wrong?

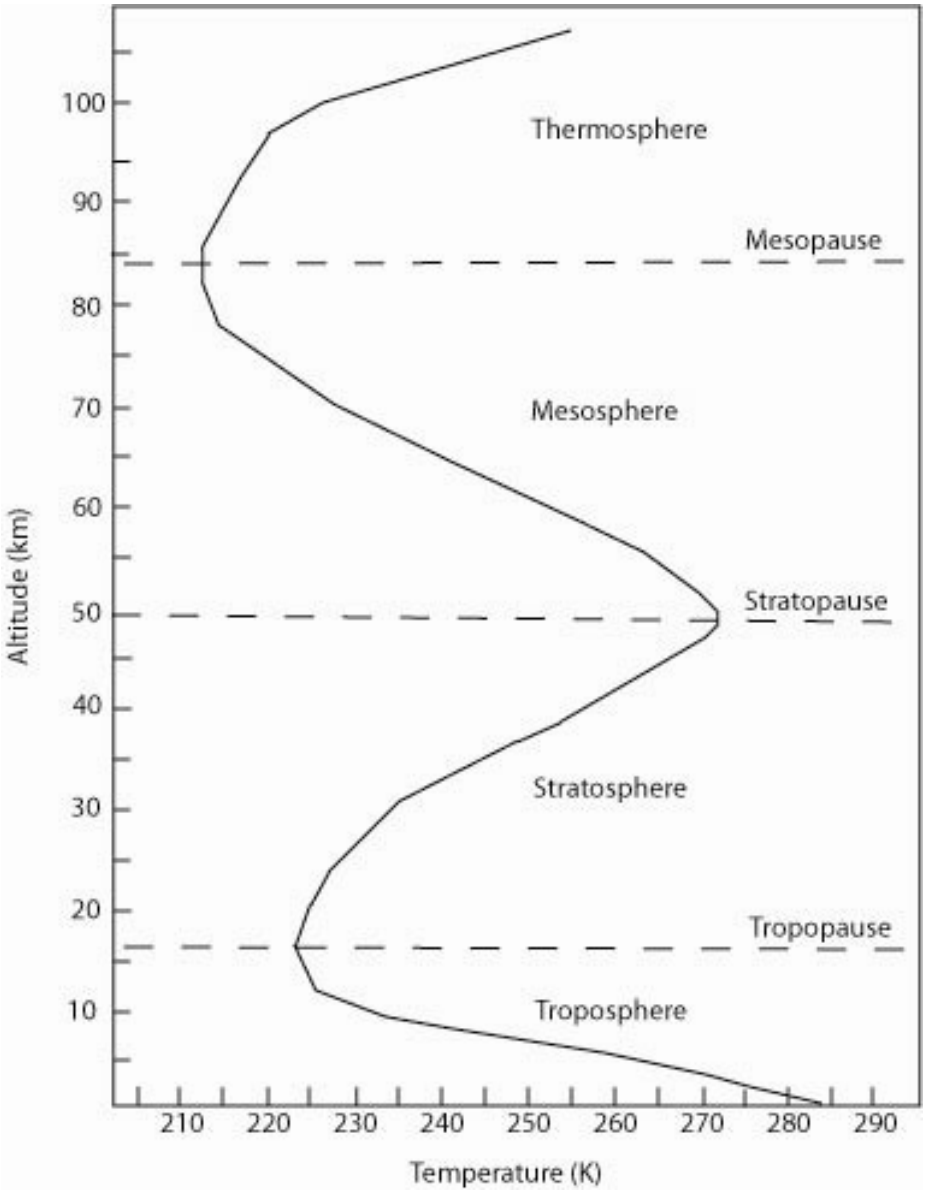
Atmospheric Circulation

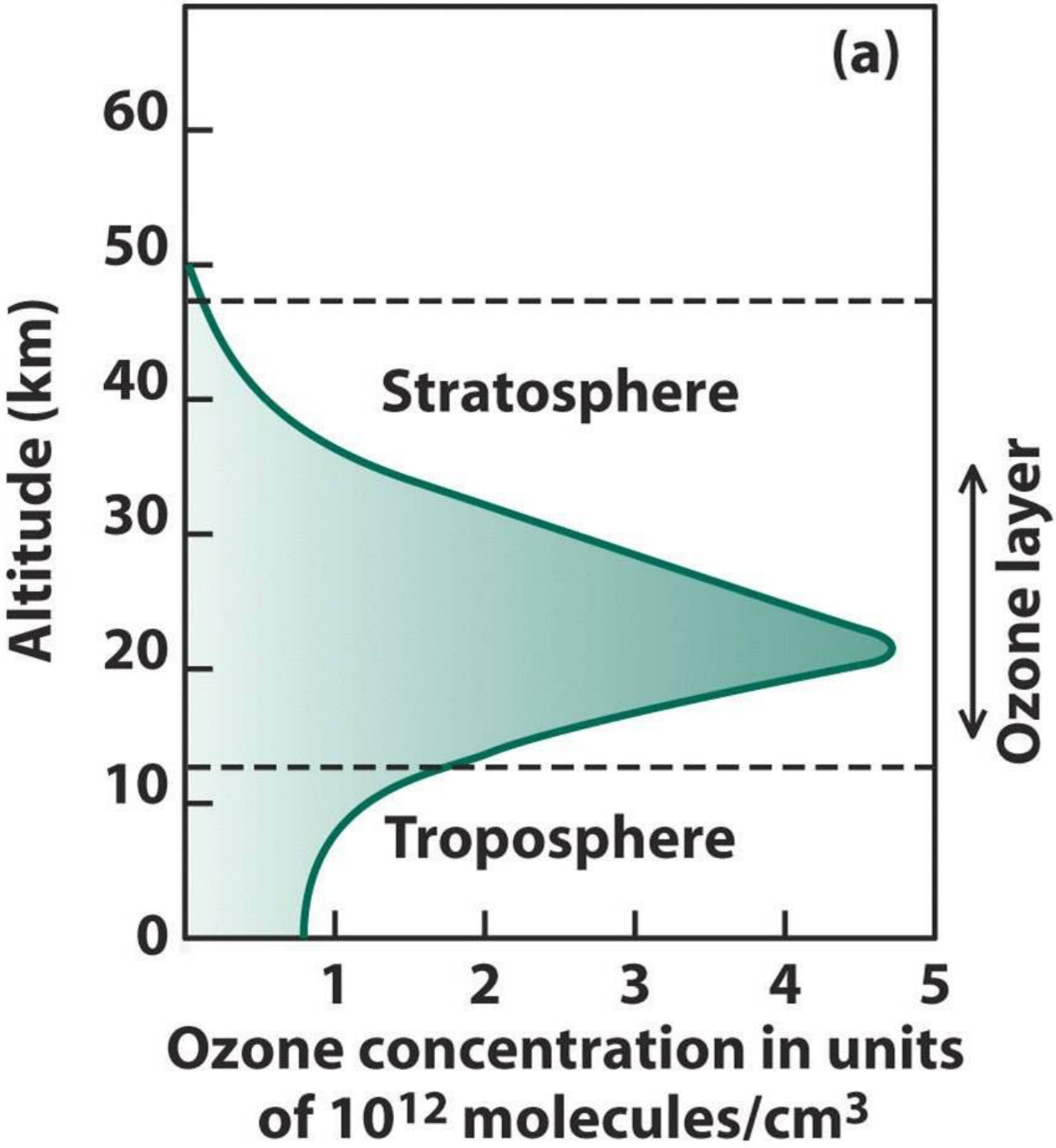


Vertical Structure of the Atmosphere - Pressure



Vertical Structure of the Atmosphere - Temperature




(a)
60
50
40
30
20
10
0
Altitude (km)
Stratosphere
Troposphere
Ozone layer
1
2
3
4
5
Ozone concentration in units of 10^{12} molecules/cm^3

The Chapman Mechanism

$$O_2 + h\nu\ (\lambda < 245nm) \rightarrow 2\ O(^1D)$$

$$O(^1D) + O_2 + M \rightarrow O_3 + M$$ *Exothermic*

$$O(^1D) + O_3 \rightarrow 2\ O_2$$

$$O_3 + h\nu\ (\lambda < 320nm) \rightarrow O(^1D) + O_2(^1\Delta_g)$$ *Exothermic*

How does this mechanism explain the highly localized ozone layer?

Absorption Spectrum of O_2

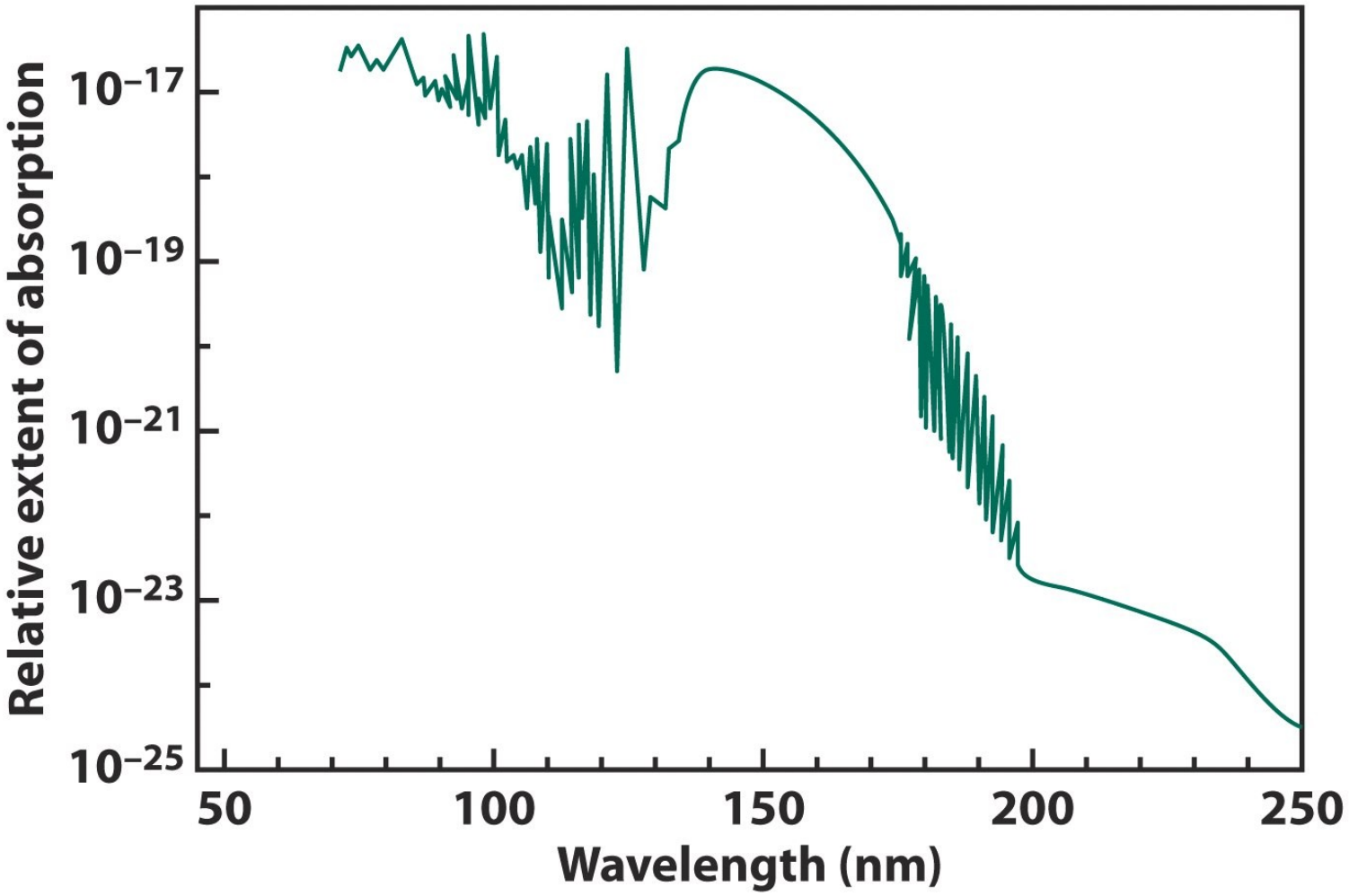


Figure 1-7
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Absorption Spectrum of O_3

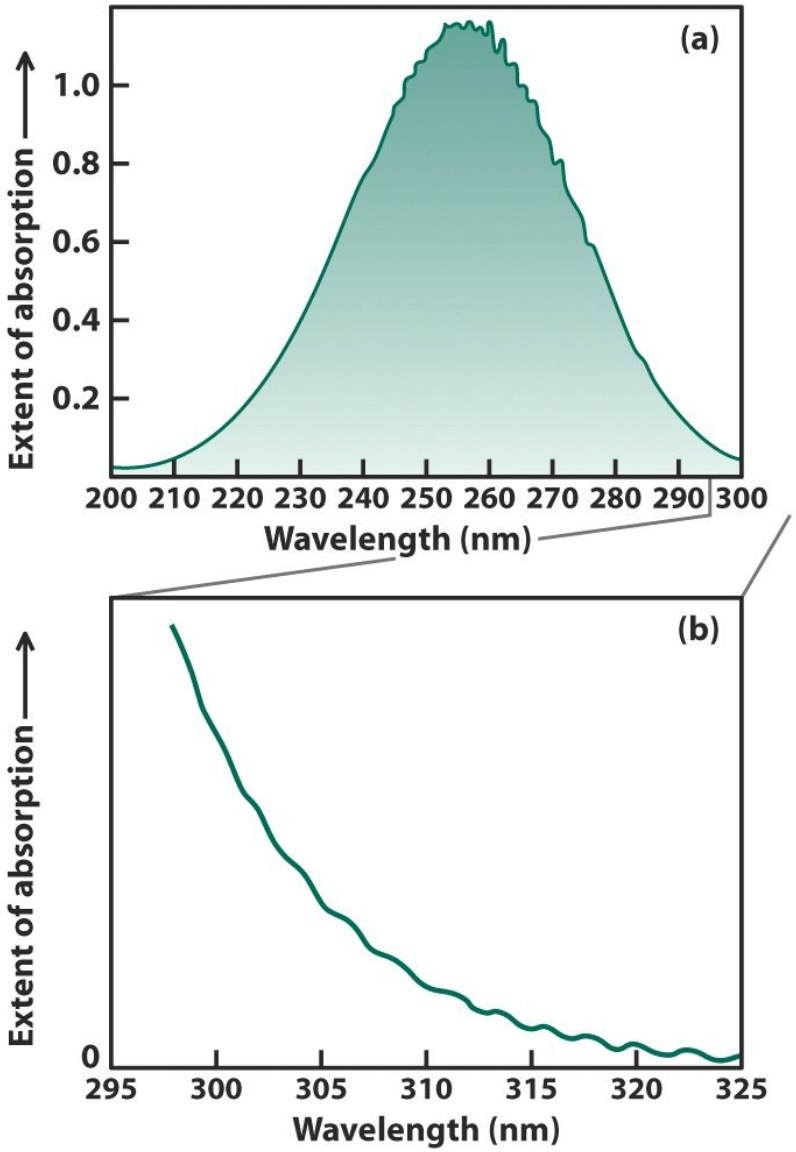

Figure 1-8
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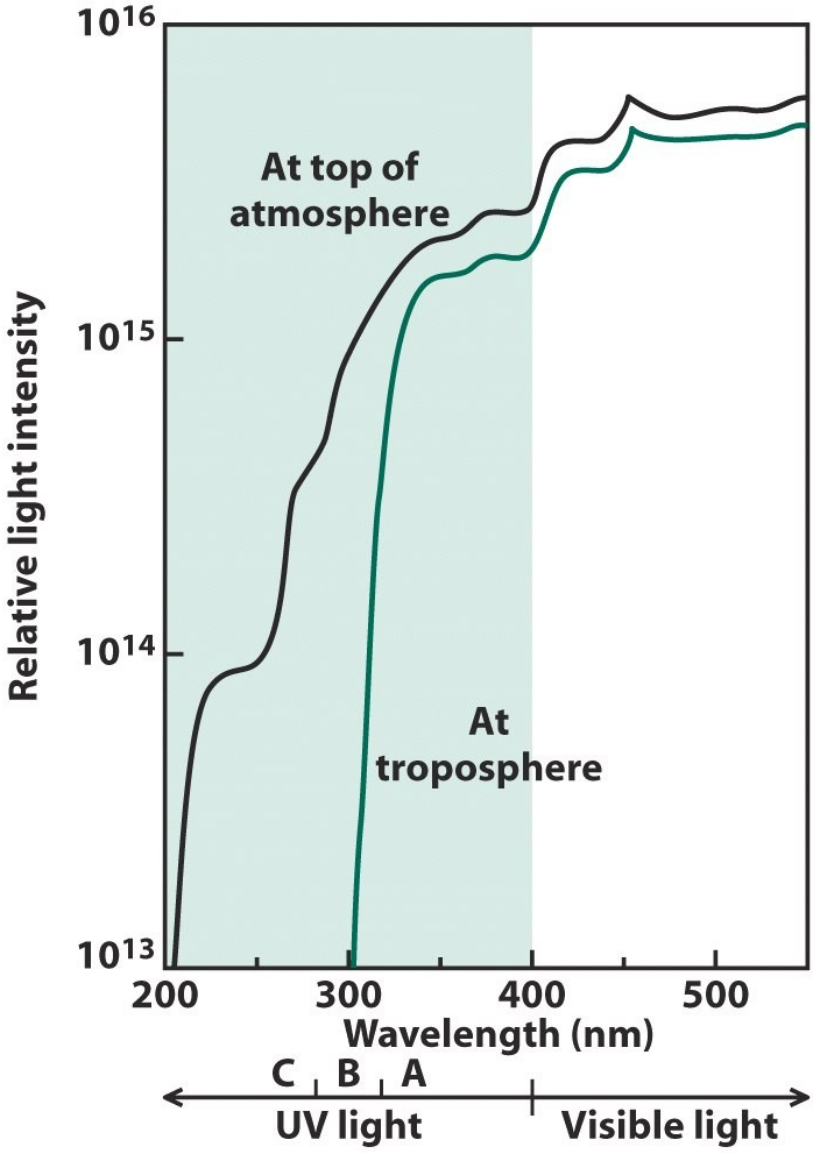
Actinic Flux



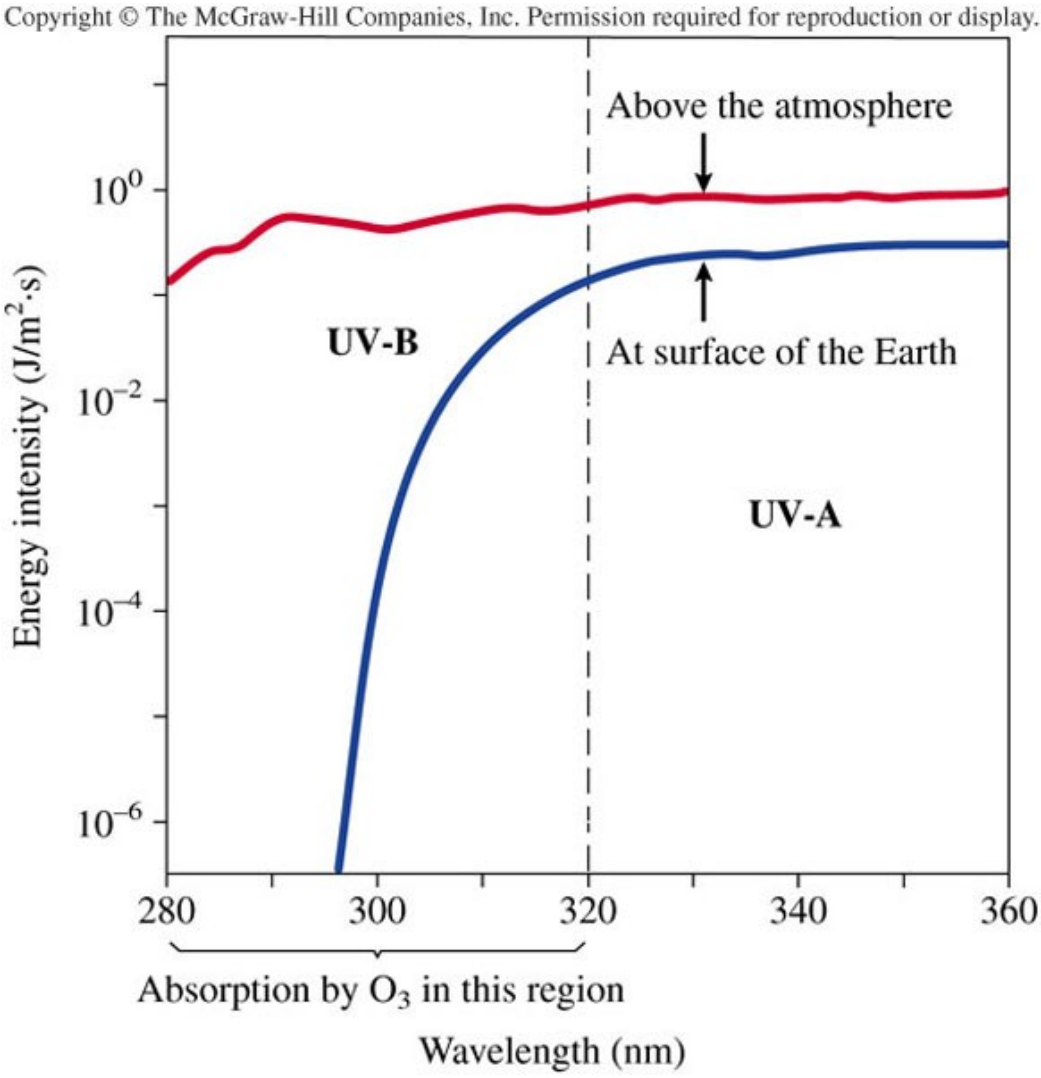


Figure 1-9
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Absorption Spectrum of Human DNA

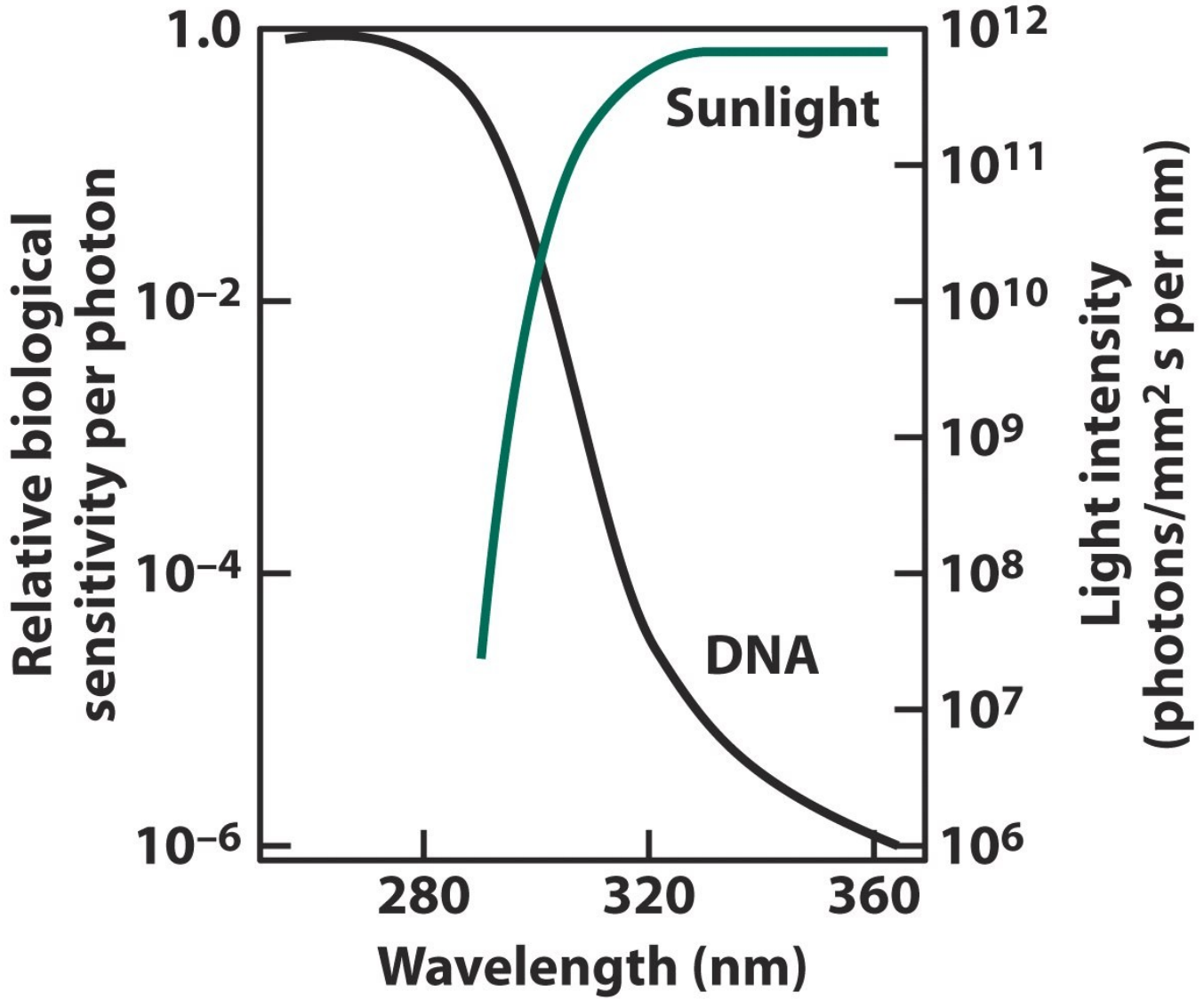

Figure 1-10
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Incidence of Nonmelanoma Skin Cancer

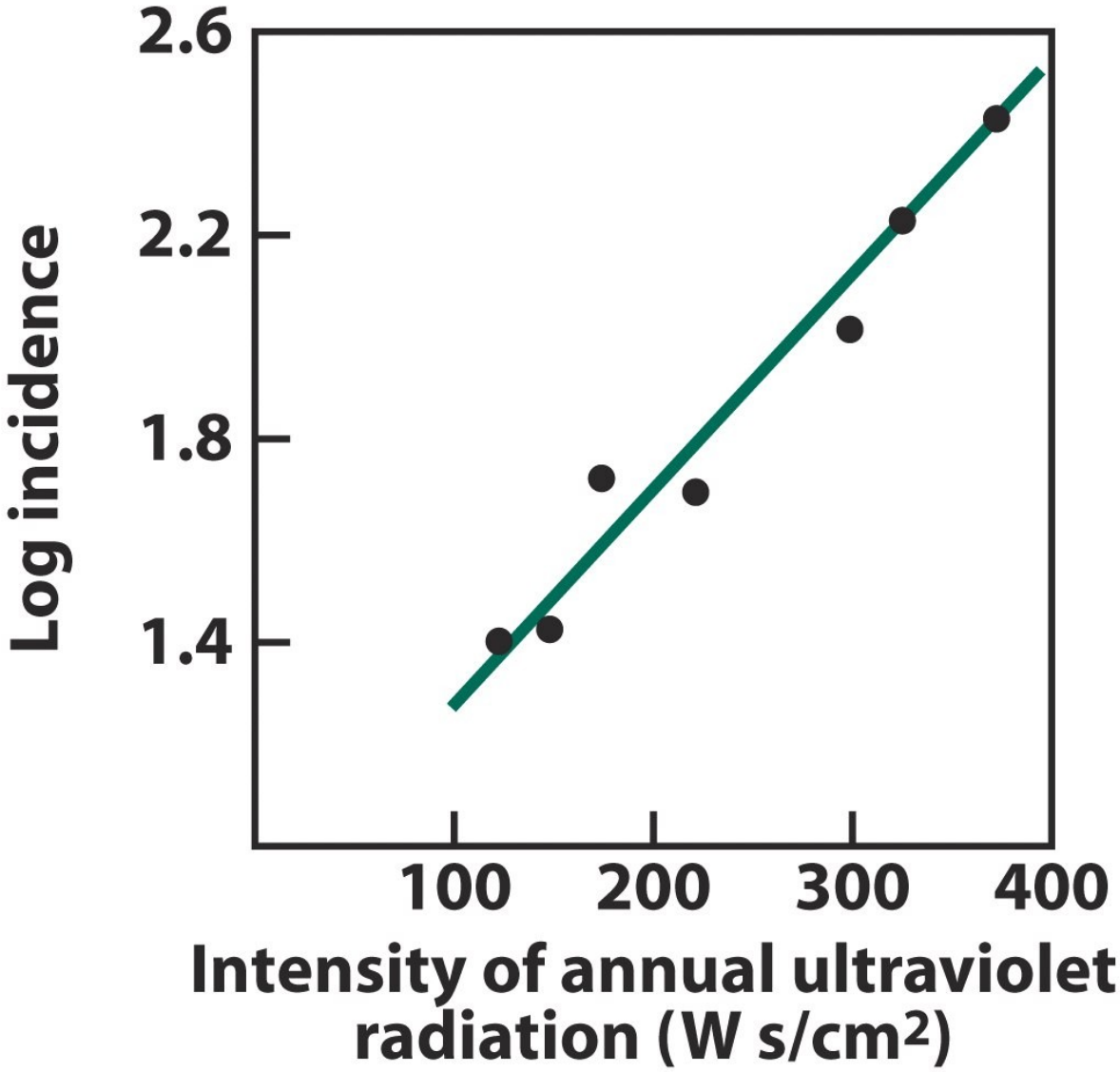

Figure 1-11
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Atmospheric Structure

- *Altitude* within the Earth's atmosphere is a variable which implies specific correlations with pressure, temperature, and solar flux.
- While there is generally significant mixing within the troposphere, there is little transport across the equator.
- While there is generally significant mixing within the troposphere, there is little transport across the tropopause, and little mixing within the stratosphere.

This implies that the chemistry of the troposphere and the chemistry of the stratosphere are largely independent!