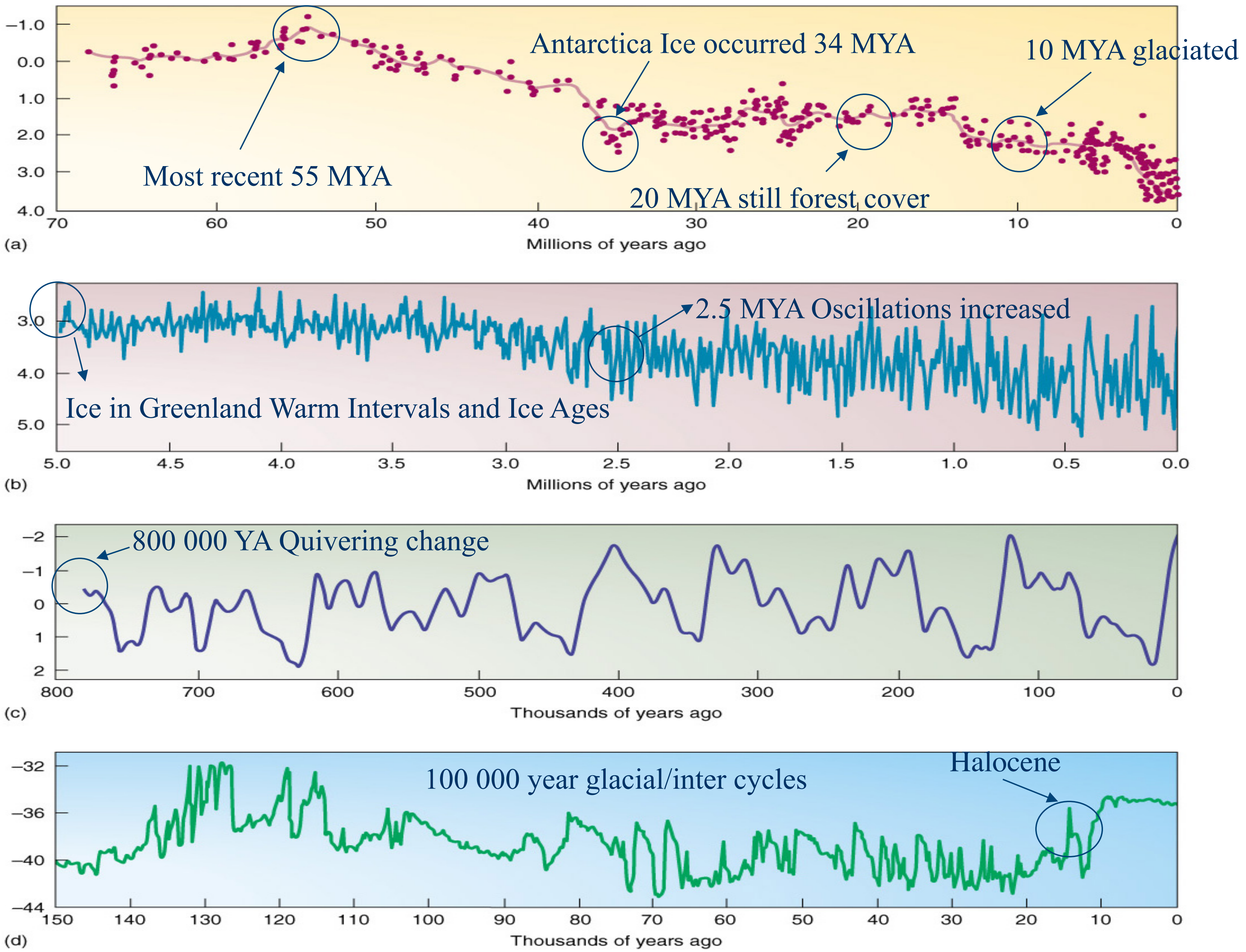
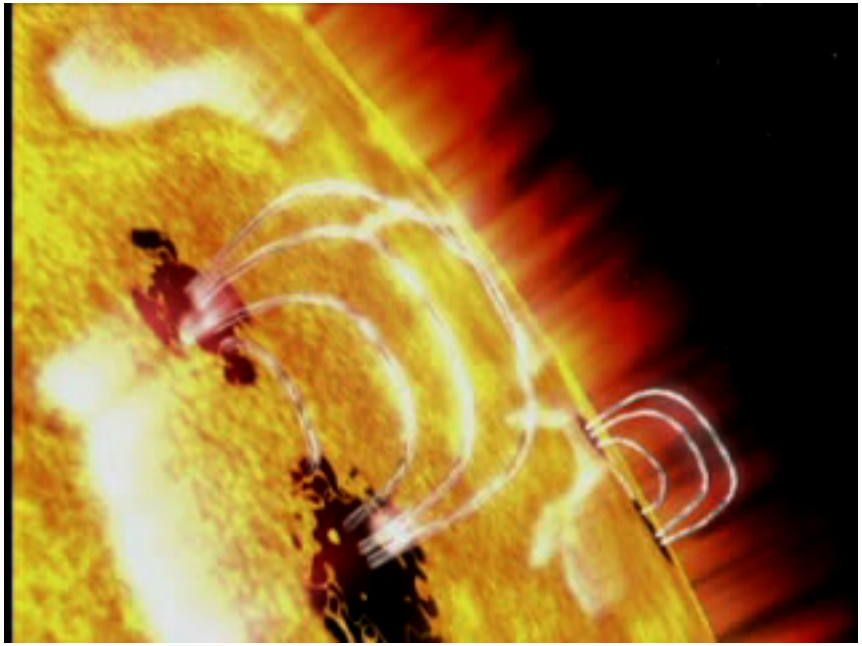
Chapter 2: Energy Flows and Ecosystems

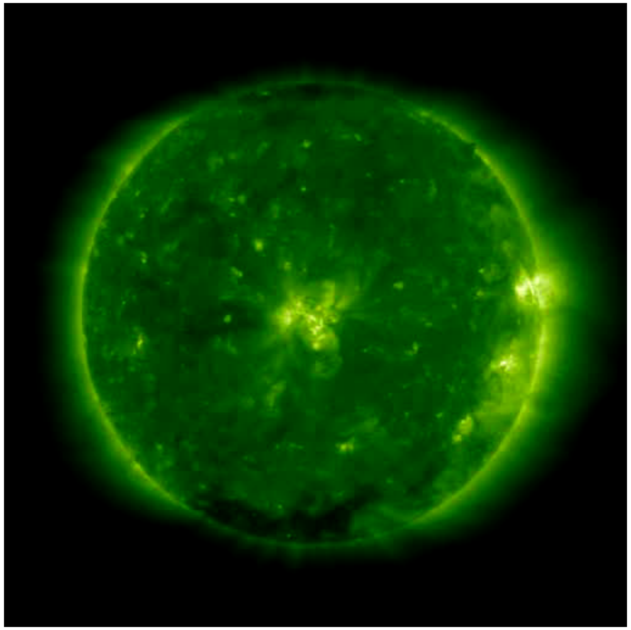
Indicators of Recent Climate Change



Potential Factors of Climatic Change

•Variations in Solar Output - changes on the order of 0.1–0.2% due to sunspot activities (cold spots oscillate along an 11-year cycle)





A sunspot is a dark part of the sun's surface that is cooler than the surrounding area. It is cooler because of a strong magnetic field that inhibits the transport of heat via convective motion in the sun. The magnetic field is formed below the sun's surface, and extends out into the sun's corona."

Solar Constant

- The intensity of electromagnetic radiation is not reduced with distance through the vacuum of space
- A reduction of intensity is proportional to increasing distance only as energy is distributed over a larger area
- Due to this, radiation intensity decreases in proportion to the distance squared (***inverse square law***)

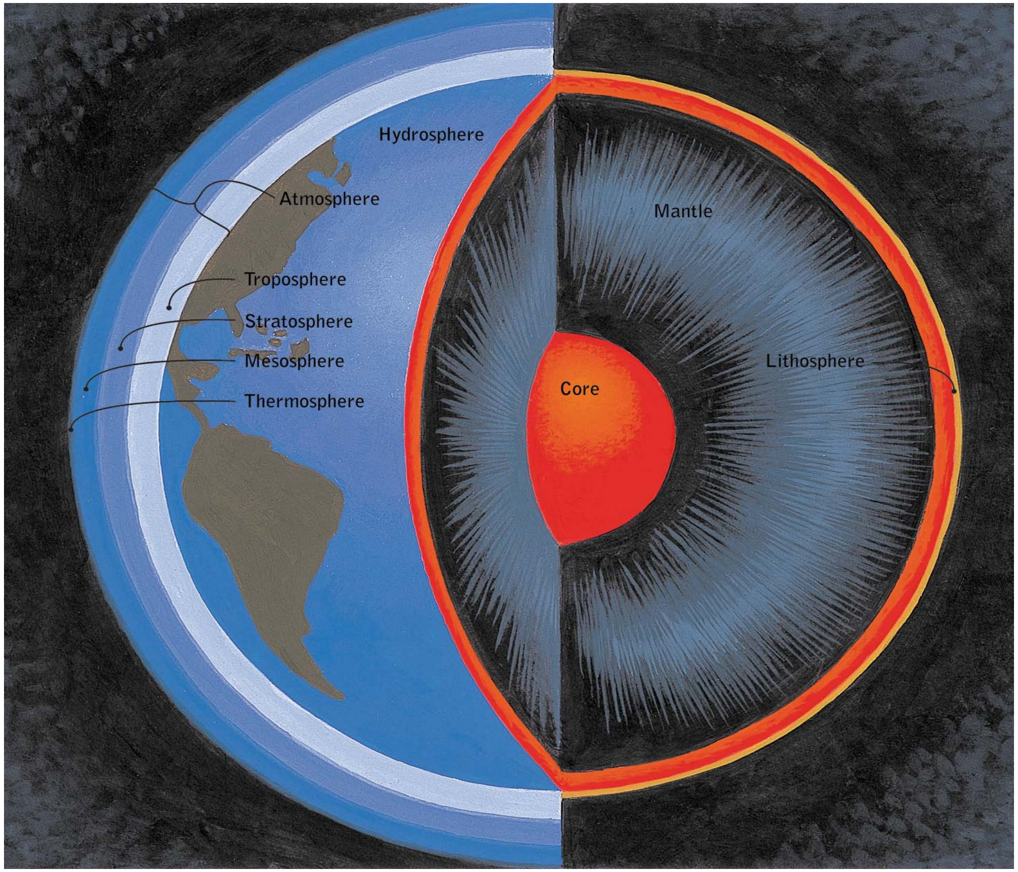
Causes of the Earth's Seasons

– Variations in the relationship between Earth's orbital alignment and the Sun are responsible for variations in incoming solar radiation at Earth's surface

1. Revolution
2. Earth's Rotation

a) Solar Angle
b) Period of Daylight
c) Beam depletion
d) Changes in energy receipt with latitude

PART B: Earth's Ecosphere



Chapters 1,2 and 3 provide a basic overview of the main processes that maintain the planetary life support system

We are most concerned with the outer layer, the ***ecosphere,*** about 20km containing 30 million organisms

- **The Atmosphere:** A mixture of gas molecules, microscopically small suspended particles of solid and liquid, and falling precipitation

Residency time = molecule mass / by exchange rate

- Homosphere and Heterosphere (Gas Layers)
- Permanent and Variable Gases

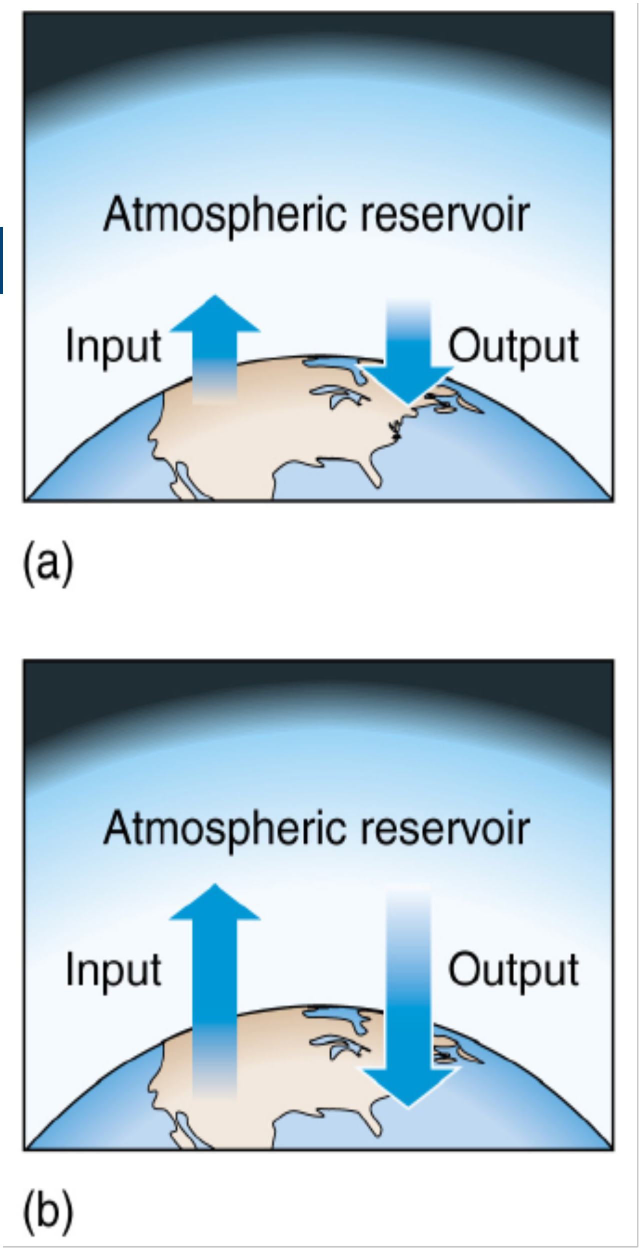


Table 1–1 Permanent Gases of the Atmosphere

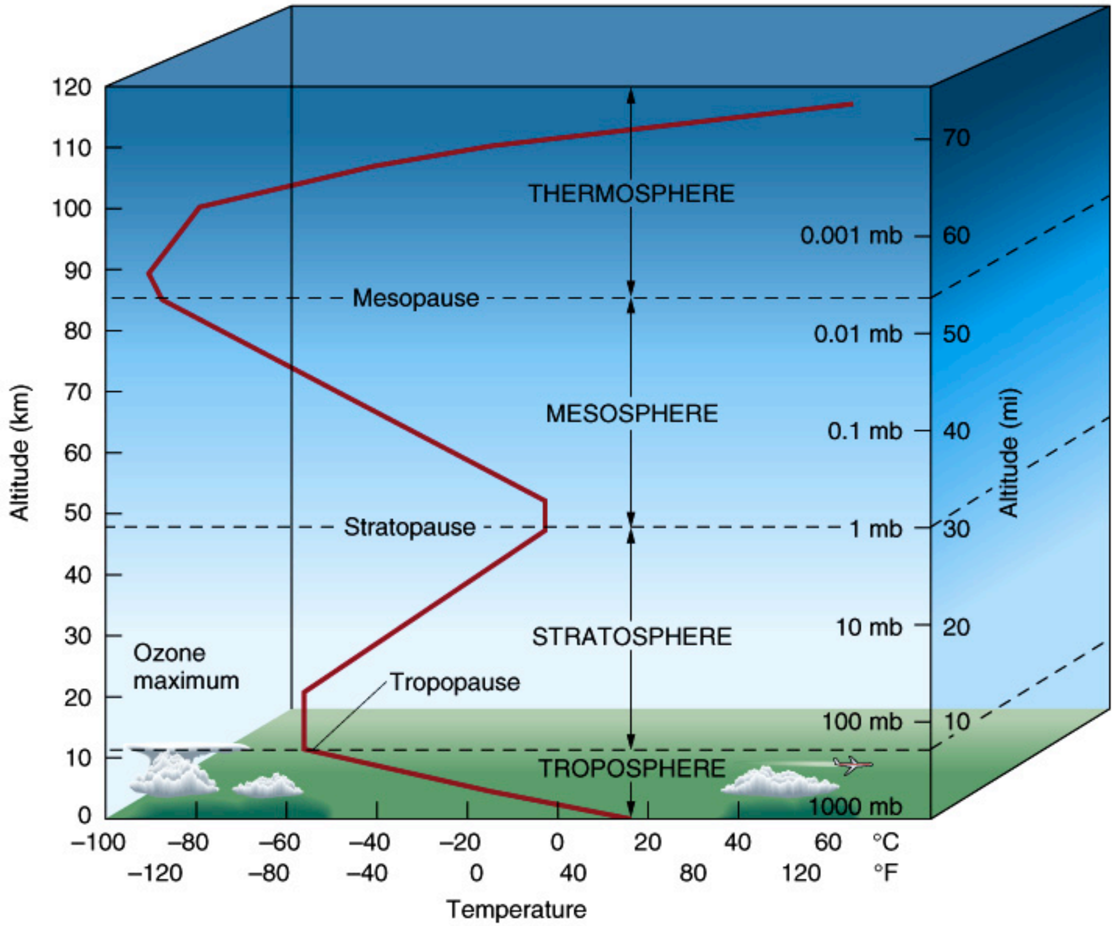
Constituent	Formula	Percent by Volume	Molecular Weight
Nitrogen	N_2	78.08	28.01
Oxygen	O_2	20.95	32.00
Argon	Ar	0.93	39.95
Neon	Ne	0.002	20.18
Helium	He	0.0005	4.00
Krypton	Kr	0.0001	83.8
Xenon	Xe	0.00009	131.3
Hydrogen	H_2	0.00005	2.02

Table 1–2 Variable Gases of the Atmosphere

Constituent	Formula	Percent by Volume	Molecular Weight
Water Vapor	H_2O	0.25	18.01
Carbon Dioxide	CO_2	0.036	44.01
Ozone	O_3	0.01	48.00

– Thermal Layers of the Atmosphere

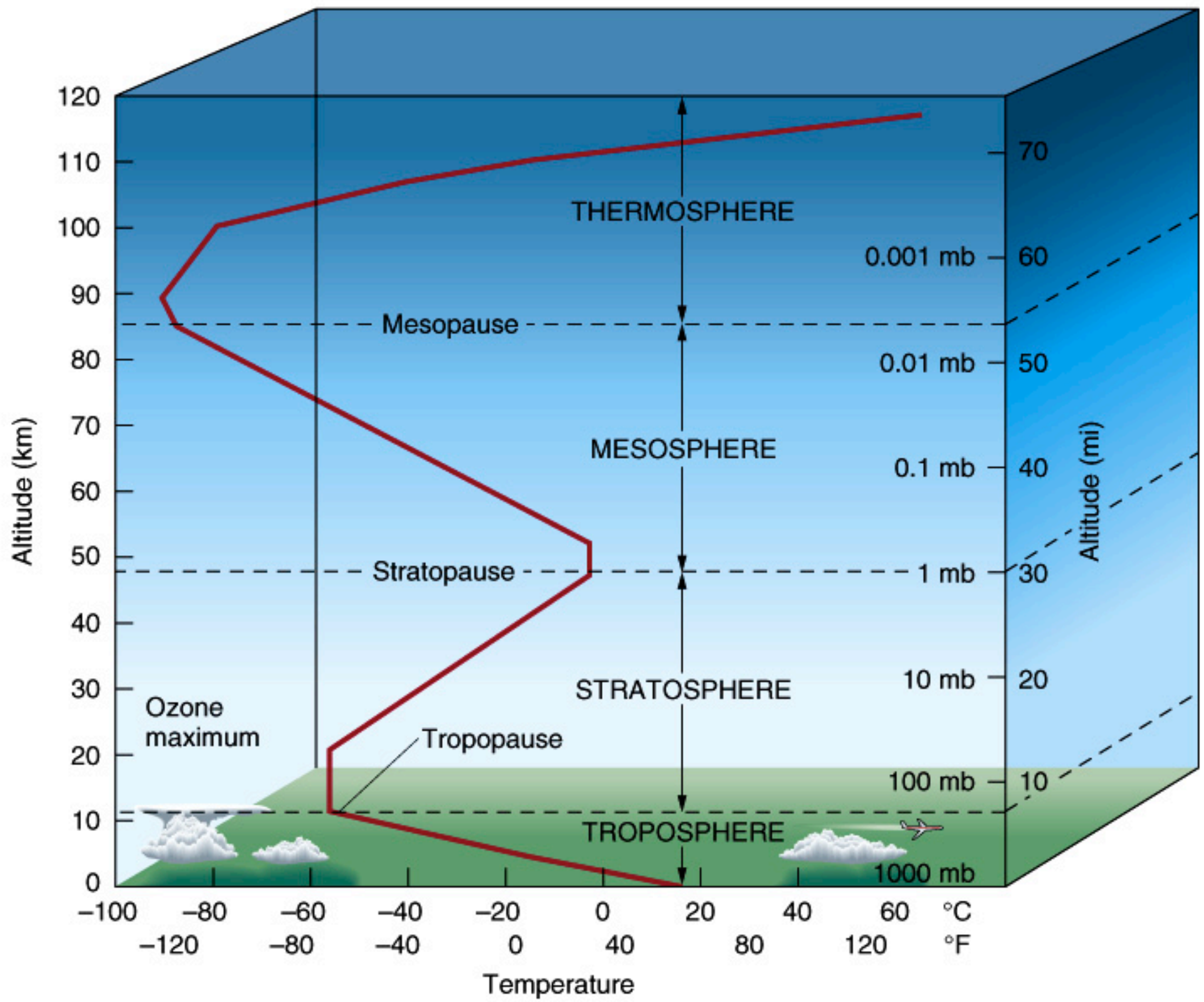
- Four distinct layers of the atmosphere emerge from identifiable temperature characteristics with height



Troposphere

Identified by a steady temperature decrease with height decrease

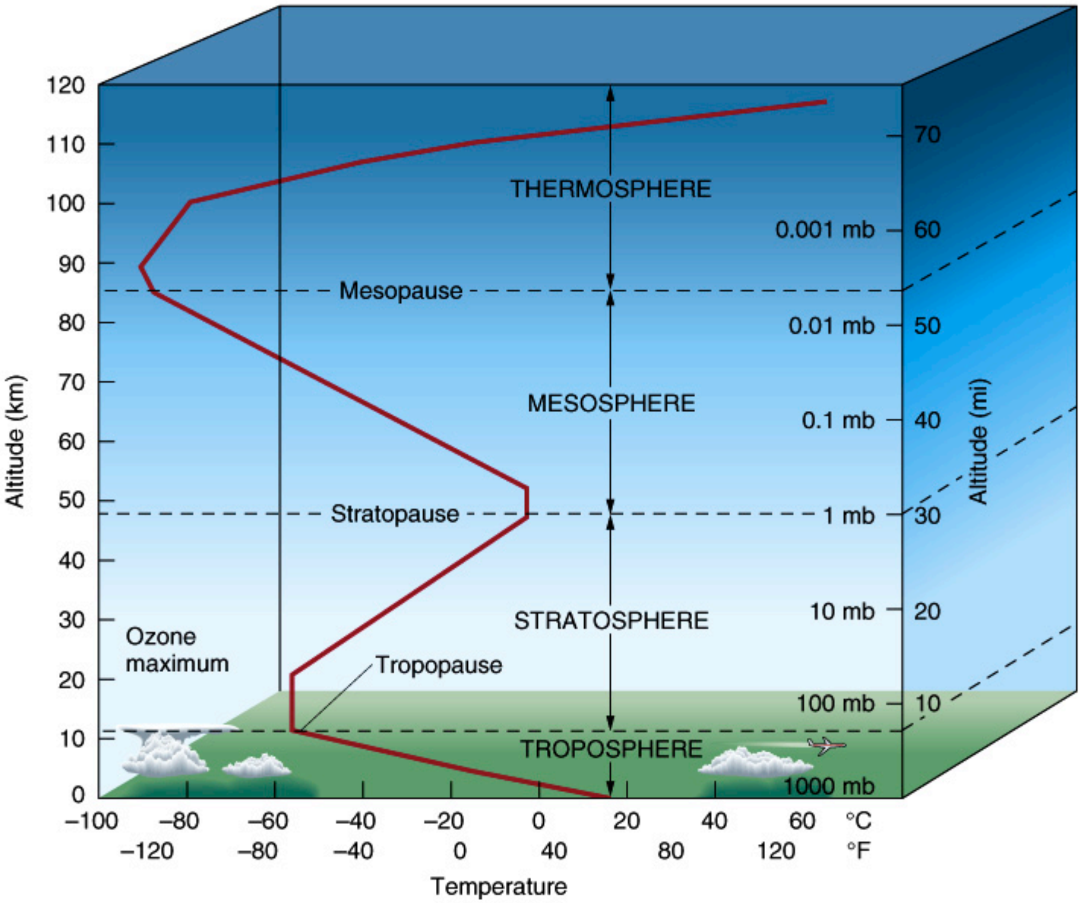
= 6.5°C/km (3.6°F/ 1000ft)



- The lowest layer promotes atmospheric overturning and virtually all weather processes
- Contains 80% of the mass of the atmosphere

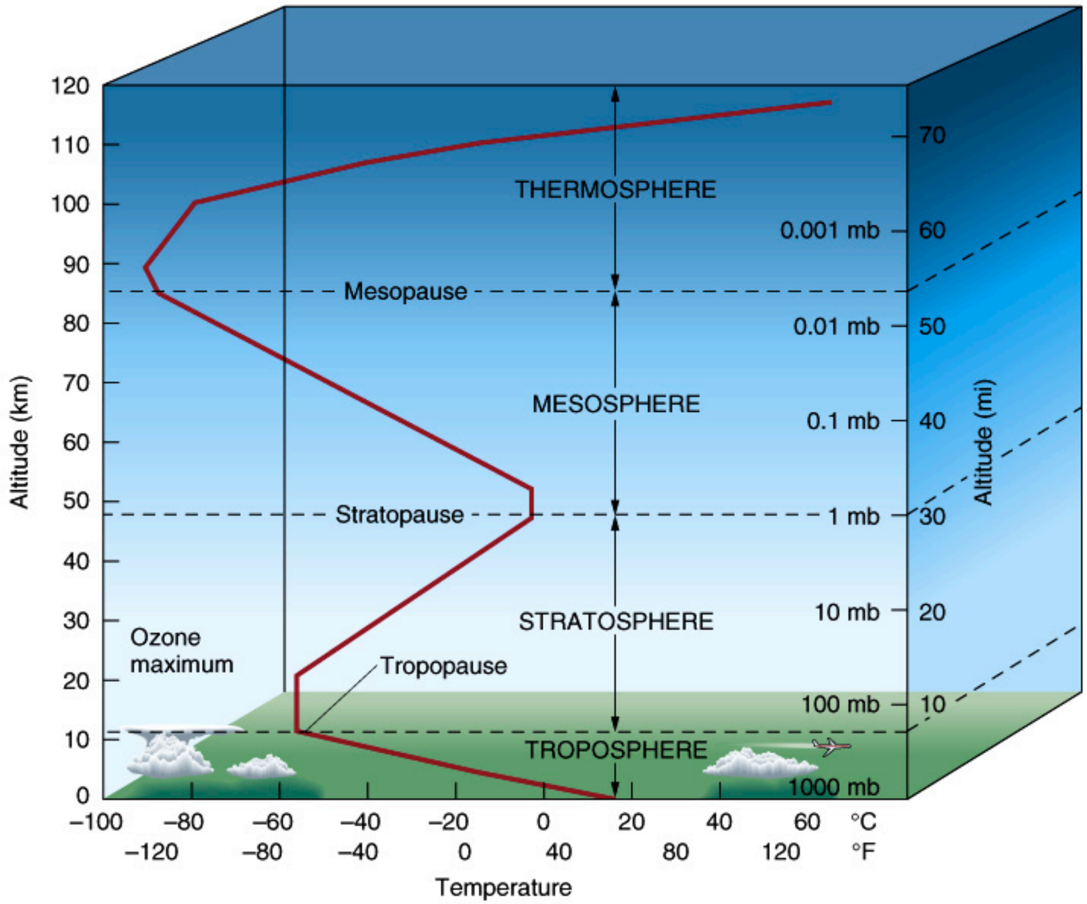
Most clouds exist in the troposphere. Occasionally, violent updrafts penetrate cloud tops into the stratosphere. The flattened top of this cumulonimbus cloud is in the stratosphere.

The Stratosphere



- Little weather and a layer of constantly inverted temperature after an initial layer of constant temperature with height
- The layer warms with height to the freezing point of water near the **stratopause**

Mesosphere and Thermosphere

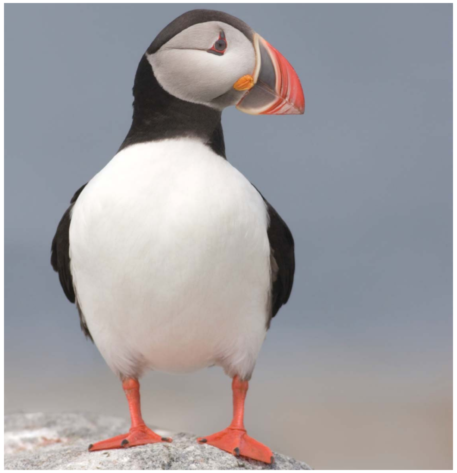


- Mesosphere, which extends to about 80 km (50 mi) is characterized by decreasing temperatures with height and is the coldest atmospheric layer

- The thermosphere above slowly merges with interplanetary space and is characterized by increasing temperatures with height

Chapter 2

- Changing the energy available at one part of the food chain will cause changes throughout the ecosystem
- Focus on energy in relation to transformations, how energy flows through ecosystems, and the ecosystem consequences that result

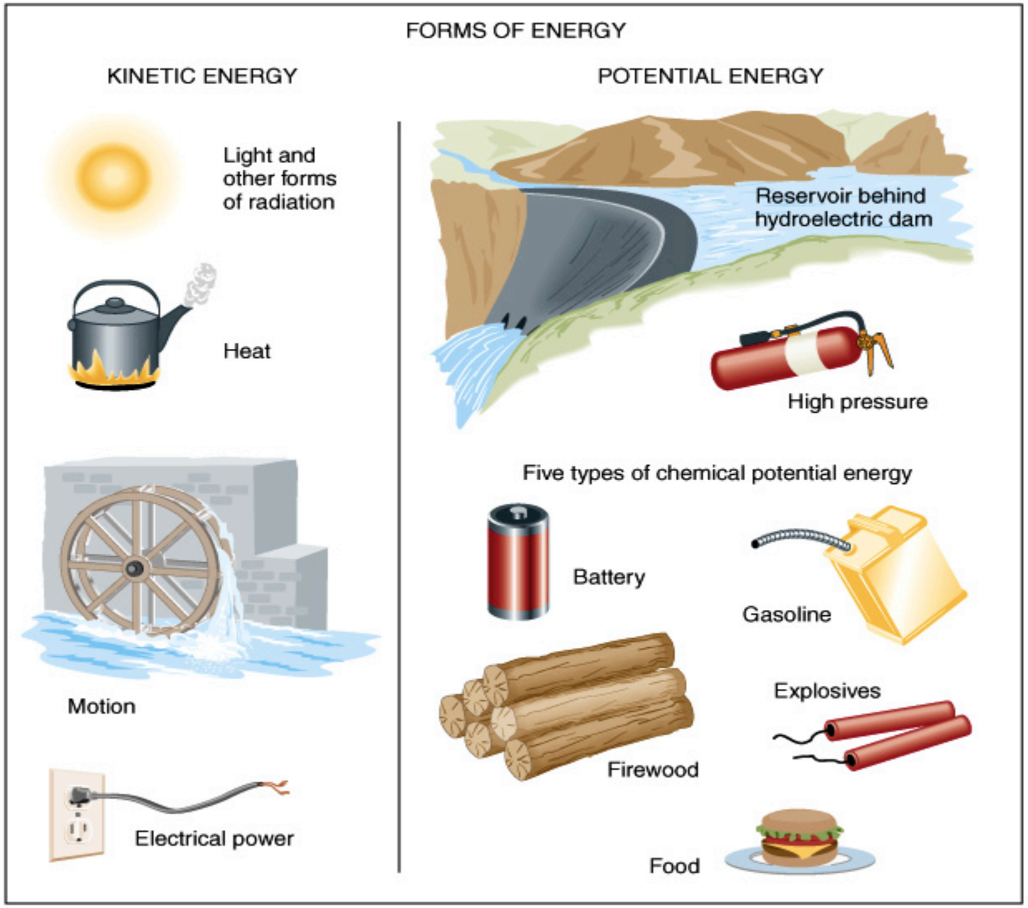


Energy

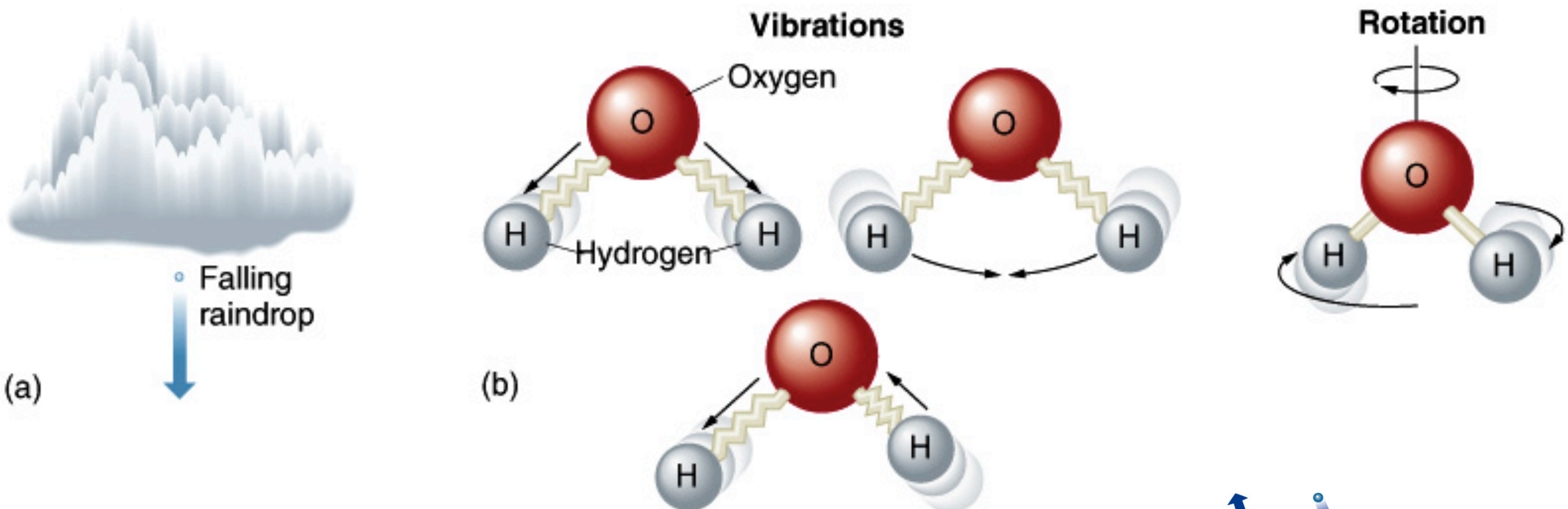
- **Energy** is the capacity to do work and is measured in calories
- A **calorie** is the amount of heat needed to raise one gram or one millilitre of water one degree Celsius (C), starting at 15 degrees
- Energy derived from an object's motion and mass is known as **kinetic energy**

- **Potential energy** is stored energy that is available for later use
- Most of the energy available for use is called **low-quality energy**
- Low-quality energy is diffuse, dispersed at low temperatures, and difficult to gather
- The total of all moving atoms is referred to as **heat**
- **High quality energy,** such as a hot fire or coal, is easy to use, but the energy disperses quickly

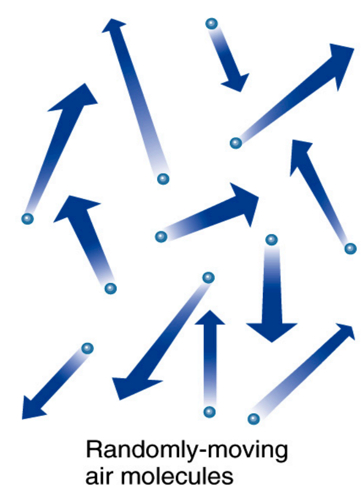
A Few Examples…



Examples of kinetic energy

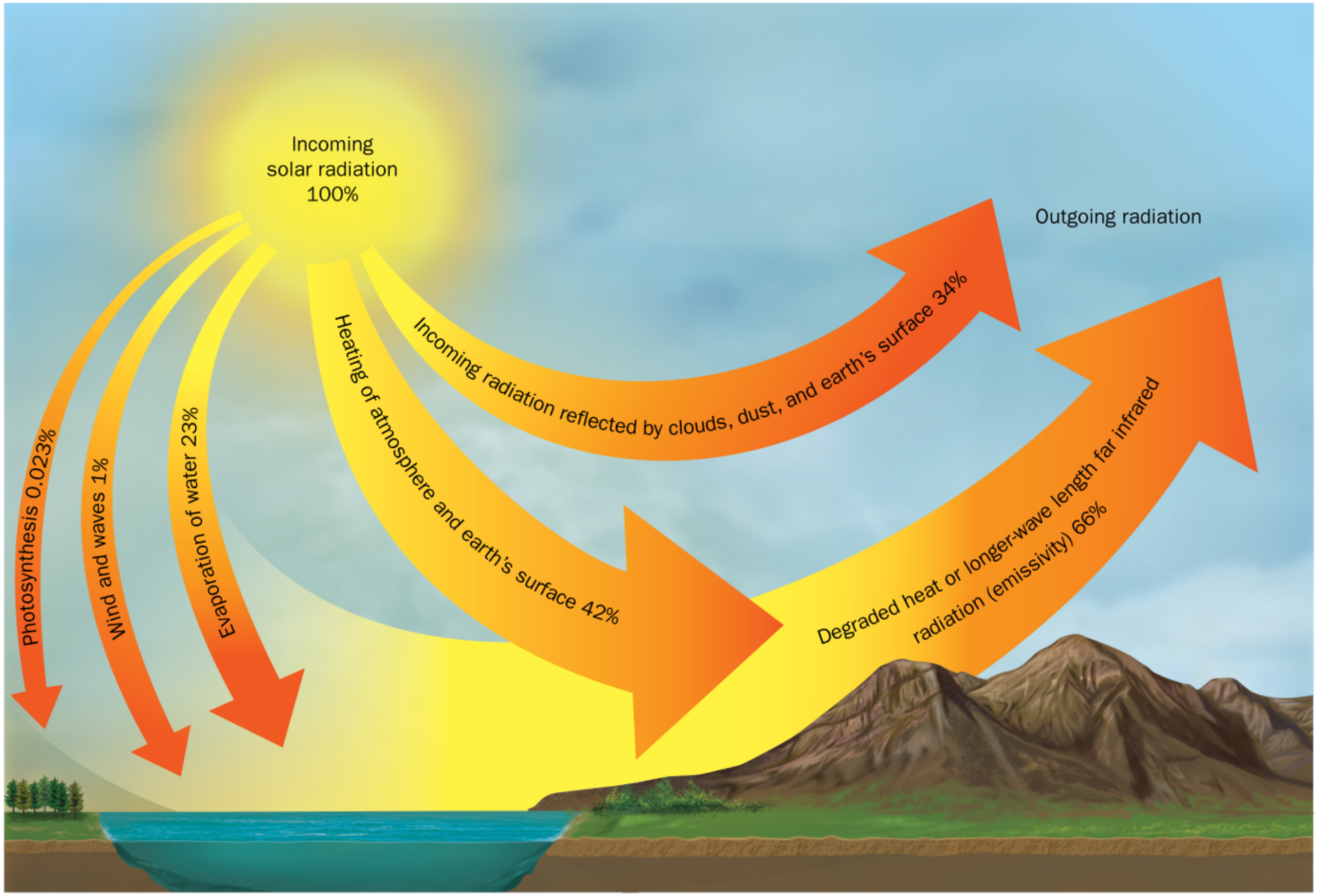


Gas molecules have no bonds to other molecules and as such they move in random motion

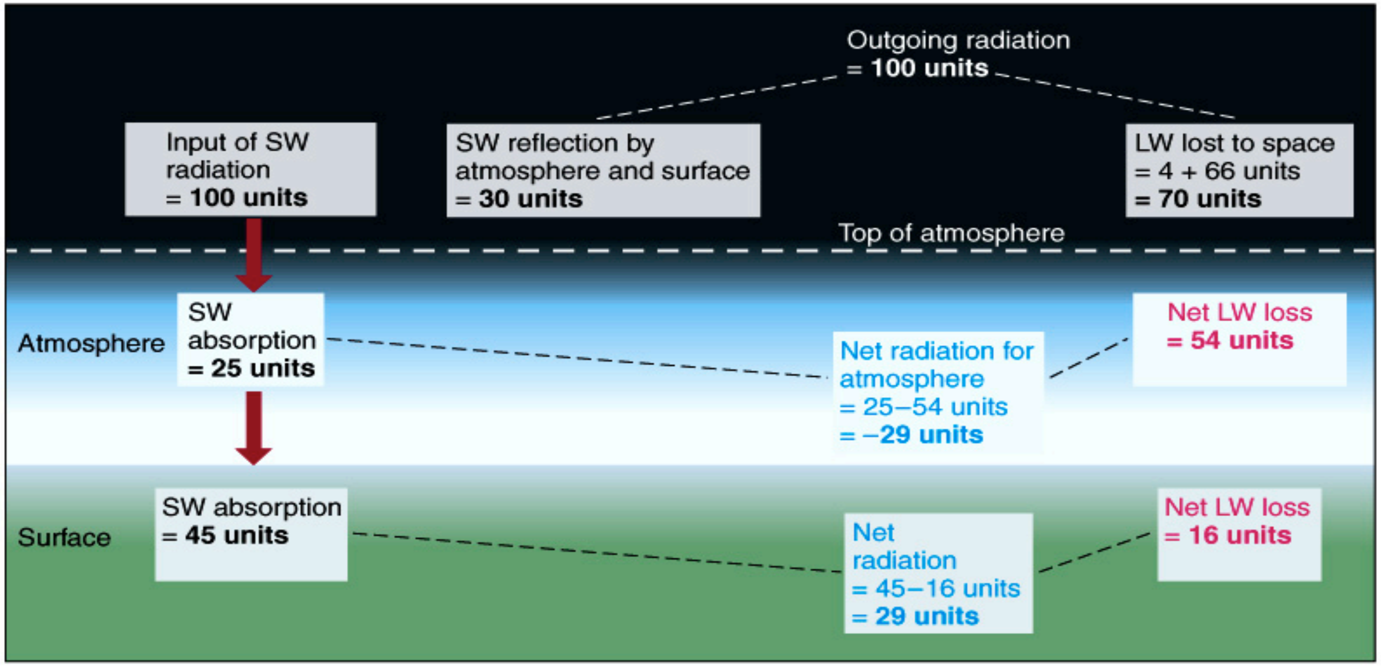


- Law of Thermodynamics
  - Two laws of physics describe the way in which trillions of energy transformations per second take place all over the world
  - The first law is the **law of conservation of energy**
  - This law tells us that energy can neither be created nor destroyed; it is merely changed from one form into another

A Few Examples…

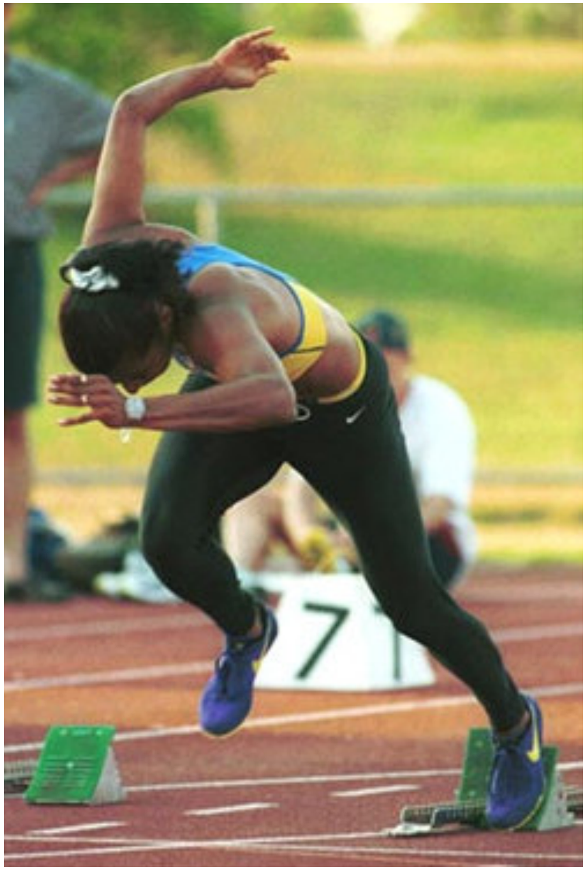


Net all-wave radiation or ***Net radiation (Deficit = Surplus)***



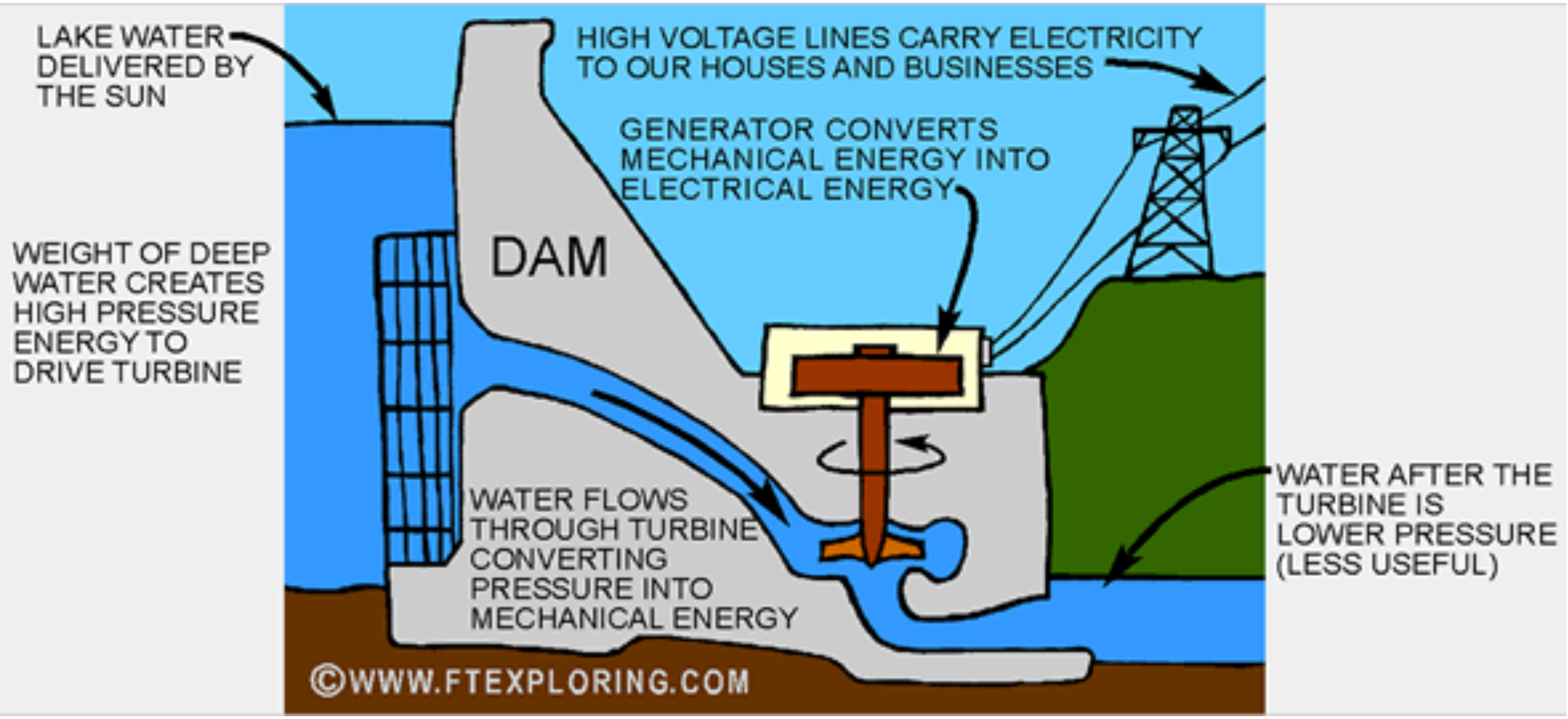
- The **second law of thermodynamics** tells us that when energy is transformed from one form into another, there is always a decrease in the quality of usable energy
- **Entropy** is a measure of the disorder or randomness of a system. High-quality, useful energy has low entropy.

A Few Examples…



This athlete is converting concentrated food energy through work processes into mechanical muscle movement, kinetic energy of motion, and thermal energy (heat) - mostly thermal energy. All of the mechanical energy will be converted to low-grade thermal energy by the end of the race.

One last example of the 2nd Law



Conclusions

- Living organisms have a number of common characteristics:
  - They use energy to maintain internal order
  - They increase in size and complexity over time
  - They can reproduce
  - They react to their environment
  - They regulate and maintain a constant internal environment
  - They fit the biotic and abiotic requirements of a specific habitat