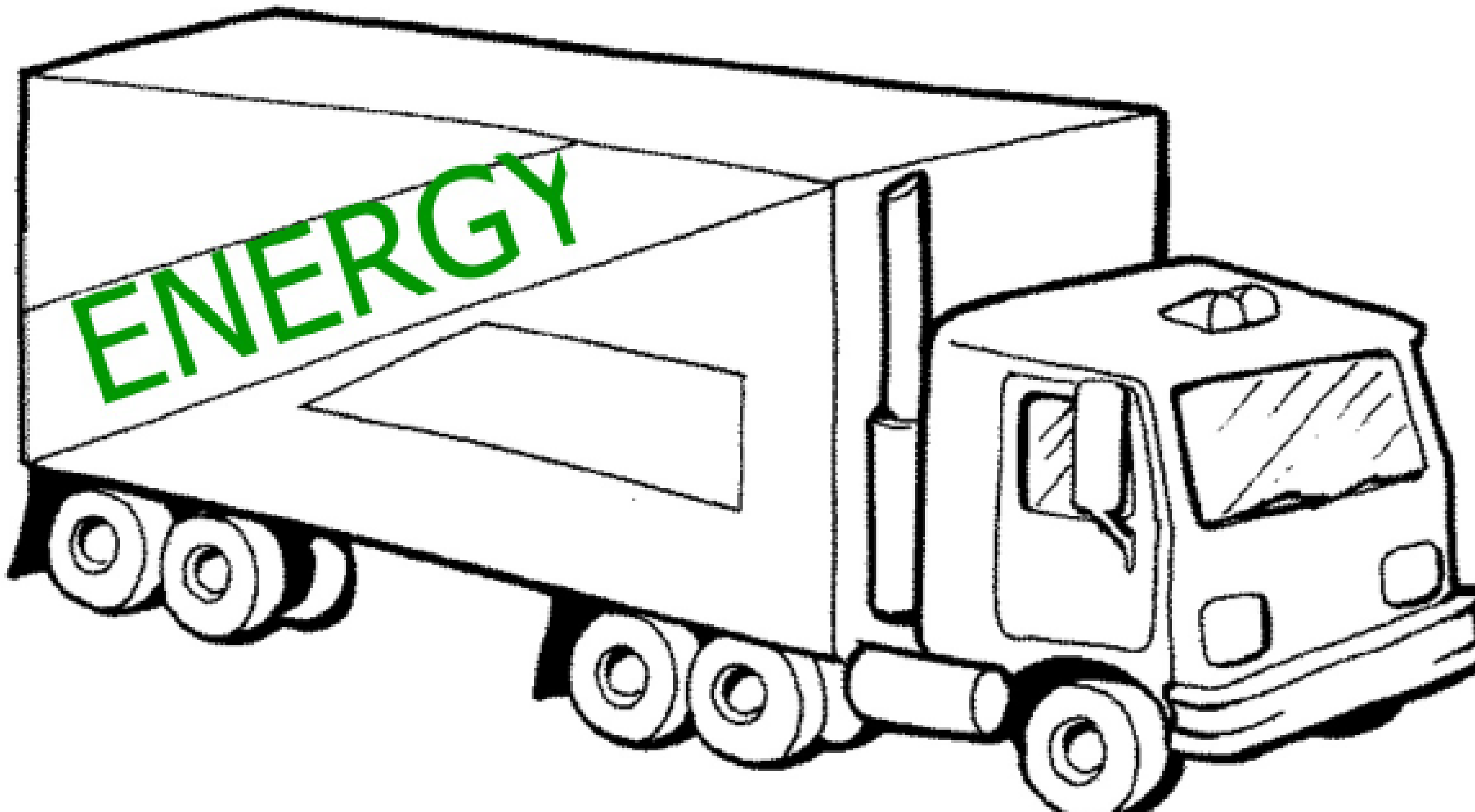
Science 10 Unit D: Energy Flow in Global Systems

# Energy Moving in the Biosphere



**Review:**

***Use the following information to answer this question.***

The region of the biosphere represented by letter *A* is the:


a) stratosphere.
b) mesosphere.
c) atmosphere.
d) hydrosphere.

**Review:**

**The absorption of the Sun's thermal energy by the Earth is called**

**a) albedo**
**b) insulation**
**c) incidence**
**d) insolation**

**Review:**

**The portion of the Earth of dry land where life exists is called the**

**a) atmosphere**
**b) hydrosphere**
**c) lithosphere**
**d) hemisphere**

**Review:**

***Use the following information to answer the next two questions:***

**1 - Mesosphere 3 - Troposphere**
**2 - Stratosphere 4 - Thermosphere**

**NR: The layers of the atmosphere in order from closest to Earth's surface to furthest is __________.**

**Review:**

**Explain how different seasons are produced on Earth using the terms insolation, electromagnetic radiation and inclination.**

**Review:**

1. Which of the following statements are examples of climate?

I. Not another day of rain!

II. Once again, it’s a cold winter.

III. We had 3 mm of rain last night.

IV. Spring always seems to come about this time of year.

a) I and II

b) II and III

c) II and IV

d) III and IV

**Ans:**

Which of the following statements is an example of scientific evidence of climate change?

I. The growing season seems longer now.

II. There are fewer elk now than there were 30 years ago.

**Ans:**

III. Snow cover has increased by 4% over the past 10 years.

IV. The average global surface temperature has increased by 0.5°C in the last century

a) II and IV

b) I and IV

c) II and III

d) III and IV

A town along the equator gets more insolation, on average, than Calgary, Alberta, because of the effect of:

a) less atmospheric dust

b) the angle of incidence

c) the angle of inclination

d) both the angle of incidence and angle of inclination

**Ans:**

**Recall the 4 main topics we are studying in this Unit D:**

1. **How energy moves from the Sun to the Earth and through the biosphere.**

2. **How energy moves around the Earth.**

3. **How different amounts of energy make for different biomes on Earth.**

4. **What happens when energy flow goes wrong.**

**Today we look at topic #2. We know how energy gets to the Earth, now how does it move around once it gets here?**

**First of all, let's get some definitions down:**

# Term Time

## What is heat?
## What is temperature?
## What is thermal energy?


heat as energy

# Temperature vs. Heat

- The average of the kinetic energy of all the particles in an object is called temperature.
- The total of the kinetic energy of all the particles is called heat.

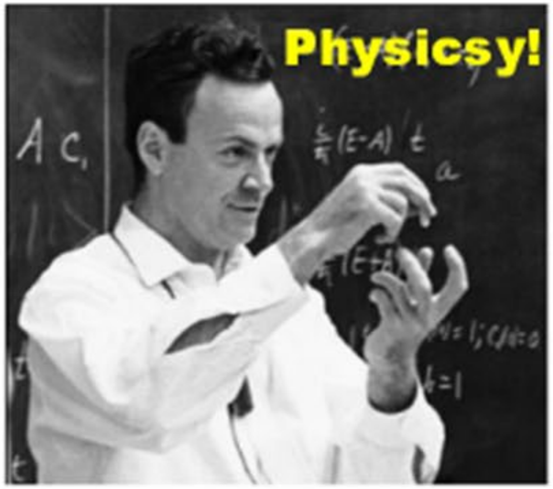
Temp vs. Heat

Measuring Temp

**Thermal energy transfers from areas of high temperature to areas of low temperature.**

**As usual, all things come back to Physics, and this is no different. This is actually a restating of the 2nd law of thermodynamics:**

**Second Law of Thermodynamics: thermal energy moves from areas of high energy to areas of low energy.**



# Three ways thermal energy is transferred

- Radiation
- Conduction
- Convection

**- Conduction: transfer through the bumping together and contact of particles.**


Conduction

**- Convection: particles moving in the form of currents in liquids and gases transferring energy.**


[Convection]

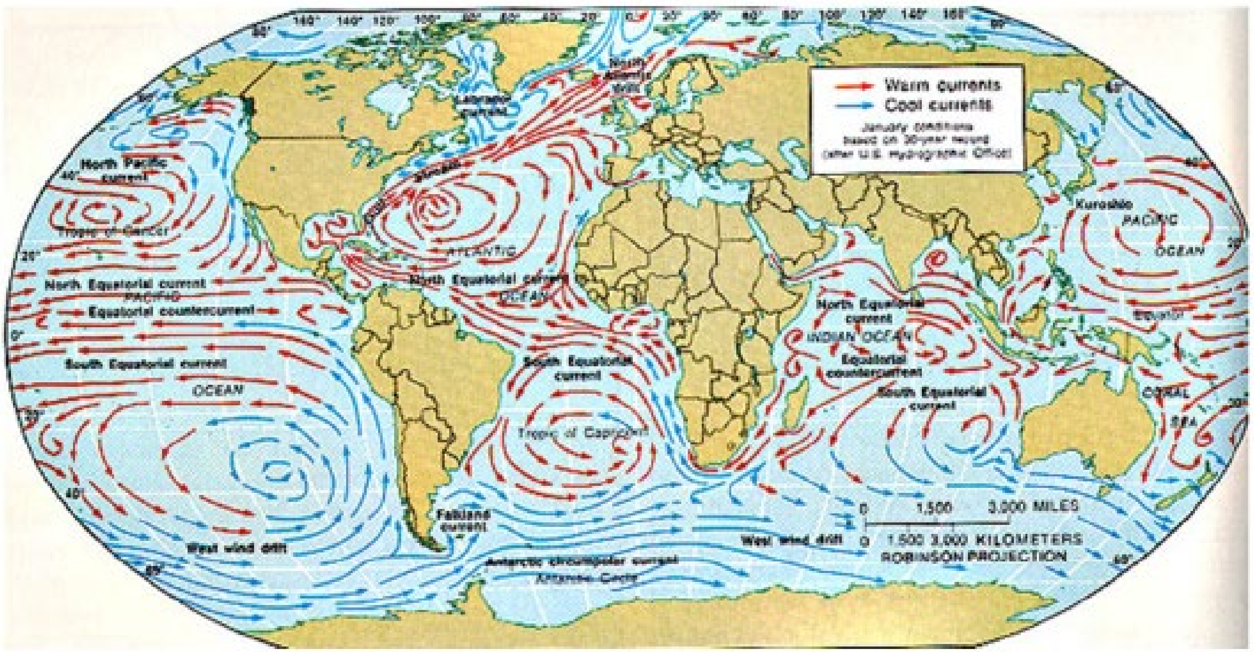
**Radiation: is the emission or transmission of energy in the form of waves through space or through a material medium.**


Radiation

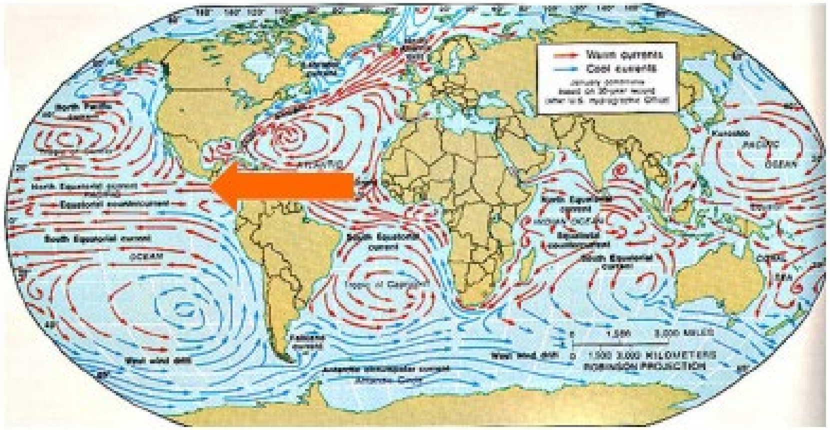
**How do these energy transfers take place in the biosphere?**

# Energy Transfer in the Atmosphere

- absorption of energy through radiation from Sun
- movement of energy through <u>convection</u> and <u>wind</u>

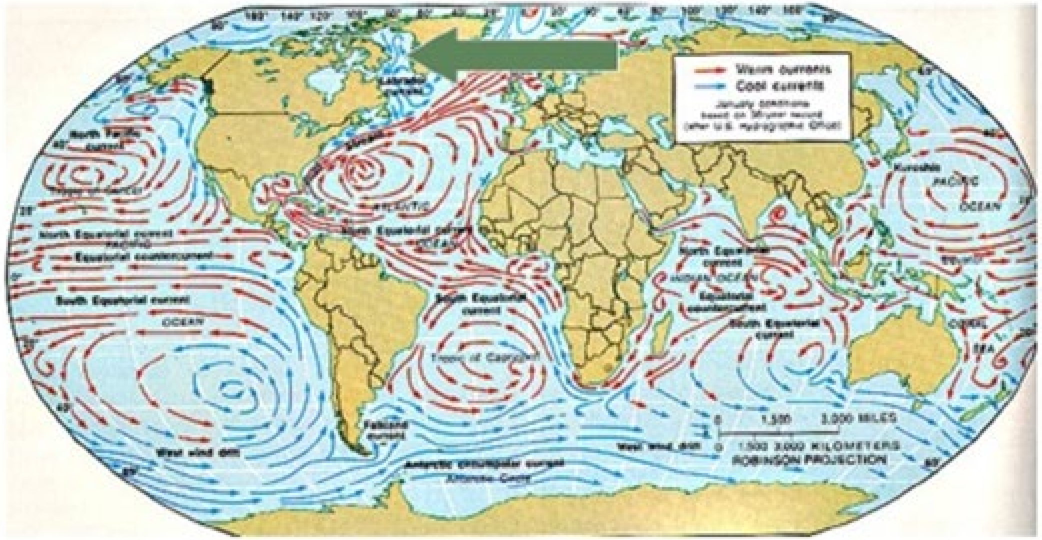


Winds that blow from the east along the equator are traditionally called trade winds.

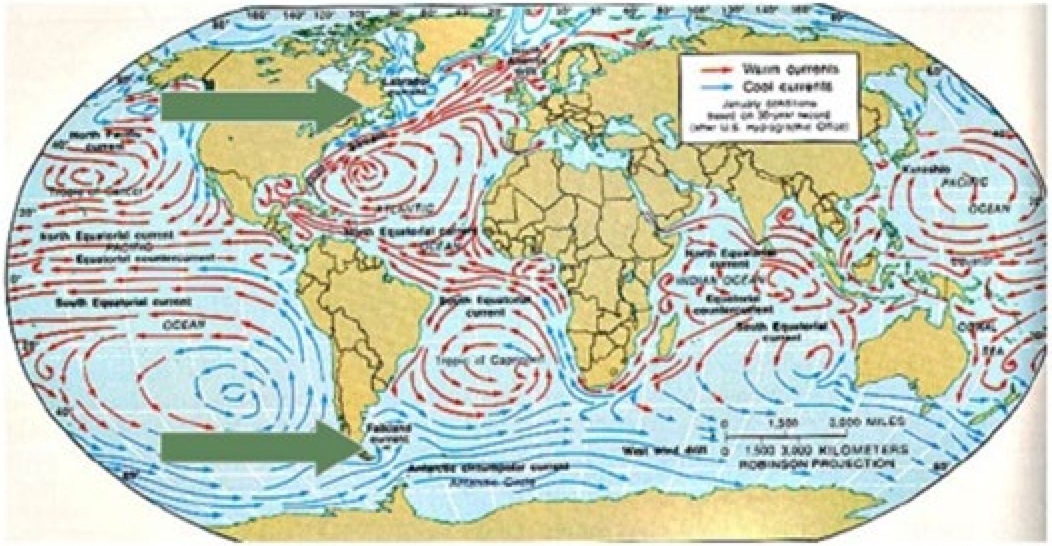


Trade winds took early European settlers east to North America for trade, hence the name.

**Those blowing from the east are called easterlies.**



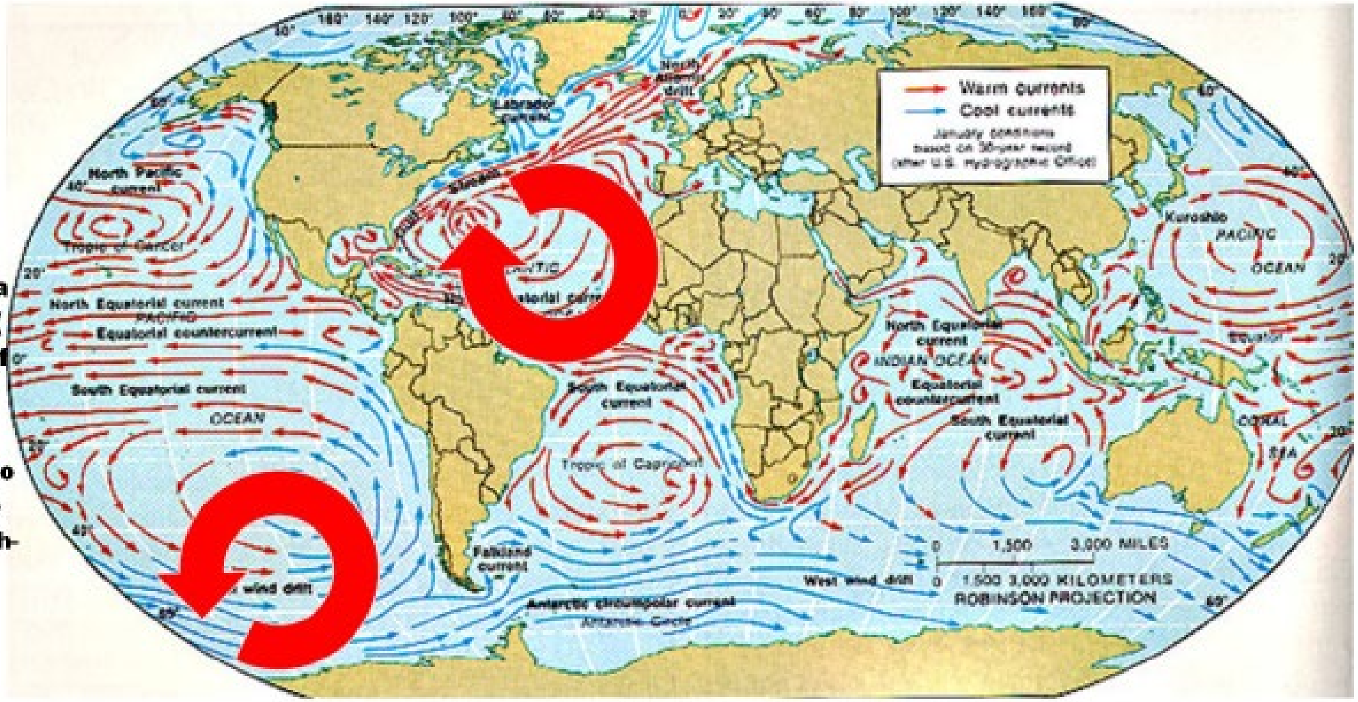

**Winds blowing from the west in general are called westerlies.**



# The wind does not only blow in straight lines:

http://ww2010.atmos.uiuc.edu/(Gh)/guides/mtr/fw/crls.rxml

http://science.howstuffworks.com/rotation-earth-toilet-baseball.htm




**Winds also tend to move energy in circles; this is called the Coriolis Effect.**

- Winds in the Northern Hemisphere go clockwise.
- " " " Southern " " counter-clockwise.

**The coriolis effect is caused by the rotation of the earth and some fairly complicated physics, but it does not only apply to fluids like air in the atmosphere:**

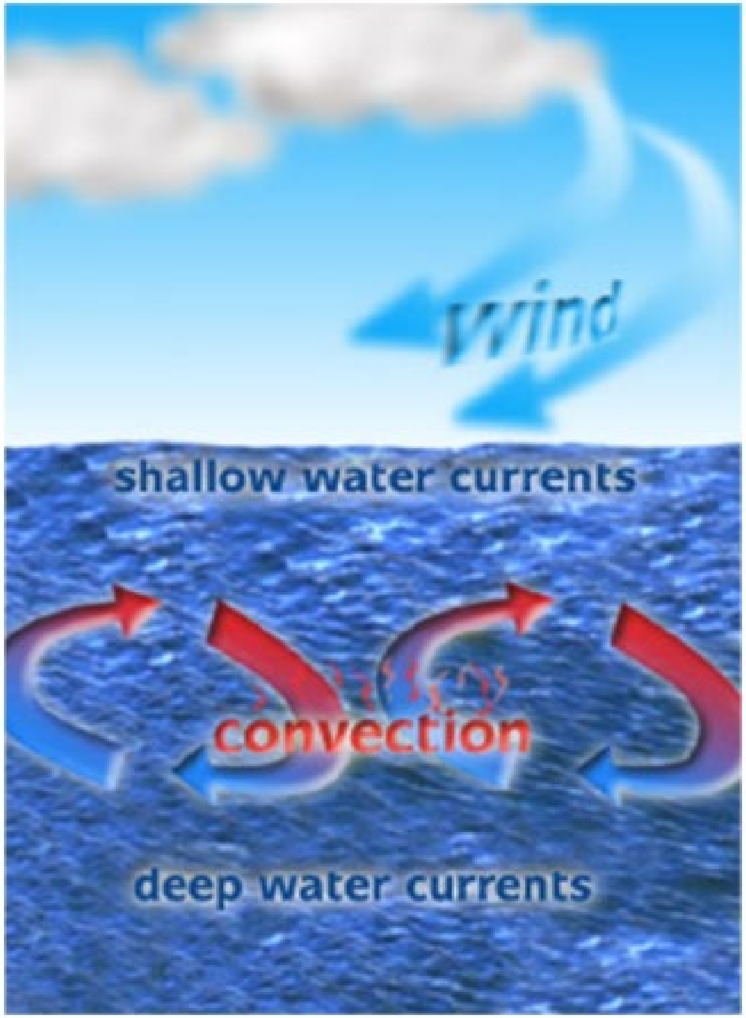
**You may recall in Simpson's Episode 119 that Bart racked up a $900 collect call to Australia to see which way the toilets flushed.**

**He discovered they flushed opposite of the toilets in North America.**

**However, the cartoon is inaccurate. While it is true the coriolis effect does effect water, it is not strong enough to effect small bodies like that in a toilet or bathtub.**

# Energy Transfer in the Hydrosphere

- Thermal energy is transferred vertically through oceans and other bodies of water via convection currents.
- The density of water decreases when its temperature increases, so warm water tends to rise.
- Cooler water is more dense, so it tends to sink.



**Average temperatures increase as you move closer to the ocean.**

**Why is this?**


**It has to do with another special property of water.**

# Specific Heat Capacity

- Every substance has specific thermal properties, one is the amount of energy that the substance can absorb before it changes temperature.

- The specific heat capacity (c) of a substance is the amount of energy required to raise the temperature of 1 g of substance by $1^0C$.

- The specific heat capacity of water, for example, is 4.19 $J/g^0C$, whereas the specific heat capacity of aluminum is 0.897 $J/g^0C$.

•4.19 $J/g^{0}C$ is a large number!

•It takes a lot of energy to raise the temperature of water by one degree.


•Water holds lots of energy when heated. Therefore, regions on Earth’s surface that have little water tend to heat and cool more rapidly than regions at similar latitudes with a lot of water.

# Calculating Thermal Energy

**Thermal Energy can be calculated using the equation:**

$$Q = mc\Delta t$$

**where:**

**Q = amount of thermal energy (J)**
**m = mass (g)**
**c = specific heat capacity (J/g°C)**
**$\Delta$ t = change in temperature (°C)**

**As usual, this formula, along with units, is in your data booklet.**

**ex) Calculate the amount of energy 250 g of water will release as it cools from 80.0°C to 20.0 °C . ($c_{water}$= 4.19 J/g$^{0}$C )**

**Ans:**

ex) Determine the final temperature of 500 g of water if you were to add 9.00 kJ to it. Assume its initial temperature is 20.0°C.

Ans:

**ex) If you add 3.57 kJ of energy to a substance, its temperature increase from 20.0 °C to 30.0 °C. If the mass of the object is 1.51 kg, determine the heat capacity of the object.**

**Ans:**