

CLIMATE

What is climate and how does it impact life on Earth?

What causes Climate?

- **Climate** - the long term average weather pattern in an area (year to year conditions of temperature, precipitation, wind and clouds in an area)
- Temperature changes cause Evaporation and Precipitation
- Temperature is affected by Latitude (the amount of direct sunlight received), Altitude (higher = cooler), distance from Large Bodies of water (solar heat banks), and Ocean Currents (like air currents move due to density and temperature).



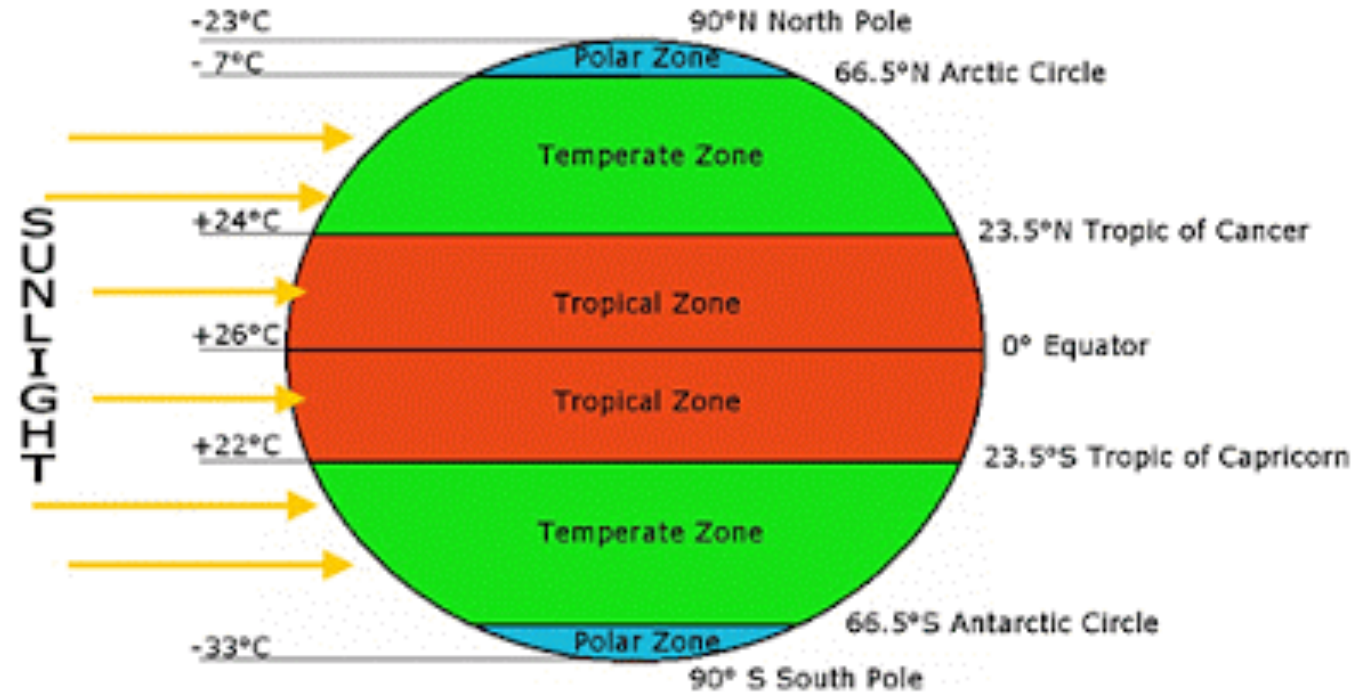
Latitude 0° to 90° (Equator to the North and South Poles)

- Zones:

- **Tropical** (near equator - direct sunlight ALL year, warm climate)
MORE solar energy per unit of surface area due to Earth's curved surface

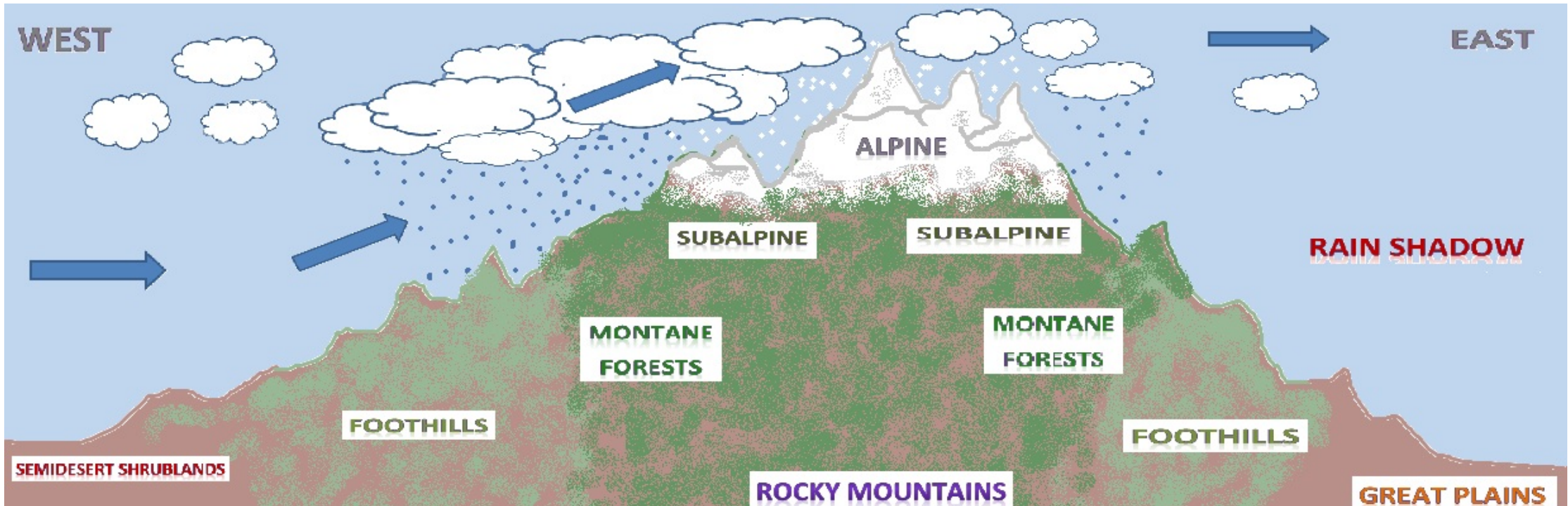
- **Polar** (North and South poles, sunlight is at a low angle, cold climate)
LEAST solar energy per unit of surface area

- **Temperate** (between tropical and polar zones, sunlight angle changes when seasons change, warm in summer, cool in winter)

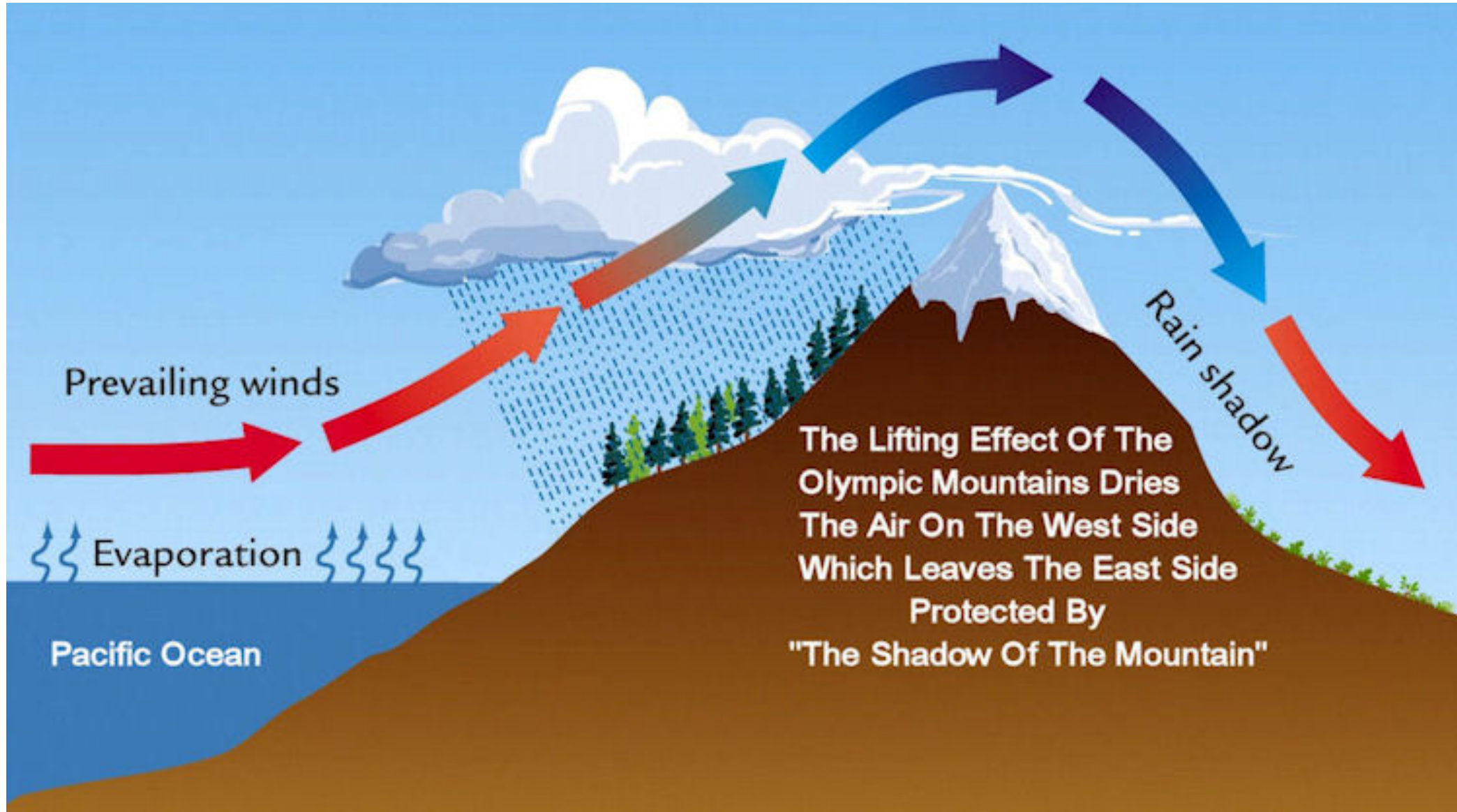


Altitude

- **Altitude** (height of landscape) can be just as important a factor in determining climate. Temperature Decreases as altitude Increases. Colorado = Mile High City
- HIGH Mountains have cooler zones near peaks than in the lower regions surrounding them.



Rain Shadows - determines what Vegetation can be supported



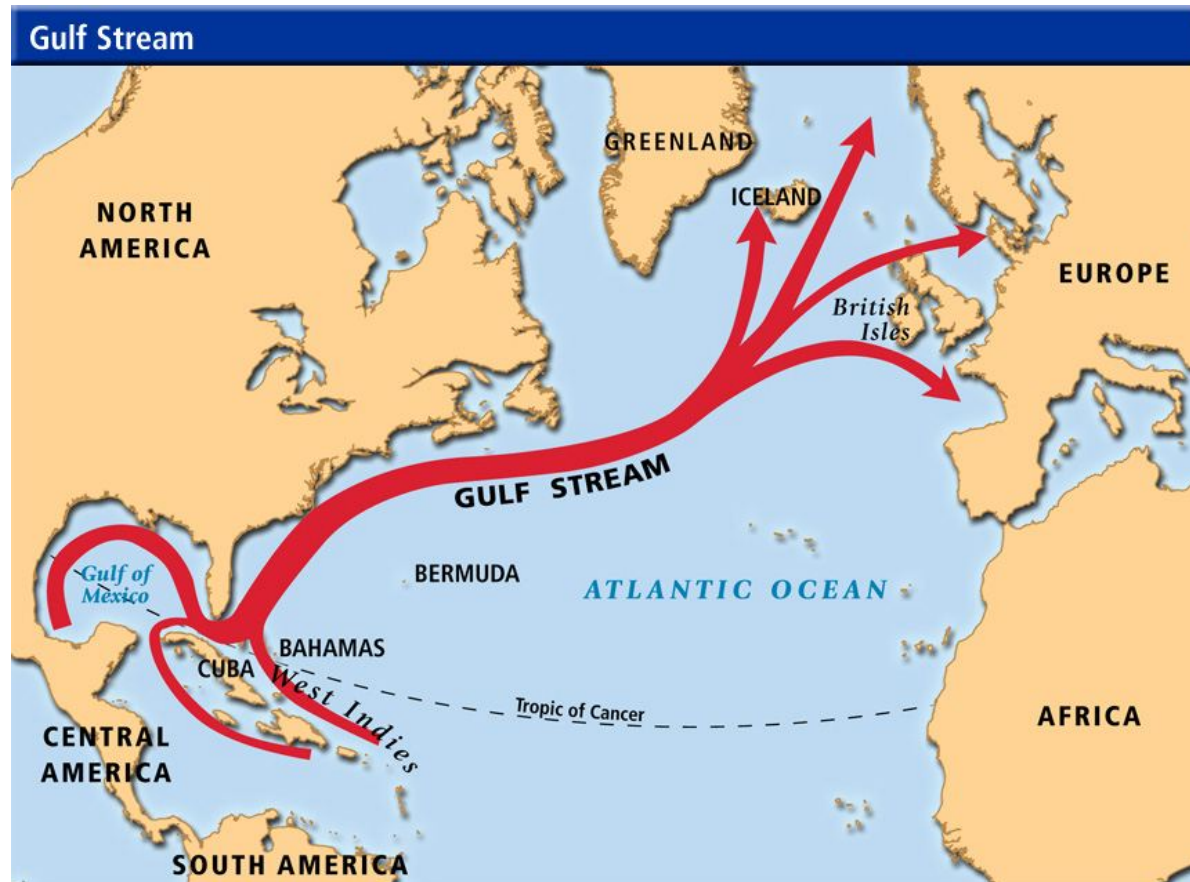
Water has a HIGH Specific Heat -the amount of thermal energy needed raise the temperature of 1kg of material by 1°C

- Large bodies of water can affect temperatures (solar heat bank)
- Oceans generally make weather changes along coast lines less extreme
- MARINE climates - coastal areas (relatively mild winters and cool summers)
- CONTINENTAL climate - inland areas (winters are cold and summers are warm or hot)

Ocean Currents - surface or deep currents can be warm or cold

Warm ocean warms air above it, Cold ocean brings cooler air

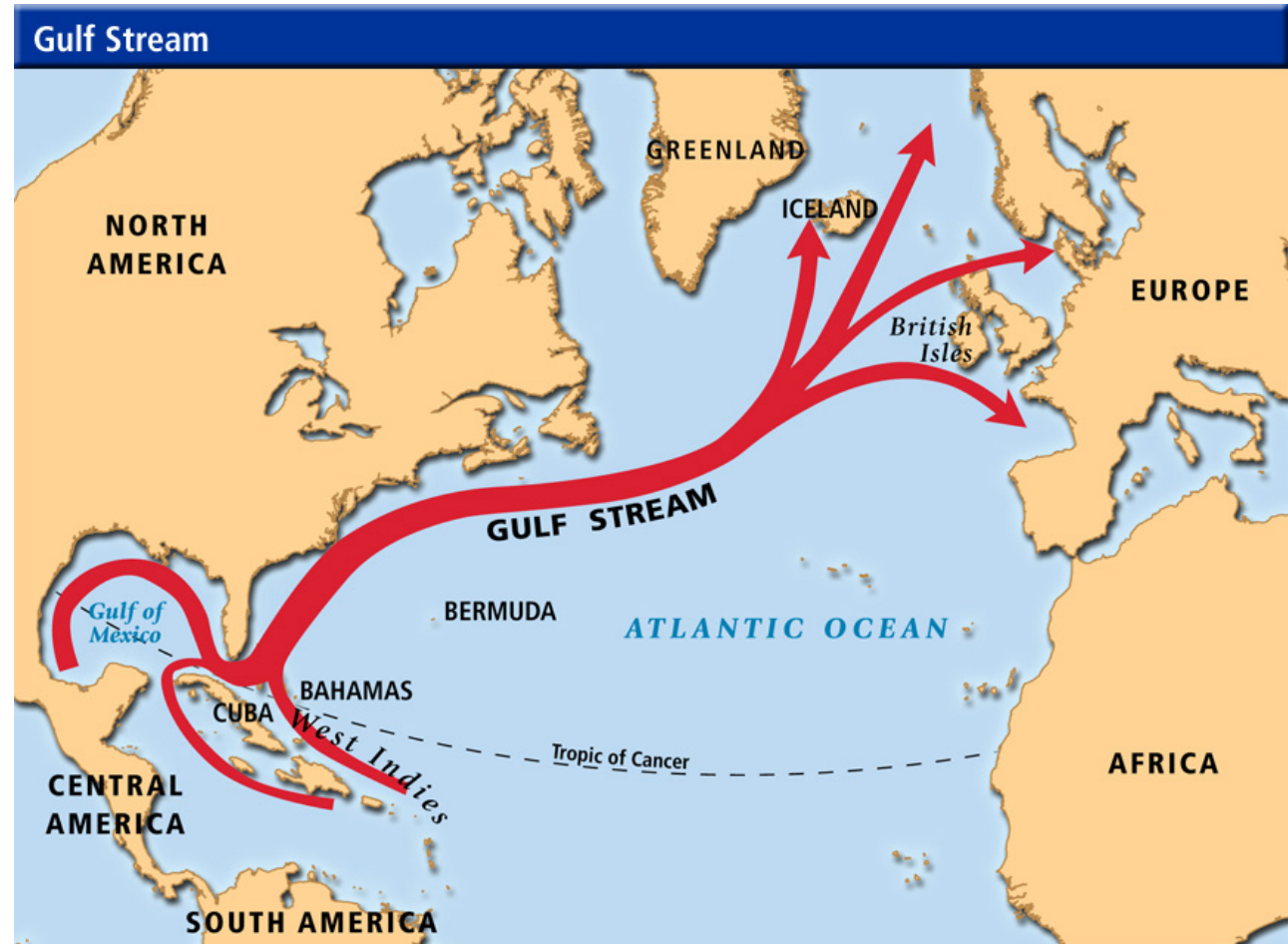
The Gulf Stream is a warm water current, brings warmer temperatures



Surface Currents : Gulf Stream

Gulf Stream

- The largest & most powerful surface current in the North Atlantic Ocean
- Caused by strong winds from the west
- Moves warm water from Gulf of Mexico to Caribbean sea and continues North crossing the Atlantic as it becomes the North Atlantic Drift



Classifying Climates

Wladimir Koppen developed a system classifying climates:
Temperature, precipitation, and native vegetation

5 types:

Tropical - warm year round

Mild - warm summers, mild winters, high precipitation, humid

Dry - hot summers, cooler winters, VERY low precipitation

Continental - warm summers, cold winters, moderate precipitation

Polar - cold year round, minimal precipitation

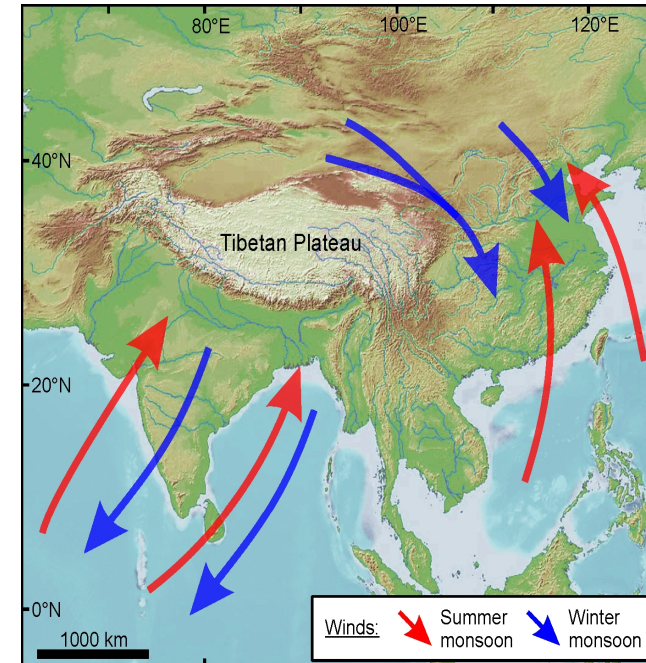
Microclimates - A localized climate that is DIFFERENT from the climate of the larger area surrounding it - forests (cooler), cities (concrete/hotter)

Living things have special adaptations so that they can survive:

Polar bears - thick fur,
desert plants - shallow roots,
deciduous trees, lose leaves in winter,
areas to grow crops for food,
what type of structures we build

Factors that affect Precipitation

- The main factors that affect precipitation are prevailing winds, presence of mountains, and seasonal winds.
- **Prevailing winds**: winds that blow in one direction in a region
 - The amount of water vapor in prevailing winds depends on where the winds blow from
- **Mountain Ranges**:
 - **Windward** side (rain or snow falls on the side of the mountain the wind hits)
 - **Leeward** side (in the rain 'shadow' - little rain falls on this side)
- **Seasonal Winds**:
 - **Monsoons**: Sea and land breezes that change with the seasons

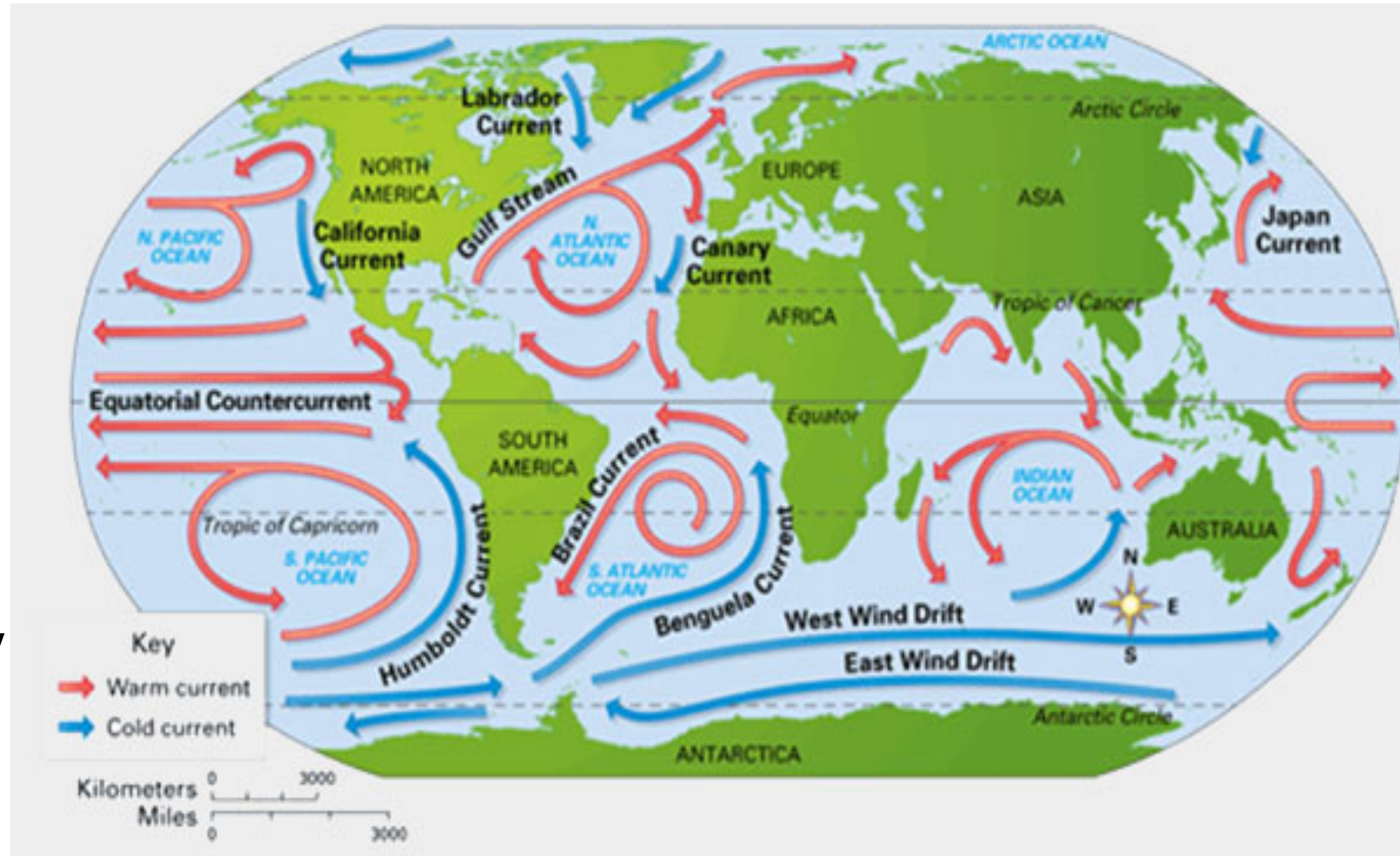


Oceans and Climate: Opening Video:

- <https://www.youtube.com/watch?v=6vgvTeuoDWY>

Ocean Surface Currents

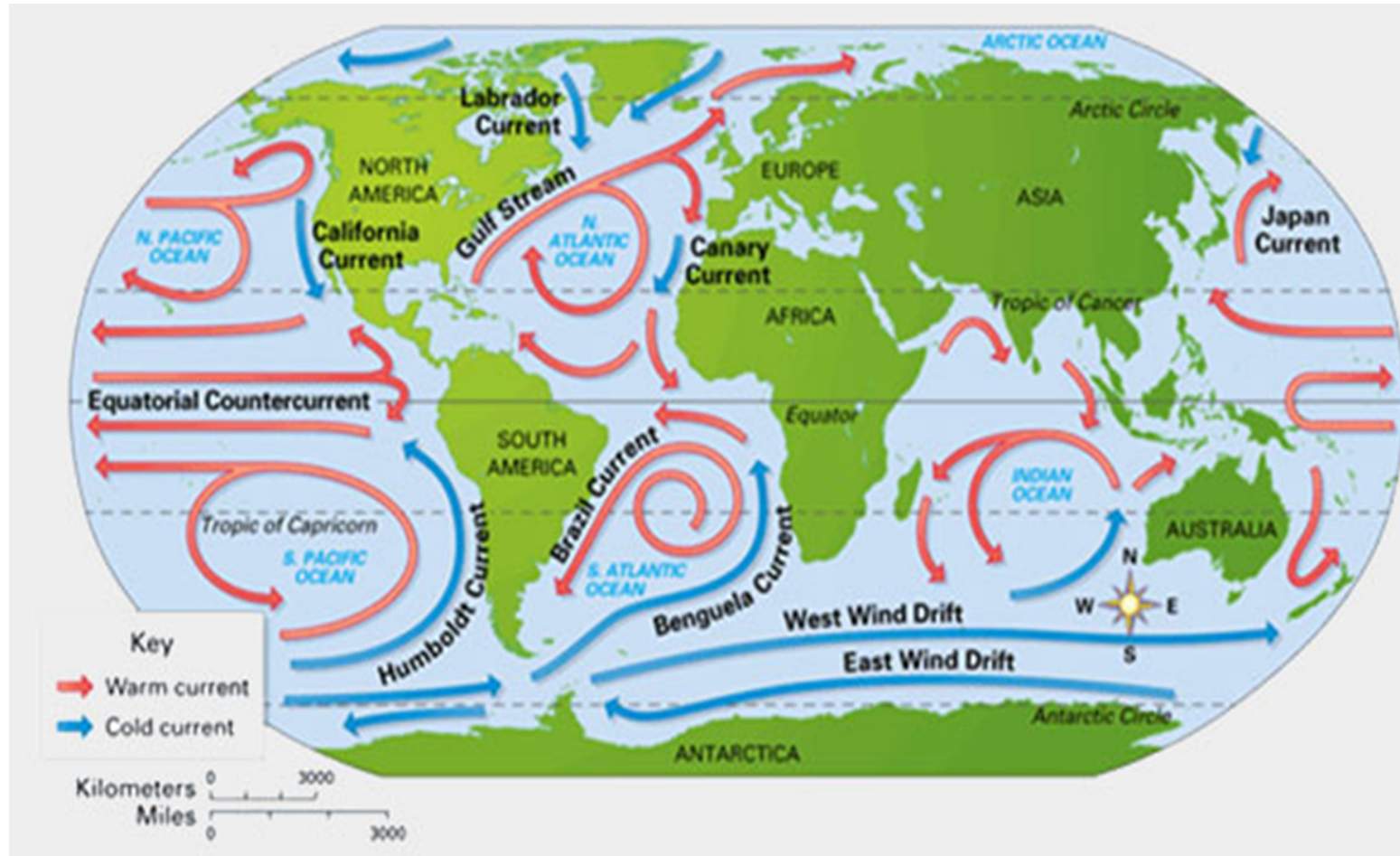
- **Current**: a large stream of moving water that flows through oceans.
- Surface currents affect water to a depth of several hundred meters. They are mainly driven by winds.



Coriolis Effect & Surface Currents

Coriolis Effect

- The effect of Earth's rotation on the direction of winds and currents. In the Northern Hemisphere - causes the currents to move Clockwise.



Surface Currents & Climate

- **Climate**: the pattern of temperature & precipitation typical of an area over a long period of time.
- The Gulf Stream has a warming affect on the climate of nearby land areas (North Carolina, Virginia for example have a more moderate climate because of the Gulf stream)
- Currents affect climate by moving warm and cold water around the globe.
- **A surface current warms or cools the air above it. This affects the climate of land near the coast.**

Climate Cycles

Long term - Ice age, interglacial

Short term

seasons,

El Nino,

monsoons,

droughts - a long period of below normal precipitation,

heat waves - an extended period of ABOVE normal temperatures,

cold waves - an extended period of BELOW normal temperatures

Ice age and Interglacials

ICE AGE - Cold periods lasting from hundreds to millions of years - glaciers covering most of Earth's surface

Most recent 2 million years ago, the ice sheets reached maximum size 20,000 years ago - ICE CORES

Interglacials are warm periods that occur during or between ice ages

Began 10,000 years ago and the temperature has fluctuated - there was a "Little Ice Age" from 1250-1850

Causes of Long Term Climate Cycles

Shape of Earth's orbit varying from elliptical to circular every 100,000 years

Change in Earth's tilt in 41,000 year cycles - decreases in angle = decrease in temperature. Tilt is currently 23.5 (22° - 24.5°)

Short Term Cycles

Seasons: Changes in solar energy received at different latitudes :
Changes in temperature due to changes in the number of hours
of day and night

REVOLUTION

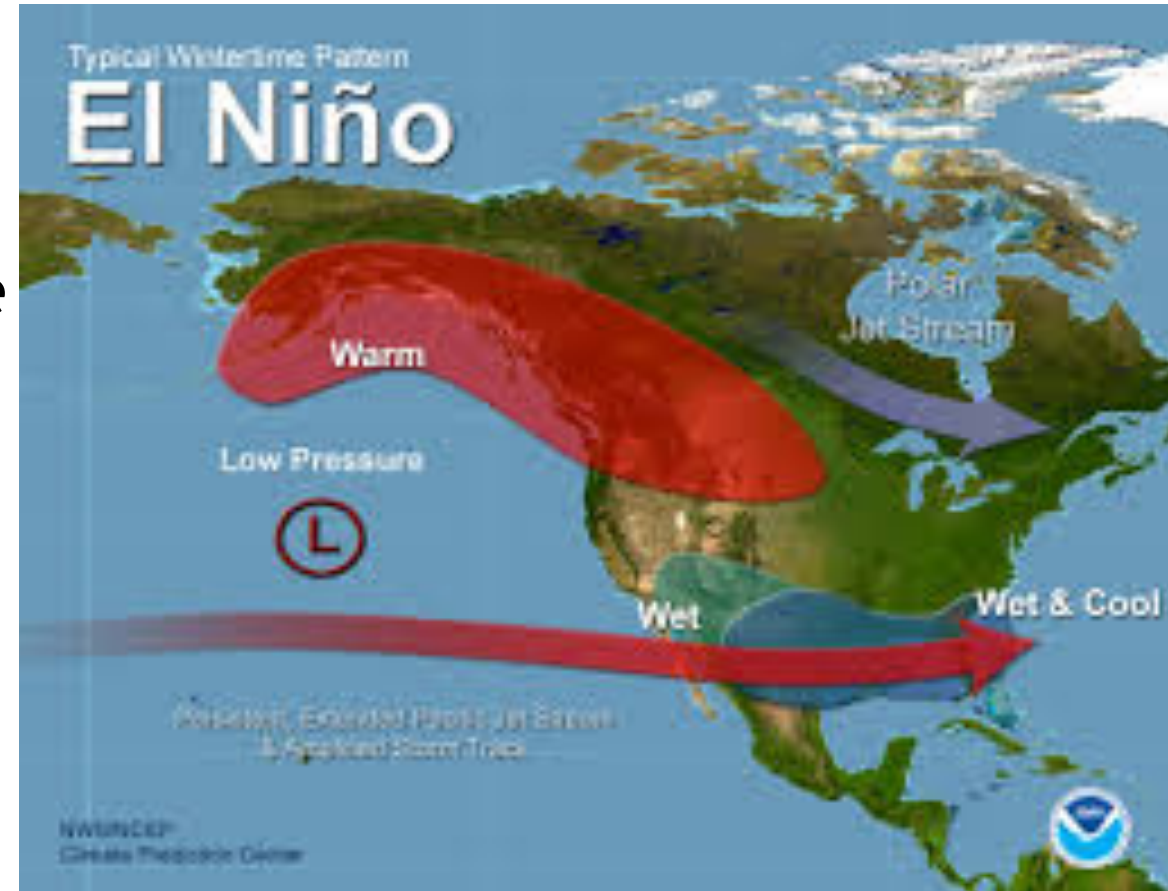
Solstices - extreme hours of day light

Equinoxes -equal amount of hours of day and night

El Niño

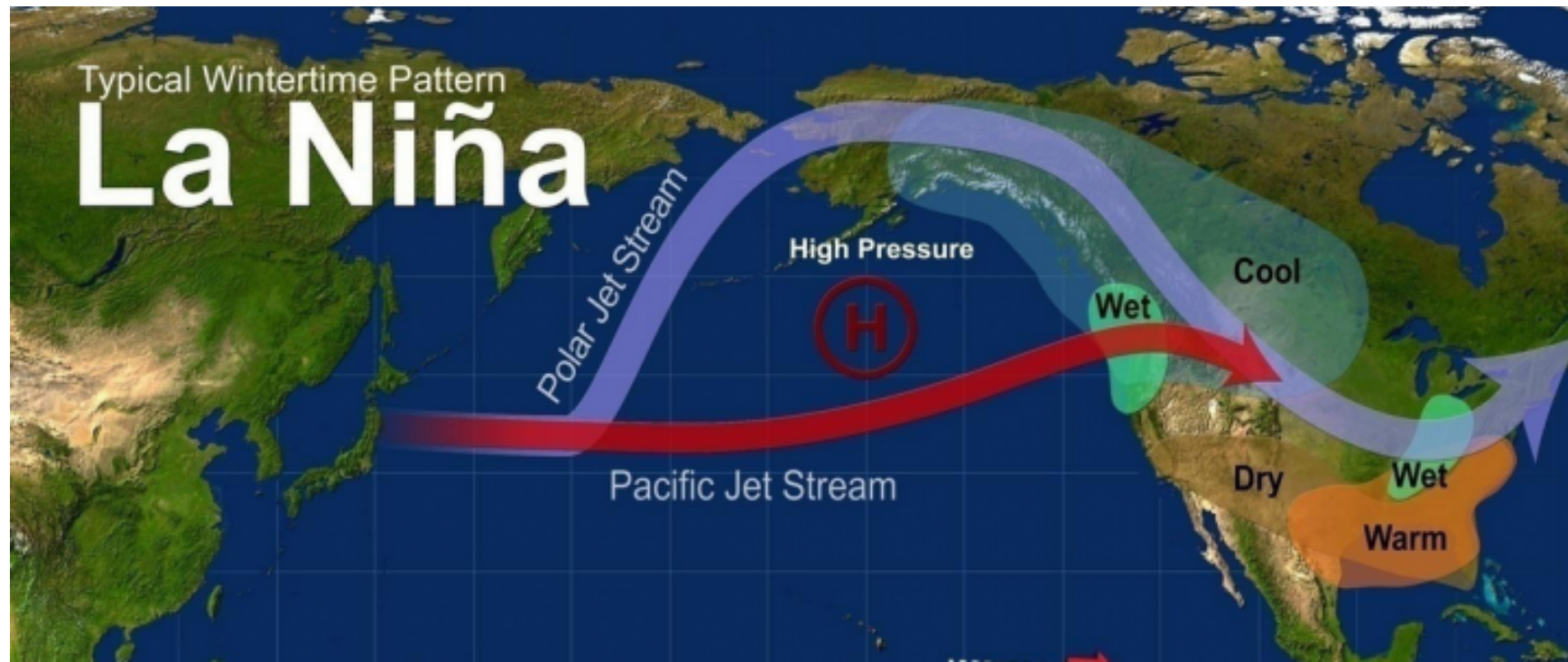
Connects Ocean and Atmosphere

- a climatic event that occurs every two to seven years in the Pacific Ocean
- Begins when an unusual wind pattern forms over the western Pacific which causes a big sheet of warm water to move eastward toward South America
- This prevents cold deep water from moving to the surface
- Brings unusual and severe conditions - especially warm winters, heavy rains, flooding, mudslides in CA, and deadly tornadoes in FL
- Can last 1-2 years



La Niña

- when surface waters in the eastern Pacific are colder than normal this occurs. Opposite of El Niño
- Bring colder than normal winters and greater precipitation to Pacific Northwest and north central United States



Monsoons

Is a pattern of wind circulation that changes direction with the seasons

Temperature differences between the ocean and the land cause changes in the density of air - warm air is less dense and goes up

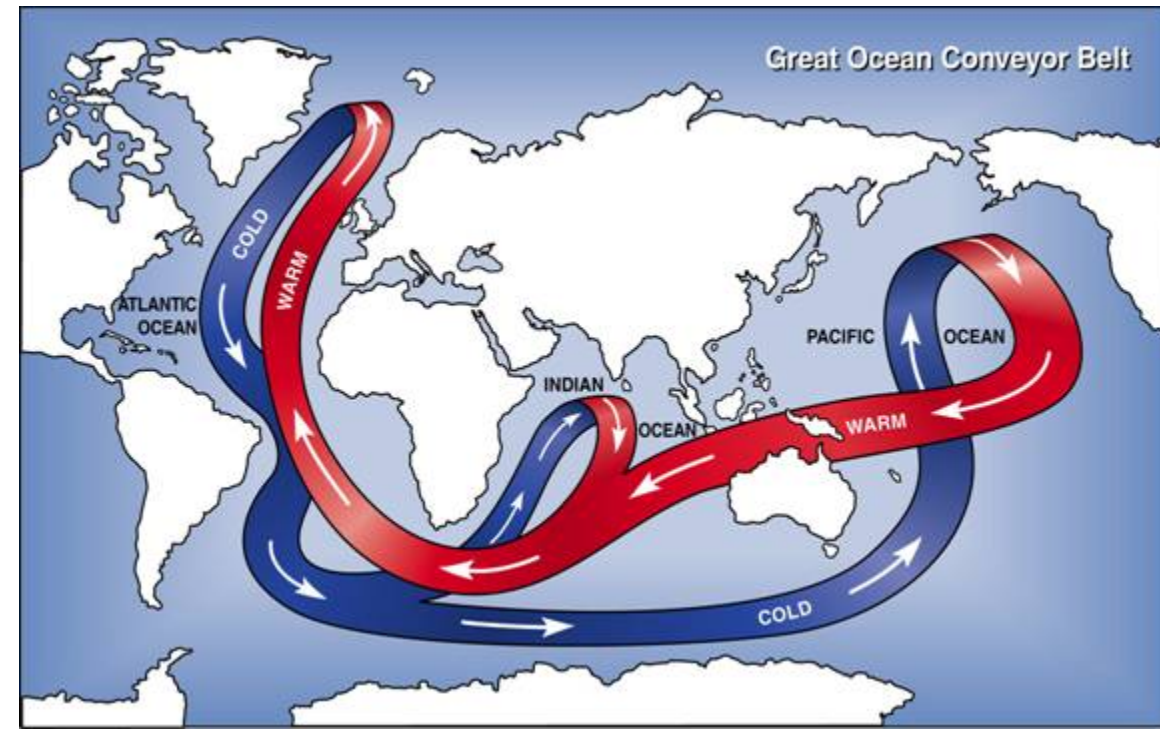
Cool air is more dense and sinks = wind blows off the water onto the land bringing great amounts of rain - WORSE during El Niño

Mostly associated with Asia - India - 10 METERS of rain per year

Deep Ocean Currents

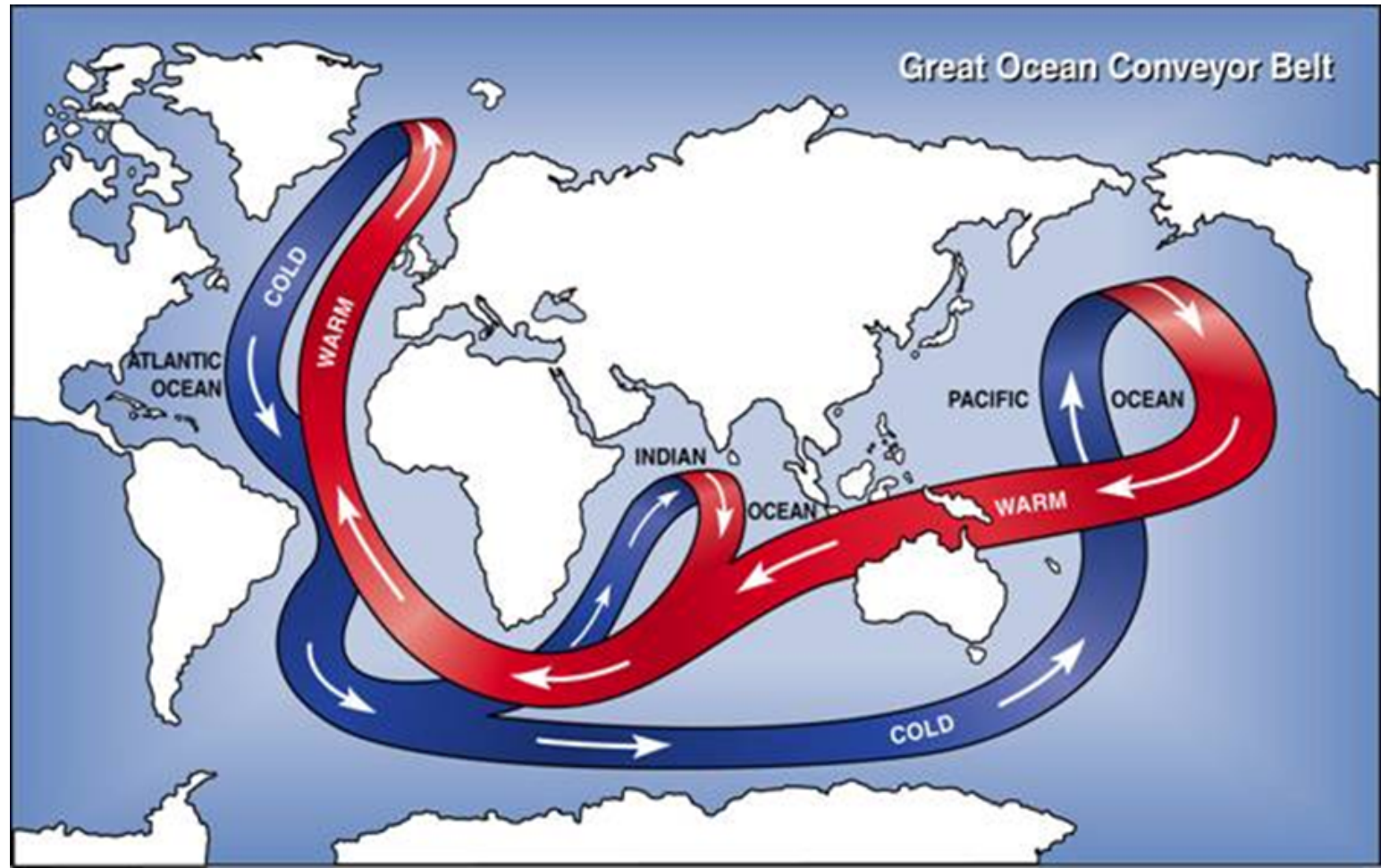
- Deep Ocean currents are caused by differences in density of ocean water.
- Salinity: the ocean is salty - and salt water's density changes when temperature changes.

When water temp decreases (like near the poles) salinity increases. The saltwater becomes more dense and sinks, and this cold water flows back along ocean floor as a deep ocean current



Deep Ocean Currents

- Deep currents move and mix water around the world. They carry cold water from the poles toward the equator. The pattern of ocean currents looks like a conveyor belt, moving water between the oceans. This pattern of ocean currents is called the **thermohaline circulation**.



Humans and Climate

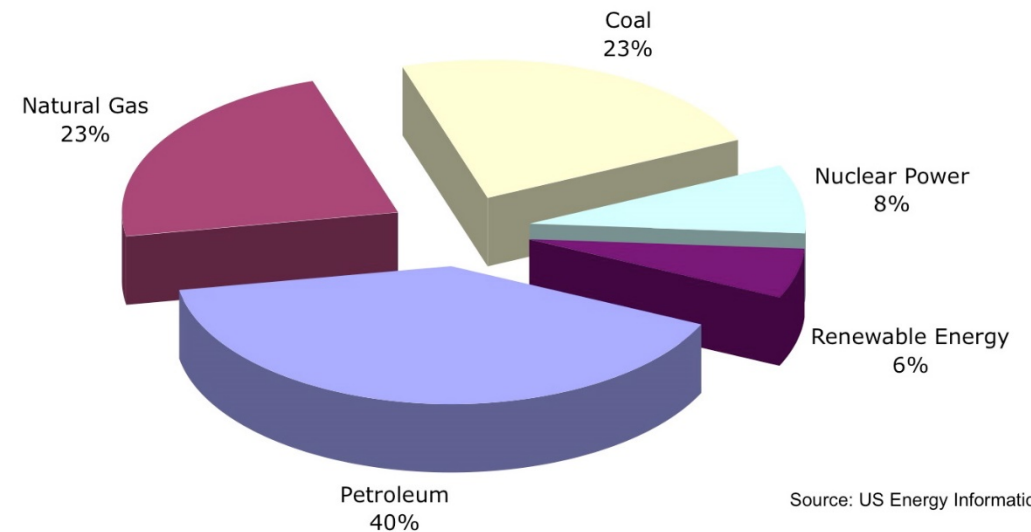
- The ocean drives weather cycles
- Humans have created changes in the atmosphere affecting weather and climate.
- The average temperatures on Earth have been increasing for the past 100 years - Global warming which has led to global climate change
- Intergovernmental Panel on Climate Change (2007) concluded that human activities were responsible for global warming

Fossil Fuels – non renewable energy sources

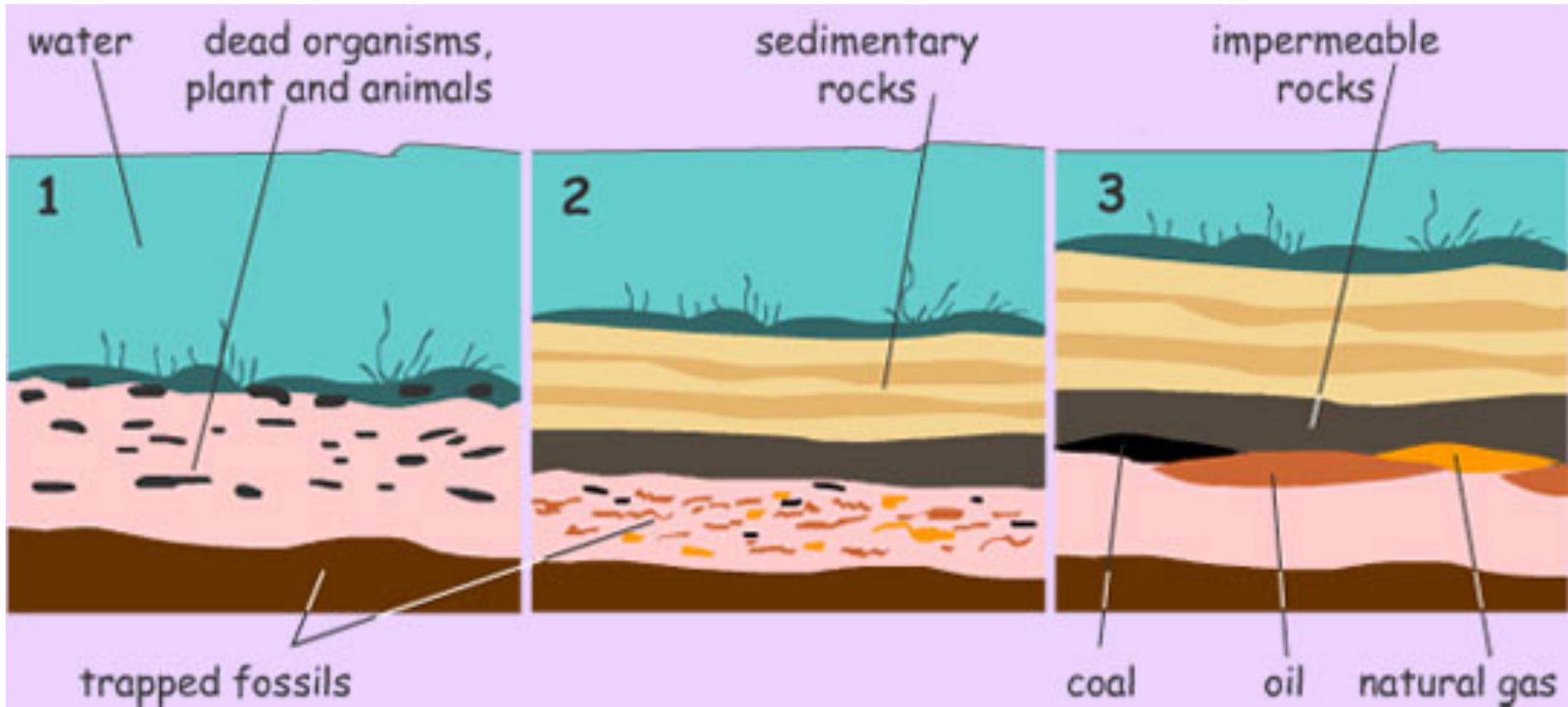
- increases release of green house gases

- Coal - a solid fossil fuel - formed from million years of decay and compaction of land vegetation (most abundant form)
- Oil - a liquid fossil fuel - formed from remains of marine microorganisms that are left on the seafloor (most widely used form)
- Natural Gas - a gas fossil fuel - formed similar to oil (newest form of energy, abundant)

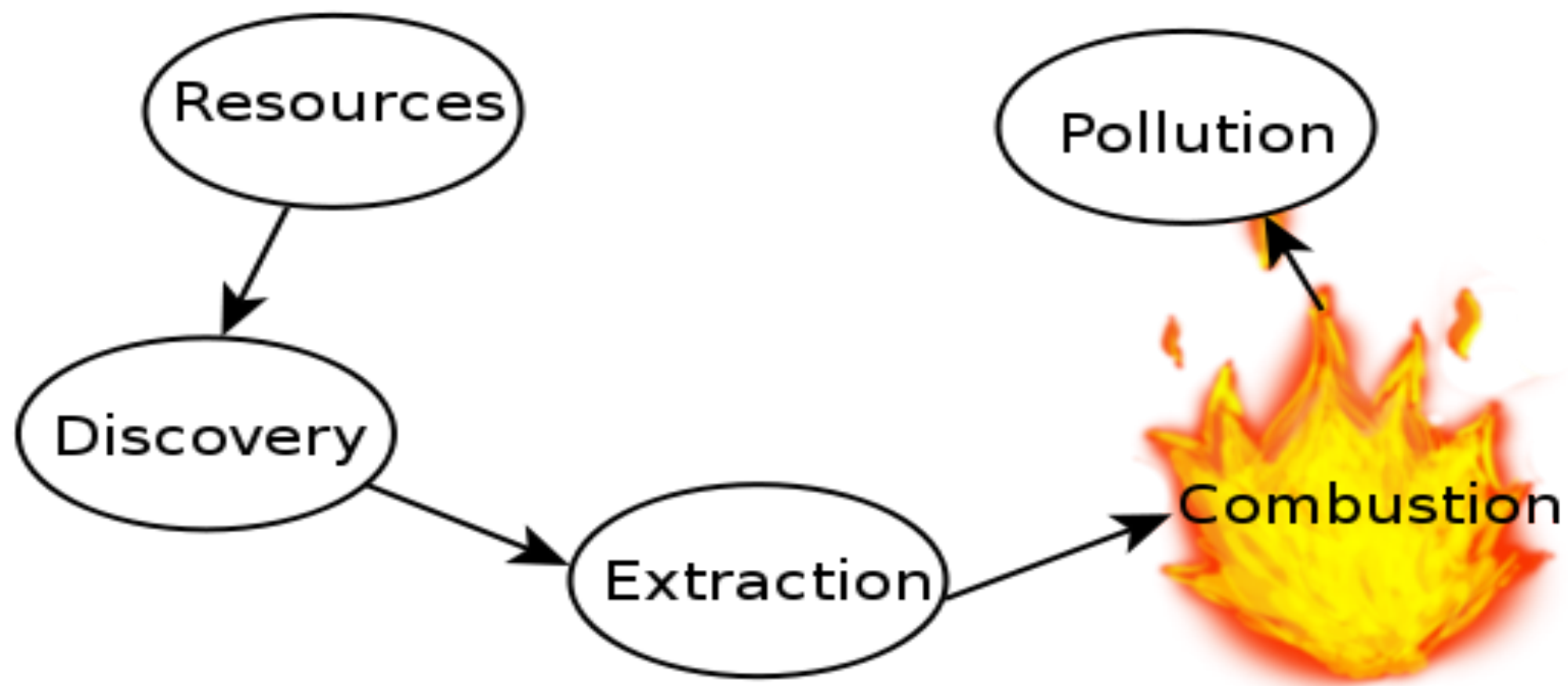
Figure 1: 86% of US Energy Consumption Is Fossil Fuels



Fossil Fuel Formation



Fossil Fuel Life Cycle



Worldwide distribution of Fossil Fuels

Table 17.2 Nations with Largest Proven Reserves of Fossil Fuels

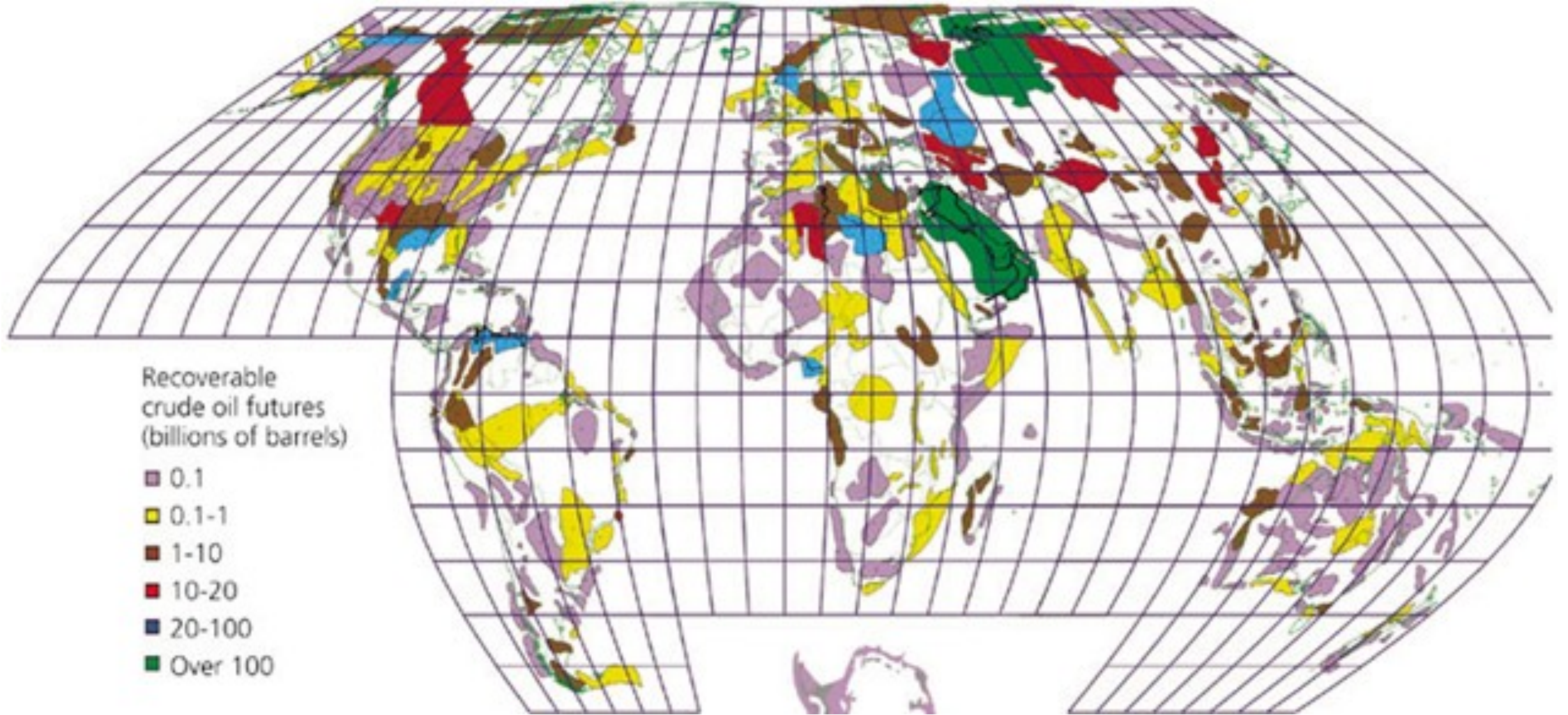
Oil (% world reserves)	Natural Gas (% world reserves)	Coal (% world reserves)
Saudi Arabia, 25.0	Russian Federation, 30.5	United States, 25.4
Iraq, 10.7	Iran, 14.8	Russian Federation, 15.9
United Arab Emirates, 9.3	Qatar, 9.2	China, 11.6
Kuwait, 9.2	Saudi Arabia, 4.1	India, 8.6
Iran, 8.6	United Arab Emirates, 3.9	Australia, 8.3
Venezuela, 7.4	United States, 3.3	Germany, 6.7
Russian Federation, 5.7	Algeria, 2.9	South Africa, 5.0
United States, 2.9	Venezuela, 2.7	Ukraine, 3.5
Libya, 2.8	Nigeria, 2.3	Kazakhstan, 3.5
Nigeria, 2.3	Iraq, 2.0	Poland, 2.3

The US has the most coal

Russia has the most natural gas

Saudia Arabia has the most oil

Fossil Fuel Reserves



Uses of Fossil Fuels

- Coal - is mined from the earth and is used to generate electricity. Heat from burning coal creates steam that turns a turbine to power a generator.
- Oil - crude oil is drilled from the ground and is refined to make petroleum products (plastics, clothing, sunscreen, gasoline, heating oil, etc)
- Natural Gas - extracted from the ground and used as a fuel source
- ALL OF THESE ARE EXTRACTED AND ONCE USED AND CANNOT BE REPLACED FOR LONG, LONG PERIODS OF TIME BY EARTH'S NATURAL PROCESSES.
- BURNING FOSSIL FUELS RELEASES GREENHOUSE GASSES INTO THE ATMOSPHERE

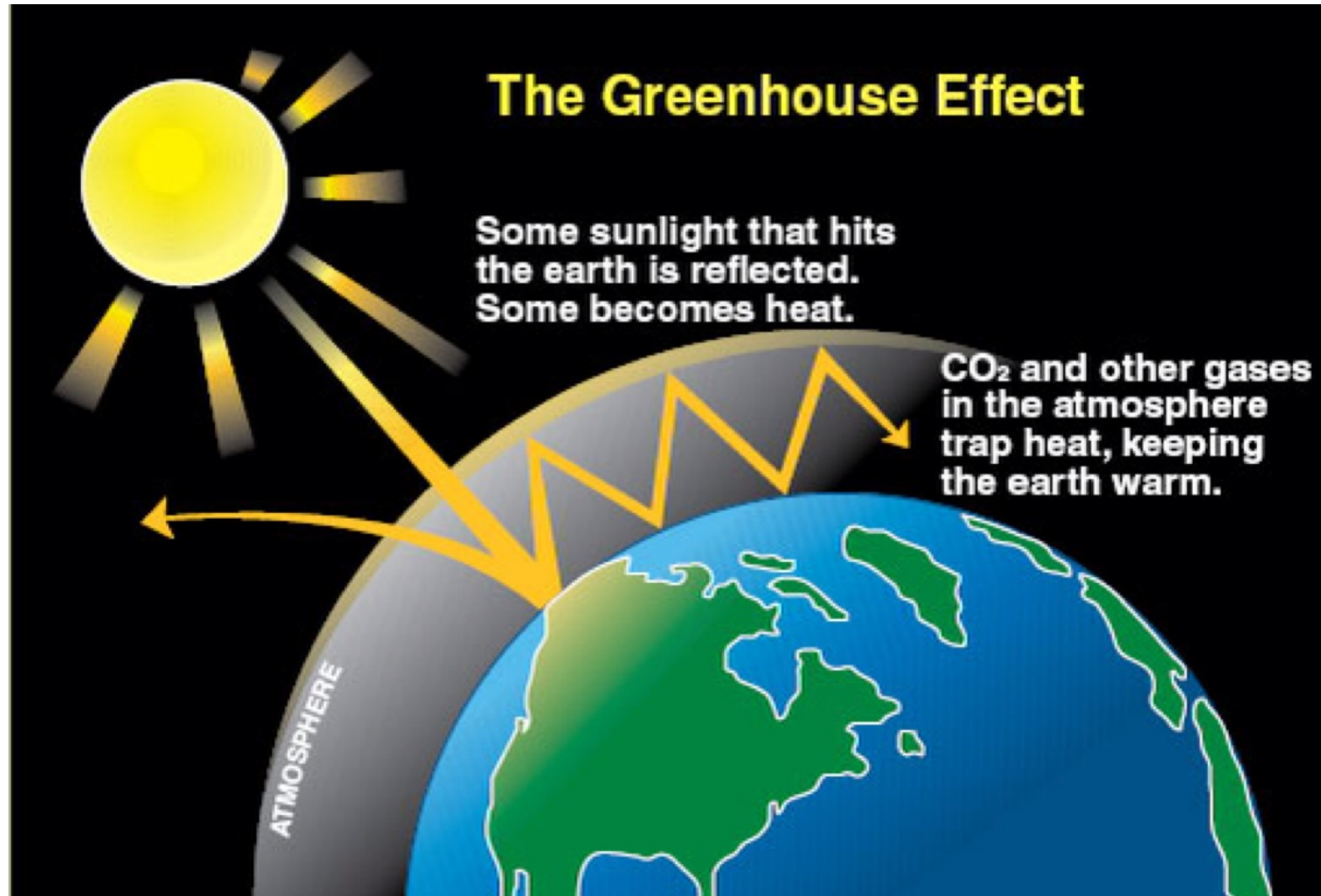
Human Activities and Climate Change

- **Changes in Climate are studied through various evidence collections such as:**
 - **Pollen Record**- Each type of plant has a type of pollen and by studying pollen records scientists can tell what types of plants lived there
 - **Tree Rings** - patterns in tree rings can show if previous years were wet, dry, warm or cool based on size of tree rings
 - **Ice Cores** - Drilled and analyzed for climate record, atmospheric conditions of the past trapped in layers of ice such as gases, pollen and dust.
- **Possible explanations for major climate changes include movement of the continents, variations in positions relative to the sun, major volcanic eruptions, and changes in the sun's energy output.**



Greenhouse Effect

- Earth is insulated from the incredibly cold outer space (-270 degrees Celsius) by our Atmosphere
- The greenhouse effect is how the atmosphere keeps Earth's surface warm.



Greenhouse Gases - absorb Earth's OUTgoing infrared radiation

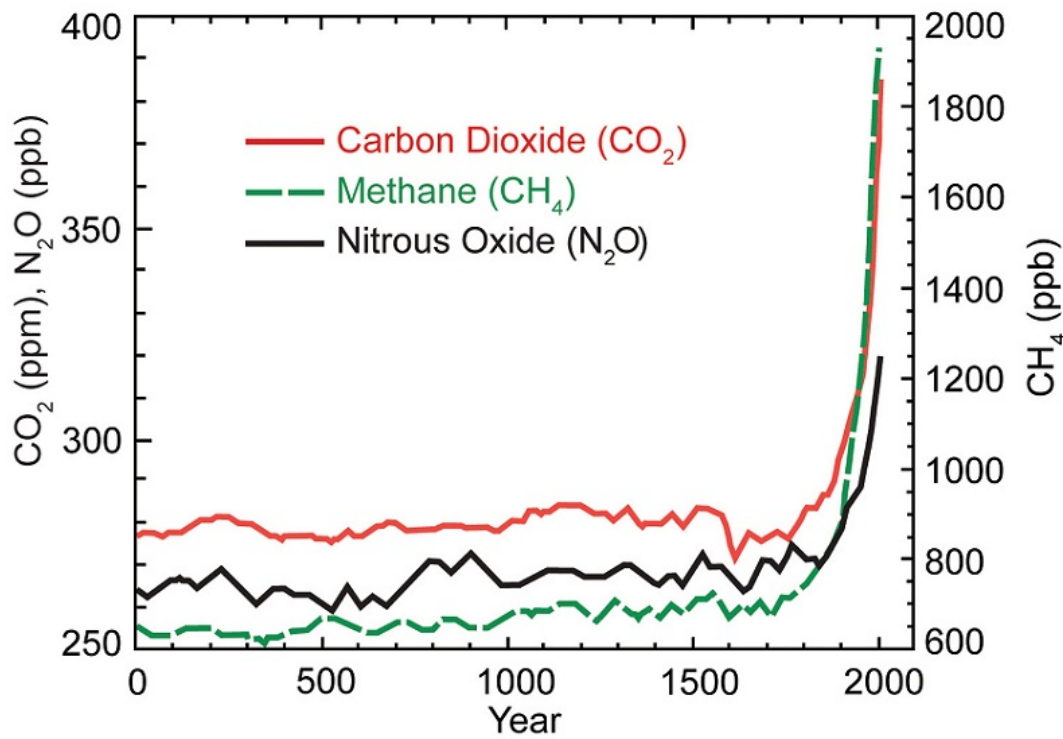
- Water vapor (H_2O)
- Carbon Dioxide (CO_2)
- Methane (CH_4)
- Dinitrogen oxide (N_2O)
- Chlorofluorocarbons (CFC'S)

Sources of greenhouse gases

Gas	Main source	Greenhouse factor	Relative abundance
H_2O	Evaporation of oceans and lakes	0.1	0.10
CO_2	Combustion of fossil fuels	1	0.036
CH_4	Anaerobic decay of organic matter by livestock	30	0.0017
N_2O	Artificial fertilizers	160	0.0003
CFCs	Refrigerants and solvents	20000	0.00001

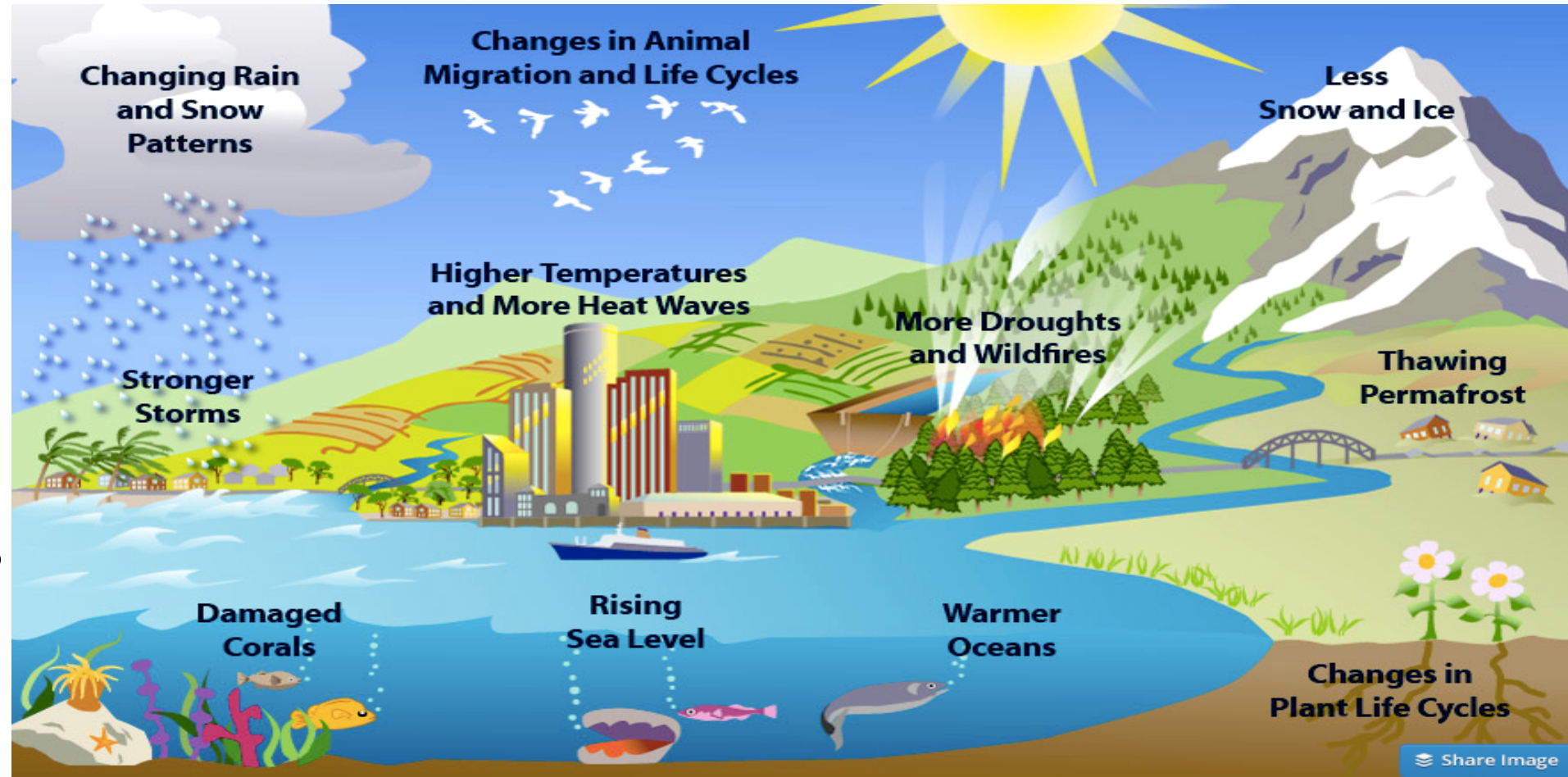
Levels of Greenhouse Gases

- Human activities are increasing the level of greenhouse gases in the atmosphere and producing changes in climate worldwide.
- This increase is causing global temperatures to rise.



Effects of Global Warming

- Melting glaciers
- Rising sea levels
- Droughts
- Desertification
- Changes to biosphere
- Regional changes temperature



GLOBAL WARMING IS A PART OF A LARGER SET OF CHANGES TO EARTH'S CLIMATE THAT ARE TOGETHER CALLED CLIMATE CHANGE

Additional Human Causes Sources

Deforestation - large scale cutting and/or burning of forests

Trees are the “lungs” of the Earth, taking in CO₂ & releasing Oxygen (Photosynthesis)

Burning them puts CO₂ into the atmosphere and it is a double whammy - no longer living/able to recycle CO₂

Environmental Impacts of Climate Change

- 1) Warmer ocean water = more evaporation = changes the pattern and amount of precipitation/storms - North and South America have increased precipitation while southern Africa, the Mediterranean and southern Asia have decreased precipitation
- 2) Increasing temperatures melt glaciers and polar ice sheets = sea level to rise impact coastal ecosystem
- 3) Extreme weather events can also affect migration patterns

Finding Solutions

- Finding sources of clean, renewable sources of energy
- Being more energy efficient
- Removing carbon dioxide from fossil fuel emissions

